Northland Regional Pest and Marine Pathway Management Plan

Amended Cost Benefit Analysis Report

August 2017

NORTHLAND REGIONAL COUNCIL

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Introduction

Executive Summary

This report is the companion document to the Proposed Northland Regional Pest and Marine Pathway Management Plan 2017 - 2027. It is intended to help readers understand how the plan was developed and the rationale behind the pests, pathways objectives, and rules chosen.

The report has been prepared by the Northland Regional Council (the Council) in conjunction with the preparation of the proposed plan.

The purpose of the proposed plan is to provide the regulatory framework to efficiently and effectively manage specified pests or pathways for the spread of pests in the Northland region. A pest management plan is a plan for the eradication or effective management of specified pest species or groups of pests. A pathways plan is for the prevention or management of the spread of harmful organisms. For Northland, the pathway plan will focus on preventing or managing the spread of harmful marine organisms, including named pest species, within coastal waters via boat hull fouling.

Many organisms in the Northland region are considered undesirable or a nuisance. The Biosecurity Act 1993 has set criteria that must be met to justify regional intervention in managing such organisms as pests. This proposal identifies those organisms classified as pests and the marine pathways to be managed. Once operative, the plan will empower the council to exercise the relevant advisory, service delivery, regulatory and funding provisions available under the Act to deliver the desired outcomes for pest management.

The pests are split into their management programmes, exclusion, eradication, progressive containment or sustained control, and assessed against criteria laid out in the National Policy Direction (NPD) to justify their inclusion in the plan. Readers should read this document in conjunction with the Proposed Northland Regional Pest and Pathway Management Plan 2017 - 2027 to understand what values may be impacted in the absence of any management of the listed pests, and the likely significance of these impacts.

Analysis of benefits and costs

The NPD includes specifications for analysing the benefits and costs for pests and pathways included in the plan. It is not necessary or even possible to quantify every benefit and cost for each of the options analysed in an analysis of benefits and costs, and not all situations require numerical analysis. The level of analysis undertaken, and the effort taken to assess the benefits and costs is based on how the situation relates to criteria in the NPD. A higher level of analysis is done if the pest/proposed measures are: highly significant to stakeholders, programme costs are high, if the benefits are likely to be similar to the costs, and if the impacts of the pest and / or effectiveness of the measures are highly uncertain.

A critical part of analysing the costs and benefits is working out the risks that a programme will not realise its benefits, or will incur additional costs. Programmes where the benefits are likely to be similar to the costs demand a higher level of analysis, as there is a greater risk that the programme will not be worthwhile. Conversely, if it is clear that the benefits will outweigh the costs under almost all scenarios, a comprehensive analysis may be unnecessary.

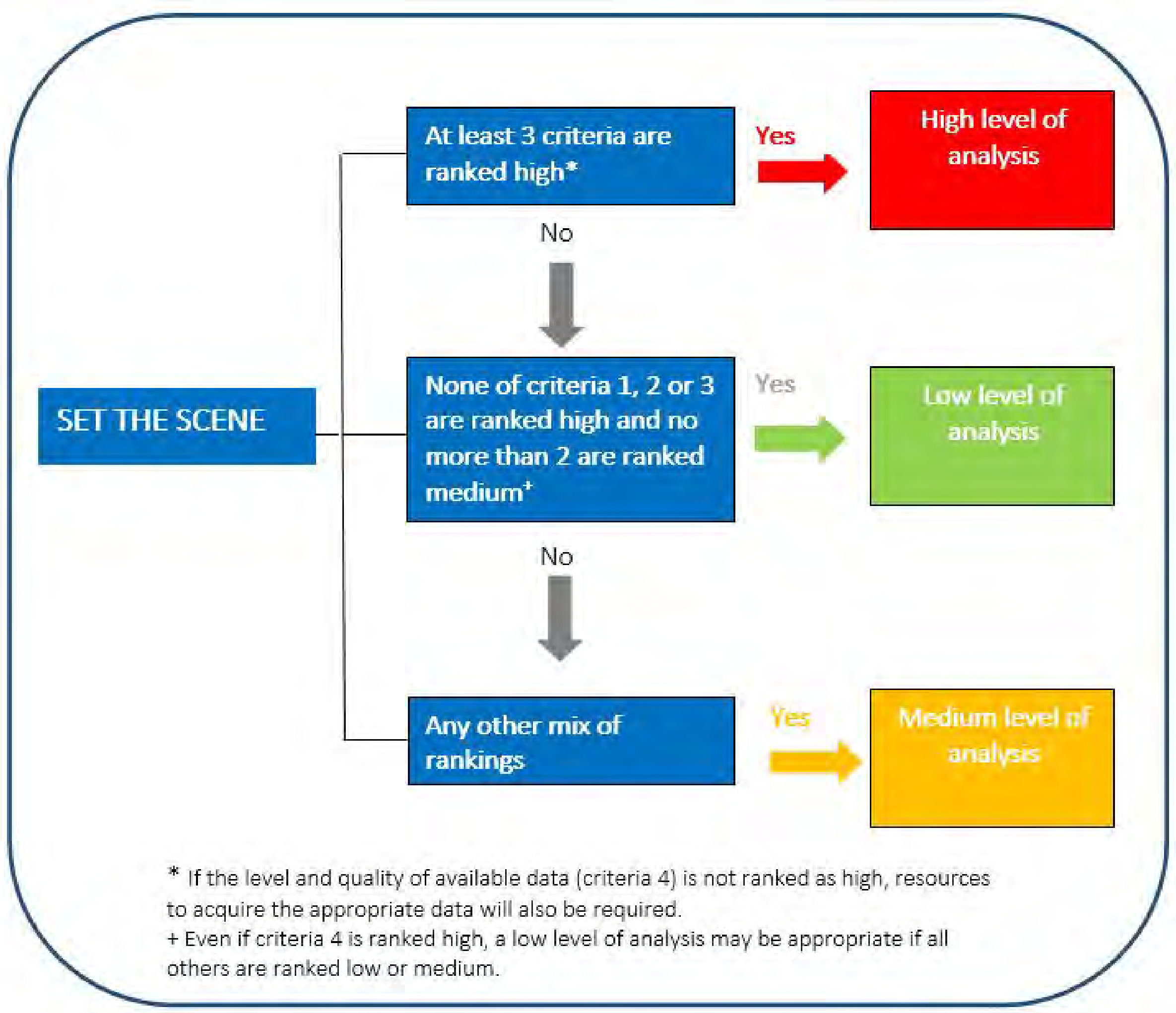
Table 1: Criteria for determining level of analysis

Criteria	Description
Assessment Criteria 1:	The likely significance of the pest or the proposed measures (NPD s6(1)(b))
High	Potential for significant interest, or strong opposing viewpoints in community or high total costs
Medium	Potential for moderate interest, opposing viewpoints in some groups within community, or moderate total costs
Low	Not generally likely to be an issue for community public or organisations, or low total costs
Assessment Criteria 2:	Likely costs relative to likely benefits (NPD s6(1)(c))
High	The costs of implementing the programme are likely to be similar to the benefits of the programme.
Medium	The costs of implementing the programme are likely to be lower than the benefits of the programme in most scenarios.
Low	The costs of implementing the programme are likely to be substantially lower than the benefits of the programme, even if the objectives are not fully achieved.
Assessment Criteria 3:	Uncertainty of the impacts of the pest and effectiveness of measures (NPD s6(1)(a))
High uncertainty	Not much known. Measures are untested.
Medium uncertainty	Known to have impacts elsewhere in similar situations. Similar measures have been effective in other areas, or measures have only been somewhat effective.
Low uncertainty	Known to have significant impacts, spread risk known and the effectiveness of measures is well-known.
Assessment Criteria 4:	Level and quality of data available (NPD s6(1)(d))
High	Very high quality current distribution data; costs and impacts well established

Criteria	Description
Medium	Some historical information or data from other sources (outside of the region or NZ). No specific targeted monitoring data. Costs and impacts capable of being estimated from case studies.
Low	Little information available.

The first three criteria indicate what level of analysis should be done, with assessment Criteria 4 determining what level of analysis is possible – given the constraints of the available data.

Decision making matrix



These criteria were applied to all species included in this document.

Level of analysis	Species
High	Pathway Plan, Phoenix Palm, Kauri dieback disease, Mediterranean fanworm
Medium	Gorse, Gravel Groundsel, Wilding conifers, Wild ginger, Privet, Agapanthus
Low	All others

The procedures used for each level of analysis are specified by the NPD as follows:

Procedure for low level of analysis:

- Describe the costs (including effects on values) of each option and quantify / value as many as practicable;
- Describe the benefits of each option and quantify / value as many as practicable;
- Take into account the risks to being unsuccessful - as required by clause 6(2)(g) of the NPD; and
- Conclude by choosing the most appropriate option.

Procedure for medium level of analysis:

- Describe the costs (including effects on values) of each option and quantify / value as many as practicable;
- Describe the benefits of each option and quantify / value as many as practicable;
- Apply cost/benefit analysis techniques for each option;
- Take into account the risks to being unsuccessful - as required by clause 6(2)(g) of the NPD; and
- Conclude by choosing the most appropriate option.

Procedure for high level of analysis:

- Describe the costs (including effects on values) of each option and quantify / value as many as practicable;
- Describe the benefits of each option and quantify / value as many as practicable;
- Apply comprehensive cost/benefit analysis techniques for each option;
- Apply sensitivity analysis for highly uncertain values to test assumptions;
- Take into account the risks to being unsuccessful - as required by clause 6(2)(g) of the NPD; and
- Conclude by choosing the most appropriate option.

For the purposes of compliance with NPD s6(2)(g) and the associated considerations under NPD s6(3).

Pest Management Assumptions Based on NPD Intermediate Outcomes

Section 6(2)(e) of the NPD requires the consideration and documentation of any assumptions that are made regarding analysis carried out on pest impacts, benefits and costs. The following section serves three purposes:

- Summarises the outcome related categories from the NPD that the named pests in the RPMP are grouped into (a hierarchy of five designations is available);
- Summarises the principal means that NRC will use to deliver the RPMP outcome; and
- Provides examples of assumptions, or the types of assumptions, that are considered in relation to each pest outcome designation or grouping.

Assumptions are based on known and relevant data in relation to the pest, or pests which share some of the same characteristics. Many assumptions established under previous RPMP iterations remain valid in terms of developing the 2017-2027 Plan. The examples given are generic to the groupings as shown. They contribute to a broader understanding of the requirements of the NPD and help to demonstrate that there are many unknowns in pest management and judgement calls are required based on incomplete knowledge and lack of quantifiable data. For some pests, there is long standing, sound information, while for others there is stronger reliance on international data and anecdotally what is being observed in the region.

One or more pest management programmes will be used to control pests and any other organisms covered by the RPMP. The types of programme are defined by the NPD and reflect outcomes in keeping with:

- the extent of the invasion; and
- whether it is possible to achieve the desired control levels for the pests.

The intermediate outcomes for five programmes are described below.

1. Exclusion Programme: to prevent the establishment of the subject, or an organism being spread by the subject, that is present in New Zealand but not yet established in an area.

2. Eradication Programme: to reduce the infestation level of the subject, or an organism being spread by the subject, to zero levels in an area in the short to medium term.
3. Progressive Containment Programme: to contain or reduce the geographic distribution of the subject, or an organism being spread by the subject, to an area over time.
4. Sustained Control Programme: to provide for ongoing control of the subject, or an organism being spread by the subject, to reduce its impacts on values and spread to other properties.
5. Site-led Pest Programme: that the subject, or an organism being spread by the subject, that is capable of causing damage to a place is excluded or eradicated from that place, or is contained, reduced, or controlled within the place to an extent that protects the values of that place.

Vector Management: Pathway Management Plan

The intermediate outcome for the programme is to:

1. Reduce the spread of harmful organisms to and within Northland for the duration of the plan.

Programme assumptions

Exclusion pests

These are organisms that are thought to be absent from the region.

NRC wishes to keep them out due to the potentially significant effects they pose to biodiversity values or their ability to reduce the productive capacity of pastoral farming. The principal means of RPMP delivery by NRC will be region-wide surveillance for these species and instigation of direct control if or when they are discovered.

Assumptions:

- All potentially invade-able land/water has been identified;
- Some significant portions of invade-able land/water could become infested within the life of the Plan (10 years) if the organism became established;
- The effects of these species are so significant that, should they invade, it is inevitable that a future decision would be made to manage them;
- That voluntary control is unlikely to be initiated upon initial invasion, as the initial effects of these species on economic values (production) or on biodiversity values are not immediately felt by the occupier or within the wider region; and
- The cost of eradication (should the species appear in the region) is limited to an initial control event and five years of monitoring.

Eradication pests

These are organisms that are believed to be very low or low on the 'pest infestation curve' and eradicating them (or achieving zero density) from the region is feasible within the lifespan of the RPMP.

The outcome sought from the eradication objective is to accrue future benefits and prevent future costs of more extensive management measures. The principal means of RPMP delivery by NRC will be active surveillance (and monitoring of known sites) and initiate direct control of these pests through a variety of council service delivery measures.

Assumptions:

- Under an eradication programme, these pests will be eradicated within the (10 year) life of the Plan, or zero density will be achieved;
- That intensive control effort is required, for example the first five years, and thereafter costs are reduced as progress on achieving the outcome is made;
- Eradication is assumed to cost at least twice as much, compared with progressive containment/sustained control efforts, to reflect the greater effort required to achieve eradication;

- For those pests which have not changed designations or management approaches under the Proposed Plan, the estimated amount of invade-able land assessed at the time can be assumed to be similar in 2017, as there have been no significant changes to the extent of the landcover types;
- For species with long eradication programmes, the costs in 2017 are similar to or only slightly less than under prior cost benefit analyses;
- For species that are closer to eradication, the costs will have reduced, making the programme increasingly cost beneficial over time; • The annual cost of prior control work, and the dollar benefits accrued, will have generally inflated at similar rates. Where changes in the economy might have driven inflation, this would be weighted toward the benefits of pest management – e.g. with an increased economy around dairying, the dollar benefits of the protection of dairy pastures outstrip the per hectare cost of controlling production pests;
- Voluntary control of serious biodiversity pests is unlikely to be initiated immediately by the occupier as the effects on biodiversity values are not immediately felt by the occupier; and
- Effective voluntary control of serious production pests is likely to suffer from inactivity due to the delay before economic losses are felt sufficiently enough to spark action.

Progressive containment pests

These are organisms that are relatively widespread in the region or parts of the region and eradication is not feasible or realistic. The outcome focus is to contain the spread and reduce the distribution/density of the pest over the RPMP period where practicable. Freshwater pests are included in this category. Depending on the situation or status of the pest, NRC will undertake a mix of direct control (service delivery) or develop rules that involve land occupiers being responsible for controlling the pest (a regulatory regime).

Sustained control pests

These are organisms that are generally well established and widespread throughout the region and eradication and in most cases reducing their spread is not feasible. The outcome focus is to reduce the impacts of the pest (e.g. on biodiversity, production and human health values) over the RPMP period. Marine and freshwater pests and one disease are included in this category. NRC will undertake a similar mix of activities as for progressive containment above, with more emphasis on occupier control rules, advocacy and working with community and interest groups.

Common assumptions for progressive containment and sustained control programmes:

- All potentially invade-able land has been identified;
- The cost of enforcing control is across all invade-able land irrespective of whether they are private or public (Crown) occupiers;
- Many prior CBA figures remain relevant today because the costs for controlling many pests have not significantly risen in the last 5-6 years;
- Except for any new pests and new rules proposed a number of pests have not changed in their management approach under the Proposed Plan and because of this the rate of pest spread and reduction has continued on trajectories previously stated;
- Dollar benefits for biodiversity protection were $zero under previous assessments and remain the same today;
- The cost of herbicide has not significantly increased and generally, the future cost of control estimated for each species is the same rate per hectare in 2017 and the same level of cost is applicable no matter which control agency is involved carrying out work; and
- Salaries and contractor rates may have risen, but the overall rate take for biosecurity services are managed within the levels of inflation.

Within the individual species assessments that follow, assumptions are stated (where known) if they are additional to or vary significantly from the generic examples provided above.

NPD Risk Management and Mitigation Considerations

In the species by species assessments set out in the following sections of this document, an evaluation of the risks that the management options will not achieve Plan objectives has been undertaken, in accordance with NPD section 6(2)(g) and (h) and related sections 6(3) and 6(4). However, for summary purposes, the key areas of risk are identified (along with any realistic mitigation options) within the assessments of alternative approaches considered.

The table below outlines the risks that are required to be considered and provides context on how each risk may impact on RPMP implementation. Some likely mitigation examples are also noted, to contribute to a better understanding of the requirements of this section. Within the individual species assessments, accordingly, specific risks have been identified where possible and they been assigned one of five categories: low, low/medium, medium, medium/high and high.

NPD considerations s6(2)(g), s6(3)	Mitigation examples
Outcome risk - technical and operational risks (e.g. bad weather, hard to control vines, poor control carried out, lack of suitable control method)	• Seek better forecasting services and weather predictability combined with improved scheduling of work • Commission coordinated research on more effective herbicides for pests where few options exist • Upgrade contract management processes that rate higher the use of reliable and competent contractors with matching track records
Regulatory risk - extent to which option implemented or complied with (e.g. who is doing the control work, costs of compliance, community views)	• Being quite clear on the rationale behind service delivery by council versus an RPMP rule approach • Determine the cost of any compliance is less than the benefits being achieved • That the majority of the community supports the chosen approach through sound consultation processes
Legal risk - compliance with other legislation will/may affect implementation	• EPA permission (and resource consent) may be required for spraying certain aquatic pest plants using named herbicides • Declaring feral goats a pest under the Biosecurity Act - they are deemed a 'wild animal' under the Wild Animal Control Act.
Socio-politico risk - public and political concerns could affect the success of the programme	• Ensure regional politicians are fully briefed on all issues and that good internal support is obtained • Sound and effective public awareness campaigns are carried out to deliver key messages on the intent of control
Other - e.g. unintended adverse effects from controlling the target pest	• The removal of one pest plant (e.g. tradescantia) will not lead to the invasion by an equally bad or worse pest from elsewhere • Control of one pest which sees a predator pest switching prey to native/endemic species of wildlife as a consequence.

Quantitative Cost Benefit Analysis (CBA) Models

Three different models were used to conduct quantitative cost benefit analysis.

For phoenix palm, kauri dieback and mediterranean fanworm, council developed it's own model that assumes that the pest/disease would spread logistically in the absence of the intervention and that management would impact on this spread. Per hectare benefit estimates that take into account the ecosystem services of different environments, Northland specific data and NRC staff expertise were used to populate the model. The benefit of the alternative programmes assessed are determined, in dollar terms, as the difference between unmanaged and managed risk.

For the five plant pests that will be subject to Good Neighbour Rules (GNR) - gorse, gravel groundsel, privet, wild ginger, wilding conifors - a GNR model for pest plants developed for regional councils (Harris et al., 2017) was used and populated with Northland specific values. For example, the default values in the model assume 100% displacement of the productive value. These were adjusted according to the qualitative impact assessment about the impact of the specific species on the land type in Northland. The model undertakes both the cost benefit and reasonableness assessments required under sections 6 and 8 respectively of the NPD. In terms of the cost benefit analysis, the model focuses on identifying the boundary distance between two properties that creates a net benefit, i.e. where the costs of introducing a GNR (the sum of the costs of control on the source property, the costs of inspection and the costs the receptor still bears due to seed bank net of any benefit the source property owner receives from controlling the plant pest) is less than the costs that the receptor bears in the absence of a GNR. This boundary distance is presented for a range of different land uses in both the property when the pest is originating (source land use) and where it is causing a nuisance (receptor land use). For the reasonableness assessment, the model compares the costs of control imposed on the source property owner by the GNR with the additional costs of control that the receptor property faces in the absence of the GNR, and reports this as a ratio between the two. The model does not provide an indication of whether this ratio is reasonable but leaves it to council to assess.

Finally, for the assessment of the marine pathways plan a benefit-cost model originally developed by Cawthron Research (Forrest and Sinner, 2016) but adapted for the Northland situation was used. The original model was extended to allow a variety of 'level of fouling' scales to be considered at the same time, and a more detailed methodology for determining the costs and benefit values. For example, the benefits to the Northland marine environment by preventing the spread and establishment of marine pests by managing the movement of fouled vessels have been quantified by using model inputs from numerous sources, namely Marjan van der Belt and Anthony Cole (2014) and Vince Kerr (2010). Other variables in the model (e.g. likelihood of a pest species being introduced and the distribution of vessels across the level of fouling scores) were populated by council staff using data collected as part of the current programme for managing sustained control marine pests in Northland. The model includes not only the public costs of a pathways plan such as surveillance, administration and enforcement but also the private costs to vessel owners in meeting various levels of hull biofouling. The benefit of the alternative programmes assessed are determined, in dollar terms, as the difference between unmanaged and managed risk.

The following table lists the land, freshwater and marine use types incorporated into the various models and the economic values used in the analysis. Economic values for production land (i.e. dairy, sheep and beef, horticulture and forestry) were estimated as the average net cash income per hectare for Northland. The economic values for environmental and other land use types are inherently more difficult to monetise. For the purpose of this analyse ecosystem service values were derived from two sources: for land and freshwater from Patterson and Cole (2013) and marine types from van der Belt and Cole (2014). The quantitative impacts per hectare for each specific pests on each land use, freshwater or marine biome type were calculated based on an assessment as to whether it has no (no reduction in economic value per hectare), low (3% reduction in economic value per hectare), moderate (7% reduction) or high (30% reduction) impact on the type.

Land use, freshwater and marine types used in the quantitative analysis

Land use, freshwater and marine biome type	Area (ha)	Economic value per ha per annum
Dairy	123,167	$2,154
Sheep and beef	482,683	$338
Horticulture	9,322	$9,100
Plantation forest	188,209	$609
Indigenous forest	269,926	$585

Land use, freshwater and marine biome type	Area (ha)	Economic value per ha per annum
Scrub	133,989	$485
Urban	9,790	$100
Sand, gravel, rock	14,577	$100
Herbaceous freshwater vegetation	9,354	$30,855
Freshwater	6,193	$17,159
Reefs	252,545	$4,146
Salt marshes / wetland	749	$15,008
Estuary / lagoon / intertidal / mangroves / seagrass	61,457	$1,943

Sources: LCDBv4, Dairy NZ,

Species no longer included

There are a number of species that were included in the Regional Pest Management Strategies 2010-2015 that have not been included in the Regional Pest Management Plan 2017-2027.

Species not in New Zealand

The Regional Pest Management Strategies 2010-2015 (pest management strategies) included a number of pests that were not yet established in New Zealand or are now thought to have been eradicated from New Zealand. These pests cannot be included in the Regional Pest Management Plan (pest management plan) moving forward.

The Biosecurity Act requires that regional pest management plans are not inconsistent with the National Policy Direction (policy direction) on pest management. The policy direction specifies the types of programmes that can be included within pest management plans. Only these types of programme may be used, and no others. If a species is identified as a pest in a plan, one or more of these programmes must be applied to the pest.

The definition in the policy direction requires that exclusion programmes in the pest management plan aim to prevent the establishment of pests that are present in New Zealand but are not yet established in Northland.

The following pests are no longer included in the proposed Regional Pest Management Plan as they are not currently established in New Zealand, or are thought to have been eradicated, or are nearly eradicated from New Zealand, to the extent that the risk of an incursion in Northland is extremely unlikely.

Species type	Common name	Scientific name
Animal	Crazy ant	*Paratrechina longicornis*
Animal	Ghost ant	*Tapinoma melanocephalum*
Animal	Tropical fire ant	*Solenopsis geminata*
Freshwater	Fringed water lily	*Nymphoides peltata*
Freshwater	Hydrilla	*Hydrilla verticillata*
Freshwater	Marron	*Cherax tenuimanus*
Marine	Asian clam	*Potamocorbula amurensis*
Marine	Caulerpa seaweed	*Caulerpa taxifolia*
Marine	Chinese mitten crab	*Eriocheir sinensis*
Marine	European shore crab	*Carcinus maenas*
Marine	Northern Pacific seastar	*Asterias amurensis*
Marine	Asian shore crab	*Hemigrapsus sanguineus*
Marine	Wireweed	*Sargassum muticum*
Marine	Asian green mussel	*Perna viridis*
Marine	Asian rapa whelk	*Rapana venosa*
Marine	Brown mussel	*Perna perna*

Species type	Common name	Scientific name
Marine	Black-striped mussel	*Mytilopsis sallei*
Marine	European clam	*Varicorbula gibba*
Marine	Golden mussel	*Limnoperna fortune*
Plant	Johnson grass	*Sorghum halepense*
Plant	Pyp grass	*Ehrharta villosa*
Plant	Skeleton weed	*Chondrilla juncea*
Plant	White bryony	*Bryonia cretica subsp. dioica*

Species in the National Pest Plant Accord

The Regional Pest Management Strategies 2010-2015 included a number of pests that are also listed in the National Pest Plant Accord (pest plant accord). The pest plant accord is an agreement between the Nursery and Garden Industry Association, regional councils and government departments with biosecurity responsibilities. The goal of the pest plant accord is to stop the spread of pest plants through casual and nursery trade where distribution through either of those trades is the plant's primary distribution pathway (it is not intended as a wider means of pest management).

The Ministry for Primary Industries (MPI) is responsible for co-ordinating, developing and managing the accord. The pest plant accord includes approximately 150 plants. All of these plants are unwanted organisms and are banned from sale, propagation and distribution throughout New Zealand. Regional councils undertake regular surveillance to prevent their sale, propagation or distribution. The full list of species on the pest plant accord is available on MPI's website (www.mpi.govt.nz).

The following species were included in the pest management strategies 2010-2015 and are also in the pest plant accord. The council plans to remove these species from the pest management plan to avoid duplicating part of the pest plant accord. The council still regards these plants as pests, and they can still be part of a Biosecurity Partnerships programme.

The **statutory obligations** of any person under s52 and s53 of the Act continue to apply. Those sections ban anyone from selling, propagating or distributing any unwanted organism. Not complying with s52 and s53 is an offence under the Act, and may result in the penalties noted in s157(1).

National Pest Plant Accord species that are not included in the proposed Regional Pest Management Plan:

Common name	Scientific name
African club moss	*Selaginella kraussiana*
Aristea	*Aristea ecklonii*
Banana passionfruit	*Passiflora tripartita* (all subspecies) and *P. tarminiana*
Blue morning glory	*Ipomoea indica*
Blue passion flower	*Passiflora caerulea*
Boneseed	*Chrysanthemoides monilifera*
Cat's claw creeper	*Macfadyena unguis-cati*

Common name	Scientific name
Climbing asparagus	*Asparagus scandens*
Crack willow	*Salix fragilis*
Green arum lily	*Zantedeschia aethiopica 'Green Goddess'*
Green cestrum	*Cestrum parqui*
Grey willow	*Salix cinerea*
Japanese honeysuckle	*Lonicera japonica*
Japanese spindle tree	*Euonymus japonicus*
Madeira vine	*Anredera cordifolia*
Mexican daisy	*Erigeron karvinskianus*
Monkey apple	*Syzygium smithii*
Plectranthus	*Plectranthus ciliatus*
Queensland poplar	*Homalanthus populifolius*
Smilax	*Asparagus asparagoides*
Sweet pea shrub (not incl. cv. "Grandiflora")	*Polygala myrtifolia*
Tradescantia	*Tradescantia fluminensis*
Tuber ladder fern	*Nephrolepis cordifolia*

Community pest control area species and species with no proposed rules

The Regional Pest Management Strategies 2010-2015 included a number of species that either had no rules or only a rule related to inclusion in community pest control areas. The council still considers these species as pests, but as no rules are proposed for them, there is no need to include them the in the new Regional Pest Management Plan. The council will continue to provide advice to the public about these species.

The council still aims to assist communities and stakeholders to control pests where they impact upon local values, but intends to do so through a council supported management programme, which will run outside the regional pest management plan. As this programme aims to provide greater flexibility and is outside the statutory requirements of the pest management plan, there is no requirement to list the species that will be considered for inclusion in a community plan, and the plans can include any invasive species having local impacts. Therefore the council plans to remove these species from the pest management plan, if there are no other rules or objectives identified for the species.

Species with no rules that are not included in the proposed regional pest management plan:

Common name	Scientific name
Common wasp	*Vespula vulgaris*
German wasp	*Vespula germanica*

Common name	Scientific name
Guava moth	*Coscinoptycha improbana*
Hedgehog	*Erinaceus europaeus occidentalis*
Magpie	*Gymnorhina tibicen*
Mouse	*Mus musculus*
Myna	*Acridotheres tristis*
Tropical grass webworm	*Herpetogramma licarsisalis*

Plant pests

A - F plant pests

African feather grass

Cenchrus macrourus

Also known as: African feather grass, veld grass, *Pennisetum macrourum*

(Family: Poaceae)

Status in New Zealand

African feather grass is listed as an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	African feather grass is a perennial grass that forms large clumps up to two metres tall. From November to April, it produces long (up to 30cm), thin flower heads. It has a distinctive yellow to purple flower, with prominent bristles protruding from the body of the spike. When ripe, the spikelets containing the seed fall away, leaving the bare stem. The shape of the flower head readily distinguishes it from the fluffy flower heads of pampas grass and toe toe.
Habitat	African feather grass requires full sunlight and likes low-lying areas over drier sites, but it can tolerate drought and establish on dry shady banks. It has been found in pasture, roadsides, urban areas, wasteland, swamps, stream banks, cemeteries and amenity areas. In New Zealand, it has shown no preference for soil types but in Australia it favours light sandy soils. It can tolerate partly saline soil conditions.
Regional distribution	African feather grass is known from the Poutō Peninsula at Mahuta, Redhill, Te Kopuru and Poutō Point. It is found in pasture, on residential sections and roadsides and in a coastal reserve. The main infestation is at Mahuta where it occurs on sandstone cliffs and the adjacent farms, and it is probably also in the Department of Conservation Reserve next to the beach.
Competitive ability	African feather grass can completely suppress all other low growing plants. Its dense clumps restrict the movement of animals, people and machinery and it impairs drainage and visibility along roads. Mature plants are drought resistant. It tolerates, or benefits from, cultivation and browsing pressure. Dense infestations provide cover for rabbits and create a fire hazard. African feather grass is very persistent and is difficult to eradicate. It recovers quickly from damage and from fire.
Reproductive ability	African feather grass has a vigorous creeping root system that allows the plant to spread. New colonies will arise from moved or broken rhizomes. It also produces large numbers of seeds and up to 88% of the seeds are viable. However, a Tasmanian study found that most seed does not remain viable in the soil for longer than six months, and it cannot emerge from a depth greater than 8cm. Rhizomes begin developing after seven months and this is the main method of spread. Vectors of spread: the seeds of African feather grass are dispersed locally by wind. The barbed bristles on the seed husk enable the seeds to become entangled in animal hair and clothing and the seed is also dispersed by water. Rhizomes are spread by machinery and cultivation and there is also potential for spread by dumping of plant material or soil.

Resistance to control	African feather grass has an extensive root system making it a difficult species to remove. However, good control can be achieved with herbicide and manual control.
Benefits	African feather grass was introduced as an ornamental plant.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	Low	High
Sheep and beef	Low	High
Forestry	-	Low
Horticulture	-	Low
Native	Low	Low
Urban	Low	High
Coastal	Low	Low
Estuarine and marine	-	-
Freshwater/wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	L	H	In Northland, African feather grass is present in pasture on the Poutō Peninsula. It has the potential to spread further and/or increase in density.	Northland Regional Council
Sheep and beef	L	H	In Northland, African feather grass is present in pasture on the Poutō Peninsula. It has the potential to spread further and/or increase in density.	Northland Regional Council
Forestry	-	L	African feather grass will only rarely occur within a shady or forest environment.	Invasive Species Specialist Group.
Horticulture	-	L	African feather grass can benefit from cultivation.	Invasive Species Specialist Group.
Other	-	-		
International trade	-	-		

Category	Current	Potential	Comment	Source
Environment				
Soil resources	-	-		
Water quality	-	L	African feather grass can block drains and waterways.	Invasive Species Specialist Group.
Species diversity	-	M	African feather grass can displace low-growing plants and has the potential to invade open areas, coastal cliffs and headlands and forest margins. It is already present on land managed by the Department of Conservation in Northland. Large areas of Northland are vulnerable to infestation.	Hartley, 1973; Williams & Champion, 2008.
Threatened species	-	M	African feather grass can displace low-growing plants. It is already present on land managed by the Department of Conservation in Northland.	Hartley, 1973.
Social/cultural				
Human health	L	L	There are many fine hairs on the stems which cause skin irritations.	New Zealand Plant Conservation Network.
Recreation	-	L	African feather grass may reduce the aesthetic values of natural areas.	
Māori culture	-	L	Impacts upon native/taonga species.	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be limited short-term financial costs incurred by land occupiers in relation to this species. Due to the ongoing control programme it is currently present in low densities.	African feather grass is a serious weed that has the potential to spread within Northland. If no action is taken it will continue to spread, with consequent adverse effects on the environment and economic costs associated with control and lost pasture production.	High. African feather grass is invasive and difficult to control. It spreads via seed and root fragments and may be spread intentionally, for ornamental purposes. Therefore, if no action is taken African feather grass will spread to more sites, its numbers will increase and its

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
			impacts will become more severe.
Exclusion programme	Not applicable.	Not applicable.	African feather grass is already present in Northland.
Eradication programme	African feather grass currently has a limited distribution in Kaipara District but there are large areas of potential habitat for this species in Northland. If it could be eradicated before it spreads elsewhere, it would prevent long-term impacts and financial costs.	Eradication of African feather grass would require an investment of resources to control the known infestations, undertake surveillance to ensure control has been successful, and carry out surveys to identify any additional infestations. If the species is not eradicated there will be on-going control costs.	Moderate. African feather grass currently has only a limited distribution in Northland. It can be difficult to control, but with sustained effort it is achievable. While it is present in low densities at most known sites there are several larger sites, where control is difficult.
Progressive containment programme	A progressive containment programme would incur lower financial cost to the regional council. It would aim to confine or reduce the distribution of African feather grass and reduce its adverse effects on the environment. A progressive containment programme has been underway for a number of years, and African feather grass densities are continuing to decline, as is the area infested.	A progressive containment programme would require an investment of time and resources from the council and affected landowners. It would not aim to eradicate the species in the short term, but would aim to continue to decrease the size and density of the infestation. Control costs would be lower than for an eradication programme but would be ongoing for longer. If the progressive containment programme is not successful the opportunity to eradicate the species may be lost.	Low - Moderate. African feather grass is included as a containment species in the pest management strategies. Most of the programme objectives have been met. African feather grass can be difficult to control, but with sustained effort it is achievable.
Sustained control programme	A sustained control programme would incur lower short-term financial cost to the council, but may place more responsibility for control directly with land owners or occupiers. A sustained control programme would aim to restrict the spread and impacts of African feather grass and prevent it from having increasingly severe impacts on the environment.	A sustained control programme would require an investment of time and resources by the council and affected landowners or occupiers. A sustained control programme would not aim to eradicate or contain the species, so control costs would be on-going and the opportunity to eradicate or contain the species may be lost.	High. African feather grass currently has a restricted distribution in Northland but there is available habitat for this species throughout the region. The aims of a sustained control programme may not be ambitious enough to prevent this species from having increasingly severe economic and environmental impacts, either within or beyond the existing infestation area.
Site-led pest programme	A site-led programme, where control of African	A site-led programme would require an investment of time	Moderate - High. The risks of a site-led programme failing

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	feather grass is required in defined parts of Northland where there are high environmental values, would reduce the impact of this species in high priority areas.	and resources by the council and affected landowners. It would not reduce or restrict the impacts of African feather grass in areas that are not identified as being of high priority. Any sites found outside of the defined site-led programme area would not be subject to rules or a control programme, increasing the risk of ongoing spread.	depend on the goal of the programme, how it is initiated and implemented, and the level of support within the community. This species is hard for the public to identify unless it is already flowering, increasing the likelihood of plants being missed. There is a moderate to high risk that the species could spread outside of the defined site-led programme area.
Summary of alternative assessments and preferred option:	Progressive containment programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for African feather grass. In terms of alternative approaches assessed, under no regional intervention (or do nothing), there would be unacceptable loss of both biodiversity and production values and there would be significant public and political concerns and consequences. Eradication of African feather grass is not considered technically feasible, although much of the region is free of the pest and some sites may achieve zero density over time. There would be political risks associated with seeking region-wide eradication and then being unable to achieve that goal. A sustained control or site led approach would be unpalatable to many communities who have been actively involved in support or direct control programmes, to a higher standard, for many years. The option considered to carry the least risk is progressive containment. Invasive grasses can be cryptic by nature and problematic to control with herbicides, particularly large infestations, therefore there is some residual risk. NRC intends to undertake direct control of this pest plant outside of the containment zone (through its service delivery programme) and build on a previously successful control land occupier control approach, within the west coast containment zone. Any operational risks are relatively minor and are not expected to adversely affect control outcomes.		

Agapanthus

Agapanthus praecox

Including A. praecox subsp. orientalis, A. praecox subsp. minimus, hybrids and cultivars.

Also known as: agalanthus, African lily, lily of the Nile

(Family: Agapanthaceae)

Status in New Zealand

No legal status. *Agapanthus praecox* subsp. *orientalis* is included in the Auckland Council RPMS.

Relevant biology

Form	Agapanthus is one of the most commonly-cultivated plants in New Zealand. It grows as clumps of arching, strap-like leaves that are usually green and have a watery sap. It has thick, long, white rhizomes (roots) and in summer it produces showy balls of purplish-blue or white flowers that grow at the top of tall stalks. The seeds are held within a 3-sided capsule that is about 5cm long. There are two subspecies: *Agapanthus praecox* subsp. *orientalis* is usually around 1m tall. *Agapanthus praecox* subsp. *minimus* is about 60cm tall. There are hybrids between these subspecies and many types (cultivars) exist in New Zealand. "Dwarf" cultivars may be only 50cm tall. Most cultivars have green leaves but some are marked with white or yellow.
Habitat	Agapanthus flourishes in coastal, frost-free (or lightly frosted), temperate climates. It is commonly cultivated in public and private gardens, along roadsides and on traffic islands. It grows wild on roadsides and in urban areas, on cliffs, streamsides, damp sites within dunes, beside ditches and on forest margins.
Regional distribution	Agapanthus is widely cultivated in Northland and there are localised wild populations, especially in coastal areas and roadsides e.g. Tutukaka, Glenbervie, Ruatangata, Pipiwai, Woolley's Bay. There are many sites where agapanthus has been planted at the gates of properties and has spread along the roadside and in the water tables. This creates a cost to District Council's because agapanthus is not killed by glyphosate, which is the usual herbicide used in these areas.
Competitive ability	Agapanthus tolerates a wide range of soil types and growing conditions – from dry exposed environments to damp, lightly-shaded sites. It can form dense and robust monocultures that exclude native plants and modify plant communities. It is a known weed in Britain, the USA and Australia (Williams 2008). In New Zealand agapanthus has become particularly invasive on coastal cliffs and has the potential to become more of a problem on forest edges.
Reproductive ability	Agapanthus has strong, fleshy roots that can spread underground to create large, continuously enlarging clumps. If a fragment of the root is broken off it can re-grow into a new plant. Agapanthus also reproduces from seed. From only a year old, *Agapanthus praecox* subsp. *orientalis* can produce large numbers of seeds (up to 4,000 per flower head) that germinate readily. Until recently, it was widely accepted that short/dwarf forms of agapanthus are of lower fertility than *Agapanthus praecox* subsp. *orientalis*. In 2010, a report published by Landcare Research recommended that the fertility of supposedly sterile or low-fertility cultivars be investigated (Ford and Dawson, 2010). Subsequently, a selection of dwarf cultivars were tested and at least one (A. 'streamline') was found to be very fertile. The following cultivars were found to be of low-fertility or sterile (Dawson 2016): A. 'Agapetite' A. 'Finn' A. 'Gold Drops', A. 'Golden Drop'

	A. 'Goldstrike A. 'Sarah' A. 'Thunderstorm Vectors of spread: The seeds are spread by gravity and water, particularly along drains and waterways. Root fragments can be spread in soil and dumped vegetation. Agapanthus is also spread intentionally by gardeners who cultivate it for ornamental purposes.
Resistance to control	Agapanthus is resistant to some herbicides and there is no biological control available. The roots are extremely difficult to dig out and remove and any that are left behind will regrow, even after being left out in the air.
Benefits	Agapanthus is popular for mass plantings in gardens, along driveways and on roadside banks and traffic islands. It is valued for its vigorous growth, long flowering time and dense, lush foliage.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	-	-
Horticulture	-	-
Native bush or forests	Low	High
Urban	High	High
Coastal	Low	High
Estuarine and marine	-	-
Freshwater/Wetland	Low	Low

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	-		
Horticulture	-	-		

Category	Current	Potential	Comment	Source
Other	+	+	Agapanthus is cultivated and sold by many plant nurseries.	Williams 2008
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	Low	Moderate	Agapanthus can have serious impacts on native ecosystems. It can form dense and robust monocultures that exclude native plants and modify plant communities, particularly in coastal areas. It threatens indigenous ecosystems, particularly cliffs, riparian areas, damp areas within coastal dunes and forest margins.	Dawson and Ford, 2012; Williams 2008
Threatened species	Low	Moderate	Agapanthus can form dense and robust monocultures that exclude native species, potentially including threatened species.	Dawson and Ford, 2012.
Social/cultural				
Human health	Low	Low	Agapanthus is among the National Poisons Centre's top 10 poisonous plants and is regularly involved in childhood poisonings. The sap causes severe ulceration of the mouth and it is also a skin irritant.	Popay et al., 2010; Landcare Research, 2002.
Recreation	Low	Moderate	The flowers of agapanthus make it a particularly conspicuous plant that can reduce the aesthetic values of natural areas.	Williams, 2008
Māori culture	Low	Moderate	Impacts upon native/taonga species.	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council through the RPMP in relation to this species.	Agapanthus is already present in Northland, in cultivation and in the wild. If no action is taken it may spread, with consequent environmental impacts and future control costs.	High. Agapanthus is an invasive species that is already present in Northland. There are large areas of available habitat in Northland where it can establish (Williams 2008).
Exclusion programme	Not applicable	Not applicable	Agapanthus is already present in Northland.
Eradication programme	Agapanthus is cultivated in Northland, also grows in the wild and has the potential to spread to more sites. Eradication would enable long-term economic and environmental impacts to be avoided. As a declared pest, agapanthus would be banned from sale under the Biosecurity Act.	Eradication of agapanthus would require a large investment of resources to remove all plants cultivated in gardens throughout the Region, in addition to controlling wild infestations.	High. There is a high risk of eradication being unsuccessful because agapanthus widely cultivated and is difficult to control. Eradication is not feasible at this time.
Progressive containment programme	A progressive containment programme would incur lower financial cost to the regional council in the short-term. It would aim to confine the impacts of agapanthus to current infestation areas, and gradually reduce the population. As a declared pest, it would be banned from sale under the Biosecurity Act.	Agapanthus is cultivated throughout Northland and large amounts of resources would be required to undertake surveys and control.	High. Agapanthus is not a suitable candidate for a progressive containment programme because it is widely cultivated in Northland.
Sustained control programme	A sustained control programme would incur lower financial cost to the regional council in the short-term, and would aim to restrict the spread and impacts of agapanthus. Sites where it is growing in the wild could be targeted for control (as opposed to sites of cultivation). Educational material could be developed to encourage people to replace cultivated agapanthus with alternative species that are not invasive. As a declared pest, agapanthus would be	Resources will be required to develop educational material, undertake surveillance and control any infestations that are found. A sustained control programme would not aim to remove agapanthus from all the sites where it is present. Therefore, if/when it does become more widely established, eradication and containment may no longer be options and there will be long-term financial and environmental costs associated with the species.	Moderate. Agapanthus is an invasive, poisonous plant that is widely distributed in Northland, is capable of producing large numbers of seeds and can also spread from root fragments. For these reasons, a sustained control programme has a moderate chance of preventing this species from spreading to new sites. A component of the programme could include information and encouragement for landowners to remove

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	banned from sale under the Biosecurity Act.		agapanthus and replace it with appropriate, non-invasive species. Including agapanthus in the RPMP would enable it to be banned from sale in Northland. This would prevent it from being planted at new sites and slow its spread throughout Northland. It would also enable wild infestations to be controlled. A ban on the sale of agapanthus could exclude varieties which have been shown to be sterile or of low fertility (Dawson 2016). However, low fertility plants can still spread from root fragments (e.g. In dumped garden waste and soil). Low fertility plants should not be sold as seed. Vegetative propagation, usually through root division, is the best method to maintain the uniformity of cultivars and offering named cultivars as seed is poor practice (Dawson and Ford, 2012).
Site-led pest programme	A site-led programme, where control of agapanthus is required in defined parts of Northland could reduce the impacts of this species within the programme area(s).	A site-led programme would require an investment of time and resources by the council and affected landowners. It would not reduce or restrict the impacts of agapanthus in areas that are not identified as being of high priority.	Moderate-High. A site-led programme could effectively reduce or eliminate specific infestations of agapanthus in sites with high ecological values but the species is widely cultivated and the programme would not provide for the control of outlying infestations.
Summary of alternative assessments and preferred option:	Sustained control programme - Banned from sale & distribution With regard to section 6(1) of the NPD a low-level analysis was considered appropriate for agapanthus. In terms of alternative approaches assessed, under a do-nothing approach there would be no ability for Council to prevent the formal (nursery trade) or informal (fairs and on-line marketing) trade or circulation of this pest. Agapanthus is already naturalised in Northland and its distribution and assessment of effects mean that eradication and progressive containment programmes are not realistic or affordable. Site-led management would control some plants at some sites, but ultimately this approach would also be unsustainable.		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	Sustained control is the preferred outcome and most viable option. Declaring agapanthus praecox formally as a pest in the Plan automatically triggers sections 52 and 53 of the Biosecurity Act, banning the pest from sale, propagation and distribution in Northland. This plant is not covered in the current National Pest Plant Accord (NPPA) which has over 150 plants listed, banning them from sale, propagation and distribution nationally. However, the NPPA is nationally focused and doesn't necessarily account for regional differences. The risks of this plant have been evaluated specifically in terms of its effects in Northland. It is important to recognise the wide climate and temperature ranges in New Zealand and that some pests require regional based initiatives based on these factors. Accordingly, agapanthus praecox is one of 32 pest plants banned from sale, propagation and distribution in the Northland region. This designation recognises that generally they are a lower risk to the regions' values compared with other more invasive species. Council wishes to take a more proactive stance over their management, as opposed to disregarding them under a do-nothing scenario, while acknowledging it must operate within a finite budget and limited resources. Nurseries in general support the concept of the NPPA and the outcomes being sought.		

Quantitative analysis

The medium level analysis for agapanthus was undertaken using a benefit-cost model. The model was developed using a logistic model for spread, per hectare benefit estimates that take into account the ecosystem services of different environments, Northland specific data and NRC staff expertise. The benefit of the alternative programmes assessed are determined, in dollar terms, as the difference between unmanaged and managed risk.

Impact evaluation

The following table outlines the specific programme assumptions that have been used in the benefit-cost analysis for agapanthus. The council costs are based on the total annual cost of nursery inspection ($5,000). While agapanthus will be one of 33 specifically banned plants in the plan that will be subject to inspection, the analysis allocates 10% of the total inspection cost to agapanthus. The occupier compliance cost is based on a survey of Northland nurseries which indicated the revenue from agapanthus sales in Northland of approximately $2,850. The profit margin on the revenue earned from the sales is assumed to be 50%. The likelihood of programme failure has been rated as low (1-9% chance of failure).

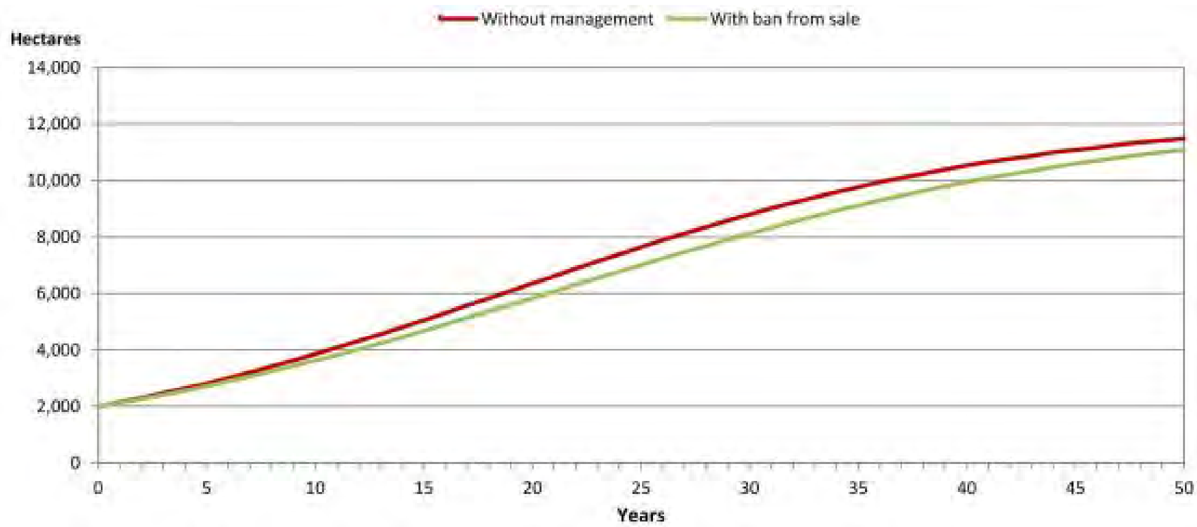
Programme specific assumptions

Variables for analysis	Ban from sale
Council costs ($/pa)	$500
Occupier compliance costs ($/pa)	$1,425
Reduction in spread rate	10%
Likelihood of programme failure	Low
Likelihood of programme failure	5%

A survey of plant nurseries was undertaken in 2016 to gauge both the potential pest species sold and the approximate value of each species in tems of sales per year. Of the 46 nursery outlets that were surveyed (and provided a response), seven nurseries stated that they sold Agapanthus sp. Of these seven nurseries, six nurseries stated that they sold hybrid/sterlie species and not A. pracecox.

Nursery alias	Species	Sold?	Estimated number sold over past 12 months	Approximate retail value per unit	Approximate value to business in ($/year)	Nursery comments
Nursery 2	Agapanthus (Agapanthus praecox v.)	Yes	0	$6.50	$0.00	500 but not A.praecox subsp. Orientalis
Nursery 3			500	$4.50	$2,250	
Nursery 13			0	$6.50	$0.00	50 Ag Streamline, no praecox
Nursery 28			0	-	$0.00	Agapanthus inapertus hybrid (sterile). Var. Labis (dward hybrid) appears sterile to own pollen. Gold strike (variegated sterile hybrid).
Nursery 29			0	-	$0.00	Sell many self sterile hybrids
Nursery 33			0	-	$0.00	Only short form varieties sold.
Nursery 45			100	$6.0	$600	"Streamline" and "Peter pan" varieties. Look for sterile forms of agapanthus, "Baby petel".

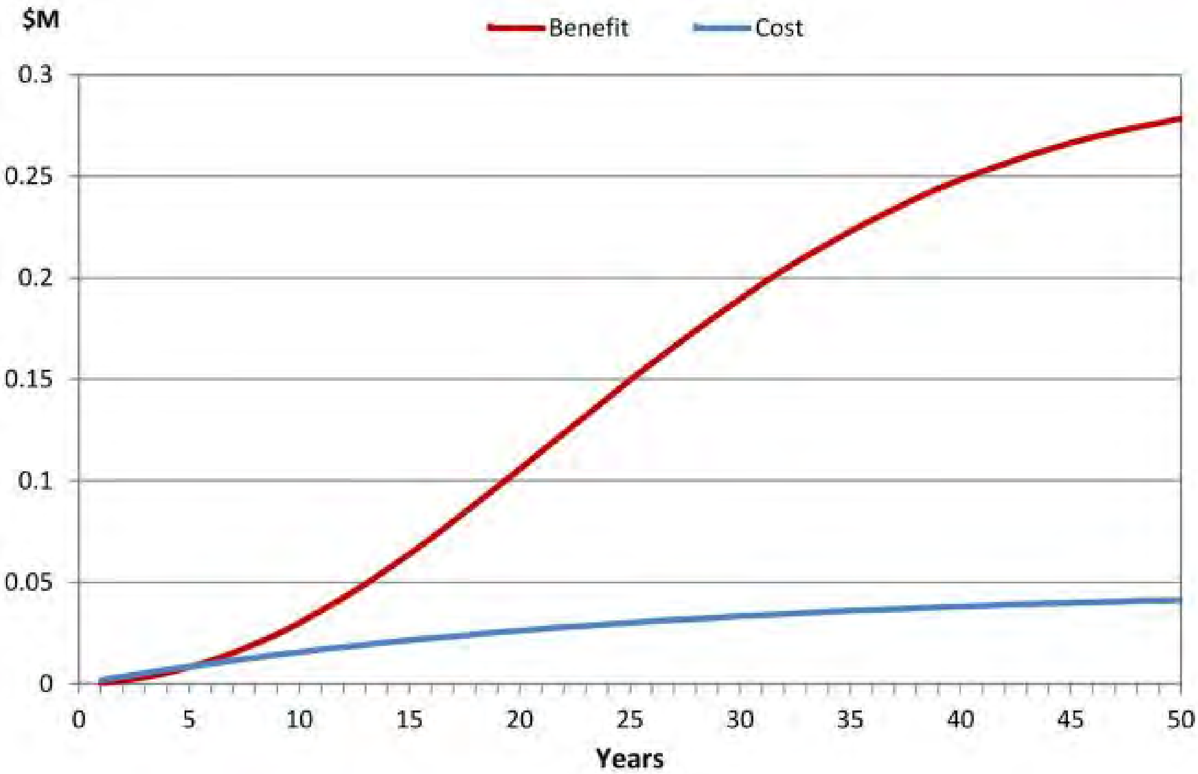
The following graph projects the invasion trajectory of phoenix palm without any regional intervention and with the implementation of banning the species from sale.



The following table summarise the benefits and costs of banning agapanthus from sale over a ten year and fifty year time frame. In both scenarios banning agapanthus from sale returns a net positive result, indicating that the programme is worthwhile. From this analysis it is clear that the benefits of banning A. praecox from sale and distribution will outweigh the costs to nursery owners/distributors.

Cumulative present value of additional benefits and costs of agapanthus ban from sale ($M)		
	Ten years	Fifty years
Benefit ($M)	$0.03	$0.28
Cost ($M)	$0.02	$0.04
Net benefit (B-C) ($M)	$0.01	$0.24

The following figure shows the cumulative value of benefits and costs for the ban on agapanthus sales over time. It shows that benefits will be greater than costs from year six onwards.



Assumptions of the model

Standard assumptions of the model

Invasion Trajectory Without Management	
Initial area infested (ha):	2,000
Maximum area that could become infested (ha):	12,320
Time for infestation to reach 90% of maximum:	45
Spread rate	9%

Benefits	
Value of land ($ per ha):	$1.269
Reduction in value caused by the weed / pest:	3%
Discount rate	4%

Akebia

Akebia quinata

Also known as: chocolate vine, five-leaved akebia.

(Family: Lardizabalaceae)

Status in New Zealand

Akebia is listed as an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Akebia grows as a twining vine or ground cover. It has five oval-shaped leaflets (each 3cm long) that meet at a central stem to create a hand shape. From August to October it has chocolate/purple-coloured flowers, which have an odour that is similar to chocolate or vanilla. The fruits are purple-violet, sausage-shaped pods up to 100mm long.
Habitat	Akebia grows in open to semi-shaded sites along forest edges or road sides, where it climbs over structures or trees. In Northland, it has been recorded growing over trees, fences and hedges on roadsides and in gardens.
Regional distribution	Akebia is currently known from three sites in Northland at Awaroa, Mangonui and Maunu. No seedlings have been found by council staff in Northland.
Competitive ability	Akebia grows rapidly (up to 6-14m in a single growing season) to form dense patches that out-compete and kill ground cover, shrubs and young trees. It is tolerant to shade, drought and frost and can invade a range of habitats. Once established, its dense growth prevents seed germination and seedling establishment of native plants.
Reproductive ability	Akebia mainly spreads vegetatively (for example, from plant fragments or rooting stems). It is not clear if it produces viable seeds in New Zealand (NZ Plant Conservation Network versus Williams, 2008). Its high growth rate also means infestations grow rapidly to spread over a wide area. Localised spread can be rapid but range expansion is relatively slow. Vectors of spread: Akebia is mostly spread by human activity such as dumping of garden waste, movement of soil containing plant fragments, transport of fragments during roadside mowing etc. It could also be introduced to a site intentionally for ornamental purposes.
Resistance to control	Akebia can grow from plant fragments so it is important to dispose of plant material carefully. Cut stumps require repeated control to prevent regrowth.

Benefits	Akebia has ornamental value and the fruit and leaves are edible.

Land uses occupied

Land use type	Current land use infested	Potential land use infested
Dairy	-	-
Sheep and beef	-	-
Forestry	-	High
Horticulture	-	-
Native	-	High
Urban	Low	High
Coastal	-	-
Estuarine and marine	-	-
Freshwater/wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-	Akebia grows in open to semi-shaded sites along forest edges or road sides, where it climbs over structures or trees. It has very little impact in production systems.	Williams, 2008.
Sheep and beef	-	-	Akebia grows in open to semi-shaded sites along forest edges or road sides, where it climbs over structures or trees. It has very little impact in production systems.	Williams, 2008.
Forestry	-	L	Akebia grows along forest edges and climbs over trees so it could invade the edges of production forests or recently planted forest.	NZ Plant Conservation Network.
Horticulture		-	Akebia grows in open to semi-shaded sites along forest edges or road sides, where it climbs over structures or trees. Therefore, it is unlikely to invade horticultural land but could establish in shelter belts, hedges and riparian areas.	NZ Plant Conservation Network.
Other		-		

Category	Current	Potential	Comment	Source
International trade		-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	H	Akebia out-competes and displaces native plant species, thereby decreasing biodiversity. It smothers the plants it grows on, including native species.	Invasive Species Specialist Group; Williams, 2008.
Threatened species	-	M	Akebia is reported to out-compete and displace native plant species, potentially including threatened species.	Invasive Species Specialist Group.
Social/cultural				
Human health	-	-		
Recreation	-	M	Akebia could have an adverse effect on the recreational and aesthetic values of natural areas.	
Māori culture	-	M	Potential impacts on native/taonga species.	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs to the council associated with this species.	Akebia is an invasive species that can grow rapidly to spread over a wide area. It can also grow from fragments to spread to new sites. If no action is taken, the number and extent of infestations is likely to increase with consequent adverse effects on the environment. Future control costs would also increase.	High. Akebia is an invasive species. If no action is taken, the number and extent of infestations is likely to increase with consequent adverse effects on the environment, and increased control costs in future.
Exclusion programme	Not applicable	Not applicable	Exclusion is not an option because akebia is already present in Northland.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Eradication programme	Akebia is a highly invasive species that is currently limited to only three sites in Northland. If these sites could be eradicated, its potential to spread within Northland will be virtually eliminated, avoiding environmental and economic impacts (including long-term control costs if it spreads further).	Eradication will require a short to medium-term investment of control effort.	Low. Akebia is present at only three sites in Northland. Control efforts thus far have been effective and eradication is feasible if all infestations are treated and followed-up.
Progressive containment programme	When compared to an eradication programme, a progressive containment programme would incur lower financial cost to the council in the short-term. A progressive containment programme would aim to prevent akebia establishing new infestation sites.	Akebia is an invasive species with the potential to spread rapidly. The time-frame of a progressive containment programme would potentially provide the species with the opportunity (that is, time) to spread.	High. There is a high risk that a progressive containment programme will not prevent akebia from spreading within Northland.
Sustained control programme	When compared to an eradication programme, a sustained control programme would incur lower financial cost to the council in the short-term. A sustained control programme would aim to restrict the spread and impacts of akebia and prevent it from having increasingly severe impacts on the environment.	Akebia is an invasive species with the potential to spread rapidly. The time-frame of a sustained control programme would potentially provide the species with the opportunity (that is, time) to spread.	High. There is a high risk that a sustained control programme will not prevent akebia from spreading within Northland.
Site-led pest programme	Not applicable	Not applicable	Akebia is present in low numbers at widely separated sites across Northland so is not a suitable candidate for a site-led programme.
Summary of alternative assessments and preferred option:	**Eradication programme** In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for akebia. In terms of alternative approaches assessed, under no regional intervention (or do nothing), there would be unacceptable loss of biodiversity values if akebia was allowed to spread unimpeded from the current three known sites. However, because there is only very limited occurrence of the vine, the biodiversity gains from control efforts on currently affected land are limited. If there was no regional intervention there would also be moderate public or political concerns expressed by environmental groups, with the knowledge that eradication is feasible. A 'no intervention' approach may appeal to some in the community that value the plant as a garden ornamental even though it is banned from sale. Under 'no intervention' there would be no advocacy or awareness programmes and akebia could spread through the naïve dumping of garden waste.		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	Progressive containment or sustained control approaches would not be appropriate as the plant is very limited in distribution and occupies only a small area of suitable habitat in the region. Accordingly, it would be risky relying on 'lesser' management options when eradication/zero density is deemed to be achievable. Another compounding issue in relying on occupier or voluntary control is that, like most vigorous growing exotic vines, successful control may be problematic, requiring multiple visits to the treatment sites. Land occupier control would be costlier to oversee and inspect and is unlikely to be very successful. These operational risks would compromise the lesser outcomes that would be sought under these two scenarios. Eradication is the preferred outcome and is realistic given the current low level distribution of known infestations. NRC will undertake direct control of akebia wherever it occurs in the region (through its service delivery programme). There is some low-level risk around achievement of the eradication outcome through the informal garden trade and exchange although this is thought to be very minor. The control costs involved under an eradication programme are relatively minor compared to the perceived ecological benefits and are not expected to affect control outcomes.		

Apple of Sodom

Solanum linnaeanum

Also known as: devil's apple, Sea apple, Thorny apple.

(Family: Solanaceae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Apple of Sodom is a spiny, woody shrub that grows to 1 m or more tall. It has mauve or violet flowers that are about 3cm across and are followed by green and white berries that resemble tomatoes and become yellow as they ripen. The leaves are up to 9cm long, lobed and covered with a hairy down underneath.
Habitat	Apple of Sodom favours frost-free sites on coastal sand, poor pasture and scrub, and forest margins.
Regional distribution	In Northland, apple of Sodom is scattered throughout the region, particularly in coastal areas. It is the most common prickly species of Solanum in New Zealand.
Competitive ability	Apple of Sodom is regarded as an invasive species in Australia, Hawaii, Fiji, New Caledonia, and other Pacific Islands. It produces large number of seeds. Its spines discourage herbivores from grazing on it, giving it a competitive advantage over more palatable species.
Reproductive ability	In common with other species of *Solanum,* such as tomatoes, apple of Sodom produces berry-like fruits that contain many seeds. Vectors of spread: The fruits and seeds of apple of Sodom may be spread by birds and other animals. Intentional dispersal by humans is unlikely but unintentional dispersal of seeds in soil, hay and waste vegetation or on machinery may occur.

Resistance to control	Apple of Sodom can be controlled with herbicides or by physically removing plants.
Benefits	

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	Low	Low
Sheep and beef	Low	Low
Forestry	Low	Low
Horticulture	-	-
Native bush or forests	Low	Low
Urban	Low	Low
Coastal	Low	Low
Estuarine and marine	-	-
Freshwater/Wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	L-M	Apple of Sodom is unpalatable to livestock so reduces grazing area. It is generally regarded as being poisonous to stock but they do not often eat it.	Greater Wellington Regional Council; Popay et al. 2010
Sheep and beef	-	L-M	Apple of Sodom is unpalatable to livestock so reduces grazing area. It is generally regarded as being poisonous to stock but they do not often eat it.	Greater Wellington Regional Council; Popay et al. 2010
Forestry	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				

Category	Current	Potential	Comment	Source
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	L-M	Apple of Sodom favours frost-free coastal sands, scrub and forest margins. It may suppress native plants in these habitats.	Popay et al. 2010
Threatened species	-	-		
Social/cultural				
Human health	-	L	The large berry has been reported as poisoning children, but the spines on the plant are usually a deterrent.	Landcare Research 2002
Recreation	-	L	The spiny plants may impede access.	
Māori culture	-	L	The spiny plants may impede access to sites.	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	Rather than applying a programme under the pest management plan, the species could come under a 'council supported management' programme, where advice and support are provided for specific species. This will provide support to communities as and where the species is having local impacts.	By not applying a programme and rules to the species, there would be no provisions under the pest management plan to manage inappropriate practises that are exacerbating the spread. Occupiers are likely to undertake control on their land as it can affect stock	Moderate. Without education and regulation there is a moderate risk that apple of Sodom could spread further within Northland.
Exclusion programme	Not applicable.	Not applicable.	Apple of Sodom is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Apple of Sodom is s present throughout the region so would not be suitable for an eradication programme.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Progressive containment programme	Not applicable.	Not applicable.	Apple of Sodom is present throughout the region so would not be suitable for a progressive containment programme.
Sustained control programme	Apple of Sodom could be included in a sustained control programme. As a declared pest it would be banned from sale under the Biosecurity Act, and subject to rules about distribution. This could help reduce the risk of spread over time. However, apple of Sodom is unlikely to be sold so there is no benefit to a ban from sale.	A sustained control programme would require an investment of time and resources by the council and affected landowners. It would not aim to eradicate the species, so control costs would be on-going and, in future, eradication or containment may no longer be options.	Moderate. Apple of Sodom could still spread and become more common.
Site-led pest programme	A site-led programme, where control of apple of Sodom is required in defined parts of Northland, for example some high value dune areas, could reduce the impacts of this species within the programme area(s).	A site-led programme would require an investment of time and resources by the council and affected landowners. It would not reduce or restrict the impacts of apple of Sodom in areas that are not identified as being of high priority.	Moderate. A site-led programme could effectively reduce or eliminate the adverse effects of apple of Sodom in some areas.
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that apple of Sodom does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be <u>no regional intervention</u> for apple of Sodom, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding. While apple of Sodom has not been afforded pest status in Northland, it may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes.		

Arum lily

Zantedeschia aethiopica

Also known as: arum, green goddess.

(Family: Araceae)

Status in New Zealand

Naturalised. The 'Green Goddess' variety is is listed as an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Arum lily forms clumps up to 1.5m tall. It has large, arrowhead shaped leaves up to 45 cm long. During spring it produces white, funnel-shaped flowers that are up to 25cm long and have a bright-yellow, narrow, sausage-shaped centre. The 'Green Goddess' variety has green flowers flushed with white. Arum grows from tuberous roots. Taro (*Colocasia esculenta)* and elephant's ear (*Alocasia brisbanensis*) look similar and can be found in the same sorts of habitat but in arum the veins are the same colour as the leaf.
Habitat	Arum grows best in damp sites with partial shade. It often grows under willows, in damp pasture and in waste areas such as roadsides. Tolerances are wider for the 'Green Goddess' variety which can grow in deep shade as well as full sun light.
Regional distribution	Arum lily is scattered throughout Northland, particularly in association with old homesteads.
Competitive ability	Arum lily tolerates wind, salt, most soil types, moderate - deep shade and wet sites but it is drought-resistant once established. It is long-lived and can persist beneath a forest canopy, forming dense patches that exclude other plant species. Stock avoid it as it is poisonous, allowing it to gradually dominate grazed sites. The 'Green Goddess' cultivar is more invasive than other forms.
Reproductive ability	Arum lily produces seeds and clumps gradually expand by producing new shoots. Seeds drop near to parent plants, and are occasionally spread by birds and water. The tubers (roots) can re-grow after being damaged or moved. Vectors of spread: Seeds can be dispersed by water movement, birds and other animals. Tubers and seeds are spread by vegetation dumping and soil movement, water movement, and deliberate planting.
Resistance to control	Arum lily can an be controlled manually, mechanically or with herbicide depending on the location.
Benefits	Arum lily is used as ornamental garden plant and as cut flowers.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	Low	Low
Sheep and beef	-	-

Land use type	Current land use infested	Potential land use
Forestry	-	-
Horticulture	-	-
Native bush or forests	Low	Low (High*)
Urban	High	High
Coastal	Low	Low
Estuarine and marine	-	-
Freshwater/Wetland	Low	Low

High = Most infested/preferred Low = Less infested/preferred

* 'Green Goddess' cultivar can tolerate deep shade, so is more invasive in bush areas than other forms.

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	L	M	Arum lily is poisonous so is rarely grazed by stock. This can allow it to gradually dominate.	Roy et al.,1998.
Sheep and beef	-	L	Arum lily is poisonous so is rarely grazed by stock. This can allow it to gradually dominate.	Roy et al., 1998.
Forestry	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	L	L	Arum lily can block drains.	Williams, 2008.
Species diversity	L	M	Arum lily grows as dense, long-lived clumps. These can crowd out native plant species and prevent seedling establishment.	Williams, 2008.
Threatened species	L	M	Arum lily can crowd out native plant species.	Williams, 2008.
Social/cultural				

Category	Current	Potential	Comment	Source
Human health	L	L	If eaten, it causes burning of the mouth and alimentary canal, stomach pains and vomiting.	Landcare Research, 2002.
Recreation	-	-		
Māori culture	L	M	Impacts upon native/taonga species.	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council in relation to this species. Rather than applying a programme under the Regional Pest Management Plan, the species could come under a 'Connecting Communities' programme outside the pest management plan, where advice and support are provided for specific sites. This will provide support to communities as and where the species is having impacts.	Arum lily is already present in Northland but is not usually seen dominating large natural areas. The more invasive 'Green Goddess' variety is already banned from sale and distribution. If no action is taken arum lily may spread, with consequent environmental impacts and future control costs.	Low. If no action is taken, existing infestations of arum lily may expand and it may spread to new sites.
Exclusion programme	Not applicable.	Not applicable.	Arum lily is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Arum lily is present throughout the region so would not be suitable for an eradication programme.
Progressive containment programme	Not applicable.	Not applicable.	Arum lily is present throughout the region so would not be suitable for an progressive containment programme.
Sustained control programme	Arum lily could be included in a sustained control programme. As a declared pest it would be banned from	'Green Goddess' variety is already banned from sale but other varieties are not. There would be costs to plant retail	Moderate. Arum lily could still spread and become more common.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	sale under the Biosecurity Act. This could help reduce the risk of spread over time.	outlets from a ban of all varieties. Plant retail outlets are inspected regularly by council staff checking for many different plants and this species could be added to the list.	
Site-led pest programme	A site-led programme, where control of arum lily is required in defined parts of Northland could reduce the impacts of this species within the programme area(s).	A site-led programme would require an investment of time and resources by the council and affected landowners. It would not reduce or restrict the impacts of arum lily in areas that are not identified as being of high priority.	Moderate. A site-led programme could effectively reduce or eliminate the adverse effects of arum lily.
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that arum lily does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be <u>no regional intervention</u> for arum lily, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding. While arum lily has not been afforded pest status in Northland, it may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes.		

Asiatic knotweed

Fallopia japonica

Also known as: Japanese knotweed, *Reynoutria japonica*

(Family: Polygonaceae)

Status in New Zealand

Asiatic knotweed is listed as an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Asiatic knotweed is a thicket-forming herb that can grow to 2m tall. It has zig-zagging stems and red-purple shoots which appear early in spring. As the canes grow, the leaves unfurl and the plant turns green. The mature canes are hollow and have a characteristic pattern of purple speckles. The leaves are long, triangular (15 x 10cm) and pointed at the tip, with a flattened leaf base. In late summer it produces masses of creamy white flowers.
Habitat	Asiatic knotweed grows primarily in open sites such as disturbed areas, urban sites, roadsides and near water, for example, riparian margins. It can tolerate a wide range of soil conditions, high temperatures, high salinity and drought but its growth is depressed by shade.
Regional distribution	Asiatic knotweed is not currently known to be in Northland.
Competitive ability	Asiatic knotweed spreads rapidly and forms dense stands, which compete with and displace native vegetation and prohibit its regeneration. Its dead stems and leaf litter decompose very slowly and form a deep organic layer, which prevents native seeds from germinating. Its tough shoots and roots can break through gravel, tarmac, and even concrete to damage foundations, walls, pavements, drainage works, and flood prevention structures.
Reproductive ability	Asiatic knotweed reproduces from seed and can regrow from detached or broken fragments of roots or stems. Its rapid growth also allows it to spread widely across a site. Vectors of spread: Seed and plant fragments are transported by water, in soil or by humans, either deliberately or inadvertently.
Resistance to control	Asiatic knotweed can re-grow from fragments so plant waste must be disposed of carefully. It's difficult to control so follow-up is required every three months, for at least two years.
Benefits	Asiatic knotweed was introduced to New Zealand for ornamental purposes.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	-	-
Horticulture	-	Low
Native bush or forests	-	Low

Land use type	Current land use infested	Potential land use
Urban	-	High
Coastal	-	Low
Estuarine and marine	-	-
Freshwater/wetland	-	High

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-	Asiatic knotweed is a weed of open sites in riparian margins, road verges, gardens, other disturbed sites and urban areas. Therefore, it is unlikely to establish in pasture but may grow on adjacent roadsides and riparian margins.	Invasive Species Compendium.
Sheep and beef	-	-	Asiatic knotweed is a weed of open sites in riparian margins, road verges, gardens, other disturbed sites and urban areas. Therefore, it is unlikely to establish in pasture but may grow on adjacent roadsides and riparian margins.	Invasive Species Compendium.
Forestry	-	L	Asiatic knotweed is a weed of open sites in riparian margins, road verges, gardens, other disturbed sites and urban areas. Therefore, it is unlikely to establish in production forestry but may grow on adjacent roadsides and riparian margins.	Invasive Species Compendium.
Horticulture	-	L	Asiatic knotweed is a weed of open sites in riparian margins, road verges, gardens, other disturbed sites and urban areas. Therefore, it is unlikely to establish in horticultural land but may grow on adjacent roadsides and riparian margins.	Invasive Species Compendium.
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	M	Asiatic knotweed forms dense stands, which compete with and displace native	Invasive Species

Category	Current	Potential	Comment	Source
			vegetation, and prohibits its regeneration. It dramatically reduces species diversity and alters habitat for wildlife.	Specialist Group.
Threatened species	-	M	Asiatic knotweed forms dense stands, which compete with and displace native vegetation including, potentially, threatened species.	Invasive Species Specialist Group.
Social/cultural				
Human health	-	-		
Recreation	-	M	Asiatic knotweed has the potential to reduce aesthetic or recreational enjoyment of natural areas.	
Māori culture	-	M	Potential impacts on native/taonga species.	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	Asiatic knotweed is not known to be in Northland. If neighbouring regions were relied on to control the species there would be no economic cost to the Northland region.	There would be limited public awareness of Asiatic knotweed and a risk that it would be intentionally or accidentally introduced. If it is not in the pest management plan there would be no rules to prevent possession of the species in Northland.	Medium-high. Without education and regulation there is a medium-high risk that Asiatic knotweed could arrive and establish in Northland.
Exclusion programme	Public awareness and education about the risks and impacts of Asiatic knotweed and a rule banning possession of the species in Northland could prevent it from establishing in the region. If it is included in the pest management plan there is the ability to respond immediately if an infestation is detected in Northland.	Low. There is already educational material available for Asiatic knotweed. Excluding this species would prevent expenditure on its control if/when it invades Northland.	Low. People will be aware of the species and its potential impacts. There will be a rule banning possession of the species in Northland, which could help discourage people from bringing it to Northland and allow immediate control should any be found.
Eradication programme	Not applicable	Not applicable	Asiatic knotweed is not known to be present in Northland.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Progressive containment programme	Not applicable	Not applicable	Asiatic knotweed is not known to be present in Northland.
Sustained control programme	Not applicable	Not applicable	Asiatic knotweed is not known to be present in Northland.
Site-led pest programme	Not applicable	Not applicable	Asiatic knotweed is not known to be present in Northland.
Summary of alternative assessments and preferred option:	Exclusion programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for Asiatic knotweed. In terms of alternative approaches assessed, under no regional intervention (or do nothing) there would be a significant risk of public and political criticism of Northland Regional Council for not being more proactive while knowing Asiatic knotweed was already established in neighbouring regions. Although this plant is principally found in disturbed areas, roadsides and river banks, regional biodiversity and production values would potentially be impacted if Asiatic knotweed was discovered and no intervention measures were available. As Asiatic knotweed is not currently found in Northland an exclusion programme outcome is the only appropriate option available. There is a low overall risk associated with this approach, but a very high risk if it were to establish. Knotweeds in general are very tough (rhizomes are able to penetrate just about any natural or man-made surface structure) and are notoriously difficult to control. An exclusion programme focusing on a comprehensive surveillance programme (looking for Asiatic knotweed and other undesirable pest plants) will help to mitigate these risks by detecting any infestations very early on.		

Balloon vine

Cardiospermum grandiflorum

(Family: Sapindaceae)

Status in New Zealand

Balloon vine is listed as an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Balloon vine is a perennial climbing vine native to Central and South America. It has light green coarsely toothed or lobed leaves that grow up to 16cm long, a ribbed stem and fragrant white flowers with four petals that occur in clusters. The stems, flower stalks and fruits are covered in short bristly yellow hairs, and tendrils fall from the base of the flower stalk. The seed pods (fruits) of the vine are formed by 4-8cm long inflated membranous capsules that are light green and papery and dry to straw-coloured in the autumn. The seed pods are carried by wind or water and each contains three round black seeds with an oblong to heart-shaped spot. Balloon vine is known to be long-lived, and can climb up to 10m high, smothering taller vegetation and shading smaller plants.

Habitat	Prefers moist areas along river edges, forest margins and road edges, and will tolerate a variety of soil types including muddy, sandy or gravely soil. In Australia, it shows very strong preference for riparian environments (77%), but is also found in roadside environments (6%), waste sites (5%), cultivated or suburban land (5%), open forest (3%), and disturbed forests (4%). The species may move from river or creek banks into nearby forest, particularly if there has been some disturbance, and it may enter new areas following natural events that result in exposed or disturbed land.
Regional distribution	There is one known site of balloon vine in Northland, in Onerahi in the Whāngārei district. There may be other sites in Northland, however, these have not been reported or discovered. There are several sites recorded in the Auckland area.
Competitive ability	Balloon vine is a vigorous canopy climber that will climb up into trees or spread at ground level, blanketing other vegetation with the ability to smother it completely. Such vines are sometimes regarded as 'transformer' species due to their ability to significantly alter the ecosystem they inhabit. There are historic recordings of the vine climbing over canopy 16-20m tall in Australia. The vine may change the ecology of an area, and inhibit recolonisation by native species.
Reproductive ability	Seeds are carried in pods by wind or water. Fruits that remain attached to the plant release the seeds, which are carried by wind, and fruits that drop into the water are able to float and be moved long distances. This provides for a wide dispersal distance. Seedlings germinate in disturbed land, but seed viability is relatively short at 18 months. It is also able to reproduce by suckering, or through establishment of root fragments. Case studies of the vine in Australia have shown that warmer climates may support a longer breeding period. Vectors of spread: Movement of seed pods via wind or water, human movement of plants for ornamental purposes or improper disposal.
Resistance to control	Mature plants will re-sprout if cut, and require manual removal and/or treatment with glyphosate. Control is best applied to the least infested areas before a dense infestation occurs. Consistent follow-up work is required. There is potential for biological control.
Benefits	Ornamental.

Land uses occupied

Land use type	Current land use infested	Potential land use infested
Dairy	-	-
Sheep and beef	-	-
Forestry	-	High
Horticulture	-	Low
Native	-	High
Urban	Low	High
Coastal	-	Low
Estuarine and marine	-	-

Land use type	Current land use infested	Potential land use infested
Freshwater	-	Low

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	M	Can blanket other vegetation, smothering it completely.	
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	H	Can blanket other vegetation, smothering it completely. Known as a transformer species due to its ability to significantly alter ecosystems. The vine may change the ecology of an area and inhibit recolonisation by native species.	Carroll et al., 2005.
Threatened species	-	M	Can blanket other vegetation, smothering it completely. Known as a transformer species due to it's ability to significantly alter ecosystems. The vine may change the ecology of an area, and inhibit recolonisation by native species.	Carroll et al., 2005.
Social/cultural				
Human health	-	-		
Recreation	-	L	Nuisance to gardeners. Smothering ability may impede use of recreational areas.	
Māori culture	-	L	Potential impacts on native/taonga species.	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	No operational cost.	Establishment of the vine is likely. The rate at which the vine could become established in Northland is largely unknown. Northland's warm climate could support longer breeding periods for the vine, and it may establish quickly.	Medium risk that the vine will become established in Northland.
Exclusion programme	Not applicable.	Not applicable.	Exclusion is not an option because balloon vine is already present in Northland.
Eradication programme	Would fit the scenario of the known locations of the vine well – one known location, infestation level near zero already. Would contribute to maintenance of the very low levels in Northland.	Rules prohibiting the sale and propagation would be appropriate; rules prohibiting the knowing possession, transport, and reporting would also be appropriate. Costs are involved in responding to reports and managing the eradication, however, the costs at this stage are less than if the pest were to become widely established in Northland.	Low risk that the vine will become established in Northland.
Progressive containment programme	Not applicable.	Not applicable.	There is only one known site in Northland and it is very small.
Sustained control programme	Not applicable.	Not applicable.	There is only one known site in Northland and it is very small.
Site-led pest programme	Not applicable.	Not applicable.	There is only one known site in Northland and it is very small.
Summary of alternative assessments and preferred option:	Eradication programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for balloon vine. In terms of alternative approaches assessed, under <u>no regional intervention</u> (or do nothing), there would be unacceptable loss of biodiversity values if balloon vine was allowed to spread unimpeded from the current known site or be transported accidentally or deliberately to new areas (with no advocacy programme in place). There would also be moderate public or political concerns expressed by environmental groups, with the knowledge that eradication of the vine is feasible. A 'no intervention' approach could appeal to a minority in the community that might view the plant as a garden ornamental. <u>Progressive containment or sustained control</u> approaches would not be appropriate as the plant is very limited in distribution and occupies only one very small site, from all the suitable habitat in the region. Accordingly, it would be risky relying on 'lesser' management options		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	when eradication/zero density is readily achievable. Another compounding issue in relying on occupier or voluntary control is that, like most vigorous growing exotic vines, successful control may be problematic, requiring multiple visits to the treatment sites. Land occupier control would over time be costlier to oversee and inspect and is unlikely to be successful. These operational risks would compromise the outcomes that would be sought under these two lesser scenarios. Eradication is the preferred outcome and is realistic given the current distribution level. NRC will undertake direct control of balloon vine wherever it occurs in the region (through its service delivery programme). The control costs involved under an eradication programme are relatively minor compared to the perceived ecological benefits and are not expected to affect control outcomes.		

Bangalow palm

Archontophoenix cunninghamiana

Also known as: bangalow palm, piccabeen

(Family: Arecaceae)

Status in New Zealand

No legal status

Relevant biology

Form	Bangalow plam grows to approximately 14m tall in Auckland and Whangarei and around 25m tall in its native range. It has a single, straight trunk that is ringed with leaf scars and topped with a leafy crown. The initial seedling leaves are partially divided, closely resembling those of juvenile nikau. Sapling and adult leaves are up to 4.5 m long, bright-green to dark-green on both surfaces and have 70 - 90 pairs of leaflets that are up to 1 m long. Hanging clusters of pink or lilac flowers are present most of the year. The fruits are round, about 1.5cm across and riped from green to a bright orange-red. Each fruit contains a single seed that is 9-12mm in diameter. Fruit are present in Autumn and Winter.
Habitat	Bangalow palm is native to eastern Australia, where it grows in moist sites such as gullies and ravines. It is currently naturalised in New Zealand in the upper North Island. Bangalow palm is shade tolerant but it grows more slowly in heavy shade. It is able to invade intact native forest and light gaps (such as where a tree has fallen). It occupies similar habitats to the native nikau palm and is most often recorded from gullies and stream banks, but also forested wetland. It is frost sensitive when young. Bangalow palm is likely to expand its range across New Zealand under the influence of climate change.
Regional distribution	Bangalow palms have been planted in many parts of Northland and wild plants are becoming more common. Populations of this plant are found near established trees in many urban areas in Northland. In Northland there are more than 20 naturalised populations over more than 1000ha. Areas invaded range from dune and coastal environments, off shore islands, native forest, wetlands, roadsides, and waste areas. As an example, bangalow palm seedlings first appeared in the Kerikeri River Scenic Reserve in 2013, in small numbers, but the crops of seedlings have been getting larger

	year by year. A local weedbusters group removed over 600 seedlings between October 2015 and June 2016. Palms of 2-3m tall have even been found in native forest at Motutau, at least 2km from the closest house or garden.
Competitive ability	Bangalow palm has attributes that can make it a high weed threat to New Zealand forests. It can live for 100 years, is self-fertile and produces large numbers of seeds that are dispersed by birds and water. In suitable conditions the seeds germinate rapidly (1-3 months) and the plants grow quickly. Its ability to tolerate shade means it invades intact native forest, competing with native species for space, light and nutrients. It can grow in stands that are so dense that it excludes all other species, including nikau, which occupies the same habitat. Wild bangalow palms have been recorded in all size classes, including mature fruiting trees e.g. at Meadowbank in Auckland (Cameron 2000). Bangalow palm is cultivated in New Zealand as an ornamental garden plant and by 1992 it was recorded growing in native forest in Whangarei. In Auckland it has been recorded growing in forest at densities up to 1069 seedling per square metre (Sullivan 2006). It has also been found growing wild in hedges and gardens. Bangalow palm is not only a problem in New Zealand: it is highly invasive in South America, where it is known to dominate forests and out-compete native South American palms, and is regarded as an invasive plant in parts of Australia outside its natural range. Williams (2008) notes that "this species is at the early stages of its invasion in NZ . Unlike most 'weeds' it has the potential to establish as a shade species under intact forest and therefore its weed potential should be taken very seriously".
Reproductive ability	Bangalow palms can produce fruit at around 7-10 years old and can live for more than 100 years. Each tree is self-fertile and can produce over 4,000 fruits per year. The seeds germinate in 1-3 months but seed longevity is uncertain (varying reports). Population growth rates in Brazil have been reported at 6-19% per year. Vectors of spread: seed is dispersed by birds and is attractive to a range of native and non-native species, such as black birds and kukupa. It tends to establish beneath trees where birds perch. It can also spread by gravity, when seed falls to the ground from the parent tree, and in flowing water.
Resistance to control	Seedlings are usually controlled by hand pulling, which is laborious. Seedlings look very similar to those of nikau, so there is potential for accidental removal of juvenile nikau.
Benefits	Bangalow palm is grown as an ornamental. The fruits are eaten by some native species (for example, kukupa).

Land uses occupied

Land use type	Current land use infested	Potential land use infested
Dairy	-	-
Sheep and beef	-	-
Forestry	Low	High
Horticulture	-	-

Land use type	Current land use infested	Potential land use infested
Native	Low	High
Urban	High	High
Coastal	-	High
Estuarine and marine	-	-
Freshwater	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	-		
Horticulture	-	-		
Other	+	+	Bangalow palm is cultivated and sold by the plant nursery industry.	Williams 2008
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	L	H	The ability of bangalow palm to tolerate shade means it invades intact native forest, competing with native species for space, light and nutrients. It can grow in dense stands that exclude all other species. It competes with nikau, which occupies very similar habitats but has a slower growth rate, produces fewer seeds that take longer to germinate, and takes longer to mature. Bangalow palm produces large numbers of bird-dispersed seeds that germinate and grow quickly. It has also become invasive in Brazil and in parts of Australia outside of its natural range. In Brazil, it has been recorded comprising almost one third of all the adult individuals in a forest and in Auckland it has been recorded growing in forest at densities up to 1069/m^2. Bangalow palm has already been found growing in native forest in Northland.	Cameron 2000; Mangardo & Pavillo 2014; Sheppard et al. 2016; Sullivan 2006

Category	Current	Potential	Comment	Source
Threatened species	-	L-M	Bangalow palm can invade intact native forest, competing with native species for space, light and nutrients. It can grow in dense stands that exclude all other species potentially including threatened species.	Cameron 2000
Social/cultural				
Human health	-	-		
Recreation	L	L	Bangalow palms have been recorded growing wild in gardens and hedges. Mature trees can produce so many fruits that they blanket the ground like marbles, making it dangerous to walk.	Cameron 2000
Māori culture	L	M	Impacts upon native/taonga species	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Do nothing	If no management action is undertaken there will be no short-term financial costs incurred by the council through the RPMP in relation to this species.	Bangalow palm is already present in Northland, in cultivation and in the wild. If no action is taken it may spread, with consequent environmental impacts and future control costs.	High. Bangalow palm is an invasive species that is already present in Northland. There are large areas of available habitat into which it could spread, particularly gullies in native forest.
Exclusion programme	Not applicable	Not applicable	Bangalow palm is already present in Northland.
Eradication programme	Bangalow palm is cultivated in Northland and also grows in the wild and has the potential to spread to more sites. Eradication would enable long-term economic and environmental impacts to be avoided. As a declared pest, bangalow palm would be banned from sale under the Biosecurity Act.	Eradication of bangalow palm would require a large investment of resources to remove all plants cultivated in gardens throughout the Region, in addition to controlling wild infestations.	High. There is a high risk of eradication being unsuccessful because bangalow palm is widely cultivated. Eradication is not feasible at this time.
Progressive containment programme	A progressive containment programme would incur lower financial cost to the regional council in the short-term. It would aim to confine the impacts of bangalow palm to current infestation areas, and gradually reduce the	Bangalow palm is cultivated throughout Northland and large amounts of resources would be required to undertake surveys and control.	High. Bangalow palm is not a suitable candidate for a progressive containment programme because it is widely cultivated in Northland.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	population. As a declared pest, it would be banned from sale under the Biosecurity Act.		
Sustained control programme	A sustained control programme would incur lower financial cost to the regional council in the short-term, and would aim to restrict the spread and impacts of bangalow palm. Sites where it is growing in the wild could be targeted for control (as opposed to sites of cultivation). Educational material could be developed to encourage people to replace cultivated bangalow palm with alternative species that are not invasive. As a declared pest, bangalow palm would be banned from sale under the Biosecurity Act.	Resources will be required to develop educational material, undertake surveillance and control any infestations that are found. A sustained control programme would not aim to remove bangalow palm from all the sites where it is present. Therefore, if/when it does become more widely established, eradication and containment may no longer be options and there will be long-term financial and environmental costs associated with the species.	Low-Moderate. Bangalow palm can establish and grow to maturity in native vegetation. It produces bird-dispersed seed so any cultivated or wild palm has the potential to be a source of wild plants. If bangalow palm was banned from sale it would prevent the species from being planted at new sites that could provide seed sources. It would also enable wild infestations to be controlled. A component of the programme could include information and encouragement for landowners to remove cultivated bangalow palms and replace them with appropriate, non-invasive species. Bangalow palm has all the hall marks of a highly invasive, long lived plant at the early stage of naturalisation when steps taken to limit its spread can be the most effective. Stopping the supply of these invasive palms to new gardens and subdivisions will assist in slowing its spread throughout Northland. (Brill 2011a)
Site-led pest programme	A site-led programme, where control of bangalow palm is required in defined parts of Northland could reduce the impacts of this species within the programme area(s).	A site-led programme would require an investment of time and resources by the council and affected landowners. It would not reduce or restrict the impacts of bangalow palm in areas that are not identified as being of high priority.	High. A site-led programme could effectively reduce or eliminate specific infestations of bangalow palm but the species is widely cultivated and the programme would not provide for the control of outlying infestations.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that bangalow palm does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be no regional intervention for bangalow palm, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding. While bangalow palm has not been afforded pest status in Northland, it may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes.		

Bathurst bur

Xanthium spinosum

Also known as: spiny cocklebur

(Family: Asteraceae)

Status in New Zealand

Bathurst bur is listed as an unwanted organism under the Biosecurity Act 1993.

Form	Bathurst bur is a spiny plant that grows up to 1m tall. It has well-branched upright stems with triple spines grouped in opposite pairs. The leaves are three-pronged, narrow and pointed with a white midrib above and a whitish colour on the underside. Bathurst bur has inconspicuous flowers and the fruit are bur-like with hooked spines.
Habitat	Bathurst bur is a highly invasive weed that is capable of growing in a range of habitats and environmental conditions. It is usually found on fertile, disturbed or bare ground, particularly in pasture and cultivated areas.
Regional distribution	Most infestations of Bathurst bur in Northland are in the cropping areas of the Kaipara district. However, there are isolated patches throughout Northland.
Competitive ability	Bathurst bur's international distribution can be attributed partly to its ability to adapt to a wide range of climatic conditions. It prefers moist soil, as it has a high water requirement. It can quickly dominate large areas, out-competing crops, forage plants and native flora.

Reproductive ability	Bathurst bur spreads entirely by seeds, which are within the spiny burs. Seed may lie dormant for many years before germinating, forming a very long-lived seed bank. Vectors of spread: the burs are spread mainly by attachment to animals, (for example, in wool), equipment, and clothing, and within produce. The burs also float on water and are moved rapidly along watercourses.
Resistance to control	Bathurst bur has a very long-lived seed bank, which makes eradication difficult.
Benefits	

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	Low	High
Sheep and beef	Low	High
Forestry	-	Low
Horticulture	-	High
Native	-	Low
Urban	-	Low
Coastal	-	Low
Estuarine and marine	-	-
Freshwater/wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	L	M	Dense stands of Bathurst bur can impede the movement of stock, its spines can cause injuries and young plants may be toxic.	Invasive Species Compendium.
Sheep and beef	L	M	Dense stands of the Bathurst bur can impede the movement of stock, its spines can cause injuries and young plants may be toxic. Its burs devalue wool.	Invasive Species Compendium.
Forestry	-	-		

Category	Current	Potential	Comment	Source
Horticulture	-	H	Bathurst bur competes with agricultural crops, leading to a drastically reduced yield. Dense stands of the plant can impede harvesting of field crops. It is a host to fungal diseases of horticultural crops.	Invasive Species Specialist Group; Williams and Champion 2008.
Other	-	-		
International trade	-	M	Bathurst bur can contaminate wool and other material due to its hooked spines, potentially affecting exports.	Invasive Species Specialist Group.
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	L	Bathurst bur is not known to invade intact forest but may become a problem in disturbed ecosystems of low stature. It has the potential to invade regenerating scrub, shrublands, cliffs, banks where it can outcompete early successional species.	Invasive Species Compendium; Williams and Champion 2008.
Threatened species	-	L	Bathurst bur can out-compete native flora.	Williams and Champion 2008.
Social/cultural				
Human health	-	L	The burs can cause skin irritations and dermatitis in some people.	
Recreation	-	-		
Māori culture	-	-		

L = low; M= moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs	Bathurst bur is a serious agricultural weed that has the potential to spread within Northland. If no action is taken it	High. Bathurst bur is invasive and difficult to control. If no action is taken it will spread to

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	incurred in relation to this species.	may spread and the economic costs of control and lost production will increase. It is primarily an agricultural weed and usually controlled by land occupiers as part of normal land management practices.	more sites, its numbers will increase and its impact will become more severe.
Exclusion programme	Not applicable.	Not applicable.	Bathurst bur is already present in Northland.
Eradication programme	Bathurst bur currently occurs mainly in Kaipara district but there are large areas of potential habitat for this species in Northland. If it could be eradicated before it spreads elsewhere, it would prevent long-term impacts and financial costs.	Eradication of Bathurst bur would require a reasonably significant investment of resources to control the known infestations, undertake surveillance to ensure control has been successful, and carry out surveys to identify any additional infestations. If the species is not eradicated there will be on-going control costs.	Medium-high. Infestations of Bathurst bur are concentrated in Kaipara district but it does occur elsewhere in Northland. There is a reasonable chance that there are unrecorded infestations and this species is difficult to eradicate once established, due its long-lived seed bank.
Progressive containment programme	A progressive containment programme would incur lower financial cost to the regional council in the short-term than an eradication programme. It would aim to confine or reduce the distribution of Bathurst bur.	A progressive containment programme would require an investment of time and resources from the regional council and affected landowners. It would not aim to eradicate the species, so control costs would be on-going.	Medium. Bathurst bur is an invasive species with the potential for its seeds to be spread by water, machinery and animals. Therefore, there is a moderate risk that a progressive containment programme will fail to confine the spread and the economic impacts of Bathurst bur.
Sustained control programme	When compared to an eradication programme, a sustained control programme would incur lower financial cost to the regional council in the short-term. It would aim to restrict the spread and impacts of Bathurst bur.	A sustained control programme would require an investment of time and resources by the regional council and affected landowners. It would not aim to eradicate the species, so control costs would be on-going and, in future, eradication or containment may no longer be options.	Medium. There is a moderate risk that a sustained control programme will fail to manage the spread and the economic costs of this species.
Site-led pest programme	A site-led programme, where control of Bathurst bur is required in defined parts of Northland, would reduce the impact of this species in high priority areas.	A site-led programme would require an investment of time and resources by the regional council and affected landowners. A site-led programme would not reduce or restrict the impacts of	Medium. With adequate input of resources, there is a low to moderate risk that a site-led programme could fail within the target area.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
		Bathurst bur in geographical areas that are not identified as being of high priority.	High. There is a high risk that Bathurst bur will spread from existing infestations outside the area(s) that are not subject to a site-led programme.
Summary of alternative assessments and preferred option:	Sustained control programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for Bathurst bur. In terms of alternative approaches assessed, under no regional intervention (or do nothing), maintaining the gains of previous control efforts would be lost. Any control would become voluntary and unenforceable, although many crop farmers would continue to control it in the absence of a Plan. Doing nothing would be unacceptable for many land occupiers and farming communities, particularly those in Kaipara District, with moderate to high political and landowner concerns likely to be expressed. Eradication is unrealistic due to the long-lived seed bank and the high risk of discovering unknown infestations. Overall, this scenario would be beyond the ability of NRC to resource and implement to be fully effective. The control costs that would be imposed on landowners (and council through an extensive advocacy and enforcement regime) would be inappropriate and unsustainable. Progressive containment and site led control may potentially be achieved in some areas but at the region-wide scale these scenarios would be onerous, costly and high risk to council and ultimately unsustainable. A total control rule across all properties in the region but with a sustained control programme outcome (to reduce the impacts and spread to other properties) is the preferred option and will address most landowner concerns and is a pragmatic and affordable management measure.		

Bat-wing passion flower

Passiflora apetala

(Family: Passifloraceae)

Status in New Zealand

Bat-wing passionflower is listed as an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Form	Bat-wing passionflower is an invasive, shade-tolerant vine. It has distinctive bat-wing shaped leaves that may have a pale green stripe along the midrib. It has small yellow or light-green coloured flowers (7-12mm diameter) and produces small black berries the size of a small grape (7-15mm diameter).
Habitat	Bat-wing passionflower is shade-tolerant and can grow in a range of locations. It has been found in regenerating native forest and scrub, home gardens and among hedges and fence lines.
Regional distribution	Infestations of bat-wing passionflower are known to exist in and around Kerikeri, Kaitāia, Mangonui, Waikare Inlet, Kamo, and Whau Valley.

Competitive ability	Bat-wing passion flower is very invasive, with the ability to smother, shade and strangle the vegetation it grows on. Regional council staff have observed vines growing high into the canopy of tall trees and smothering them and even unripe fruit producing viable seeds.
Reproductive ability	Bat-wing passion flower can produce large numbers of fruit, with each fruit containing many viable seeds. Many hundreds of seedlings have been found under some plants. In common with other species of *Passiflora*, bat-wing passionflower can grow from stems that touch the ground or from plant fragments. Vector of spread: The berries are attractive to birds, which spread the seed. The seed also spreads over short distances by gravity, that is, fruit that falls from the parent plant. It can be spread through dumping of vegetation or movement of soil that contains plant fragments and could be spread intentionally, for ornamental purposes. Its climbing and creeping habit enables it to spread easily.
Resistance to control	Bat-wing passionflower can grow from stems that touch the ground or from plant fragments. Therefore, plant waste must be disposed of appropriately. Follow up control is required every 3 - 4 months for best results.
Benefits	Ornamental.

Land uses occupied

Land use type	Current land use infested	Potential land use infested
Dairy	-	-
Sheep and beef	-	-
Forestry	-	Low
Horticulture	-	Low
Native	Low	High
Urban	Low	High
Coastal	-	Low
Estuarine and marine	-	-
Freshwater/wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-	Bat-wing passionflower has been found in regenerating native forest and scrub, home gardens and amongst hedges and fence lines. Therefore, it is unlikely to establish in intensively grazed dairy land	Christian *et al.,* 2012.

Category	Current	Potential	Comment	Source
			but could invade associated riparian areas and hedges.	
Sheep and beef	-	-	Bat-wing passionflower has been found in regenerating native forest and scrub, home gardens and amongst hedges and fence lines. Therefore, it is unlikely to establish in intensively grazed dairy land but could invade associated riparian areas and hedges.	Christian *et al.,* 2012.
Forestry	-	M	Bat-wing passionflower has been found in regenerating native forest and scrub. Therefore, it is conceivable that it could invade production forests.	Christian *et al.,* 2012.
Horticulture	-	M	Bat-wing passionflower has been found in regenerating native forest and scrub, home gardens and amongst hedges and fence lines. Therefore, it is conceivable that it could invade shelter belts, hedges or riparian areas associated with horticultural production.	Christian *et al.,* 2012.
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	L	H	In Northland, bat-wing passionflower is currently confined to gardens and adjacent forest margins at only six sites. However, it is very invasive, with the potential ability to smother, shade and strangle the vegetation it grows on, reducing biodiversity.	Brill pers. comm.; MPI.
Threatened species	-	M	In Northland, bat-wing passionflower is currently confined to gardens and adjacent forest margins at only six sites. It has the potential to smother, shade and strangle the vegetation it grows on, including any threatened species that may be present.	Brill pers. comm.; MPI.
Social/cultural				
Human health	-	-	The berries are non-toxic but inedible.	NZ Plant Conservation Network
Recreation	-	M	Bat-wing passionflower may reduce recreational or aesthetic enjoyment of natural areas.	
Māori culture	-	M	Potential impacts on native/taonga species.	

L = low; M= moderate; H = high

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful *
No regional intervention	If no management action is undertaken there will be no short-term financial costs associated with this species.	Bat-wing passionflower is currently known from only a few sites in Northland but it is an invasive species, which has the potential to spread through urban areas, natural areas and riparian margins. The economic and environmental cost of waiting and controlling larger/more infestations is potentially considerable.	High. If bat-wing passionflower is not managed it is highly likely to spread.
Exclusion programme	Not applicable	Not applicable	Exclusion is not an option because bat-wing passionflower is already present in Northland.
Eradication programme	Bat-wing passionflower is currently present at a limited number of sites. If the species could be eradicated now, before it spreads, it would prevent long-term impacts and financial costs.	Eradication of bat-wing passionflower would require an investment of resources to control known infestations and undertake on-going surveys to ensure all plants have been removed and there is no regrowth. Eradicating the species from Northland would avoid long-term economic and environmental impacts. An eradication programme has been in progress for several years.	Moderate. There is a moderate risk of the programme being unsuccessful if inadequate resources are allocated for control and surveillance or if there is a large, currently undetected infestation within the region.
Progressive containment programme	When compared to an eradication programme, a progressive containment programme would incur lower financial cost to the regional council in the short-term and would aim to confine the impacts of bat-wing passionflower to current infestation areas.	Bat-wing passionflower is an invasive species that is already present at a number of scattered locations across Northland and has the potential to spread rapidly. The time-frame of a progressive containment programme would potentially provide the species with the opportunity (that is, time) to spread. If/when it does become more widely established, eradication and containment may no longer be options and there will be long-term financial and environmental costs associated with the species.	High. There is a high risk that a progressive containment programme will not prevent bat-wing passionflower from spreading within Northland.
Sustained control programme	When compared to an eradication programme, a sustained control programme would incur	Bat-wing passionflower is an invasive species with the potential to spread rapidly. The time-frame of a sustained control programme	High. There is a high risk that a sustained control programme will not prevent bat-wing

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful *
	lower financial cost to the regional council in the short-term, and would aim to restrict the spread and impacts of bat-wing passionflower.	would potentially provide the species with the opportunity (that is, time) to spread. If/when it does become more widely established, eradication and containment may no longer be options and there will be long-term financial and environmental costs associated with the species.	passionflower from spreading within Northland.
Site-led pest programme	Not applicable	Not applicable	Bat-wing passionflower is present in low numbers at a limited number of separated sites in Northland so is not a suitable candidate for a site-led programme.
Summary of alternative assessments and preferred option:	Eradication programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for bat-wing passion flower. In terms of alternative approaches assessed, under no regional intervention (or do nothing), there would be unacceptable loss of biodiversity values if it was allowed to spread unimpeded from the current known sites. However, there is less likelihood of significant public or political concerns as this pest plant is not widely known. A 'no intervention' approach may appeal to some in the community that value the plant as a garden ornamental even though it is banned from sale, therefore there is some low-level risk around achievement of the eradication outcome. Progressive containment or sustained control approaches would not be appropriate as the plant is very limited in distribution and occupies only a small area of suitable habitat. Accordingly, it would be risky relying on 'lesser' management options when eradication/zero density is deemed achievable. Another compounding issue in relying on occupier control is that, like most vigorous growing exotic vines, successful control is inherently problematic and requires multiple visits to the same sites. Land occupier control would be costlier to oversee and inspect and is unlikely to be very successful. These operational risks would compromise the outcomes sought. Eradication is the preferred outcome and is realistic given the current low level nature of known infestations. NRC will undertake direct control of bat-wing passion flower wherever it occurs in the region (through its service delivery programme). The costs involved under an eradication programme are relatively minor and are not expected to adversely affect control outcomes.		

Berry heath

Erica baccans

Also known as: berry flower heath

(Family: Ericaceae)

Status in New Zealand

No legal status

Relevant biology

Form	Berry heath is an upright or spreading shrub that can grow up to 2.5m tall. It has small, narrow leaves that are 4-9mm long and arranged in groups of four along the stems. The margins of the leaves roll downwards so that the leaf underside is not visible. Berry heath has small, pink to rose-coloured tubular flowers (5-6mm long).
Habitat	Berry heath is native to the Cape Peninsula of South Africa where it grows in heathland communities on warm, rocky mountain slopes or in damp to moist places at lower altitudes. In Victoria (Australia) it has invaded heathland, woodland, lowland grassland, and grassy woodland. In New Zealand it has been recorded in Northland, North Auckland, on Great Barrier Island, and on the Awhitu Peninsula. On a small island off the coast of Great Barrier Island, it was found growing with manuka and flax in an area that had been burnt off within the last 10-15 years. It has also been recorded among native scrub on the Poutō Peninsula.
Regional distribution	Berry heath has been recorded near Kaitāia and Houhora and in the Kaipara district, where it is common. It is widespread on the west coast of Northland and in some places, locally abundant. It is especially common on escarpments on the old sand country around Pouto and north up through areas such as Te Kopuru, Bayleys Beach and Maitahi. There is a small amount at the Kai iwi lakes.
Competitive ability	Berry heath grows best in full sun and free-draining, sandy, acidic soils with low levels of phosphate.
Reproductive ability	The flowers of berry heath are thought to be pollinated by insects. Many thousands of seeds are produced each year and they germinate prolifically after fire or on disturbed land. It can form a persistent seed bank in the soil. Vegetatively, berry heath plants re-sprout from the base if damaged. Vectors of spread: seeds are dispersed by wind, gravity, water and humans. Berry heath has ornamental value so may also be spread and propagated by gardeners. Probably shifted around by roading and forestry equipment.
Resistance to control	Berry heath can re-sprout from the base if plants are damaged.
Benefits	Ornamental

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	Low	Low
Sheep and beef	Low	Low
Forestry	-	Low
Horticulture	-	-
Native bush or forests	Low	Low
Urban	Low	High
Coastal	Low	Low
Estuarine and marine	-	-

Land use type	Current land use infested	Potential land use
Freshwater/wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	L	L	An online literature review did not locate any records of berry heath invading managed pasture. However, it does occur in pasture on sand country in Northland.	Brill, pers.comm.
Sheep and beef	L	L	An online literature review did not locate any records of berry heath invading managed pasture. However, it does occur in pasture on sand country in Northland.	Brill, pers.comm.
Forestry		L	An online literature review did not locate any records of berry heath invading production forest. However, its preference for open coastal sites suggests it could invade harvested forest.	
Horticulture	-	-	An online literature review did not locate any records of berry heath invading horticultural land.	
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	L	M	Berry heath can invade native heathland, woodland and scrub.	Beever et al., 1985; Cameron et al., 2001; Csurhes and Edwards, 1998.

Category	Current	Potential	Comment	Source
Threatened species	-	M	Berry heath can invade native heathland, woodland and scrub. In Northland it could impact upon gumland communities or scrub, which are habitats for threatened plant species.	Beever et al., 1985; Cameron et al., 2001; Csurhes and Edwards, 1998.
Social/cultural				
Human health	-	-		
Recreation	-	L	Berry heath may reduce the aesthetic values of natural areas.	
Māori culture	-	M	Impacts upon native/taonga species.	

L = low; M= moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council under the RPMP in relation to this species. Rather than applying a programme under the Regional Pest Management Plan, the species could come under a 'Connecting Communities' programme outside the pest management plan, where advice and support are provided for specific sites. This will provide support to communities as and where the species is having impacts.	Berry heath is already present in Northland but is not usually seen dominating large areas. If no action is taken it may spread, with consequent environmental impacts and future control costs.	Low. If no action is taken, existing infestations of berry heath may expand and it may spread to new sites.
Exclusion programme	Not applicable.	Not applicable.	Berry heath is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Berry heath is present throughout the region so would not be suitable for an eradication programme.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Progressive containment programme	Not applicable.	Not applicable.	Berry heath is present throughout the region so would not be suitable for a progressive containment programme.
Sustained control programme	Berry heath could be included in a sustained control programme. As a declared pest it would be banned from sale under the Biosecurity Act. This could help reduce the risk of spread over time.	Berry heath is not currently banned from sale in Northland. There would be costs to plant retail outlets from a ban from sale. Plant retail outlets are inspected regularly by council staff checking for many different plants and this species could be added to the list.	Moderate. Berry heath could still spread and become more common.
Site-led pest programme	A site-led programme, where control of berry heath is required in defined parts of Northland could reduce the impacts of this species within the programme area(s). This could include high value dune lakes, and some nationally critical gumland habitats.	Site-led programme would require an investment of time and resources by the council and affected landowners. It would not reduce or restrict the impacts of berry heath in areas that are not identified as being of high priority.	Moderate. A site-led programme could effectively reduce or eliminate the adverse effects of berry heath in particular high value habitats.
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that berry heath does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be no regional intervention for berry heath, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding. While berry heath has not been afforded pest status in Northland, it may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes.		

Black-eyed susan

Thunbergia alata

Also known as: Black-eyed susan vine

(Family: Acanthaceae)

Status in New Zealand

No legal status

Relevant biology

Form	Black-eyed susan is a vine-type plant that can grow to a height of 8ft. It has twining stems with arrow-shaped leaves. The flowers are typicall orange, although different varieties can be red, white, yellow or red-orange with or without the characteristic dark centre
Habitat	Black-eyed susan is a native of Eastern Africa. Its original natural area is unknown due to its long history of cultivation. It prefers full sun or light shade and is frost-sensitive. Flowers spring-autumn
Regional distribution	Black-eyed susan is grown ornamentally around New Zealand and occurs sporadically on roadsides or waste areas where it has grown from dumped garden waste
Competitive ability	Black-eyed susan will grow atop native plants and trees, smothering them and preventing further growth activity. Considered an aggressive invasive plant in Australia, Japan, Brazil, Costa Rica, Colombia, the Pacific and other tropical regions.
Reproductive ability	Black-eyed susan is known to be pollinated by bees in Eastern Africa but it has not been extensively studied outside of its home range. Vectors of spread: In new Zealand, black-eyed susan is spread mainly via garden waste, seeds or propagation by gardeners
Resistance to control	Black-eyed susan can be removed manually, although large, mature plants can have extensive underground root systems, requiring removal via specialized machinery
Benefits	Ornamental. Used in East Africa and India as a traditional medicine and animal feed.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	-	-
Horticulture	-	-
Native bush or forests	Low	Medium
Urban	Low	High

Land use type	Current land use infested	Potential land use
Coastal	-	-
Estuarine and marine	-	-
Freshwater/wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry		-		
Horticulture	-	-		
Other	Low	High	Black-eyed susan is very capable of covering large amounts of native vegetation in warmer climes	Queensland Department of Primary Industries and Fisheries 2011
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	L	M	Black-eyed susan can invade native scrub and forest areas, reducing species diversity by preventing germination and regenerations.	Queensland Department of Primary Industries and Fisheries 2011
Threatened species	-	-		
Social/cultural				
Human health	-	-		
Recreation	-	L	Black-eyed susan may reduce the aesthetic values of natural areas.	
Māori culture	-	M	Impacts upon native/taonga species.	

L = low; M= moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council under the RPMP in relation to this species. Rather than applying a programme under the Regional Pest Management Plan, the species could come under a 'Connecting Communities' programme outside the pest management plan, where advice and support are provided for specific sites. This will provide support to communities as and where the species is having impacts.	Black-eyed Susan is already present in Northland but is not usually seen dominating large areas. If no action is taken it may spread, with consequent environmental impacts and future control costs.	Moderate. If no action is taken, existing infestations of berry heath may expand and it may spread to new sites.
Exclusion programme	Not applicable.	Not applicable.	Black-eyed susan is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Black-eyed susan is present throughout the region so would not be suitable for an eradication programme.
Progressive containment programme	Not applicable.	Not applicable.	Black-eyed susan is present throughout the region so would not be suitable for a progressive containment programme.
Sustained control programme	Black-eyed susan could be included in a sustained control programme. As a declared pest it would be banned from sale under the Biosecurity Act. This could help reduce the risk of spread over time.	Black-eyed susan is not currently banned from sale in Northland. There would be costs to plant retail outlets from a ban from sale. Plant retail outlets are inspected regularly by council staff checking for many different plants and this species could be added to the list.	Low. Black-eyed susan spread would be reduced.
Site-led pest programme	A site-led programme, where control of Black-eyed susan is required in defined parts of Northland could reduce the	Site-led programme would require an investment of time and resources by the council and affected landowners. It	Moderate. A site-led programme could effectively reduce or eliminate the adverse

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	impacts of this species within the programme area(s). This could include high value native forest areas.	would not reduce or restrict the impacts of berry heath in areas that are not identified as being of high priority.	effects of Black-eyed susan in particular high value habitats.
Summary of alternative assessments and preferred option:	Sustained control programme - Banned from sale & distribution With regard to section 6(1) of the NPD a low-level analysis was considered appropriate for Black-eyed susan. In terms of alternative approaches assessed, under a do-nothing approach there would be no ability for Council to prevent the formal (nursery trade) or informal (fairs and on-line marketing) trade or circulation of this pest. Black-eyed susan is already reasonably wide-spread in Northland and its distribution and assessment of effects mean that eradication and progressive containment programmes are not realistic or affordable. Site-led management would control some plants at some sites, but ultimately this approach would also be unsustainable. Sustained control is the preferred outcome and most viable option. Declaring Black-eyed susan formally as a pest in the Plan automatically triggers sections 52 and 53 of the Biosecurity Act, banning the pest from sale, propagation and distribution in Northland. This plant is not covered in the current National Pest Plant Accord (NPPA) which has over 150 plants listed, banning them from sale, propagation and distribution nationally. However, the NPPA is nationally focused and doesn't necessarily account for regional differences. The risks of this plant have been evaluated specifically in terms of its effects in Northland. It is important to recognise the wide climate and temperature ranges in New Zealand and that some pests require regional based initiatives based on these factors. Accordingly, Black-eyed susan is one of the pest plants banned from sale, propagation and distribution in the Northland region. This designation recognises that generally they are a lower risk to the regions' values compared with other more invasive species. Council wishes to take a more proactive stance over their management, as opposed to disregarding them under a do-nothing scenario, while acknowledging it must operate within a finite budget and limited resources. Nurseries in general support the concept of the NPPA and the outcomes being sought.		

Bracelet honey myrtle

Melaleuca armillaris

(Family: Myrtaceae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Bracelet honey-myrtle is a shrub that grows up to 5m tall. It has hard or corky bark and linear leaves that are 2-25mm long, and around 1mm wide. It produces white, bottle-brush like flowers on spikes that are 3-7cm long.
Habitat	Bracelet honey-myrtle is native to south-eastern Australia (eastern New South Wales, eastern Victoria and Tasmania), where it grows in heath communities on headlands and coastal ranges. It is also naturalised beyond its native range in southern Victoria, South Australia, and some coastal districts of Western Australia.

Regional distribution	Bracelet honey-mrytle is known to be locally abundant is a few areas, inlcuding the Karikari Peninsula, the Te Hapua area and near Ahipara in disturbed coastal shrubland.
Competitive ability	Outside its natural range, bracelet honey-myrtle is regarded as an environmental weed in Victoria and South Australia. It is fast-growing and has spread from deliberate plantings to invade coastal heathlands, reserves and roadsides. It replaces native species and increases fuel loads, which makes invaded areas more prone to fires. It is tolerant of saline soils and many *Melaleuca* species are highly fire-tolerant.
Reproductive ability	*Melaleuca* species usually reproduce by seeds, which germinate readily in moist, warm conditions with no pretreatment. Vectors of spread: seed is distributed by gravity, wind and water from canopies that hold a store of mature fruit, often for many years, awaiting the right conditions to stimulate release. It may also be spread deliberately, for ornamental purposes.
Resistance to control	Can be controlled through stump-treating with a 50% glyphosate solution. Triclopyr mixes and mechanical control are also effective. Small seedlings can be hand-pulled.
Benefits	Bracelet honey-myrtle is cultivated for its oil, as an ornamental plant and in shelterbelts.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	-	-
Horticulture	-	Low
Native bush or forests	-	Low
Urban	Low	Low
Coastal	Low	High
Estuarine and marine	-	-
Freshwater/wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-	An online literature review did not find any reference to bracelet honey-myrtle invading pasture.	

Category	Current	Potential	Comment	Source
Sheep and beef	-	-	An online literature review did not find any reference to bracelet honey-myrtle invading pasture.	
Forestry	-	-	An online literature review did not find any reference to bracelet honey-myrtle invading production forests. However, it grows in scrub and shrubland so may be able to establish on forest margins or in young forests.	
Horticulture	-	+	Bracelet honey-myrtle is cultivated for its medicinal oil.	Ecology Partners Ltd., 2008.
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	M-H	Bracelet honey-myrtle can replace native species and increases fuel loads, which can make invaded areas more prone to fires.	Ecology Partners Ltd., 2008.
Threatened species	-	M	Bracelet honey-myrtle can replace native species including, potentially, threatened species.	Ecology Partners Ltd., 2008.
Social/cultural				
Human health	-	-	The oil is used topically (i.e. On the skin) for medicinal purposes but is toxic when consumed.	
Recreation	-	L	Bracelet honey-myrtle may reduce the aesthetic values of natural areas.	
Māori culture	-	M	Impacts upon native/taonga species.	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Do nothing	If no management action is undertaken there will be no short-term financial cost to the council under the pest management plan associated with control of this species. Rather than applying a programme under the pest management plan, the species could come under a 'council supported management' programme, where advice and support are provided for specific species. This will provide support to communities as and where the species is having local impacts.	Bracelet honey-myrtle is currently known from limited locations in Northland. If it spreads further is the potential for it to have serious environmental impacts. The economic cost of delaying control until there are larger/more infestations is potentially considerable.	Moderate. Without education, regulation and control there is some risk that bracelet honey-myrtle could spread.
Exclusion programme	Not applicable.	Not applicable.	Bracelet honey-myrtle is already present in Northland.
Eradication programme	Bracelet honey-myrtle is currently known at only three sites in Northland but it has the potential to invade more habitats and have adverse effects on the environment. If it could be eradicated before it spreads elsewhere, it would prevent long-term impacts and financial costs.	Eradication of bracelet honey-myrtle would not require a large investment of resources because the species is known from only three sites and the populations are not large. If control is delayed, environmental costs and the cost of control could escalate.	Moderate-high. There is a moderate risk that eradication of the known infestations would fail due to limited resources. There is also a high risk that the species occurs at other unknown locations.
Progressive containment programme	Not applicable.	Not applicable.	While limited populations are currently known, it is likely that there are other populations in Northland.
Sustained control programme	Bracelet honey-myrtle could be included in a sustained control programme. As a declared pest it would be banned from sale under the Biosecurity Act, and subject to rules about distribution. This could help reduce the risk of spread over time. However, Bracelet honey-myrtle is not known to be particularly invasive and is a sterile hybrid.	A sustained control programme would require an investment of time and resources by the council and affected landowners, and plant nurseries.	Low. Bracelet honey-myrtle may still spread and become more common.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Site-led pest programme	Not applicable.	Not applicable.	Not applicable
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that bracelet honey-myrtle does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be no regional intervention for bracelet honey-myrtle, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding. While bracelet honey-myrtle has not been afforded pest status in Northland, it may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes.		

Brazilian pepper tree

Schinus terebinthifolius

Also known as: Christmas berry, pepper tree.

(Family: Anacardiaceae)

Status in New Zealand

Brazilian pepper tree is listed as an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Brazilian pepper tree is a small, evergreen bushy tree 3-7m tall. The short trunk is usually hidden in a dense head of contorted, intertwining branches with leathery fern-like leaves. The crushed leaves produce a pungent smell that has been described as "peppery" or "turpentine-like". Each leaf is comprised of 4 or 6, or sometimes more, rounded and often toothed leaflets that are arranged in pairs with a single, terminal leaflet. Male and female trees are separate, Small, white flowers on the female trees are followed by bright red fruit, 4-6mm across.
Habitat	Brazilian pepper tree can be found in disturbed areas, but overseas it is a problem weed of wetland and water body margins. It can also establish in relatively undisturbed

	plant communities and on undisturbed substrates. It is widely reported as a weed overseas in several countries, and is naturalised in most tropical and subtropical regions.
Regional distribution	Brazilian pepper tree is widespread and scattered throughout Northland on both the west and east coasts.
Competitive ability	Brazilian pepper tree seedlings survive and grow in a wide range of light levels, but grow faster in full sunlight. The species can grow on sites with varying water availability, from areas that are rarely inundated to those that are flooded for several weeks at a time, but is not generally found at sites that are flooded for long periods. It is highly competitive in wet habitats. It has limited tolerance to salinity and is sensitive to freezing, but it sprouts after frost damage. It can grow very quickly, for example, 1m per year. Brazilian pepper tree is a serious weed in subtropical areas (for example, Florida, Australia) where it excludes other species.
Reproductive ability	Brazilian pepper tree reproduces by seed and also forms root suckers which develop into new plants. Damage to the plant apparently does not need to occur to trigger root sprouting. It generally produces large amounts of seed and reaches maturity within 3 years of germinating. In southeastern Brazil, fruit production averaged 8373 fruits/plant but the seeds are relatively short-lived. Seed viability is 30-60% and can last up to 2 months, but declines to 0.05% at 5 months. Vectors of spread: Humans disperse Brazilian pepper tree by introducing it to new areas as an ornamental plant, disturbing vegetation and soil to facilitate its spread, and improper disposal of garden waste. Birds also disperse seed and it may be carried considerable distances by water.
Resistance to control	Control should be performed carefully because contact with the sap may cause serious rashes.
Benefits	Ornamental.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	-	-
Horticulture	-	-
Native bush or forests	-	High
Urban	Low	High
Coastal	-	Low
Estuarine and marine	-	Low
Freshwater/wetland	Low	High

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-	Brazilian pepper tree fruits and leaves may be toxic to young cows and horses.	Williams, 1980.
Sheep and beef	-	-		
Forestry	-	L		
Horticulture	-	L		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	M	Brazilian pepper tree may produce chemicals that inhibit the growth of other species.	Meyer, 2011.
Water quality	-	-		
Species diversity	-	M	Brazilian pepper tree may produce chemicals that inhibit the growth of native species. It is an aggressive weed that can invade natural areas and disturbed habitats where it shades out and displaces native vegetation, often forming dense monocultures that reduce the biological diversity of plants and animals in the invaded areas. It can suppress many other smaller wetland species. Large areas of wetland throughout Northland may be vulnerable to this plant.	Invasive Species Specialist Group; Meyer, 2011; Williams, 2008.
Threatened species	-	L	Brazilian pepper tree can shade out and displace native species, potentially including threatened species.	
Social/cultural				
Human health	-	L	Brazilian pepper tree fruits, leaves and resinous seep from the trunk may be toxic to humans. It commonly causes an allergic reaction that includes an itchy rash and swelling of the	Morton, 1978.

Category	Current	Potential	Comment	Source
			face. In some people, sneezing and asthma-like reactions often occur near blooming plants.	
Recreation	-	L	Brazilian pepper tree may reduce the aesthetic values of natural areas. It may also impede access through its toxic effects (see above).	
Māori culture	-	M	Impacts upon native/taonga species.	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Do nothing	If no management action is undertaken there will be no short-term financial costs to the council under the pest management plan associated with this species.	Brazilian pepper tree is a potentially invasive species that is already present in northland. If no action is taken, the number and extent of infestations is likely to increase with consequent adverse effects on the environment. Future control costs would also increase.	Medium-high. Brazilian pepper tree is an invasive species in other countries. If no action is taken, the number and extent of infestations is likely to increase with consequent adverse effects on the environment, and increased control costs in future.
Exclusion programme	Not applicable.	Not applicable.	Brazilian pepper tree is already present in Northland.
Eradication programme	Brazilian pepper tree is present in Northland. It is not common but the extent and abundance of naturalised populations is not known. If it could be eradicated before it becomes more established, it would prevent long-term impacts and financial costs.	Eradication of Brazilian pepper tree would require a significant investment of resources to determine the distribution and abundance of the species, followed by control and surveillance. If it is not eradicated and becomes widely naturalised, there will be on-going control costs.	High. The distribution and abundance of Brazilian pepper tree is poorly understood. If, during the course of an eradication program it was found to be much more common than originally thought, eradication could fail. Resources to undertake an eradication of this scale are not available.
Progressive containment programme	Not applicable.	Not applicable.	Brazilian pepper tree is scattered throughout Northland so is not suitable for a progressive containment programme.
Sustained control programme	A sustained control programme would aim to	A sustained control programme would require an	Medium - there is some risk that a sustained control

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	reduce the distribution of Brazilian pepper tree and reduce its adverse effects on the environment and people. Rules requiring land occupiers to control the plant would help reduce spread and impacts. It would incur lower financial cost to the regional council in the short-term.	investment of time and resources by the regional council and affected landowners. It would not aim to eradicate the species, so control costs would be on-going and, in future, eradication or containment may no longer be options.	programme will fail to manage the spread.
Site-led pest programme	Not applicable.	Not applicable.	The distribution and abundance of Brazilian pepper tree is limited and is poorly understood.
Summary of alternative assessments and preferred option:	Sustained control programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for Brazilian pepper tree. In terms of alternative approaches assessed, under <u>no regional intervention</u> (or do nothing) land occupiers who have genuine health issues because of this pest would have no redress other than relying on voluntary control by the exacerbating land occupier. Due to its dispersed and generally undetermined distribution and growth in the region there is a low level of risk around political or landowner concerns under a do-nothing scenario. Due to the widespread and scattered (but generally unknown) extent of Brazilian pepper tree, <u>eradication</u> is not deemed feasible or realistic and would likely fail to be achieved should a full survey reveal the true extent of infestations. Its scattered nature does not lend itself to <u>progressive containment or site led control</u>, although protection of some sites may potentially be achieved in some areas under a site-led approach. However, on a region-wide scale these options would be onerous, costly to maintain any gains made and ultimately would have a high likelihood and risk of failure. <u>Sustained control</u>, with land occupier total property clearance rules (which are activated by either the infestation being a source of wilding trees or a valid health related complaint from a directly affected person) is a pragmatic way to address at least the human health concerns around this pest plant and is the preferred management option. A medical certificate/letter must be provided by the person affected. While Brazilian pepper tree is both a human health and environmental pest in the region the favoured outcome, which aims to reduce demonstrated human health effects, is a cost effective solution for council to adopt.		

Broom

Cytisus scorparius

(Family: Fabaceae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Broom is an erect, many-branched, almost leafless woody shrub, up to 3m tall. It is a perennial plant, with a stout taproot. Leaves are sparse, mostly narrow and simple. It has golden-yellow flowers in spring that are 2.5cm long, and it seeds prolifically in summer. Seed pods are black when ripe and explode loudly on warm days, scattering the seed.
Habitat	Broom grows in river beds, hedgerows, low-fertility hill country, scrubland, coastal and disturbed land. It is tolerant of a wide range of conditions including drought and frost, but requires good drainage.
Regional distribution	It is common and widespread throughout New Zealand, but not especially common throughout Northland.
Competitive ability	Aggressive invasive shrub.
Reproductive ability	Seeds prolifically, with each pod producing nine seeds and usually more than 2000 pods/bush. Broom forms a substantial seedbank and the seeds can still be viable after five years. Vectors of spread: Explosive seed pods, spreading seeds more than 1.5m away. Also spread by gravel, mud, animals, agricultural produce, machinery, people, tracks and railroads, roads and water.
Resistance to control	Can be controlled by hand removal, spraying and cutting and stump treating. There are also five biological control agents that control broom.
Benefits	Sometimes used in herbal medicine, however seeds are poisonous.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	Low	Low
Sheep and beef	High	High
Forestry	Low	Low
Horticulture	-	-
Native bush or forests	Low	Low
Urban	High	High
Coastal	High	High
Estuarine and marine	-	-
Freshwater/wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	L	M	Seeds are poisonous. It can dominate low canopy habitats and is drought tolerant.	NZ Plant Conservation Network; Weedbusters.
Sheep and beef	L	M	Seeds are poisonous. It can dominate low canopy habitats and is drought tolerant.	NZ Plant Conservation Network; Weedbusters.
Forestry	L	L	It can dominate in scrubland and disturbed land, for example after logging and during replanting.	NZ Plant Conservation Network; Weedbusters.
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	L	M	Increased nitrogen in gumlands and other low nutrient soil types may result in changing habitats.	NZ Plant Conservation Network; Weedbusters.
Water quality	-	-		
Species diversity	L	L	It can dominate low canopy habitats, preventing native species from establishing.	NZ Plant Conservation Network; Weedbusters.
Threatened species	L	L	Increased nitrogen in gumlands and other low nutrient soil types may result in changing habitats, which may effect threatened species in these habitats	NZ Plant Conservation Network; Weedbusters.
Social/cultural				
Human health	L	L	Sometimes used in herbal medicine, however seeds are poisonous.	NZ Plant Conservation Network; Weedbusters.
Recreation	L	L	It can dominate low canopy habitats.	NZ Plant Conservation Network; Weedbusters.
Māori culture	L	L	Impacts upon native/taonga species.	

L = low; M= moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council in relation to this species. Rather than applying a programme under the Regional Pest Management Plan, the species could come under a 'Connecting Communities' programme outside the pest management plan, where advice and support are provided for specific sites. This will provide support to communities as and where the species is having impacts.	Broom is already present in Northland but is not usually seen dominating large areas. If no action is taken it may spread, with consequent environmental impacts and future control costs.	Low. If no action is taken, existing infestations of broom may expand and it may spread to new sites.
Exclusion programme	Not applicable.	Not applicable.	Broom is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Broom is present throughout the region so would not be suitable for an eradication programme.
Progressive containment programme	Not applicable.	Not applicable.	Broom is present throughout the region so would not be suitable for an progressive containment programme.
Sustained control programme	Broom could be included in a sustained control programme. As a declared pest it would be banned from sale under the Biosecurity Act. This could help reduce the risk of spread over time.	Broom is already banned from sale and distribution in Northland and has been for a number of years so would be no costs to plant retail outlets from a ban. Plant retail outlets are inspected regularly by council staff checking for many different plants.	Moderate. Broom could still spread and become more common.
Site-led pest programme	A site-led programme, where control of broom is required in defined parts of Northland could reduce the impacts of this species within the programme area(s).	A site-led programme would require an investment of time and resources by the council and affected landowners. It would not reduce or restrict the impacts	Moderate. A site-led programme could effectively reduce or eliminate the adverse effects of broom. But broom does appear to be having large impacts in

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
		of broom in areas that are not identified as being of high priority.	Northland at present and the council has not received any calls about this species in the last few years.
Summary of alternative assessments and preferred option:	**Sustained control programme - Banned from sale & distribution** With regard to section 6(1) of the NPD a low-level analysis was considered appropriate for broom. In terms of alternative approaches assessed, under a do-nothing approach there would be no ability for Council to prevent the formal (nursery trade) or informal (fairs and on-line marketing) trade or circulation of this pest. Broom is already naturalised in Northland and its distribution and assessment of effects mean that eradication and progressive containment programmes are not realistic or affordable. Site-led management would control some plants at some sites, but ultimately this approach would also be unsustainable. Sustained control is the preferred outcome and most viable option. Declaring broom formally as a pest in the Plan automatically triggers sections 52 and 53 of the Biosecurity Act, banning the pest from sale, propagation and distribution in Northland. This plant is not covered in the current National Pest Plant Accord (NPPA) which has over 150 plants listed, banning them from sale, propagation and distribution nationally. However, the NPPA is nationally focused and doesn't necessarily account for regional differences. The risks of this plant have been evaluated specifically in terms of its effects in Northland. It is important to recognise the wide climate and temperature ranges in New Zealand and that some pests require regional based initiatives based on these factors. Accordingly, broom is one of 32 pest plants banned from sale, propagation and distribution in the Northland region. This designation recognises that generally they are a lower risk to the regions' values compared with other more invasive species. Council wishes to take a more proactive stance over their management, as opposed to disregarding them under a do-nothing scenario, while acknowledging it must operate within a finite budget and limited resources. Nurseries in general support the concept of the NPPA and the outcomes being sought.		

Brush wattle

Paraserianthes lophantha

(Family: Fabaceae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Brush wattle is a short-lived tree, usually 5-10m tall. It has densely hairy twigs and bronze, hairy young shoots. Leaves are 20-30cm long, frond-like, alternate, and twice divided along the midrib. It has many tiny green-yellow flowers from May to August. The flower heads resemble a bottle brush, and are followed by flat, green to brown seed pods, which contain 9-11 hard-coated black seeds about 7mm long.
Habitat	Brush wattle prefers disturbed open land, especially scrubland, riverbanks, gumland, and coastal sites. It can persist in low forest for many years but does not tolerate deep shade. It forms tall, rapidly establishing stands that over-top low-growing vegetation, but native forest species establish under wattle so impacts usually occur in open, low-growing vegetation.
Regional distribution	Common to locally abundant throughout the North Island.

Competitive ability	It is fast growing and maturing, and produces many long-lived seeds. Tolerates high to low rainfall, poor soils, salt, wind and low fertility (fixes nitrogen).
Reproductive ability	Plants seed prolifically and seed is likely to be viable for at least 20 years. **Vectors of spread:** Contaminated soil and gravel, fresh and salt water movement all spread seeds.
Resistance to control	Stumps regrow, and it reseeds following disturbance by fire, machinery or spraying.
Benefits	

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	High	High
Sheep and beef	Low	Low
Forestry	Low	Low
Horticulture	-	-
Native bush or forests	High	High
Urban	Low	Low
Coastal	High	High
Estuarine and marine	-	-
Freshwater/wetland	Low	Low

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	L	L	Suppression of pasture on marginal hill country farms.	Taranaki Regional Council
Forestry	L	L	It can persist in low forest for many years but does not tolerate deep shade. It forms tall, rapidly establishing stands that over-top low-growing vegetation, but forest species establish under wattle so impacts usually occur in open, low-growing vegetation.	Weedbusters

Category	Current	Potential	Comment	Source
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	L	M	Nitrogen fixer so may alter soils changing habitats.	Weedbusters
Water quality	-	-		
Species diversity	L	L	Particularly along stream banks and low and disturbed forests. It forms tall, rapidly establishing stands that over-top low-growing vegetation, but native forest species establish under wattle so impacts usually occur in open, low-growing vegetation.	Taranaki Regional Council Weedbusters
Threatened species	-	L	Particularly along stream banks and low and disturbed forests. It forms tall, rapidly establishing stands that over-top low-growing vegetation, but native forest species establish under wattle so impacts usually occur in open, low-growing vegetation.	Taranaki Regional Council Weedbusters
Social/cultural				
Human health	-	-		
Recreation	L	L	Brush wattle prefers disturbed open land which could affect recreation activities.	
Māori culture	L	L	Impacts upon native/taonga species.	

L = low; M= moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council in relation to this species. Rather than applying a programme under the regional pest management plan, the species could come under a 'Connecting Communities' programme outside of the pest management plan, where advice and support are provided for specific sites. This will provide support to communities as and where the species is having impacts.	Brush wattle is already present in Northland. If no action is taken it may spread, with consequent environmental impacts and future control costs.	Moderate. If no action is taken, existing infestations of brush wattle may expand and it may spread to new sites.
Exclusion programme	Not applicable.	Not applicable.	Brush wattle is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Brush wattle is present throughout the region so would not be suitable for an eradication programme.
Progressive containment programme	Not applicable.	Not applicable.	Brush wattle is present throughout the region so would not be suitable for a progressive containment programme.
Sustained control programme	Brush wattle could be included in a sustained control programme. As a declared pest it would be banned from sale under the Biosecurity Act. This could help reduce the risk of spread over time.	Brush wattle is already banned from sale and distribution in Northland and has been for a number of years so would be no costs to plant retail outlets from a ban. Plant retail outlets are inspected regularly by council staff checking for many different plants.	Moderate. Brush wattle could still spread and become more common.
Site-led pest programme	A site-led programme, where control of brush wattle is required in defined parts of Northland could reduce the impacts of this species within the programme area(s).	A site-led programme would require an investment of time and resources by the council and affected landowners. It would not reduce or restrict the impacts of brush wattle in areas that are not	Moderate. A site-led programme could effectively reduce or eliminate the adverse effects of brush wattle in some areas.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
		identified as being of high priority.	
Summary of alternative assessments and preferred option:	Sustained control programme - Banned from sale & distribution With regard to section 6(1) of the NPD a low-level analysis was considered appropriate for brush wattle. In terms of alternative approaches assessed, under a do-nothing approach there would be no ability for Council to prevent the formal (nursery trade) or informal (fairs and on-line marketing) trade or circulation of this pest. Brush wattle is already naturalised in Northland and its distribution and assessment of effects mean that eradication and progressive containment programmes are not realistic or affordable. Site-led management would control some plants at some sites, but ultimately this approach would also be unsustainable. Sustained control is the preferred outcome and most viable option. Declaring brush wattle formally as a pest in the Plan automatically triggers sections 52 and 53 of the Biosecurity Act, banning the pest from sale, propagation and distribution in Northland. This plant is not covered in the current National Pest Plant Accord (NPPA) which has over 150 plants listed, banning them from sale, propagation and distribution nationally. However, the NPPA is nationally focused and doesn't necessarily account for regional differences. The risks of this plant have been evaluated specifically in terms of its effects in Northland. It is important to recognise the wide climate and temperature ranges in New Zealand and that some pests require regional based initiatives based on these factors. Accordingly, brush wattle is one of 32 pest plants banned from sale, propagation and distribution in the Northland region. This designation recognises that generally they are a lower risk to the regions' values compared with other more invasive species. Council wishes to take a more proactive stance over their management, as opposed to disregarding them under a do-nothing scenario, while acknowledging it must operate within a finite budget and limited resources. Nurseries in general support the concept of the NPPA and the outcomes being sought.		

Buddleia

Buddleja davidii

(Family: Buddlejaceae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Buddleia is a fast-growing, open, woody, deciduous perennial ornamental shrub that grows up to 3m tall. It has mauve to purple flowers, that are orange inside. The flowers form distinctive cone-shaped hanging clusters of many small flowers, between December to February and are followed by seed capsules 5-10mm long.
Habitat	The plant invades river beds, streamsides, disturbed forest and shrubland and margins, stony and bare land. It tolerates a wide range of soils and temperatures, wet to moderately dry conditions, shade or open areas, damage and wind. Seedlings require high light levels.
Regional distribution	Common throughout the North Island.

Competitive ability	Buddleia establishes and grows quickly, forming dense thickets in a wide range of habitats.
Reproductive ability	The plant reproduces vegetatively through regeneration from suckers. Vast amounts of seed are produced and seed viability is initially high. **Vectors of spread:** Seed spreads by wind, water and soil movement, and dumped vegetation.
Resistance to control	Seed bed re-infests cleared sites, and cut stumps re-sprout. It can survive burial to 0.5m of fine alluvium by producing adventitious roots and shoots on buried or flattened stems. Re-invasion can be difficult to prevent, and requires regular follow up work. An effective biocontrol agent is now available.
Benefits	Originally introduced to New Zealand as a garden ornamental. Used in herbal medicine.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	-	-
Horticulture	-	-
Native bush or forests	High	High
Urban	Low	Low
Coastal	Low	Low
Estuarine and marine	-	-
Freshwater/wetland	High	High

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy				
Sheep and beef				
Forestry		L	Invasive in forest plantations especially following land disturbance, such as forest harvesting.	New Zealand Plant Conservation Network
Horticulture				

Category	Current	Potential	Comment	Source
Other	L	H	Currently present in many urban gardens or disturbed roadsides	Weedbusters
International trade				
Environment				
Soil resources				
Water quality		M	In riverbeds it can alter water flow, causing silt build up and flooding.	Weedbusters
Species diversity			Buddleia establishes and grows quickly and forms dense self-replacing thickets. It is very versatile, tolerating a wide range of soils, temperatures, wet to moderately dry conditions, deep shade or open areas, damage and wind. Major pest, often the only exotic species found in forests in mountain regions. Very invasive of forest margins and revegetation areas.	New Zealand Plant Conservation Network; Weedbusters
Threatened species			As above.	
Social/cultural				
Human health	L	L	Sometimes used in herbal medicine.	
Recreation	L	L	It can dominate low canopy habitats.	Weedbusters
Māori culture	L	L	Impacts upon native/taonga species.	

L = low; M= moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council in relation to this species.	Buddleia is already present in Northland but is not usually seen dominating large areas. If no action is taken it may spread, with consequent environmental	Low. If no action is taken, existing infestations of broom may expand and it may spread to new sites.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	Rather than applying a programme under the Regional Pest Management Plan, the species could come under a 'Connecting Communities' programme outside the pest management plan, where advice and support are provided for specific sites. This will provide support to communities as and where the species is having impacts.	impacts and future control costs.	
Exclusion programme	Not applicable.	Not applicable.	Buddleia is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Buddleia is present throughout the region so would not be suitable for an eradication programme.
Progressive containment programme	Not applicable.	Not applicable.	Buddleia is present throughout the region so would not be suitable for an progressive containment programme.
Sustained control programme	Buddleia could be included in a sustained control programme. As a declared pest it would be banned from sale under the Biosecurity Act. This could help reduce the risk of spread over time.	Buddleia is already banned from sale and distribution in Northland and has been for a number of years so would be no costs to plant retail outlets from a ban. Plant retail outlets are inspected regularly by council staff checking for many different plants.	Moderate. Buddleia could still spread and become more common.
Site-led pest programme	A site-led programme, where control of buddleia is required in defined parts of Northland could reduce the impacts of this species within the programme area(s).	A site-led programme would require an investment of time and resources by the council and affected landowners. It would not reduce or restrict the impacts of broom in areas that are not identified as being of high priority.	Moderate. A site-led programme could effectively reduce or eliminate the adverse effects of broom. But buddleia does appear to be having large impacts in Northland at present and the council has not received any calls about this species in the last few years.
Summary of alternative assessments	Sustained control programme - banned from sale and distribution With regard to section 6(1) of the NPD a low-level analysis was considered appropriate for buddleia. In terms of alternative approaches assessed, under a do-nothing approach there		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
and preferred option:	would be no ability for Council to prevent the formal (nursery trade) or informal (fairs and on-line marketing) trade or circulation of this pest. Buddleia is already naturalised in Northland and its distribution and assessment of effects mean that eradication and progressive containment programmes are not realistic or affordable. Site-led management would control some plants at some sites, but ultimately this approach would also be unsustainable. Sustained control is the preferred outcome and most viable option. Declaring buddleia formally as a pest in the Plan automatically triggers sections 52 and 53 of the Biosecurity Act, banning the pest from sale, propagation and distribution in Northland. This plant is not covered in the current National Pest Plant Accord (NPPA) which has over 150 plants listed, banning them from sale, propagation and distribution nationally. However, the NPPA is nationally focused and doesn't necessarily account for regional differences. The risks of this plant have been evaluated specifically in terms of its effects in Northland. It is important to recognise the wide climate and temperature ranges in New Zealand and that some pests require regional based initiatives based on these factors. Accordingly, buddleia is one of 32 pest plants banned from sale, propagation and distribution in the Northland region. This designation recognises that generally they are a lower risk to the regions' values compared with other more invasive species. Council wishes to take a more proactive stance over their management, as opposed to disregarding them under a do-nothing scenario, while acknowledging it must operate within a finite budget and limited resources. Nurseries in general support the concept of the NPPA and the outcomes being sought.		

Californian thistle

Cirsium arvense

Also known as: California thistle

(Family: Asteraceae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Californian thistle is a perennial thistle, from 50-150cm tall with small purple flowers. No other thistle species in New Zealand is a perennial and it is the only thistle that has a creeping root system. The tendency to grow in patches is another distinguishing feature. The flower heads are smaller than many other thistle species. Scotch thistle usually has small spines on the tops of leaves, unlike Californian thistle.
Habitat	Californian thistle is a particular threat in pasture, riparian habitats, roadsides,and croplands. It does not tolerate shade but can grow on all but waterlogged, poorly aerated soils and has some tolerance to soil salinity. It characteristically grows as patches of plants that are connected by a creeping root system.
Regional distribution	The population of Californian thistles in Northland is not large but is widely scattered throughout the region. There are currently 51 known sites.
Competitive ability	Californian thistle establishes readily and, through rapid rhizome growth, competes with both crop and pasture. Once a plant has established, it forms a patch of plants

	that are initially connected by the creeping root system. These patches eventually get larger. Every winter, the foliage dies off but the creeping root system is still alive underground.
Reproductive ability	Californian thistle spreads primarily through its rhizomes (roots). Root fragments can grow into new plants. It also produces seeds, which contribute to dispersal but do not form persistent seed banks. Vectors of spread: Root fragments may be transported by machinery or in soil. The seeds are dispersed by the wind and may also be transported by water, as a contaminant in agricultural seeds or hay, in stock droppings and on farm machinery.
Resistance to control	Californian thistle is very tenacious and difficult to control once established. There are biocontrol agents available in New Zealand for Californian thistles: • Green thistle beetle (*Cassida rubiginosa*) - adults make some holes in the leaves but the main damage is caused by the larvae which can defoliate plants. Prefers Californian thistle but is likely to attack all thistles to some extent. It was released in Northland at Oneriri in 2013 but has not been recovered from there since, although it is doing well in some other parts of New Zealand. • Scotch thistle gall fly (*Urophora stylata*) - larvae burrow into the seedhead receptacle where their feeding stimulates the plant to form a gall (swelling), affecting seed propduction. This insect prefers Scotch thistle but may also attack Californian thistle. • Several other biocontrol agents have been released in New Zealand but have either failed to establish or are only present in low numbers. Californian thistle infestations can be reduced in pasture by a 2-year defoliation programme, with three defoliations (removing all shoots to ground level) per growing season, and virtually eradicated by a 4-year programme. Defoliation may be achieved by mowing, hard rotational grazing or with herbicide, and as much of the above ground vegetation should be removed as possible for as long as possible. This will minimise root formation and, as a result, minimise the number of shoots that will emerge in the following growing season. Mowing is about 30% more effective when done during rainfall.
Benefits	Thistles are used as both food and medicine.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	Low	High
Sheep and beef	Low	High
Forestry	-	-
Horticulture	-	Low
Native	-	-
Urban	Low	Low
Coastal	Low	Low
Estuarine and marine	-	-

Land use type	Current land use infested	Potential land use
Freshwater/wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	L	M	In addition to reducing pasture production through competition for water, nutrients and minerals, Californian thistle is allelopathic, that is, it may suppress plants that are growing around it. It may scratch grazing animals, resulting in small infections and become a contaminant in hay. However it can be effectively controlled with biocontrol agents or repeated defoliation.	AgPest; Invasive Species Specialist Group; Williams, 2008 (a).
Sheep and beef	L	M	In addition to reducing pasture production through competition for water, nutrients and minerals, Californian thistle is allelopathic, that is, it may suppress plants that are growing around it. It may scratch grazing animals, resulting in small infections and become a contaminant in hay. However it can be effectively controlled with biocontrol agents or repeated defoliation.	AgPest; Invasive Species Specialist Group; Williams, 2008 (a).
Forestry	-	-		
Horticulture	-	M	Californian thistle can occur in horticultural crops, field crops, vineyards and orchards. In the United States, Californian thistle is a host for insects that affect corn and tomatoes and in Bulgaria it is a host for the cucumber mosaic virus.	Invasive Species Compendium; Invasive Species Specialist Group.
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		

Category	Current	Potential	Comment	Source
Water quality	-	-		
Species diversity	-	-	Californian is primarily an agricultural weed.	Williams, 2008(a).
Threatened species	-	-		
Social/cultural				
Human health	-	-		
Recreation	-	-		
Māori culture	-	-		

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the regional council under the pest management plan in relation to this species.	California thistle has the potential to become a serious weed of pasture and horticultural land. If no action is taken it may spread to new sites, with consequent loss of production and increased control costs. However, due to the impacts on agricultural land it is generally dealt with by occupiers as part of usual land management practise. There are also effective biocontrol agents now available.	Low. Californian thistle is a weed of pasture and, as such, there is an incentive for landowners to control it. Therefore, uncontrolled spread is unlikely.
Exclusion programme	Not applicable.	Not applicable.	California thistle is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Californian thistle is widely scattered at multiple sites across the region and there is a high chance that there are unrecorded infestations.
Progressive containment programme	A progressive containment programme would incur some short-term financial cost to the council and landowners, but would aim to confine or reduce the	A progressive containment programme would require an ongoing investment of time and resources from the council and affected landowners. This programme would not aim to	Low. California thistle is an invasive species that primarily spreads vegetatively. Therefore, there is a low risk that a progressive containment programme will

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	distribution of California thistle to current areas over the duration of the plan.	eradicate the species, so control costs would be on-going.	fail to confine the spread and the economic impacts of Californian thistle.
Sustained control programme	A sustained control programme would incur lower short-term financial cost to the council and landowners. It would aim to restrict the spread and impacts of California thistle through rules requiring land occupier control.	This programme would require an investment of time and resources by the council and affected landowners. It would not aim to eradicate the species, so control costs would be on-going and, in future, eradication or containment may no longer be options.	Low. There is some risk that a sustained control programme will fail to manage the spread and the economic costs of this species.
Site-led pest programme	Not applicable.	Not applicable.	Californian thistle is present at many scattered sites so is not a suitable candidate for a site-led programme.
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that Californian thistle does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be <u>no regional intervention</u> for Californian thistle, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding. While Californian thistle has not been afforded pest status in Northland, it may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes. Good neighbour rule test In the previous RPMS a GNR was included for California thistle, however the GNR test for California thistle failed due to the unreasonable cost it would place		

Good neighbour rule test

Before a rule can be identified as a good neighbour rule in a RPMP, the regional council must be satisfied of the matters in subclause (a), (c), and (d) and must comply with the requirements in subclause (b) and (e):	
Tests	
In the absence of the rule, the pest would: • spread to land that is adjacent or nearby within the life of the plan; and • cause unreasonable costs to an occupier of that land.	California thistles spreads primarily through its rhizomes (roots) but it also produces seeds. It could spread to nearby land through wind-dispersed seed, by the movement of root fragments (e.g. on machinery) or by vegetative spread. An invasion of California thistle will accrue costs to a landowner as a result of weed control and lost pasture production.
In determining whether the pest would spread as described in subclause (a) the regional council must consider: • the proximity and characteristics of the adjacent or nearby land; and • the biological characteristics and behaviour of the particular pest (the greater the distance between properties, the more difficult to satisfy the test in subclause (a)).	California thistle is predominantly a weed of pasture. Seeds are dispersed by wind but its main mechanism of spread is through its spreading roots. It would need to be close to a property boundary to spread vegetatively, but it can spread over greater distances by seed.
The land that is adjacent or nearby, as described in subclause (a), must be clear from a pest or, if the pest is present on that land, the occupier of that land must be taking measures to manage the pest or its impacts	In order for the good neighbour rules in the RPMP to apply, it is a requirement that the neighbouring property from where the complaint arises be clear of California thistle or, if California thistle is present, it is actively being controlled.
The rule must not set a requirement on an occupier that is greater than that required to manage the spread of the pest.	It is unreasonable that landowners control California thistle to prevent it from spreading to neighbouring properties.
In determining the rules to be set to manage the costs to an occupier of land that is adjacent or nearby, of the pest spreading, the regional council must consider: • the biological characteristics and behaviour of the particular pest; and • whether the costs of compliance with the rule are reasonable relative to the costs that such an occupier would incur, from the pest spreading, in the absence of a rule.	California thistle is an invasive weed that reduces pasture production and, once established, it is difficult to control. If a landowner does not control California thistle they will incur costs as a result of lost production. In light of this, a requirement for California thistle to be controlled would place an unfair cost on landowners.
Proposed Good neighbour rules discussion: Current RPMS rule: Occupiers are required to kill all individuals of California thistle wherever they occur on the property. Proposed RPMP rule: No regional intervention - Failed GNR test.	

Camphor laurel

Cinnamomum camphora

(Family: Lauraceae)

Status in New Zealand

Relevant biology

Form	Evergreen tree up to 30m high, with a dense and spreading canopy. Leaves are alternate, 5-10cm long and 2.5-5cm wide, and glossy green. Flowers are minute, white, borne on panicles near the ends of branches, hermaphroditic, distinctly odorous and attractive to small flies. Flowers occur in spring with fruit maturing in autumn. Fruit is a round drupe 8-10mm in diameter, green when immature ripening to black, containing a single seed 5mm in diameter. Mature trees can produce up to 100 000 fruit per year. It is easily identified by the pungent camphor odour arising from crushed leaves or exposed wood.
Habitat	Overseas, it is most commonly naturalised in riparian areas and disturbed areas such as roadsides and fence rows. It is also able to naturalise in both disturbed and undisturbed forest and scrubland areas. Prefers fertile, sandy soils. Light-demanding and prefers full sun but will tolerate moderate shade. Tolerates mildly alkaline to moderately acidic soils, also tolerant of mildly saline soils. Does not do well in wet soils. Established trees tolerant of drought and frost to -10°C. Grows well on either flat or sloping sites.
Regional distribution	Widespread throughout Northland, deliberately planted.
Competitive ability	Forms dense monocultures which suppress native regeneration. Possible allelopathic effect, suppressing other plants. Readily colonises exposed fertile soils. Shade-tolerant and known to come up through and replace native forest vegetation in Australia.
Reproductive ability	Mature trees seed prolifically in Australia (up to 100 000 seeds per year). Seeds are dispersed primarily by birds. Seeds also transported by water, which does not reduce germination rates, and intentionally or unintentionally by humans. Seed viability is 70% in the first year, declining rapidly so that few seeds remain viable by the third year.
Resistance to control	Large mature trees are difficult to remove manually.
Benefits	Grown as an ornamental or garden tree. Some evidence for use as facilitation crop for native re-vegetation of farmland in Australia. Camphor essential oil has medicinal value with anti-inflammatory and antiseptic properties. Also has culinary uses and is a component of incense. Camphor wood prized for woodworking.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	Low
Sheep and beef	-	Low
Forestry	-	-

Land use type	Current land use infested	Potential land use
Horticulture	-	Low
Native bush or forests	-	Low
Urban	Low	High
Coastal	-	-
Estuarine and marine	-	-
Freshwater/Wetland	Low	High

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	L	Where established, land is unusable for agriculture or grazing and is expensive to reclaim. Control along fence lines and water courses are an ongoing cost for land owners.	
Sheep and beef	-	L	Where established, land is unusable for agriculture or grazing and is expensive to reclaim. Control along fence lines and water courses are an ongoing cost for land owners.	
Forestry	-			
Horticulture	-	L	Where established, land is unusable for agriculture or grazing and is expensive to reclaim. Control along fence lines and water courses are an ongoing cost for land owners.	
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	L	Leaf litter falling into streams can impact on aquatic communities.	Davies and Boulton 2009

Category	Current	Potential	Comment	Source
Species diversity	-		Develops extensive monospecific stands which prevent regeneration of native trees and shrubs. Leaf litter and roots contain allelochemicals (terpenes) capable of restricting growth of other species, even after removal.	Firth 1979 (in Davies and Boulton 2009); Murray and Ramey 2003; Weber 2003.
Threatened species	-			
Social/cultural				
Human health	-	L	Fruits, leaves, and roots are toxic to humans in large doses. They contain chemicals that stimulate the central nervous system and may affect respiration or cause convulsions.	LCD 2000
Recreation	-			
Māori culture	-			

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council in relation to this species. Rather than applying a programme under the regional pest management plan, the species could come under a 'Connecting Communities' programme outside of the pest management plan, where advice and support are provided for specific sites. This will provide support to communities as and where the species is having impacts.	Camphor laurel is already present in Northland. If no action is taken it may spread, with consequent environmental impacts and future control costs.	Moderate. If no action is taken, existing infestations of camphor laurel may expand and it may spread to new sites.
Exclusion programme	Not applicable	Not applicable	Exclusion is not an option because camphor laurel is already present in Northland.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Eradication programme	Not applicable	Not applicable	Camphor laurel is present throughout the region so would not be suitable for an eradication programme.
Progressive containment programme	Not applicable	Not applicable	Camphor laurel is present throughout the region so would not be suitable for a progressive containment programme.
Sustained control programme	Camphor laurel could be included in a sustained control programme. As a declared pest it would be banned from sale under the Biosecurity Act. This could help reduce the risk of spread over time.	A site-led programme would require a significant investment of time and resources by the council and affected landowners. It would not reduce or restrict the impacts of camphor. Placement in this category would see the plant banned from sale and distribution.	Camphor laurel is present throughout the region so would not be suitable for a sustained control programme. It would still spread and become more common.
Site-led pest programme	A site-led programme, where control of camphor laurel is required in defined parts of Northland could reduce the impacts of this species within the programme area(s).	A site-led programme would require a significant investment of time and resources by the council and affected landowners. It would not reduce or restrict the impacts of camphor laurel in areas that are not identified as being of high priority.	Moderate. A site-led programme could effectively reduce or eliminate the adverse effects of camphor laurel in some areas.
Summary of alternative assessments and preferred option:	Sustained control programme - banned from sale and distribution With regard to section 6(1) of the NPD a low-level analysis was considered appropriate for camphor laurel. In terms of alternative approaches assessed, under a do-nothing approach there would be no ability for Council to prevent the formal (nursery trade) or informal (fairs and on-line marketing) trade or circulation of this pest. Camphor laurel is already naturalised in Northland and its distribution and assessment of effects mean that eradication and progressive containment programmes are not realistic or affordable. Site-led management would control some plants at some sites, but ultimately this approach would also be unsustainable. Sustained control is the preferred outcome and most viable option. Declaring camphor laurel formally as a pest in the Plan automatically triggers sections 52 and 53 of the Biosecurity Act, banning the pest from sale, propagation and distribution in Northland. This plant is not covered in the current National Pest Plant Accord (NPPA) which has over 150 plants listed, banning them from sale, propagation and distribution nationally. However, the NPPA is nationally focused and doesn't necessarily account for regional differences. The risks of this plant have been evaluated specifically in terms of its effects in Northland. It is important to recognise the wide climate and temperature ranges in New Zealand and that some pests require regional based initiatives based on these factors. Accordingly, camphor laurel is one of 32 pest plants banned from sale, propagation and distribution in the Northland region. This designation recognises that generally they are a lower risk to the regions' values compared with other more invasive species. Council wishes		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	to take a more proactive stance over their management, as opposed to disregarding them under a do-nothing scenario, while acknowledging it must operate within a finite budget and limited resources. Nurseries in general support the concept of the NPPA and the outcomes being sought.		

Cape honey flower

Melianthus major

Also known as giant honey flower, honey bush, false caster oil plant.

(Family: Melianthaceae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Cape honey flower is a smelly, clump-forming shrub to approximately 2m tall, with stout, rough, soft-wooded, hollow stems and a suckering root system. It has frond-like leaves divided into 11-21 distinctively folded leaflets and covered in grey, hairy down especially underneath. Tall, erect flower stalks have foul smelling, dark reddish-brown flowers from July to April, followed by inflated, papery, sharply-angled seed capsules containing long, shiny black seeds.
Habitat	Sand dunes, sheltered coastal and steep areas, estuaries, inshore islands, disturbed lowland forest margins, shrubland, and fernland, especially on the east coast. Also gardens, waste places and roadsides.
Regional distribution	Common in northern North Island, with some large infestations on coastal sands.
Competitive ability	Cape honey flower grows in well drained soils of any quality. It tolerates wind, salt, hot and cold temperatures, and damp or drought conditions, and is partly shade-tolerant. It is poisonous and not grazed by stock.
Reproductive ability	Seeds are long-lived and it forms dense, spreading stands via suckering roots. Vectors of spread: Seed capsules are water-borne (sea or fresh) and some are wind-borne. Suckering roots are spread in dumped vegetation. Common sources are gardens, waste places and tips.
Resistance to control	Small plants can be dug out. Plants can be cut down and stump painted, or sprayed. Suckering shoots will regrow after control and need ongoing follow up. These roots re-sprout profusely.
Benefits	Ornamental.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	Low	Low
Horticulture	-	-
Native bush or forests	Low	Low
Urban	High	High
Coastal	High	High
Estuarine and marine	Low	Low
Freshwater/Wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	L	L	It is poisonous, and not grazed by stock.	Auckland Council; Weedbusters.
Sheep and beef	L	L	It is poisonous, and not grazed by stock.	Auckland Council; Weedbusters.
Forestry	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	L	L	Cape honey flower can smother low-growing coastal species, forming large stands and destroying habitats, often leading to subsequent invasion by weedy vines. Native birds may be affected by the nectar.	Auckland Council; Weedbusters.

Category	Current	Potential	Comment	Source
Threatened species	L	L	As above.	
Social/cultural				
Human health	-	-		
Recreation	-	-		
Māori culture	L	L	Impacts upon native/taonga species.	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council in relation to this species. Rather than applying a programme under the Regional Pest Management Plan, the species could come under a 'Connecting Communities' programme outside the pest management plan, where advice and support are provided for specific sites. This will provide support to communities as and where the species is having impacts.	Cape honey flower is already present in Northland. If no action is taken it will continue to spread, with consequent environmental impacts and future control costs.	Low. If no action is taken, existing infestations of Cape honey flower may expand and it may spread to new sites.
Exclusion programme	Not applicable.	Not applicable.	Cape honey flower is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Cape honey flower is present throughout the region so would not be suitable for an eradication programme.
Progressive containment programme	Not applicable.	Not applicable.	Cape honey flower is present throughout the region so would not be suitable for an progressive containment programme.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Sustained control programme	Cape honey flower could be included in a sustained control programme. As a declared pest it would be banned from sale under the Biosecurity Act. This could help reduce the risk of spread over time.	Cape honey flower is already banned from sale and distribution in Northland and has been for a number of years so would be no costs to plant retail outlets from a ban. Plant retail outlets are inspected regularly by council staff checking for many different plants.	Moderate. Cape honey flower could still spread and become more common.
Site-led pest programme	A site-led programme, where control of Cape honey flower is required in defined parts of Northland could reduce the impacts of this species within the programme area(s).	A site-led programme would require an investment of time and resources by the council and affected landowners. It would not reduce or restrict the impacts of Cape honey flower in areas that are not identified as being of high priority.	Moderate. A site-led programme could effectively reduce or eliminate the adverse effects of Cape honey flower . But Cape honey flower does appear to be having large impacts in Northland at present and the council has not received any calls about this species in the last few years.
Summary of alternative assessments and preferred option:	Sustained control - banned from sale and distribution With regard to section 6(1) of the NPD a low-level analysis was considered appropriate for Cape honey flower. In terms of alternative approaches assessed, under a do-nothing approach there would be no ability for Council to prevent the formal (nursery trade) or informal (fairs and on-line marketing) trade or circulation of this pest. Cape honey flower is already naturalised in Northland and its distribution and assessment of effects mean that eradication and progressive containment programmes are not realistic or affordable. Site-led management would control some plants at some sites, but ultimately this approach would also be unsustainable. Sustained control is the preferred outcome and most viable option. Declaring Cape honey flowerformally as a pest in the Plan automatically triggers sections 52 and 53 of the Biosecurity Act, banning the pest from sale, propagation and distribution in Northland. This plant is not covered in the current National Pest Plant Accord (NPPA) which has over 150 plants listed, banning them from sale, propagation and distribution nationally. However, the NPPA is nationally focused and doesn't necessarily account for regional differences. The risks of this plant have been evaluated specifically in terms of its effects in Northland. It is important to recognise the wide climate and temperature ranges in New Zealand and that some pests require regional based initiatives based on these factors. Accordingly, Cape honey flower is one of 32 pest plants banned from sale, propagation and distribution in the Northland region. This designation recognises that generally they are a lower risk to the regions' values compared with other more invasive species. Council wishes to take a more proactive stance over their management, as opposed to disregarding them under a do-nothing scenario, while acknowledging it must operate within a finite budget and limited resources. Nurseries in general support the concept of the NPPA and the outcomes being sought.		

Cape ivy

Senecio angulatus

(Family:)

Status in New Zealand

Relevant biology

Form	Cape ivy is a hairless, scrambling, perennial plant which often forms a dense tangled shrub 2-3m tall. It can form a vine able to climb up to 5m. It has wiry to woody stems with few branches and very fleshy, leathery leaves with coarse serrations on each side. Dense clusters of yellow, ragwort-like flowers are produced from March to August, followed by fluffy seeds.
Habitat	Grows in drier, more open sites, including waste places and scrubland, especially near the sea. Coastal, rocky areas, cliffs, bush edges, regenerating lowland forests and inshore islands.
Regional distribution	Established locally in coastal areas throughout the North Island.
Competitive ability	Cape ivy can become an aggressive weed once established and can scramble over large trees. It has a moderate growth rate with layering stems, which scramble over shrubs and the ground forming dense, tall thickets. Tolerates salt, wind, drought, semi-shade and damage. Has demonstrated an ability to escape, naturalise and spread in several other countries.
Reproductive ability	It produces many long-lived seeds that are dispersed a long way from parent plants Vectors of spread: Wind spreads the seed, and seed and fragments are spread in dumped vegetation and soil movement. Common sources include waste places, roadsides, bush edges and gardens.
Resistance to control	Best controlled at flowering when it is highly visible, and before seed is produced. Plants can be hand pulled, cat and stump painted or sprayed. Cut stumps and dropped stems can re-sprout, and bared areas re-seed.
Benefits	Ornamental.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	Low	Low
Horticulture	-	-
Native bush or forests	Low	Low
Urban	High	High

Land use type	Current land use infested	Potential land use
Coastal	High	High
Estuarine and marine	-	-
Freshwater/Wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	L	Senecio species in general are known to be toxic to stock.	
Sheep and beef	-	L	Senecio species in general are known to be toxic to stock.	
Forestry	L	L	It readily forms dense infestations in open/disturbed areas, particularly coastal environments.	Williams and Hayes, 2007.
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-			
Water quality	-			
Species diversity	L	L-M	Cape ivy smothers ground and low growing plants to 3m tall, forming dense, long-lived mats that prevent the establishment of native plant seedlings. It readily forms dense infestations in open/disturbed areas, particularly coastal environments. It forms dense vine tangles and mats, and can change community structure, alter species composition and reduce regeneration of native species.	Weedbusters; Williams and Hayes, 2007.
Threatened species	L	L-M	As above, likely to threaten rare species.	Weedbusters; Williams and Hayes, 2007.

Category	Current	Potential	Comment	Source
Social/cultural				
Human health	-	L	Senecio species in general are known to be toxic to humans.	
Recreation	-	-		
Māori culture	L	L	Impacts upon native/taonga species.	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council in relation to this species. Rather than applying a programme under the Regional Pest Management Plan, the species could come under a 'Connecting Communities' programme outside the pest management plan, where advice and support are provided for specific sites. This will provide support to communities as and where the species is having impacts.	Cape ivy is already present in Northland but is not usually seen dominating large areas. If no action is taken it may spread, with consequent environmental impacts and future control costs.	Low. If no action is taken, existing infestations of Cape ivy may expand and it may spread to new sites.
Exclusion programme	Not applicable.	Not applicable.	Cape ivy is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Cape ivy is present throughout the region so would not be suitable for an eradication programme.
Progressive containment programme	Not applicable.	Not applicable.	Cape ivy is present throughout the region so would not be suitable for an progressive containment programme.
Sustained control programme	Cape ivy could be included in a sustained control programme. As a declared pest it would be banned from	Cape ivy is already banned from sale and distribution in Northland and has been for a number of years so would	Moderate. Cape ivy could still spread and become more common.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	sale under the Biosecurity Act. This could help reduce the risk of spread over time.	be no costs to plant retail outlets from a ban. Plant retail outlets are inspected regularly by council staff checking for many different plants.	
Site-led pest programme	A site-led programme, where control of Cape ivy is required in defined parts of Northland could reduce the impacts of this species within the programme area(s).	A site-led programme would require an investment of time and resources by the council and affected landowners. It would not reduce or restrict the impacts of Cape ivy in areas that are not identified as being of high priority.	Moderate. A site-led programme could effectively reduce or eliminate the adverse effects of Cape ivy.
Summary of alternative assessments and preferred option:	Sustained control programme - banned from sale and distribution With regard to section 6(1) of the NPD a low-level analysis was considered appropriate for Cape ivy. In terms of alternative approaches assessed, under a do-nothing approach there would be no ability for Council to prevent the formal (nursery trade) or informal (fairs and on-line marketing) trade or circulation of this pest. Cape ivy is already naturalised in Northland and its distribution and assessment of effects mean that eradication and progressive containment programmes are not realistic or affordable. Site-led management would control some plants at some sites, but ultimately this approach would also be unsustainable. Sustained control is the preferred outcome and most viable option. Declaring Cape ivy formally as a pest in the Plan automatically triggers sections 52 and 53 of the Biosecurity Act, banning the pest from sale, propagation and distribution in Northland. This plant is not covered in the current National Pest Plant Accord (NPPA) which has over 150 plants listed, banning them from sale, propagation and distribution nationally. However, the NPPA is nationally focused and doesn't necessarily account for regional differences. The risks of this plant have been evaluated specifically in terms of its effects in Northland. It is important to recognise the wide climate and temperature ranges in New Zealand and that some pests require regional based initiatives based on these factors. Accordingly, Cape ivy is one of 32 pest plants banned from sale, propagation and distribution in the Northland region. This designation recognises that generally they are a lower risk to the regions' values compared with other more invasive species. Council wishes to take a more proactive stance over their management, as opposed to disregarding them under a do-nothing scenario, while acknowledging it must operate within a finite budget and limited resources. Nurseries in general support the concept of the NPPA and the outcomes being sought.		

Cape tulip

Moraea flaccida

Also known as: *Moraea collina, Homeria collina.*

(Family: Iridaceae)

Status in New Zealand

Cape tulip is listed as an unwanted organism under the Biosecurity Act 1993, is a notifiable organism (Biosecurity (Notifiable Organisms) Order 2010), is listed in the National Pest Plant Accord 2012. It is also one of eleven pest species that are part of the National Interest Pests Response.

Relevant biology

Form	Cape tulip is a perennial herb in the iris family. It produces shoots in winter, and dies back to an underground corm in early summer. Plants grow to 90cm tall, with a single strap-like leaf and a branched, zig-zagged flower stalk. Flowers are 6-petalled, usually salmon pink with a band of deeper colour near the base of the petals, with or without a yellow centre, but rarely all yellow or deeper red. Flowers are usually 5cm across. The seeds are produced in narrow, green capsules, up to 5cm long.
Habitat	Cape tulip grows best in open environments, such as grasslands and pasture.
Regional distribution	Cape tulip is present in grassland and coastal shrubland at Woolleys Bay, north of Whāngārei, where it is being controlled. It had been recorded here prior to 1980 (Edgar and Healy, 1980).
Competitive ability	Cape tulip has the potential to establish dense colonies over wide areas of pasture, and could have a serious economic impact on agriculture if it were to become widely established.
Reproductive ability	Cape tulip reproduces by both corms and seeds (3000 to 6000 per plant). Corms may be abundant and occur to a depth of 30cm. They can remain dormant in the soil, in a viable state, for at least eight years. The mature stems, which are brittle when dry, snap off and are blown by the wind, shedding seed from the capsules. Vectors of spread: both corms and seeds are dispersed by run-off water and in mud on animals, implements and vehicles. Seeds and stems are also wind-dispersed.
Resistance to control	Cape tulip is extremely difficult to control as corms may remain dormant in the soil for at least eight years.
Benefits	Ornamental.

Land uses occupied

Land use type	Current land use infested	Potential land use infested
Dairy	-	High
Sheep and beef	-	High
Forestry	-	-
Horticulture	-	-
Native	Low	Low
Urban	-	High
Coastal	Low	Low
Estuarine and marine	-	-
Freshwater/wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	H	Cape tulip grows best in open environments, such as grasslands and pasture, where it competes with and replaces desirable plants. All parts of the plant are toxic to sheep and cattle.	Healey and Edgar, 1980.
Sheep and beef	-	H	Cape tulip grows best in open environments, such as grasslands and pasture, where it competes with and replaces desirable plants. All parts of the plant are toxic to sheep and cattle.	Healey and Edgar, 1980.
Forestry	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	L	M	Cape tulip grows best in open environments, such as grasslands and pasture. Therefore, it may also compete in disturbed indigenous habitats.	Healey and Edgar, 1980.
Threatened species	-	L	Cape tulip grows best in open environments, such as grasslands and pasture. Therefore, it may also compete with any threatened species that occur in disturbed indigenous habitats.	Healey and Edgar, 1980.
Social/cultural				
Human health	-	L	All parts of the plant are toxic to people. All parts of the cape tulip are poisonous (even when dead and dried). Symptoms of poisoning include gastroenteritis, thirst, paralysis, blindness and heart and kidney failure.	Healey and Edgar, 1980.
Recreation	-	-	May affect recreational or aesthetic enjoyment of natural areas.	
Māori culture	-	-	Potential impacts on native/taonga species.	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial cost to the council associated with control of this species.	Cape tulip is currently known from only one location in Northland, and control is managed by MPI contractors. It is an invasive species with the potential to spread through pastoral land causing loss of production. The economic costs of lost production and delaying control until there are larger/more infestations is potentially considerable. Although control is currently undertaken by the Ministry for Primary Industries, there would be limited public awareness of Cape tulip and if it is not in the pest management plan and there would be no rules to prevent possession of the species in Northland.	Medium. Cape tulip is currently managed by the ministry, control would continue even if it wasn't in the regional council's pest management plan. If the ministry programme changed and Cape tulip was not managed, the existing infestation area is likely to increase and it may spread to new sites. Without education and regulation there is a medium risk that Cape tulip could spread more widely in Northland.
Exclusion programme	Not applicable.	Not applicable.	Exclusion is not an option because Cape tulip is already present in Northland.
Eradication programme	Cape tulip is currently present in low numbers at only one site. If the species could be eradicated before it spreads elsewhere, it would prevent long-term impacts and financial costs.	Eradication of Cape tulip is currently being undertaken by Ministry for Primary Industries contractors so would not currently require an investment of resources to control the known infestation and undertake on-going surveys to ensure all plants have been removed and there is no regrowth.	Low. There is a moderate risk of an eradication programme failing in the short-medium term because, while there is only one small infestation of this species known in Northland, it was first recorded at the site prior to 1980. The corms can persist for many years so eradication may only be achieved in the longer-term.
Progressive containment programme	Not applicable.	Not applicable.	There is only one known site in Northland and it is very small.
Sustained control programme	Not applicable.	Not applicable.	There is only one known site in Northland and it is very small.
Site-led pest programme	Not applicable.	Not applicable.	There is only one known site in Northland and it is very small.
Summary of alternative assessments	**Eradication programme** In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for cape tulip. In terms of alternative approaches assessed, under <u>no regional intervention</u> (or do nothing), there would be unacceptable loss of regional production		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
and preferred option:	values. There would also be moderate political concerns and some alarm from the farming sector as control has been regularly carried out to control cape tulip. MPI currently manages this pest in the region and NRC is a key stakeholder interested in the outcomes of control operations. Under a 'do nothing' scenario by council the relationship with MPI might diminish, although MPI control would likely continue in the absence of the Plan. There would probably be no direct cost on regional occupiers as cape tulip is part of a nationally funded pest programme. However, if MPI withdrew from the management of cape tulip it is unclear which agency would be left to manage control in the region. By default, NRC would probably be expected to pick up management, therefore inclusion now of cape tulip in the Plan is prudent. Further, under a 'do nothing' scenario, NRC could rely on current non-regulatory methods such as advocacy and education and site-led management, but loses the tools and powers to impose penalties or do certain things, in relation to accidental or deliberate spread of cape tulip, for example, to areas that might be outside of the current MPI funded programme. Progressive containment or sustained control approaches would not be appropriate as the plant is only found at one site out of all the areas suitable for it to spread to in Northland. It would be risky relying on 'lesser' management options when eradication is deemed achievable, despite a lack of knowledge regarding its impacts among occupiers and the technical difficulty around its control. Eradication is the preferred outcome and MPI service delivery is the immediate control measure proposed. Council inspection costs involved under an eradication programme are currently nil and even if control reverted to Council the costs would be minor compared with the costs of cape tulip becoming established.		

Cathedral bells

Cobaea scandens

Also known as: cup and saucer vine, monastery bells

(Family: Polemoniaceae)

Status in New Zealand

Cathedral bells is an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Cathedral bells is a fast-growing evergreen vine that climbs over trees and shrubs and can grow to 6m tall. The leaves usually occur as three pairs of oval leaflets that are whitish underneath and dark green above with twining tendrils growing from the midrib. It has angled stems. The bell-shaped flowers are green when young but turn purple as they mature (that is, after the pollen has been shed). The 'fruit' are hard, oval capsules that are usually 5.5-8.5cm long and split into sections to release numerous winged seeds.
Habitat	Cathedral bells grows over trees and shrubs in forest margins, roadsides, riverbanks, gardens, hedges, shelter belts and open areas.
Regional distribution	There is one known known site of cathedral bells in Northland near Ngunguru, and it is in Auckland.

Competitive ability	Cathedral bells can grow over trees and shrubs, forming a dense canopy that out-competes desirable plants by smothering them. It is tolerant of a range of soil conditions and light levels, including partial shade.
Reproductive ability	Cathedral bells can produce large numbers of viable seeds, which are spread over short distances by wind and over longer distances by water. Any vines that touch the ground can grow roots and it can re-grow from stem fragments. **Vectors of spread:** seeds can spread by wind or water but the most common method of spread is through dumping of vegetation or movement of soil that contains plant fragments. Its climbing and creeping habit also enables it to spread and it could also be spread intentionally for ornamental purposes.
Resistance to control	Cut stumps can re-sprout very quickly, and plant fragments and stems that touch the ground can grow roots. Therefore, stumps need to be swabbed with herbicide and plant material needs to be disposed of carefully.
Benefits	Perceived to have aesthetic appeal when cultivated in gardens.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	Low
Sheep and beef	-	Low
Forestry	-	High
Horticulture	-	High
Native	-	High
Urban	-	High
Coastal	-	-
Estuarine and marine	-	-
Freshwater/wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	L	Intensively grazed grassland is not a preferred habitat of cathedral bells.	Weedbusters.
Sheep and beef	-	L	Intensively grazed grassland is not a preferred habitat of cathedral bells.	Weedbusters.

Category	Current	Potential	Comment	Source
Forestry	-	M	Cathedral bells can establish on forest margins.	Weedbusters.
Horticulture	-	M	Cathedral bells could establish within shelter belts or hedges.	
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	H	Vines smother indigenous plants and modify natural areas, reducing species diversity.	Ministry for Primary Industries; Waikato Regional Council fact sheet.
Threatened species	-	H	Vines smother native plants, including threatened species.	Ministry for Primary Industries; Waikato Regional Council fact sheet.
Social/cultural				
Human health	-	-		
Recreation	-	L	May affect recreational or aesthetic enjoyment of natural areas.	
Māori culture	-	M	Potential impacts on native/taonga species	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	Cathedral bells is only present at two known sites in Northland. If neighbouring regions were relied on to control the species there would be no economic cost to the Northland region.	There would be limited public awareness of cathedral bells and a risk that it would be intentionally introduced for ornamental reasons. If it is not in the pest management plan there would be no rules to prevent	Medium-high. Without education and regulation there is a medium-high risk that cathedral bells could establish and spread widely in Northland.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
		possession of the species in Northland.	
Exclusion programme	Not applicable.	Not applicable.	Cathedral bells is present in Northland.
Eradication programme	Public awareness and education about the risks and impacts this species could have in Northland, and a rule banning possession of the species in Northland could prevent it from establishing in the region. As well as control of any infestations found.	There is already educational material available for cathedral bells. There are two known sites, both discovered during 2016, which are now part of a control programme. Eradicating this species would prevent greater expenditure on its control in the future as it invades Northland.	Low. People will be aware of the species and its potential impacts. There will be a rule banning possession of the species in Northland, which could help discourage people from bringing it to Northland and allow immediate control should any further infestations be found.
Progressive containment programme	Not applicable.	Not applicable.	There are only two known sites of cathedral bells in Northland, so a progressive containment programme is not appropriate.
Sustained control programme	Not applicable.	Not applicable.	There are only two known sites of cathedral bells in Northland, so a sustained control programme is not appropriate.
Site-led pest programme	Not applicable.	Not applicable.	There are only two known sites of cathedral bells in Northland, so a site-led programme is not appropriate.
Summary of alternative assessments and preferred option:	Eradication programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for cathedral bells. In terms of alternative approaches assessed, under no regional intervention (or do nothing), there would be unacceptable loss of biodiversity values if cathedral bells was allowed to spread unimpeded from the current known sites. There would also be moderate to high public or political concerns expressed by environmental and community groups, with the knowledge that eradication of the vine is feasible. A 'no intervention' approach could appeal to a minority in the community that might perceive the plant as a garden ornamental but this is viewed as a low risk. Progressive containment or sustained control approaches would not be appropriate as the plant is very limited in distribution and occupies only one small area of all the suitable habitat in the region. Accordingly, it would be risky relying on 'lesser' management options when eradication/zero density is readily achievable. Another compounding issue in relying on occupier or voluntary control is that, like most vigorous growing exotic vines, successful control may be problematic, requiring multiple visits to the treatment sites. Land occupier control would over time be costlier to oversee and inspect and is unlikely to be successful. These operational risks would compromise the outcomes that would be sought under these two lesser scenarios. Eradication is the preferred outcome and is realistic given the plants' current distribution. NRC will undertake direct control of cathedral bells wherever it occurs in the region (through its service delivery programme). The control costs involved under an eradication programme		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	are relatively minor compared to the perceived ecological benefits and are not expected to affect control outcomes.		

Century plant

Agave americana

(Family: Agavaceae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Century plant is a very large, distinctive-looking succulent plant. It doesn't have a stem so the bases of the leaves are at ground level, like those of a flax. The leaves are up to 2m long, fleshy and triangular in cross section. They are grey-green in colour and have coarse, spiky teeth on their margins. After 10 to 15 years, century plant produces a large, woody spike up to 10m tall with many yellow flowers at the tip. Black seeds are produced in 5cm-long capsules.
Habitat	Century plant thrives in open, dry sites, such as coastal cliffs and sand dunes.
Regional distribution	Century plant is scattered through Northland on dunes and in urban areas.
Competitive ability	Young plants are tolerant of salt water. Century plant can out-compete dune plants but it requires open sites, is slow-growing and dies after flowering.
Reproductive ability	Century plant can spread both vegetatively and by seed but in New Zealand it does not appear to spread readily from seed. It can spread laterally through its root system and vegetatively from runners that detach from the parent plant. Vectors of spread: Plants and plant fragments are distributed by people and water.
Resistance to control	Century plant is readily identifiable and can be controlled using physical and/or chemical methods.
Benefits	Century plant has ornamental and medicinal uses.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	-	-
Horticulture	-	-
Native bush or forests	-	-

Land use type	Current land use infested	Potential land use
Urban	High	High
Coastal	High	High
Estuarine and marine	-	Low
Freshwater/wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-	Century plant does not impact upon agriculture in New Zealand.	Williams, 2008.
Sheep and beef	-	-	Century plant does not impact upon agriculture in New Zealand.	Williams, 2008.
Forestry	-	L	Century plant thrives in open, dry sites, such as coastal cliffs and sand dunes. There is limited potential for it to establish in production forests on sand dunes.	
Horticulture	-	-	Century plant thrives in open, dry sites, such as coastal cliffs and sand dunes. Therefore, it is unlikely to invade horticultural land.	
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	L	Century plant grows on sand dunes where it can alter the movement of mobile sands.	Williams, 2008.
Water quality	-	-		
Species diversity	-	M	Century plant can shade out native plants.	Williams, 2008.
Threatened species	-	M	Century plant can shade out native plants including, potentially, threatened species.	Williams, 2008.

Category	Current	Potential	Comment	Source
Social/cultural				
Human health	L	L	Spines can cause injuries, which become infected. Children have been poisoned by the fruit.	Williams, 2008.
Recreation	L	M	Century plant is visually intrusive so can reduce the aesthetic values of natural areas.	Williams, 2008.
Māori culture	L	M	Impacts upon native/taonga species.	

L = low; M= moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council in relation to this species. Rather than applying a programme under the Regional Pest Management Plan, the species could come under a 'Connecting Communities' programme outside the pest management plan, where advice and support are provided for specific sites. This will provide support to communities as and where the species is having impacts.	Century plant is already present in Northland but is not usually seen dominating large areas. If no action is taken it may spread, with consequent environmental impacts and future control costs.	Low. If no action is taken, existing infestations of century plant may expand and it may spread to new sites.
Exclusion programme	Not applicable.	Not applicable.	Century plant is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Century plant is present throughout the region so would not be suitable for an eradication programme.
Progressive containment programme	Not applicable.	Not applicable.	Century plant is present throughout the region so would not be suitable for a progressive containment programme.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Sustained control programme	Century plant could be included in a sustained control programme. As a declared pest it would be banned from sale under the Biosecurity Act. This could help reduce the risk of spread over time.	Century plant is already banned from sale and distribution in Northland and has been for a number of years so would be no costs to plant retail outlets from a ban. Plant retail outlets are inspected regularly by council staff checking for many different plants.	Moderate. Century plant could still spread and become more common.
Site-led pest programme	A site-led programme, where control of century plant is required in defined parts of Northland could reduce the impacts of this species within the programme area(s).	A site-led programme would require an investment of time and resources by the council and affected landowners. It would not reduce or restrict the impacts of century plant in areas that are not identified as being of high priority.	Moderate. A site-led programme could effectively reduce or eliminate local adverse effects of century plant.
Summary of alternative assessments and preferred option:	Sustained control programme - banned from sale and distribution With regard to section 6(1) of the NPD a low-level analysis was considered appropriate for century plant. In terms of alternative approaches assessed, under a do-nothing approach there would be no ability for Council to prevent the formal (nursery trade) or informal (fairs and on-line marketing) trade or circulation of this pest. Century plant is already naturalised in Northland and its distribution and assessment of effects mean that eradication and progressive containment programmes are not realistic or affordable. Site-led management would control some plants at some sites, but ultimately this approach would also be unsustainable. Sustained control is the preferred outcome and most viable option. Declaring century plant formally as a pest in the Plan automatically triggers sections 52 and 53 of the Biosecurity Act, banning the pest from sale, propagation and distribution in Northland. This plant is not covered in the current National Pest Plant Accord (NPPA) which has over 150 plants listed, banning them from sale, propagation and distribution nationally. However, the NPPA is nationally focused and doesn't necessarily account for regional differences. The risks of this plant have been evaluated specifically in terms of its effects in Northland. It is important to recognise the wide climate and temperature ranges in New Zealand and that some pests require regional based initiatives based on these factors. Accordingly, century plant is one of 32 pest plants banned from sale, propagation and distribution in the Northland region. This designation recognises that generally they are a lower risk to the regions' values compared with other more invasive species. Council wishes to take a more proactive stance over their management, as opposed to disregarding them under a do-nothing scenario, while acknowledging it must operate within a finite budget and limited resources. Nurseries in general support the concept of the NPPA and the outcomes being sought.		

Chilean rhubarb

Gunnera tinctoria

(Family: Gunneraceae)

Status in New Zealand

Chilean rhubarb is listed as an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Chilean rhubarb is a giant, rhubarb-like herb with huge prickly leaves that can reach up to 2.5m tall. In winter it dies back to large creeping stems and large, sausage-like flower spikes that are up to 1m tall. The spikes are covered in little flowers that are followed by tiny orange fruits.
Habitat	In New Zealand, Chilean rhubarb mainly occupies damp sites on wetland and riparian margins, coastal cliffs, moist banks and disturbed sites. It often grows in light shade. It is scattered throughout New Zealand but is most common in high rainfall areas, such as South Taranaki and Westland.
Regional distribution	Chilean rhubarb is present in Northland, both in gardens and in the wild. In the east there is the occasional plant that has "escaped" into the wild but in the west, in the high rainfall area around Waimamaku, it is present in small amounts in pastures, wetlands, riverbanks and even forests.
Competitive ability	Chilean rhubarb is extremely tolerant of salt, a wide variety of soil conditions, and very wet swampy sites and seasonally wet ground. It produces abundant fruit, which are dispersed by birds, and forms dense patches that exclude virtually all other plants.
Reproductive ability	Chilean rhubarb produces large amounts of viable seed. There is no information about seed longevity. Once established, infestations can increase in size from the massive, spreading roots and it also grows readily from any stem fragments which break off the plants. Vectors of spread: The seeds of Chilean rhubarb are spread by birds and water. Seeds and rhizomes (roots) are also spread deliberately by humans (for ornamental purposes and inadvertently in garden waste and soil. Stem fragments can break off plants and tumble down steep slopes or be transported by water.
Resistance to control	Chilean rhubarb can be controlled manually, mechanically or chemically depending on situation.
Benefits	Chilean rhubarb is cultivated for ornamental purposes.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	Low	High
Sheep and beef	-	-

Land use type	Current land use infested	Potential land use
Forestry	-	-
Horticulture	-	-
Native bush or forests	Low	Low
Urban	Low	Low
Coastal	Low	High
Estuarine and marine	-	-
Freshwater/Wetland	Low	High

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	L	L	Chilean rhubarb is a large, prickly plant. As such, it can exclude other species, including pasture plants, and impede access.	Williams et al., 2005.
Sheep and beef	-	-		
Forestry	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	L	H	Chilean rhubarb is a weed of conservation concern. It competes directly with native species for space and light, can persist at sites and excludes native species.	Williams et al., 2005.
Threatened species	L	H	Chilean rhubarb can exclude low-growing threatened plants in communities such as coastal turfs, coastal cliffs and wetland	Williams et al., 2005.

Category	Current	Potential	Comment	Source
			herbfields. This has been observed in Taranaki and Wanganui.	
Social/cultural				
Human health	-	-		
Recreation	-	L	Chilean rhubarb is a large, rough textured plant that may impede access to waterways and wetlands.	
Māori culture	-	M	Impacts upon native/taonga species.	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs to the council under the RPMP associated with this species.	Chilean rhubarb has a limited distribution in Northland but it spreads readily from seed and is deliberately spread and cultivated for ornamental purposes. The economic and environmental costs of waiting and controlling larger/more infestations is potentially considerable.	High. If Chilean rhubarb is not managed the species has the potential to spread to additional sites in Northland and for its impacts to increase at sites where it is already present. It could be spread deliberately for cultivation as an ornamental garden plant.
Exclusion programme	Not applicable.	Not applicable.	Exclusion is not an option because Chilean rhubarb is already present in Northland.
Eradication programme	Chilean rhubarb is currently present at a reasonably limited number of known sites. It is more of a risk in high rainfall areas, and could be included in an eradication programme in those areas. This could include a rule banning possession of the species in those areas. This would significantly reduce the risks posed by Chilean rhubarb.	Eradication of Chilean rhubarb at high risk sites would require an investment of resources to control known plants and undertake on-going surveys to ensure all plants have been removed and there is no regrowth. This would help avoid long-term economic and environmental impacts in high risk areas.	Moderate. There is a moderate risk of the programme being unsuccessful if inadequate resources are allocated for control and surveillance or if there are undetected infestations or plantings.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Progressive containment programme	A progressive containment programme would incur lower financial cost to the regional council in the short-term and would aim to confine the impacts of Chilean rhubarb to current infestation areas, and gradually reduce the population. Initial focus could be on the high rainfall areas. Rules requiring land occupier control on all properties could be included.	Chilean rhubarb is an invasive species that is already present in Northland. If/when it does become more widely established, eradication and containment may no longer be options and there will be long-term financial and environmental costs associated with the species. Council resources would be required to undertake surveys and control outside of the containment zone/s.	Moderate. There is a moderate to high risk that a progressive containment programme will not prevent Chilean rhubarb from spreading within Northland. It produces large numbers of viable seeds and is also spread by humans, both deliberately and inadvertently.
Sustained control programme	A sustained control programme would incur lower financial cost to the regional council in the short-term, and would aim to restrict the spread and impacts of Chilean rhubarb. This could include a boundary control rule, requiring clearance a certain distance from property boundaries where the neighbouring property is clear or being cleared.	A sustained control programme would not aim to remove Chilean rhubarb from the sites where it is already present. If/when it does become more widely established, eradication and containment may no longer be options and there will be long-term financial and environmental costs associated with the species. Council resources would be required to follow up on boundary control complaints.	High. Chilean rhubarb is an invasive species and a sustained control programme may not be aggressive enough to prevent the spread of this species, including by gardeners. It produces large numbers of viable seeds and is also spread by humans, both deliberately and inadvertently.
Site-led pest programme	The council could specify high value wetlands and dune lakes as site-led programmes. These areas are often sites of high biodiversity value in low nutrient systems, and an incursion at these sites could have significant impacts. Chilean rhubarb could be listed as a progressive containment or eradication species in these areas, so that if a new incursion is detected through regular surveillance we are ready to act.	Rules would only be applicable in the areas defined as site led programmes and could not be enforced elsewhere. Education, publicity, responding to reports, response to new incursions, enforcing rules.	Moderate - efforts could be targeted to protecting and responding to incursions in the highest value sites in Northland, but Chilean rhubarb could still spread elsewhere.
Summary of alternative assessments and preferred option:	**Eradication programme** In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for Chilean rhubarb. In terms of alternative approaches assessed, under <u>no regional intervention</u> (or do nothing), there would be unacceptable loss of biodiversity values. However, there is less likelihood of significant public or political concerns as this pest plant is not widely known. No intervention may appeal to some in the community that value		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	the plant as a garden ornamental even though it is banned from sale, therefore there is moderate risk around achievement of the eradication outcome. <u>Progressive containment or sustained control</u> approaches would not be appropriate as the plant is thought to occupy only a fraction of the areas suitable in Northland. It would be risky relying on 'lesser' control options when zero density is deemed achievable. Although spread over land areas could be quite slow, plantings along river sides could see rapid spread to downstream sites. These situations require a high level of regional intervention (through professional surveillance and direct control approaches). It would be an unacceptable risk to rely only on landowners to control infestations – for example, if mechanical removal is carried out there is risk of rhizomes being left and control with herbicides could be difficult and expensive. Additionally, many of these sites are steep and difficult to access and therefore landholder control is unlikely to be very successful. These operational risks would compromise the outcomes sought. <u>Eradication</u> is the preferred outcome within three mapped areas (Russell, Waima and Puketi) for the reasons outlined above, and it is realistic given the current infestations and the technical challenges involved at some sites. Increasing awareness around the need to control Chilean rhubarb is anticipated, due to the relatively recent change in attitude from it being viewed as an ornamental, to invasive pest. The costs involved under an eradication programme are relatively minor and are not expected to adversely affect control outcomes. Further herbicide trials are recommended to increase efficacy of control.		

Chinese knotweed

Persicaria chinensis

(Family: Polygonaceae)

Status in New Zealand

Chinese knotweed is listed as an unwanted organism under the Biosecurity Act 1993.

Relevant biology

Form	Chinese knotweed can grow as a scrambling vine or as a shrub. It can grow to varying heights, depending on what it is climbing over. If it as growing as a shrub, without support, it can reach heights of up to 1m. The leaves are 4-16cm long, soft and wavy-edged with a white blotch in the shape of a "V". It has pinkish stems and cream/pink flowers.
Habitat	Chinese knotweed can tolerate a wide range of environmental conditions, including shade, high and low temperatures, high salinity and drought. In its native range it grows in wet valleys, grassy slopes, mixed forests, valleys, and mountain slopes from sea level to 3000 m. Outside its native range, it can be found in disturbed sites, home gardens, abandoned gardens, riverbanks, and roadsides and in agricultural lands. In New Zealand it has the potential to affect forestry, orchard and nursery operations and become a nuisance plant in home gardens and life style blocks.
Regional distribution	There are no known sites of Chinese knotweed in Northland but it is present in the Auckland and Waikato regions.

Competitive ability	Chinese knotweed is a highly invasive plant that quickly smothers other plants and trees. It can seriously impact on forest floor habitats especially on forest fringes and in light wells.
Reproductive ability	Plants grow from rhizomes (roots) and stem fragments. It is not known if the plant can produce seeds in New Zealand. **Vectors of spread:** Plant fragments can be spread in garden rubbish and soil and on contaminated gardening tools, including lawnmowers. It may also be spread intentionally, for medicinal uses.
Resistance to control	Chinese knotweed can be controlled using glyphosate herbicide with follow-up treatments.
Benefits	Chinese knotweed is used in traditional Asian medicine.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	-	High
Horticulture	-	High
Native bush or forests	-	High
Urban	-	Low
Coastal	-	-
Estuarine and marine	-	-
Freshwater/Wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	L-M	Chinese knotweed has the potential to affect forestry operations.	MPI

Category	Current	Potential	Comment	Source
Horticulture	-	M	Chinese knotweed has the potential to affect orchard and nursery operations.	MPI
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	M-H	Chinese knotweed is a fast-growing weed that forms dense mats that suppress native plants affecting plant community structure and composition, particularly along forest fringes.	MPI Invasive Species Compendium
Threatened species	-	M	Chinese knotweed is a fast-growing weed that forms dense mats that suppress native plants.	MPI Invasive Species Compendium
Social/cultural				
Human health	-	+	Chinese knotweed is used in traditional Asian medicine.	
Recreation	-	-		
Māori culture	-	M	Impacts upon native/taonga species.	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	Chinese knotweed is not known to be in Northland. If neighbouring regions were relied on to control the species there would be no economic cost to the Northland region.	There would be limited public awareness of Chinese knotweed and a risk that it would be accidentally introduced. If it is not in the pest management plan there would be no rules to prevent possession of the species in Northland.	Medium. Without education and regulation there is a medium risk that Chinese knotweed could be spread(either intentionally or unintentionally) to Northland.
Exclusion programme	Public awareness and education about the risks and	Low. There is already educational material	Low. People will be aware of the species and its potential

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	impacts of Chinese knotweed and a rule banning possession of the species in Northland could prevent it from establishing in the region. If it is included in the pest management plan there is the ability to respond immediately if an infestation is detected.	available for Chinese knotweed. Excluding this species would prevent expenditure on its control if/when it invades Northland.	impacts. There will be a rule banning possession of the species in Northland and allow immediate control should any be found.
Eradication programme	Not applicable	Not applicable	Chinese knotweed is not known to be present in Northland.
Progressive containment programme	Not applicable	Not applicable	Chinese knotweed is not known to be present in Northland.
Sustained control programme	Not applicable	Not applicable	Chinese knotweed is not known to be present in Northland.
Site-led pest programme	Not applicable	Not applicable	Chinese knotweed is not known to be present in Northland.
Summary of alternative assessments and preferred option:	**Exclusion programme** In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for Chinese knotweed. In terms of alternative approaches assessed, under no regional intervention (or do nothing) even though Chinese knotweed is not particularly well known, there would be public and political criticism of Northland Regional Council and associated risks, for not being more proactive, as Chinese knotweed is well recognized as being weedy and has been discovered in neighbouring regions. Biodiversity values would potentially be impacted if Chinese knotweed was found and no intervention ability was in place. As Chinese knotweed is not currently found in Northland an exclusion programme outcome is the only appropriate option available. The pest plant was probably brought to New Zealand for use in traditional Asian medicine and once the threats were raised through good advocacy with Asian communities, there would be expected to be good compliance with reporting any plants and around control if needed. There is a low level of risk that following discovery MPI would not take the lead on eradication efforts. NRC would be a willing partner in any joint agency surveillance activities. An exclusion programme focusing on a comprehensive surveillance programme (looking for Chinese knotweed and other undesirable pest plants) will help to mitigate any adverse risks by detecting any infestations very early on.		

Chinese windmill palm

Trachycarpus fortunei

Also known as: Chinese fan palm, Chusan palm.

(Family: Arecaceae)

Status in New Zealand

Naturalised.

Relevant biology

Form	A palm with a single straight unbranched trunk 4-12m high. Dead leaves hang from the top of the trunk, forming a skirt. Below this the upper trunk is covered with the dark brown fibrous remains of old leaf stalk bases. Leaves are large, round fan-shaped (75 x 100cm) and divided into many narrow, pleated leaflets. Usually separate male and female plants. Many small yellow flowers occur on a large, branched and drooping spike from during spring-summer. Fruit are yellow, turning blue-black with age, 9 x 12mm.
Habitat	Shade tolerant but prefers forest edges and disturbed/semi-open vegetation, early successional communities, stream banks and wetlands. Growth rate and flowering may be reduced in heavy shade, but capable of forming seedling bank which can utilise light gaps as they form. Cold tolerant, and able to withstand severe frosts even as juveniles. Moderately drought tolerant.
Regional distribution	Mostly found in gardens and garden dump sites in Northland, and is not usually found far from existing plantings. It is naturalised in bush reserves in Auckland, and along the rail corridor and some roadsides in central Auckland.
Competitive ability	Able to suppress low-growing vegetation through light interception.
Reproductive ability	Dispersed by birds, gravity and human cultivation.
Resistance to control	Juveniles require pulling, and may resprout if cut. Laborious.
Benefits	Grown as ornamental. Fruit probably utilised by some native birds. Pollen possibly utilised by native bats.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	-	-
Horticulture	-	Low
Native bush or forests	-	Low
Urban	Low	High
Coastal	-	-
Estuarine and marine	-	-
Freshwater/Wetland	-	Low

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	-		
Horticulture	-	L	Possible invasion under woody crops.	
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	L	Possible modification of soil biota in favour of habitat generalist mychorrizal species, leading to community simplification.	Moora et al., 2011.
Water quality	-	-		
Species diversity	L	M	Capable of invading intact native forest. Large leaves cast deep shade, reducing native seedling recruitment and growth. See also 'Soil resources'.	Ishii and Iwasaki, 2008.
Threatened species	-	L	Extensive displacement of native vegetation could potentially affect threatened species if any are present at infested sites. Pollen possible food source for native bats.	Peterson et al., 2006.
Social/cultural				
Human health	-	L	Risk of minor injury resulting from sharp teeth on petiole margin. Pollen allergenic when abundantly grown.	
Recreation	-	L	Some unwanted naturalisation in gardens. Some potential to obstruct track access.	
Māori culture	-	L	See 'Species diversity'.	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	Rather than applying a programme under the pest management plan, the species could come under a 'council supported management' programme, where advice and support are provided for specific species. This will provide support to communities as and where the species is having local impacts.	By not applying a programme and rules to the species, there would be no provisions under the pest management plan to manage inappropriate practises that could exacerbate the spread. However, there is not a lot of evidence to suggest it is spreading much.	Low. Without education and regulation there is a low risk that Chinese windmill palm could spread within Northland.
Exclusion programme	Not applicable.	Not applicable.	Chinese windmill palm is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Chinese windmill palm is present in gardens throughout the region so would not be suitable for an eradication programme.
Progressive containment programme	Not applicable.	Not applicable.	Chinese windmill palm is present throughout the region so would not be suitable for a progressive containment programme.
Sustained control programme	Chinese windmill palm could be included in a sustained control programme. As a declared pest it would be banned from sale under the Biosecurity Act, and subject to rules about distribution. This could help reduce the risk of spread over time.	A sustained control programme would require an investment of time and resources by the council and affected businesses.	Low. Chinese windmill palm could still spread and become more common.
Site-led pest programme	Not applicable.	Not applicable.	Chinese windmill palm is mainly present in gardens and garden waste sites so is not a suitable candidate for a site-led programme.
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate.		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	Resulting from this process, the council is of the opinion that Chinese windmill palm does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be no regional intervention for Chinese windmill palm , the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding. While Chinese windmill palm has not been afforded pest status in Northland, it may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes.		

Climbing spindle berry

Celastrus orbiculatus

(Family: Celastraceae)

Status in New Zealand

Climbing spindleberry is listed as an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Climbing spindleberry is a deciduous climber that grows up to 15m high. It usually has greyish-brown branches. Young branches are green and often have sharp spines. The serrated leaves are 5-10cm long, tapered, alternately spaced, and turn yellow in autumn. It produces clusters of small (4-10mm across), green flowers. Yellow-orange capsules split open to reveal a scarlet fruit.
Habitat	This aggressive, perennial, woody vine climbs on rocks and trees and sometimes covers the ground. In New Zealand it tolerates a range of climates and soils, but is less frequent on drought-prone soils. It is mainly found in scrub, shrubland and young forest and can establish on forest margins. Climbing spindleberry seedlings establish under moderate shade in New Zealand, primarily in the early stages of vegetation succession, then grow up more or less simultaneously with the supporting trees.
Regional distribution	The Department of Conservation has eradicated the only known infestation of climbing spindleberry in Northland and there are currently no known infestations of this species in the region.
Competitive ability	In New Zealand, climbing spindleberry can reach heights of 15m with stems up to 14cm across. Individual plants may spread to cover as much as 170m^2. The stems strangle and smother the vegetation they climb over and reach to the top of most canopies, causing them to collapse. Layering stems form dense, impenetrable thickets.

Reproductive ability	Fruit appear in early summer and ripen over summer but seedlings are uncommon in the wild in New Zealand. It grows and spreads by underground roots that form new stems. After control operations, the flush of what appears to be new seedlings is mostly re-sprouts from roots. **Vectors of spread:** whole fruit fall close to the parent plant or are eaten by birds so seed can be dispersed over long distances. It can re-grow from plant fragments that are transported by humans either accidentally (for example, in garden waste or soil) or intentionally, for ornamental purposes.
Resistance to control	Climbing spindleberry is difficult to control because stumps and suckers re-sprout and dropped stems take root. Control is labour-intensive and it's difficult to identify the bases of all vines.
Benefits	Climbing spindleberry was introduced as an ornamental plant.

Land uses occupied

Land use type	Current land use infested	Potential land use infested
Dairy	-	-
Sheep and beef	-	-
Forestry	-	High
Horticulture	-	Low
Native	-	High
Urban	-	High
Coastal	-	-
Estuarine and marine	-	-
Freshwater/wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-	Climbing spindleberry is mainly found in scrub, shrubland and young forest where is establishes in partial shade. Pasture has not been identified as a potential habitat of this species.	Williams and Timmins, 2003.
Sheep and beef	-	-	Climbing spindleberry is mainly found in scrub, shrubland and young forest where is establishes in partial shade. Pasture has not been identified as a potential habitat of this species.	Williams and Timmins, 2003.

Category	Current	Potential	Comment	Source
Forestry	-	H	Climbing spindleberry is mainly found in scrub, shrubland and young forest where it establishes in partial shade. Therefore, production forests are a potential habitat.	Williams and Timmins, 2003.
Horticulture	-	M	Climbing spindleberry is mainly found in scrub, shrubland and young forest where it establishes in partial shade. Therefore, it may be able to establish in shelter belts or hedges associated with horticultural land.	Williams and Timmins, 2003.
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	H	The stems of climbing spindleberry strangle and smother the vegetation they climb over and reach to the top of most canopies, causing them to collapse. This reduces biodiversity.	Williams and Timmins, 2003.
Threatened species	-	H	The stems of climbing spindleberry strangle and smother the vegetation they climb over and reach to the top of most canopies, causing them to collapse, with potential adverse effects on threatened species.	Williams and Timmins, 2003.
Social/cultural				
Human health	-	-		
Recreation	-	L	Climbing spindleberry may reduce the aesthetic and recreational values of natural areas.	
Māori culture	-	M	Potential impact on native/taonga species.	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	Climbing spindleberry has been eradicated from Northland. If no further management action is undertaken there will be no short-term financial costs associated with this species.	There would be limited public awareness of climbing spindleberry and a risk that it would be intentionally introduced for ornamental reasons. If it	High. Climbing spindleberry has been recorded in Northland in the past and has been eradicated. Without management there is a high chance that it could be

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
		is not in the pest management plan there would be no rules to prevent possession of the species in Northland.	re-introduced and re-establish in Northland.
Exclusion programme	Public awareness and education about the risks and impacts of climbing spindleberry in Northland, and a rule banning possession of the species could prevent it from re-establishing in the region. If it is included in the pest management plan there is the ability to respond immediately if an infestation is detected.	Low. There is already educational material available for climbing spindleberry. Excluding this species would prevent expenditure on its control if/when it invades Northland.	Low-medium. People will be aware of the species and its potential impacts. There will be a rule banning possession of the species in Northland, which could help discourage people from bringing it to the region. However, climbing spindleberry has been found in Northland in the past so there may be undiscovered infestations or it could re-invade.
Eradication programme	Not applicable.	Not applicable.	Climbing spindleberry is not currently known to be present in Northland.
Progressive containment programme	Not applicable.	Not applicable.	Climbing spindleberry is not currently known to be present in Northland.
Sustained control programme	Not applicable.	Not applicable.	Climbing spindleberry is not currently known to be present in Northland.
Site-led pest programme	Not applicable.	Not applicable.	Climbing spindleberry is not currently known to be present in Northland.
Summary of alternative assessments and preferred option:	Exclusion programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for climbing spindleberry. In terms of alternative approaches assessed, under <u>no regional intervention</u> (or do nothing) there would be a high risk of political and industry criticism of Northland Regional Council for not being more proactive. Despite the impacts of climbing spindleberry not being widely known, both biodiversity values and production values (climbing spindleberry is an increasing economic issue for plantation forests in the Central North Island) would be impacted if this vine was discovered and no intervention measures were available. As climbing spindleberry is not currently found in Northland an <u>exclusion programme</u> outcome is the only appropriate option available. Finding it and destroying it before it can naturally establish is the most cost effective long term measure for NRC. Operationally, for most of the year it is a difficult plant to identify (except during Autumn when leaves change colour) in the first instance and then to locate all the seedlings. Like most vigorous growing exotic vines, successful control is inherently problematic and requires multiple visits to the same sites. An exclusion programme focusing on a comprehensive surveillance programme will help to mitigate any future technical control risks by detecting any infestations very early on.		

Coastal banksia

Banksia integrifolia

Also known as banksia.

(Family: Proteaceae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Coastal banksia is a large, long-lived shrub or small tree that grows up to about 15m high. Leaves are a dark, shiny green on the upper surface and white beneath. They are narrow oval to spoon-shaped and are leathery and tough. Flowers occur from May - July, and are upright, cone-shaped greenish-yellow , 9 - 12cm long forming a broadly cylindrical cone. Individual flowers are very narrow and 10 - 15mm long. The flowers produce nectar that is attractive to birds like tui. Flowers are followed by hard wooden cones, with a covering of brown felt-like hairs. Cones may stay on a tree for a long time after flowering.
Habitat	Coastal banksia is tolerant of a wide range of habitats and conditions, including salty soils and estuaries, through coastal dunes to subalpine tussock grasslands. It usually occurs within 50km of the coast. Drought and frost tolerant, and prefers well-drained soils.
Regional distribution	Widespread coastal weed in New Zealand. Not known as a weed elsewhere except in Western Australia where is has been introduced outside its native range.
Competitive ability	Likely to outcompete native plants. Fast growing with high seed output.
Reproductive ability	Flowering begins at around 4 - 6 years from seed. Unlike some banksias, the seed is released spontaneously on reaching maturity in late summer. Seed is wind dispersed up to at least 300m. Vectors of spread: Spread by people, gravity, wind and seed expulsion can also occur during fire.
Resistance to control	Some recovery if cut down.
Benefits	It is used for coastal farm and horticultural shelterbelts and as an ornamental tree. Previously planted to stabilise sand dunes. Promoted as a plant that will attract birds.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	-	

Land use type	Current land use infested	Potential land use
Horticulture	-	
Native bush or forests	-	
Urban	Low	Low
Coastal	Low	High
Estuarine and marine	Low	Low
Freshwater/Wetland	Low	Low

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	L	M	Shades out native species and competes with native species in vegetation succession. Spreading into coastal communities. It imposes a tree structure in some communities which would not otherwise have this form, so can transform ecosystems. Large areas of coastal dune systems are vulnerable in Northland.	Williams, 2008.
Threatened species	L	M	As above.	
Social/cultural				

Category	Current	Potential	Comment	Source
Human health	-	-		
Recreation	L	L	Some minor interference on coastal tracks.	Williams, 2008.
Māori culture	L	M	Impacts upon native/taonga species.	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council in relation to this species. Rather than applying a programme under the Regional Pest Management Plan, the species could come under a 'Connecting Communities' programme outside the pest management plan, where advice and support are provided for specific sites. This will provide support to communities as and where the species is having impacts.	Coastal banksia is already present in Northland but is not usually seen dominating large areas. If no action is taken it may spread, with consequent environmental impacts and future control costs.	Low. If no action is taken, existing infestations of coastal banksia may expand and it may spread to new sites.
Exclusion programme	Not applicable.	Not applicable.	Coastal banksia is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Coastal banksia is present throughout the region so would not be suitable for an eradication programme.
Progressive containment programme	Not applicable.	Not applicable.	Coastal banksia is present throughout the region so would not be suitable for an progressive containment programme.
Sustained control programme	Coastal banksia could be included in a sustained control programme. As a declared pest it would be banned from sale under the Biosecurity Act.	Coastal banksia is already banned from sale and distribution in Northland and has been for a number of years so there would be no costs to plant retail outlets	Moderate. Coastal banksia could still spread and become more common.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	This could help reduce the risk of spread over time.	from a ban. Plant retail outlets are inspected regularly by council staff checking for many different plants.	
Site-led pest programme	A site-led programme, where control of coastal banksia is required in defined parts of Northland could reduce the impacts of this species within the programme area(s).	A site-led programme would require an investment of time and resources by the council and affected landowners. It would not reduce or restrict the impacts of coastal banksia in areas that are not identified as being of high priority.	Moderate. A site-led programme could effectively reduce or eliminate the adverse effects of coastal banksia.
Summary of alternative assessments and preferred option:	Sustained control programme - banned from sale and distribution With regard to section 6(1) of the NPD a low-level analysis was considered appropriate for coastal banksia. In terms of alternative approaches assessed, under a do-nothing approach there would be no ability for Council to prevent the formal (nursery trade) or informal (fairs and on-line marketing) trade or circulation of this pest. Coastal banksia is already naturalised in Northland and its distribution and assessment of effects mean that eradication and progressive containment programmes are not realistic or affordable. Site-led management would control some plants at some sites, but ultimately this approach would also be unsustainable. Sustained control is the preferred outcome and most viable option. Declaring coastal banksia formally as a pest in the Plan automatically triggers sections 52 and 53 of the Biosecurity Act, banning the pest from sale, propagation and distribution in Northland. This plant is not covered in the current National Pest Plant Accord (NPPA) which has over 150 plants listed, banning them from sale, propagation and distribution nationally. However, the NPPA is nationally focused and doesn't necessarily account for regional differences. The risks of this plant have been evaluated specifically in terms of its effects in Northland. It is important to recognise the wide climate and temperature ranges in New Zealand and that some pests require regional based initiatives based on these factors. Accordingly, coastal banksia is one of 32 pest plants banned from sale, propagation and distribution in the Northland region. This designation recognises that generally they are a lower risk to the regions' values compared with other more invasive species. Council wishes to take a more proactive stance over their management, as opposed to disregarding them under a do-nothing scenario, while acknowledging it must operate within a finite budget and limited resources. Nurseries in general support the concept of the NPPA and the outcomes being sought.		

Coral Tree

Erythrina x sykesii

Also known as: flame tree

(Family: Fabaceae)

Status in New Zealand

Naturalised.

Relevant biology

Form	A large, spreading, deciduous tree up to 12-18m tall. The trunk and branches have light coloured bark and stout prickles 5-10mm long. Leaves are bright green, and broad oval to heart-shaped, up to 20cm long. Flowers occur in late winter, and are dark orange, 50-60mm long, and in clusters on the branch tips from August to October.
Habitat	Naturalised in disturbed places, cliffs, along roadsides and creeks, often in sites with moist soil. Sites that have received mulched or dumped vegetation.
Regional distribution	
Competitive ability	Capable of forming dense thickets which exclude other vegetation.
Reproductive ability	Reproduces vegetatively from cuttings, dropped branches, dumped vegetation and mulch. The wood is very weak and will easily break, leading to vegetative spread, including downstream movement along waterways. It doesn't produce seed (sterile hybrid).
Resistance to control	Can resprout from very small fragments of trunk, branch or root.
Benefits	Grown as ornamental tree and for bank stabilisation. Nectar source for native birds such as tui and bellbirds.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	-	-
Horticulture	-	-
Native bush or forests	Low	Low
Urban	Low	Low
Coastal	Low	Low
Estuarine and marine	-	-
Freshwater/Wetland	Low	Low

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		

Category	Current	Potential	Comment	Source
Sheep and beef	-	-		
Forestry	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	L	L	Can block waterways, exacerbate flooding and alter patterns of bank erosion and sediment deposition.	Queensland Govternment, 2011; Weedbusters, 2011.
Species diversity	L	L	Provides nectar source for nectivorous native birds such as bellbirds and tui. Riparian habitats and wetlands at risk due to water-mediated dispersal. Can form dense thickets which displace native vegetation locally. No empirical assessments of impact available.	
Threatened species	-	L		
Social/cultural				
Human health	L	L	Sharp prickles can cause injury when handling vegetation. Branches weak and prone to breaking, therefore risk of injury from falling branches.	
Recreation	L	L	Could be perceived as positive due to food source for native birds.	
Māori culture	L	L	Could be perceived as positive due to food source for native birds.	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	Rather than applying a programme under the pest management plan, the species could come under a 'council supported management' programme, where advice and support are provided for specific species. This will provide support to communities as and where the species is having local impacts.	By not applying a programme and rules to the species, there would be no provisions under the pest management plan to manage inappropriate practises that are exacerbating the spread. Does not appear to be particularly invasive.	Low. Without education and regulation there is a low risk that coral tree could spread further within Northland.
Exclusion programme	Not applicable.	Not applicable.	Coral tree is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Coral tree is s present throughout the region so would not be suitable for an eradication programme.
Progressive containment programme	Not applicable.	Not applicable.	Coral tree is present throughout the region so would not be suitable for a progressive containment programme.
Sustained control programme	Coral tree could be included in a sustained control programme. As a declared pest it would be banned from sale under the Biosecurity Act, and subject to rules about distribution. This could help reduce the risk of spread over time. However, coral tree is not known to be particularly invasive and is a sterile hybrid.	A sustained control programme would require an investment of time and resources by the council and affected landowners, and plant nurseries.	Low. Coral tree may still spread and become more common.
Site-led pest programme	A site-led programme, where control of coral tree is required in defined parts of Northland, for example some high value dune areas, could reduce the impacts (no assessments of impacts available) of this species within the programme area(s).	A site-led programme would require an investment of time and resources by the council and affected landowners. It would not reduce or restrict the impacts of coral tree in areas that are not identified as being of high priority.	Moderate. A site-led programme could effectively reduce or eliminate the adverse effects of coral tree in some areas.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that coral tree does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be no regional intervention for coral tree, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding. While coral tree has not been afforded pest status in Northland, it may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes.		

Cotoneaster

Cotoneaster glaucophyllus and C. franchetii

(Family: Rosaceae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Cotoneasters are long lived, evergreen shrubs up to approximately 3m tall. Flowers are small, white and borne in clusters (more flowers per cluster for *C. glaucophyllus* than *C. franchetii*). Fruit are red berries up to 7mm diameter (*C. glaucophyllus*) or 9mm long (*C. franchetii*). Two-three seeds per fruit.
Habitat	It inhabits open scrub and coastal forest, lava flats, cliffs, forest and river margins, roadsides and track margins, grasslands, plantation forests, wastelands. A wide range of soil moisture is tolerated but it prefers free draining conditions. Salt spray, frost and semi-shade are also tolerated.
Regional distribution	*C. glaucophyllus* is more common within the region and elsewhere in country than *C. franchetii*. Cotoneaster is scattered and widespread throughout Northland at low densities.
Competitive ability	Naturalised overseas. Tolerates grazing.

Reproductive ability	Seed bank thought to be viable for approximately 2 years. Vectors of spread: Bird dispersed seeds. Human-mediated dispersal as a garden ornamental and via dumping of garden waste.
Resistance to control	Re-sprouts following manual control.
Benefits	Grown as an ornamental.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	Low	Low
Sheep and beef	Low	Low
Forestry	Low	Low
Horticulture	-	-
Native bush or forests	Low	Low
Urban	Low	Low
Coastal	Low	Low
Estuarine and marine	-	-
Freshwater/Wetland	Low	Low

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	Nil-L	L	Can invade grasslands, and tolerate some grazing.	New Zealand Plant Conservation Network.
Sheep and beef	Nil-L	L	As above.	
Forestry	Nil-L	L	Can invade plantation forests.	New Zealand Plant Conservation Network.
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				

Category	Current	Potential	Comment	Source
Soil resources	-	-	Data deficient.	
Water quality	-	-		
Species diversity	L	L-M	Widely naturalised in native habitats in Auckland and Northland (especially *C. glaucophylla*). Open coastal forest may be most at risk. Capable of forming dense thickets which exclude regeneration of other plant species. Empirical data deficient for impacts.	Auckland Museum herbarium records 2016; Queensland Government, 2011.
Threatened species	-	-		
Social/cultural				
Human health	Nil-L	L	Berries are poisonous.	Queensland Government, 2011
Recreation	Nil-L	L	Potential to impede access.	
Māori culture	Nil-L	L	See 'Species diversity', 'Human health' and 'Recreation'.	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council in relation to this species. Rather than applying a programme under the Regional Pest Management Plan, the species could come under a 'Connecting Communities' programme outside the pest management plan, where advice and support are provided for specific sites. This will provide support to communities as and where the species is having impacts.	Cotoneaster is already present in Northland but is not usually seen dominating large areas. If no action is taken it may spread, with consequent environmental impacts and future control costs.	Low. If no action is taken, existing infestations of cotoneaster may expand and it may spread to new sites.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Exclusion programme	Not applicable.	Not applicable.	Cotoneaster is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Cotoneaster is present throughout the region so would not be suitable for an eradication programme.
Progressive containment programme	Not applicable.	Not applicable.	Cotoneaster is present throughout the region so would not be suitable for an progressive containment programme.
Sustained control programme	Cotoneaster could be included in a sustained control programme. As a declared pest it would be banned from sale under the Biosecurity Act. This could help reduce the risk of spread over time.	Cotoneaster is already banned from sale and distribution in Northland and has been for a number of years so there would be no costs to plant retail outlets from a ban. Plant retail outlets are inspected regularly by council staff checking for many different plants.	Moderate. Cotoneaster could still spread and become more common.
Site-led pest programme	A site-led programme, where control of cotoneaster is required in defined parts of Northland could reduce the impacts of this species within the programme area(s).	A site-led programme would require an investment of time and resources by the council and affected landowners. It would not reduce or restrict the impacts of cotoneaster in areas that are not identified as being of high priority.	Moderate. A site-led programme could effectively reduce or eliminate the adverse effects of cotoneaster.
Summary of alternative assessments and preferred option:	Sustained control programme - banned from sale and distribution With regard to section 6(1) of the NPD a low-level analysis was considered appropriate for cotoneaster. In terms of alternative approaces assessed, under a do-nothing approach there would be no ability for Council to prevent the formal (nursery trade) or informal (fairs and on-line marketing) trade or circulation of this pest. Cotoneaster is already naturalised in Northland and its distribution and assessment of effects mean that eradication and progressive containment programmes are not realistic or affordable. Site-led management would control some plants at some sites, but ultimately this approach would also be unsustainable. Sustained control is the preferred outcome and most viable option. Declaring cotoneaster formally as a pest in the Plan automatically triggers sections 52 and 53 of the Biosecurity Act, banning the pest from sale, propagation and distribution in Northland. This plant is not covered in the current National Pest Plant Accord (NPPA) which has over 150 plants listed, banning them from sale, propagation and distribution nationally. However, the NPPA is nationally focused and doesn't necessarily account for regional differences. The risks of this plant have been evaluated specifically in terms of its effects in Northland. It is important to recognise the wide climate and temperature ranges in New Zealand and that some pests require regional based initiatives based on these factors. Accordingly, cotoneaster is one of 32 pest plants banned from sale, propagation and distribution in the Northland region. This designation recognises that generally they are a		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	lower risk to the regions' values compared with other more invasive species. Council wishes to take a more proactive stance over their management, as opposed to disregarding them under a do-nothing scenario, while acknowledging it must operate within a finite budget and limited resources. Nurseries in general support the concept of the NPPA and the outcomes being sought.		

Dietes

Dietes species including D.bicolour and D.grandiflora

Also known as: dietes, yellow wild iris (*Dietes bicolour*), large wild iris (*D. grandiflora*)

(Family: Iridaceae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Dietes forms clumps of erect sword-shaped leaves that are arranged in flat fans similar to other members of the iris family. Yellow wild iris: the adult plant is approximately 1m wide and 1m tall. The leaves are 10 to 20mm wide, light green in colour and have a double central vein. The flowers are about 60mm in diameter, flat, light yellow with brown markings and are produced on the ends of many-branched flower stalks. The flowers only last for one day, but because so many buds are produced, the plant is almost always in flower during spring and summer. The fruit is a club-shaped capsule approximately 25mm in diameter, which partially splits to release the seeds. Large wild iris: the adult plant grows up to 1.5m tall. The leaves are dark green and may reach up to 1m long and 15-20mm wide. The attractive flowers are large (about 100mm across) and are white with yellow nectar guides and outer petals and violet centres. The fruit is a large capsule (up to 45mm), which splits open to release shiny, dark brown seeds.
Habitat	Both species of dietes are native to South Africa. Yellow wild iris occurs naturally near streams and in marshy places. Large wild iris may be found in full sun or partial shade on forest margins, or in the shelter of taller shrubs on exposed slopes facing the sea.
Regional distribution	Dietes is widely distributed in plantings in Northland and is sold by nurseries and garden centres and has been found growing wild near parent plants. *Dietes iridioides* has been recorded near Kerikeri. Dietes was planted in a subdivision at Matapouri but was later removed because wild seedlings were observed. Council staff have also observed and removed wild dietes seedlings.
Competitive ability	Dietes is fast-growing, drought resistant, frost hardy, and will grow in shaded or sunny positions. Large wild iris is an environmental weed in Western Australia and can be found growing wild in southeastern Queensland and on Lord Howe Island. Both species are regarded as potential environmental weeds in New South Wales.
Reproductive ability	Dietes spreads by means of modified, underground stems (rhizomes) and seeds, which are probably long-lived.

	Vectors of spread: The seeds are dispersed by gravity (falling close to the parent plant) and over short distances by wind. Longer distance dispersal can be achieved when root fragments are transported by humans either accidentally (for example, in garden waste or soil) or deliberately (propagated for gardens). It is sold at some garden centres in Northland.
Resistance to control	Gardeners posting to an Australian message board have found large wild iris difficult to control because it keeps resprouting from the rhizomes (roots) and possibly from seeds left in the soil (ABC Message Board - gardening Australia, http://www2b.abc.net.au/tmb/Client/Message.aspx?b=72&m=13101&ps=50&dm=1&pd=2&am=13101).
Benefits	Dietes have ornamental value and are sold in garden centres in Northland.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	-	-
Horticulture	-	-
Native bush or forests	-	Low
Urban	High	High
Coastal	Low	High
Estuarine and marine	-	-
Freshwater/wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	-		
Horticulture	-	-		
Other	+	+	Dietes is cultivated and sold by nurseries in Northland. An alternative could be to investigate GRAND STAR™	OzBreed

Category	Current	Potential	Comment	Source
			Dietes grandiflora 'Di1', which only rarely produces seeds.	
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	L-M	Dietes has the potential to invade natural areas by the dispersal of seed or foot fragments and is difficult to control once established. In Australia, large wild iris is showing invasive tendencies and is thought to pose a threat to natural habitats. It has been reported to have spread from garden plantings or dumped garden waste into forest in south-western Western Australia. It also grows readily from seed.	Queensland government; Keighery, 2005; PlantzAfrica database; Randall 2001
Threatened species	-	L-M	The potential impacts of *Dietes* on threatened species are unknown, but it has invasive tendencies and may out-compete threatened species.	
Social/cultural				
Human health	-	-		
Recreation	-	-		
Māori culture	-	L	Potential impacts upon native/taonga species	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Do nothing	If no management action is undertaken there will be no short-term financial costs incurred in relation to these species.	If no action is taken, species of *dietes* have the potential to become invasive weeds. This would have adverse effects on the environment	Moderate. Dietes are potential weeds that are being sold and cultivated in Northland and have been observed growing wild close to parent plants.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
		and result in economic costs associated with control.	They have the potential to invade natural areas and are difficult to control. If no action is taken, there is a moderate risk that these species will spread in Northland.
Exclusion programme	Not applicable	Not applicable	Dietes is already present in Northland.
Eradication programme	Dietes is widely distributed in plantings in Northland, but the extent and abundance of naturalised (i.e. "wild") populations is not well understood. If dietes could be eradicated before it becomes widespread, it would prevent long-term impacts and financial costs. As a declared pest, dietes would be banned from sale under the Biosecurity Act.	Eradication of dietes would require an investment of resources to determine the distribution and abundance of the species, followed by control and surveillance. If dietes is not eradicated and becomes widely naturalised, there will be on-going control costs.	High. The distribution and abundance of dietes is poorly understood and they are difficult to control. Therefore, at this stage, an eradication programme has a High chance of failure.
Progressive containment programme	A progressive containment programme would aim to confine or reduce the distribution of dietes and reduce their adverse effects on the environment. As a declared pest, dietes would be banned from sale under the Biosecurity Act. Educational material could be developed to encourage people to replace dietes with alternative species that are not invasive.	Dietes is sold and cultivated in Northland and is likely to be present in gardens throughout the Region. Therefore, large amounts of resources would be required to develop educational material, undertake surveys and control infestations. It would not aim to eradicate the species, so control costs would be on-going.	High. Dietes is not a suitable candidate for a progressive containment programme because it is widely cultivated in Northland.
Sustained control programme	A sustained control programme would aim to restrict the spread and impacts of dietes. Sites where it is growing in the wild could be targeted for control (as opposed to sites of cultivation). As a declared pest, it would be banned from sale under the Biosecurity Act. Educational material could be developed to encourage people to replace cultivated dietes with alternative species that are not invasive.	A sustained control programme would require an investment of council's time and resources to develop educational material, undertake surveillance to identify infestations of dietes and control any infestations that are found. It would not aim to eradicate the species, so control costs would be on-going.	Moderate. Dietes is widely cultivated in Northland and seedlings have been observed growing wild. The species are invasive in Australia and have the potential to become environmental weeds in Northland because they are fast-growing, drought resistant, frost hardy, will grow in shaded or sunny positions, produce viable seed and can also spread from root fragments. If dietes were included in the Regional Pest Management Plan it may result in reports of sightings

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
			and, when combined with the survey and control efforts of council staff, there is only a moderate chance that a progressive containment programme could fail. They would be banned from sale, which would prevent dietes from being planted at new sites that could provide sources of seed for wild infestations. A cultivar that produces less seed (such as GRAND STAR™ Dietes grandiflora 'Di1') could be investigated as an alternative.
Site-led pest programme	A site-led programme, where control of dietes is required in defined parts of Northland could reduce the impacts of this species within the programme area(s).	A site-led programme would require an investment of time and resources by the council and affected landowners. It would not reduce or restrict the impacts of dietes in areas that are not identified as being of high priority.	High. A site-led programme could effectively reduce or eliminate specific infestations of dietes but the species is widely cultivated and the programme would not provide for the control of outlying infestatiotables ns.
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that dietes does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be no regional intervention for dietes, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding. While dietes has not been afforded pest status in Northland, it may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes.		

Dusky coral pea

Kennedia rubicunda

(Family: Fabaceae)

Status in New Zealand

Dusky coral pea is listed as an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Dusky coral pea is a large, vigorous evergreen vine. Stems and leaves are often hairy. Leaves are comprised of 3 leaflets each 20-100mm long. Clusters of 3-12 dark red-pink-purplish flowers, each 35x15mm in size and pea-shaped occur from August to December. Seeds are held in flattened pea-like pods 50-100mm long, during spring and summer. Seeds are weigh approximately 24mg, and are 5mm long. They have a hard, impermeable seed coat. Root clusters exhibit nodules.
Habitat	Limited information is available on habitat preferences, but preferred habitats include roadsides and banks. It is a light demanding species but seedlings have been recorded in part shade, and it scrambles over shrubs and trees. Colonisation of dense/closed canopy bush is unlikely, but it has the potential to invade forest edges and open habitats. Frost sensitive. Native range is typified by nutrient-poor soils, but it also does well in high fertility soils, and tolerates dry conditions.
Regional distribution	Low density, scattered across Northland region, mainly residential gardens.
Competitive ability	Rapid growth can occur under favourable conditions. Palatable to browsers. Tolerates a wide variety of nutrient conditions, with root nodules assisting phosphorous uptake and nitrogen fixation in poor soils.
Reproductive ability	Capable of producing abundant seeds. Seeds exhibit seed coat-induced dormancy, with germination rates increased by fire exposure. The seed bank is persistent. Can be grown from cutting. Vectors of spread: Spread via planting in gardens and dumping garden waste. Seed dispersal is predominantly via gravity and water.
Resistance to control	
Benefits	Grown as an ornamental.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	-	Low
Horticulture	-	-

Land use type	Current land use infested	Potential land use
Native bush or forests	-	Low
Urban	Low	Low
Coastal	-	-
Estuarine and marine	-	-
Freshwater/Wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	L	Reported to reduce survival of Eucalyptus seedlings in Australia.	Floyd, 1966.
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	L	Nitrogen fixer, so may alter soils changing habitats.	
Water quality	-	-		
Species diversity	-	L-M	Scrambling habit in climbers is associated with high level of shading of host plants. It can grow rapidly and has the ability to shade, smother and suppress the growth of both low-growing and canopy species. It is invasive in a wide range of dry habitats where it can have an impact on native plant species. Limited information available, little history of invasiveness overseas.	Llorens and Leishman, 2008; National Pest Plant Accord, 2012; Williams, 2008.

Category	Current	Potential	Comment	Source
Threatened species	-	L		
Social/cultural				
Human health	-	-		
Recreation	-	L	Potential to for minor impacts impeding access and reducing enjoyment of bush environment.	
Māori culture	-	L		

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	Rather than applying a programme under the pest management plan, the species could come under a 'council supported management' programme, where advice and support are provided for specific species. This will provide support to communities as and where the species has local impacts.	By not applying a programme and rules to the species, there would be no provisions under the pest management plan to manage inappropriate practises that could exacerbate the spread. However, there is not a lot of evidence to suggest it is spreading much.	Low. Without education and regulation there is a low risk that dusky coral pea could spread within Northland.
Exclusion programme	Not applicable.	Not applicable.	Dusky coral pea is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Dusky coral pea is present in gardens in the region so would not be suitable for an eradication programme.
Progressive containment programme	Not applicable.	Not applicable.	Dusky coral pea is present throughout the region so would not be suitable for a progressive containment programme.
Sustained control programme	Dusky coral pea could be included in a sustained control programme. As a declared pest it would be banned from sale under the Biosecurity Act, and subject to rules about distribution. This could help reduce the risk of spread over time.	A sustained control programme would require an investment of time and resources by the council and affected businesses.	Low. Dusky coral pea could still spread and become more common.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Site-led pest programme	Not applicable.	Not applicable.	Dusky coral pea is mainly present in gardens so is not a suitable candidate for a site-led programme.
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that dusky coral pea does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be no regional intervention for dusky coral pea, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding. While dusky coral pea has not been afforded pest status in Northland, it may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes.		

Elaeagnus

Elaeagnus x reflexa

Also known as: *Elaeagnus pungens reflexa* (*E.* x *reflexa* is a hybrid of *E. Pungens* and *E. glabra*).

(Family: Elaeagnaceae)

Status in New Zealand

Relevant biology

Form	Elaeagnus is a vigorous, dense, evergreen shrub that can scramble over supporting vegetation or structures to a height of 20m. It has long, arching, tough stems. Young shoots are brown and scaly and older stems often have spines. The leaves are up to 90mm long, have irregular wavy margins, and silvery or browny-scaly undersides. It produces small, drooping clusters of tiny, whitish, fragrant flowers that are followed by pale reddish-orange, berry-like fruits that each contain one ribbed seed.
Habitat	Elaeagnus is a weed of scrub, forest margins and secondary forest. It may be present in pasture or hedges where there are abandoned gardens associated with old homesteads.

Regional distribution	Elaeagnus is present at scattered locations throughout Northland. Whāngārei Heads is a community pest control area for this species.
Competitive ability	Elaeagnus slowly smothers the plants it grows over and can reach canopy height. It can invade well-lit or partially shaded sites, and can increase soil nutrient status, affecting which native plant species can grow there. Elaeagnus is intolerant to frost and poor drainage, tolerant to drought and partly tolerant to shade. Seedlings are tolerant of partial shade but require medium to high soil fertility.
Reproductive ability	Elaeagnus produces small numbers of seeds. Its main method of reproduction is vegetatively, from plant fragments. Vectors of spread: The seeds are dispersed by birds. Plant fragments are transported by humans either deliberately or inadvertently, for example, in garden waste and soil.
Resistance to control	Elaeagnus is very difficult to control. Repeat treatments are needed because stumps can re-sprout, roots sucker and cut stems can layer.
Benefits	Elaeagnus was introduced for ornamental purposes and is a garden escape.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	Low
Sheep and beef	-	Low
Forestry	-	High
Horticulture	-	-
Native bush or forests	High	High
Urban	High	High
Coastal	-	-
Estuarine and marine	-	-
Freshwater/wetland	-	-

High = Preferred land use; Low = Less preferred land use

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	L	Elaeagnus is a weed of scrub, forest margins and secondary forest. It may be present in pasture or hedges where there are abandoned gardens	Timmins and Mackenzie, 1995.

Category	Current	Potential	Comment	Source
			associated with old homesteads.	
Sheep and beef	-	L	Elaeagnus is a weed of scrub, forest margins and secondary forest. It may be present in pasture or hedges where there are abandoned gardens associated with old homesteads.	Timmins and Mackenzie, 1995.
Forestry	-	M	Elaeagnus is a weed of forest margins. This includes the margins of production forests, along tracks and in clearings.	Timmins and Mackenzie, 1995.
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	L	Elaeagnus is a nitrogen fixing plant.	Khamzina et al., 2009.
Water quality	-	-		
Species diversity	L	M	Elaeagnus scrambles over other plants and smothers them, particularly in regenerating forest.	Timmins and Mackenzie, 1995.
Threatened species	-	M	Elaeagnus scrambles over other plants and smothers them. This could include threatened plant species.	Timmins and Mackenzie, 1995.
Social/cultural				
Human health	-	L	Elaeagnus has spines, which may cause injuries.	Timmins and Mackenzie, 1995.
Recreation	-	L	The spines on elaeagnus and its dense growth may prevent access to recreational areas.	
Māori culture	-	M	Impacts upon native/taonga species.	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful *
Do nothing	If no management action is undertaken there will be no short-term financial costs incurred by the council in relation to this species.	Elaeagnus is a serious weed that is difficult to control once it has established. If no action is taken, the density of this species within existing infestation areas will increase. It may also spread to new sites, especially in the absence of community awareness.	High. People are the main source of new infestations of elaeagnus when it is spread either deliberately or accidentally. If no action is taken, elaeagnus is likely to spread and existing infestations will become increasingly difficult to control.
Exclusion programme	Not applicable	Not applicable	Elaeagnus is already present in Northland.
Eradication programme	Elaeagnus is currently scattered throughout Northland but there are large areas of potential habitat for this species, particularly in natural areas. If it could be eradicated before it spreads elsewhere, it would prevent long-term impacts and financial costs.	Eradication of Elaeagnus would require an investment of resources to control the known infestations, undertake surveillance to ensure control has been successful, and carry out surveys to identify any additional infestations. If the species is not eradicated there will be on-going control costs.	Medium-high. Elaeagnus is difficult to control and there are likely to be more infestations of this species than are currently known.
Progressive containment programme	When compared to an eradication programme, a progressive containment programme would incur lower financial cost to council in the short-term. It would aim to confine or reduce the distribution of elaeagnus.	This type of programme would require an investment of time and resources from council and affected landowners. It would not aim to eradicate the species, so control costs would be on-going. If the programme is not successful the opportunity to eradicate the species may be lost.	Medium-high. Elaeagnus can be difficult to control, but with sustained effort it could be achievable. However, there is not enough information available about its distribution in Northland to accurately determine the containment areas.
Sustained control programme	When compared to an eradication programme, a sustained control programme would incur lower financial cost to council in the short-term. This programme would aim to restrict the spread and impacts of elaeagnus.	A sustained control programme would require an investment of time and resources from the council and affected landowners. It would not aim to eradicate the species, so control costs would be on-going.	High. Elaeagnus is not currently abundant in Northland but there is available habitat for this species throughout the region. The aims of a sustained control programme may not be ambitious enough to prevent this species from having increasingly severe environmental impacts.
Site-led pest programme	A site-led programme, where control of elaeagnus is required in defined parts of Northland, would reduce the impact of this species in high priority areas.	A site-led programme would require an investment of time and resources by council and affected landowners. It would not reduce or restrict the impacts of elaeagnus in areas	Moderate. Elaeagnus can be difficult to control but with sustained effort it should be achievable to reduce the impact of this species within defined areas. Elaeagnus

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful *
		that are not identified as being of high priority.	infestations outside the area(s) subjected to a site-led pest programme could continue to spread.
Summary of alternative assessments and preferred option:	Sustained control programme - banned from sale and distribution With regard to section 6(1) of the NPD a low-level analysis was considered appropriate for elaeagnus. In terms of alternative approaches assessed, under a do-nothing approach there would be no ability for Council to prevent the formal (nursery trade) or informal (fairs and on-line marketing) trade or circulation of this pest. Elaeagnus is already naturalised in Northland and its distribution and assessment of effects mean that eradication and progressive containment programmes are not realistic or affordable. Site-led management would control some plants at some sites, but ultimately this approach would also be unsustainable. Sustained control is the preferred outcome and most viable option. Declaring elaeagnus formally as a pest in the Plan automatically triggers sections 52 and 53 of the Biosecurity Act, banning the pest from sale, propagation and distribution in Northland. This plant is not covered in the current National Pest Plant Accord (NPPA) which has over 150 plants listed, banning them from sale, propagation and distribution nationally. However, the NPPA is nationally focused and doesn't necessarily account for regional differences. The risks of this plant have been evaluated specifically in terms of its effects in Northland. It is important to recognise the wide climate and temperature ranges in New Zealand and that some pests require regional based initiatives based on these factors. Accordingly, elaeagnus is one of 32 pest plants banned from sale, propagation and distribution in the Northland region. This designation recognises that generally they are a lower risk to the regions' values compared with other more invasive species. Council wishes to take a more proactive stance over their management, as opposed to disregarding them under a do-nothing scenario, while acknowledging it must operate within a finite budget and limited resources. Nurseries in general support the concept of the NPPA and the outcomes being sought.		

Elephant's ear

Alocasia brisbanensis

(Family: Araceae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Elephant's ear is a robust perennial that is native to the rain forests of Queensland, Australia. It has thick stems up to 1.2m long and large, wide arrow-shaped leaves that reach 50-75cm in length. Mature plants have 4-5 large leaves, and can form dense stands reaching 1-2m in height. The plant produces erect, cream-coloured and very fragrant flowers up to 6cm long surrounded by a light green sheath up to 15cm long. Flowers are produced in the summer months from January to April. The leaves of the plant die back in spring, and fruiting occurs in September with small orange or scarlet berries of 10mm in diameter clustering on the flower stalks, each with one to four seeds. It has thick rhizome rootstock that is poisonous (although it can be eaten if properly cooked).

Habitat	Elephant's ear prefers wet or damp areas such as wetlands, riverbanks or damp open areas, and will also grow in regenerating ex-pastures or heavily disturbed shrubland and forest. It prefers frost-free areas.
Regional distribution	Found in domestic gardens region-wide. Also found in some pastures and along a 2km stretch of the Kaihū River bank. Currently banned from sale in Auckland.
Competitive ability	This plant is long-lived and can out-compete other species as it smothers areas in damp sites. Once established it is drought resistant, and is avoided by stock as it is poisonous, so can dominate grazed sites. It has the potential to become more common and a problematic environmental weed.
Reproductive ability	Produces seed that is dropped below the adult plant or is spread by birds, and can also reproduce via disturbed roots or fragments. **Vectors of spread:** Vegetative spread or by bird. Spread can be exacerbated by human removal, dumping or through soil movement.
Resistance to control	Plants will regrow after slashing, and it can regrow from fragments.
Benefits	Ornamental.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	Low	Low
Sheep and beef	-	Low
Forestry	-	Low
Horticulture	-	-
Native bush or forests	-	High
Urban	Low	Low
Coastal	-	Low
Estuarine and marine	-	-
Freshwater/wetland areas	Low	High

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	L	L	The lower-lying areas of dairy farming land are likely to be favoured by the plant if	New Zealand Plant Conservation Network.

Category	Current	Potential	Comment	Source
			introduced. Avoided by stock, so may spread.	
Sheep and beef	-	-		
Forestry	-	L	The plant establishes easily on disturbed or waste land.	New Zealand Plant Conservation Network.
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	L	The plant can smother damp sites, and may exclude other species in some stretches of river bank.	New Zealand Plant Conservation Network.
Threatened species	-	-		
Social/cultural				
Human health	-	L	Stems, leaves, flowers and tubers are toxic to humans.	New Zealand Plant Conservation Network; Landcare Research, 2002.
Recreation	-	-		
Māori culture	-	-		

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Do nothing	If no management action is undertaken there will be no short-term financial costs incurred by the council in relation to this species.	Elephant's ear is already present in Northland but is not usually seen dominating large areas. If no action is taken it may spread, with consequent environmental	Low. If no action is taken, existing infestations of elephant's ear may expand and it may spread to new sites.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	Rather than applying a programme under the Regional Pest Management Plan, the species could come under a 'Connecting Communities' programme outside the pest management plan, where advice and support are provided for specific sites. This will provide support to communities as and where the species is having impacts.	impacts and future control costs.	
Exclusion programme	Not applicable	Not applicable	Elephant's ear is already found in the region.
Eradication programme	Not applicable	Not applicable	Elephant's ear is present throughout the region so would not be suitable for an eradication programme.
Progressive containment programme	Not applicable	Not applicable	Elephant's ear is present throughout the region so would not be suitable for a progressive containment programme.
Sustained control programme	Elephant's ear could be included in a sustained control programme. As a declared pest it would be banned from sale under the Biosecurity Act. This could help reduce the risk of spread over time.	Elephant's ear is not currently banned from sale but would be under this scenario. Costs maybe incurred by some who are selling it currently.	Moderate. Elephant's ear could still spread and become more common.
Site-led pest programme	A site-led programme, where control of elephant's ear is required in defined parts of Northland could reduce the impacts of this species within the programme area(s).	A site-led programme would require an investment of time and resources by the council and affected landowners. It would not reduce or restrict the impacts of elephant's ear in areas that are not identified as being of high priority.	Moderate. A site-led programme could effectively reduce or eliminate the adverse effects of elephant's ear.
Summary of alternative assessments and preferred option:	**Sustained control programme - banned from sale and distribution** With regard to section 6(1) of the NPD a low-level analysis was considered appropriate for elephant's ear. In terms of alternative approaches assessed, under a do-nothing approach there would be no ability for Council to prevent the formal (nursery trade) or informal (fairs and on-line marketing) trade or circulation of this pest. Elephant's ear is already naturalised in Northland and its distribution and assessment of effects mean that eradication and progressive containment programmes are not realistic or affordable. Site-led management		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	would control some plants at some sites, but ultimately this approach would also be unsustainable. Sustained control is the preferred outcome and most viable option. Declaring elephant's ear formally as a pest in the Plan automatically triggers sections 52 and 53 of the Biosecurity Act, banning the pest from sale, propagation and distribution in Northland. This plant is not covered in the current National Pest Plant Accord (NPPA) which has over 150 plants listed, banning them from sale, propagation and distribution nationally. However, the NPPA is nationally focused and doesn't necessarily account for regional differences. The risks of this plant have been evaluated specifically in terms of its effects in Northland. It is important to recognise the wide climate and temperature ranges in New Zealand and that some pests require regional based initiatives based on these factors. Accordingly, elephant's ear is one of 32 pest plants banned from sale, propagation and distribution in the Northland region. This designation recognises that generally they are a lower risk to the regions' values compared with other more invasive species. Council wishes to take a more proactive stance over their management, as opposed to disregarding them under a do-nothing scenario, while acknowledging it must operate within a finite budget and limited resources. Nurseries in general support the concept of the NPPA and the outcomes being sought.		

English ivy

Hedera helix

(Family: Araliaceae)

Status in New Zealand

Naturalised.

Relevant biology

Form	English ivy is an evergreen perennial climber. It forms a groundcover and climbs on trees, walls and other structures. Mature plants have woody stems. Many cultivars are available, leading to variation in leaf shape, habit and colour. Leaves are arranged alternately on stems, up to 3 x 15cm long, and usually have 3-5 shallow lobes. Juvenile foliage is distinct from adult foliage. It produces numerous tiny yellowish-green flowers from March to May. Berries are deep purple to black, 5-8mm diameter, with 2-3 seeds per fruit.
Habitat	Preferred habitat includes roadsides (present in > 5% of all 340 nationally surveyed roadside plots), native forest, riparian zones and cliffs. It often escapes from garden groundcover plantings. Shade tolerant. Tolerates poor soils but prefers high soil fertility. Very frost tolerant. Prefers moist (not waterlooged) soils but also drought tolerant.
Regional distribution	Widespread but patchy distribution across region, mostly urban, semi-urban and near old house sites.
Competitive ability	History of invasiveness overseas. It can dominate a woodland in its native range within 30 years of establishment. Invasion may have a positive feedback loop where increased ivy dominancy reduces recruitment of other species thereby increasing canopy openness

	and further invasion of ivy climbing up trees with increasing impacts on fitness of existing trees. Palatable to deer and goats despite secondary compounds.
Reproductive ability	Bird dispersed, and within the gape size of wide range of fruit eating birds including black birds, song thrush, starling and kereru. Insect pollinated (Diptera, Lepidoptera, Hymenoptera including honey bees). Fruit set is positively associated with wasp visitation rate. Vegetative spread through dumping of garden waste and deliberate planting.
Resistance to control	Herbicide tolerant; control requires frequent repeat treatments to be successful. It resprouts from vegetative fragments, making manual control difficult. Very difficult to distinguish between English ivy and Canary Islands ivy (*Hedera canariensis*). NPPA recommended including both species or neither to prevent enforcement difficulties.
Benefits	Grown as a hardy and shade tolerant ornamental ground cover. Nectar resource for honey bees. Used in herbal medicine and may have antiviral and anti-inflammatory properties.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	Low	Low
Horticulture	-	-
Native bush or forests	High	High
Urban	High	High
Coastal	Low	Low
Estuarine and marine	-	-
Freshwater/Wetland	Low	High

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-	Toxic to livestock.	Rogan 1997
Sheep and beef	-	-		
Forestry	-	L	Potential to invade plantation forests.	Binggeli 2005
Horticulture	-	-		

Category	Current	Potential	Comment	Source
Other	-	-		
International trade	-	-		
Environment				
Soil resources	L	L-M	Dense mats combined with rapidly decomposing litter have the potential to alter the decomposition dynamics and nutrient cycling within invaded ecosystems.	Bonanomi et al. 2014
Water quality	-	-		
Species diversity	L	M	Capable of invading intact interior native bush (including on off-shore islands) through bird dispersal and shade tolerance. Riparian zones are especially at risk. Forms dense monocultural groundcover, including layers of decomposing material as well as live plant parts. Substantially lowers ground-level light availability and prevents regeneration of other species. Possible minor allelopathic effects on germination. Potential damage to canopy of host trees through decreased light acquisition and increased susceptibility to wind damage. Long-term potential to substantially alter forest composition and structure including reduction in stem density and species diversity. Predicted to become more invasive in deep shade under increased carbon dioxide conditions. Potential invasion mutualism with introduced wasps. Wasp visits increase seed set, and wasps benefit from the nectar resource. Therefore increased ivy invasion has potential to magnify wasp impacts on biodiversity. Likely impacts on ground-active invertebrate communities based on life history traits and known impacts for similar species.	Bassett, 2014; Biggerstaff and Beck, 2007a; 2007b; Bickart, 2013; de Lange and Champion, 1998; Harmer et al., 2001; Jacobs et al., 2010; Okerman, 2000; Timmons, 1997; Thomas 1980; Vidra et al., 2006; Zotz et al., 2006.

Category	Current	Potential	Comment	Source
Threatened species	-	L-M	See above. Depends on future ecosystems invaded.	
Social/cultural				
Human health	L	L	Berries are mildly toxic to humans and other animals. English ivy can cause contact dermatitis.	Popay et al. 2010 Hausen et al 1987
Recreation	L	L	Smothers buildings, utility poles and other structures. Increased prevalence could lead to impaired enjoyment of the natural environment due to contact dermatitis. Grown as a hardy and shade tolerant ornamental ground cover (beneficial).	
Māori culture	L	M	See 'Species diversity'.	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council in relation to this species. Rather than applying a programme under the Regional Pest Management Plan, the species could come under a 'Connecting Communities' programme outside the pest management plan, where advice and support are provided for specific sites. This will provide support to communities as and where the species is having impacts.	English ivy is already present in Northland but is not usually seen dominating large areas. If no action is taken it may spread, with consequent environmental impacts and future control costs.	Low. If no action is taken, existing infestations of English ivy may expand and it may spread to new sites.
Exclusion programme	Not applicable	Not applicable	English ivy is already found in the region.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Eradication programme	Not applicable	Not applicable	English ivy is present throughout the region so would not be suitable for an eradication programme.
Progressive containment programme	Not applicable	Not applicable	English ivy is present throughout the region so would not be suitable for a progressive containment programme.
Sustained control programme	English ivy could be included in a sustained control programme. As a declared pest it would be banned from sale under the Biosecurity Act. This could help reduce the risk of spread over time.	English ivy is not currently banned from sale but would be under this scenario. Costs maybe incurred by some who are selling it currently.	Moderate. English ivy could still spread and become more common.
Site-led pest programme	A site-led programme, where control of English ivy is required in defined parts of Northland could reduce the impacts of this species within the programme area(s).	A site-led programme would require an investment of time and resources by the council and affected landowners. It would not reduce or restrict the impacts of English ivy in areas that are not identified as being of high priority.	Moderate. A site-led programme could effectively reduce or eliminate the adverse effects of English ivy .
Summary of alternative assessments and preferred option:	Sustained control programme With regard to section 6(1) of the NPD a low-level analysis was considered appropriate for English ivy. In terms of alternative approaches assessed, under a do-nothing approach there would be no ability for Council to prevent the formal (nursery trade) or informal (fairs and on-line marketing) trade or circulation of this pest. English ivy is already naturalised in Northland and its distribution and assessment of effects mean that eradication and progressive containment programmes are not realistic or affordable. Site-led management would control some plants at some sites, but ultimately this approach would also be unsustainable. Sustained control is the preferred outcome and most viable option. Declaring English ivy formally as a pest in the Plan automatically triggers sections 52 and 53 of the Biosecurity Act, banning the pest from sale, propagation and distribution in Northland. This plant is not covered in the current National Pest Plant Accord (NPPA) which has over 150 plants listed, banning them from sale, propagation and distribution nationally. However, the NPPA is nationally focused and doesn't necessarily account for regional differences. The risks of this plant have been evaluated specifically in terms of its effects in Northland. It is important to recognise the wide climate and temperature ranges in New Zealand and that some pests require regional based initiatives based on these factors. Accordingly, English ivy is one of 33 pest plants banned from sale, propagation and distribution in the Northland region. This designation recognises that generally they are a lower risk to the regions' values compared with other more invasive species. Council wishes to take a more proactive stance over their management, as opposed to disregarding them under a do-nothing scenario, while acknowledging it must operate within a finite budget and limited resources. Nurseries in general support the concept of the NPPA and the outcomes being sought.		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful

Evergreen buckthorn

Rhamnus alaternus

Also known as: Italian evergreen buckthorn, Italian buckthorn.

(Family: Rhamnaceae)

Status in New Zealand

Evergreen buckthorn is listed as an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Evergreen buckthorn is an evergreen shrub or tree. It can grow to 5m tall but in exposed sites it may become a stunted shrub less than 1m tall. Young shoots are angular, hairy, and usually purple. It has oval, glossy, leathery leaves (15-60 x 10-30mm), which are often slightly toothed. The flowers, which are produced from May to November, are small (3-4mm in diameter), green, petal-less and fragrant. The flowers are followed by glossy berries (5-7mm long) which ripen from dark-red to black from December to January. Evergreen buckthorn can be mistaken for a native plant but the fruits and the purplish shoots are distinctive.
Habitat	Evergreen buckthorn can invade a range of vegetation communities, including scrub, forest margins, tall forest, shrubland, fernland, riparian margins, cliffs and sand dunes. It establishes particularly readily in coastal areas. It is abundant in the Hauraki Gulf, where it forms dense and persistent communities on coastal cliffs, sometimes as an under-story to pohutukawa forest.
Regional distribution	Evergreen buckthorn is known to occur around Matakohe, where it is present in hedgerows and native vegetation within an agricultural landscape. There is also an infestation in Morningside, Whāngārei. Both areas are part of ongoing control programmes.
Competitive ability	Evergreen buckthorn forms dense stands and develops a dense leafy canopy under which no other plants can grow. It is highly tolerant of drought, shade and frost, is tolerant to poor drainage and requires low to medium soil fertility. Physical damage, grazing and fire results in re-sprouting of the plant. After a fire, large, leafy water-shoots are produced from the base of the tree.
Reproductive ability	Evergreen buckthorn can reproduce vegetatively (underground) and by seed. Each plant can produce many thousands of seeds. Seed is thought to remain viable in the seed bank for at least three years. Vectors of spread: The seeds of evergreen buckthorn are dispersed by birds.
Resistance to control	Evergreen buckthorn can re-sprout after physical damage so cut stumps must be treated with herbicide.
Benefits	Ornamental.

Land uses occupied

Land use type	Current land use infested	Potential land use infested
Dairy	-	-
Sheep and beef	-	-
Forestry	-	Low
Horticulture	-	-
Native	Low	High
Urban	Low	High
Coastal	-	High
Estuarine and marine	-	-
Freshwater/wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-	In New Zealand, evergreen buckthorn has been found in scrub, forest margins, tall forest, riparian margins, shrubland, fernland, cliffs, and bluffs. Therefore, it is unlikely to invade pasture but may establish in nearby hedges, forest fragments, or riparian margins.	Timmins and MacKenzie, 1997; Bay of Plenty Regional Council.
Sheep and beef	-	-	In New Zealand, evergreen buckthorn has been found in scrub, forest margins, tall forest, riparian margins, shrubland, fernland, cliffs, bluffs, and sand dunes. Therefore, it is unlikely to invade pasture but may establish in nearby hedges, forest fragments, or riparian margins.	Timmins and MacKenzie, 1997; Bay of Plenty Regional Council.
Forestry	-	M	Evergreen buckthorn can establish in forest and scrub. Therefore, it has the potential to invade production forests in Northland.	Timmins and MacKenzie, 1997; Bay of Plenty Regional Council.
Horticulture	-	-	In New Zealand, evergreen buckthorn has been found in scrub, forest margins, tall forest, riparian margins, shrubland, fernland, cliffs, bluffs, and sand dunes. Therefore, it is unlikely to invade horticultural land but may establish in nearby hedges, forest fragments, or riparian margins.	Timmins and MacKenzie, 1997; Bay of Plenty Regional Council.

Category	Current	Potential	Comment	Source
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	L	H	Evergreen buckthorn can invade indigenous habitats where it forms dense stands and develops a dense, leafy canopy under which no other plants can grow, thereby reducing species diversity.	Timmins and MacKenzie, 1997; Fromont, 1997.
Threatened species	-	M	Evergreen buckthorn can invade indigenous habitats where it forms dense stands and develops a dense leafy canopy under which no other plants can grow, including threatened species.	Timmins and MacKenzie, 1997; Fromont, 1997.
Social/cultural				
Human health	-	-		
Recreation	-	L	Evergreen buckthorn has the potential to reduce the recreational and aesthetic values of natural areas.	
Māori culture	-	M	Potential effects on native/taonga species.	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial cost to the council associated with this species.	Evergreen buckthorn is currently known from only two locations in Northland but it is an invasive species with the potential to spread through a range of habitats. If control work stops now, the populations will grow and spread. The environmental and economic costs of delaying control until there are larger/more infestations is potentially considerable.	High. If evergreen buckthorn is not managed, the density of the species within the existing infestation areas is likely to increase and it may spread to new sites.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Exclusion programme	Not applicable	Not applicable	Exclusion is not an option because evergreen buckthorn is already present in Northland.
Eradication programme	Evergreen buckthorn is currently known at two locations in Northland. If the species could be eradicated before it spreads elsewhere, it would prevent long-term impacts and financial costs.	Eradication of evergreen buckthorn would require an investment of resources to control the known infestations and undertake on-going surveys to ensure all plants have been removed and there is no regrowth. If the species is not eradicated there will be on-going control costs. The 2010-2015 eradication programme costs were $5000 per year plus staff time.	Low-moderate. Between 2008 and 2014, control efforts reduced the number of evergreen buckthorn plants from 6400 to 424. This success rate suggests eradication is feasible. However, there is a risk of an eradication programme failing due to the difficulty of locating all the plants and the possibility that there may be undiscovered infestations.
Progressive containment programme	When compared to an eradication programme, a progressive containment programme would incur lower financial cost to the council in the short-term. It would aim to confine the impacts of evergreen buckthorn to the locations where it is currently present and prevent it from having impacts elsewhere.	Evergreen buckthorn is an invasive species with the potential for its bird-dispersed seeds to be spread over long distances. The aim of a progressive control programme is not to eradicate the species so this type of programme could give evergreen buckthorn the opportunity (that is, time) to spread, with consequent adverse effects on the environment and long-term control costs.	High. There is a high risk that a progressive containment programme will not prevent evergreen buckthorn from spreading to new sites because it has bird-dispersed seeds and could establish in a variety of Northland habitats.
Sustained control programme	When compared to an eradication programme, a sustained control programme would incur lower financial cost to council in the short-term. A sustained control programme would aim to restrict the spread and impacts of evergreen buckthorn.	Evergreen buckthorn is an invasive species with the potential to spread widely. The aim of a sustained control programme is not to eradicate the species so it could give evergreen buckthorn the opportunity (that is, time) to spread to more sites in Northland. If/when this happens, eradication or containment may no longer be options and there will be long-term financial and environmental costs associated with the species.	High. There is a high risk that a sustained control programme will not prevent evergreen buckthorn from spreading to new sites because it has bird-dispersed seeds and can establish in a wide variety of Northland habitats.
Site-led pest programme	If evergreen buckthorn was the target of a site-led programme it would raise awareness of	Only two areas of Northland are infested with evergreen buckthorn. The direct financial cost of co-ordinating a site-led	Moderate-high. The risks of a site-led programme failing depend on the goal of the programme, how it is

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	the species in the local area, while relying on the community to assist with the control.	programme may be the same or greater than an eradication programme. Evergreen buckthorn can be difficult for the general public to identify, increasing the chance that plants could be missed. If the community does not eradicate evergreen buckthorn it could spread to more sites in Northland. Any sites found outside of the defined site-led programme area would not be subject to rules or a control programme, increasing the risk of ongoing spread.	initiated and implemented, and the level of support within the community. This species is very hard for the public to identify, increasing the likelihood of plants being missed. If the site-led programme fails to eradicate the species, it has the potential to spread to new sites.
Summary of alternative assessments and preferred option:	Eradication programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for evergreen buckthorn. In terms of alternative approaches assessed, under no regional intervention (or do nothing) there would be unacceptable loss of biodiversity values. There would also be moderate to high public and political concerns as this pest plant is widely known around Auckland and the Hauraki Gulf where a lot of control effort has occurred. Further, without any intervention the gains made over the last eight years in controlling this plant in Northland would be lost. Progressive containment or sustained control approaches would not be appropriate as the plant is thought to occupy only a fraction of the areas suitable in Northland. It would be risky relying on 'lesser' control options when zero density is deemed achievable. Although spread across the region would be quite sporadic (being bird spread), infestations along coastal areas could be more prolific. These situations require a high level of regional intervention (through professional surveillance and direct control approaches). It would be an unacceptable risk to rely only on landowners to control infestations. Additionally, this plant is hard to distinguish from native trees and future sites would likely be on steep and/or coastal areas and difficult to access. Landholder control is therefore unlikely to be very successful. These operational risks would compromise the outcomes sought and would ultimately fail to contain the spread. Eradication is the preferred outcome and it is realistic given the current infestations and the decrease in effort needed over the last years. It is unlikely but not impossible that other unknown infestations could exist in the region. However, the costs involved under an eradication programme are still relatively minor and are not expected to adversely affect control outcomes.		

Field horsetail

Equisetum arvense

Also known as: horsetail

(Family: Equisetaceae)

Status in New Zealand

All species of horsetails (*Equisetum* spp.), including field horsetail, are listed as unwanted organisms under the Biosecurity Act 1993 and are listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Field horsetail is an erect, colony-forming, primitive fern-ally that grows up to 80cm high and dies back in winter. The plants produce two types of stems. Fertile stems appear in spring and die back in summer. They are whitish to light-brown, unbranched, hollow and leafless. At the tip of each fertile stem there is a small, yellowish-brown cone. The infertile stems resemble miniature pine trees. All aerial parts die back in winter to a deep, branching root system with round tubers.
Habitat	Field horsetail can grow in a range of open habitats including damp or poorly drained soils, roadsides, beaches and well-drained sites in fields, orchards and nursery crops. It has become an aggressive weed in New Zealand, particularly in areas with moderate to high rainfall and in riparian sites.
Regional distribution	Field horsetail is currently known to be present at one site in Northland, at Tamaterau, but is likely to be present in some gardens.
Competitive ability	Field horsetail has become an aggressive weed in parts of New Zealand. It can establish in a range of habitats and form extensive colonies which are difficult to kill. Field horsetail is not tolerant to low levels of light but has some tolerance to drought.
Reproductive ability	Field horsetail only rarely produces spores in New Zealand. It can also spread from roots and tubers. Vectors of spread: The spores of field horsetail are very light and can be dispersed over long distances by wind. Root fragments and tubers may be moved by machinery, water or in soil. It is also planted and spread deliberately by people who wish to use it for medicinal purposes.
Resistance to control	Field horsetail develops extensive underground rhizomes (roots) so, once established, it is difficult and expensive to control.
Benefits	Field horsetail is used as a medicinal plant.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	Low
Sheep and beef	-	Low
Forestry	-	-
Horticulture	-	High
Native bush or forests	-	Low
Urban	-	High
Coastal	-	High
Estuarine and marine	-	-
Freshwater/wetland	-	High

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	M	Field horsetail can establish in pasture and form extensive colonies. Herbivores do not usually eat field horsetail but it can be toxic if they do.	Paynter and Barton, 2008.
Sheep and beef	-	M	Field horsetail can establish in pasture and form extensive colonies. Herbivores do not usually eat field horsetail but it can be toxic if they do.	Paynter and Barton, 2008.
Forestry	-	-		
Horticulture	-	H	Field horsetail can become a weed of field and vegetable crops.	Paynter and Barton, 2008.
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	M	Field horsetail can form pure stands in a range of damp habitats, blocking watercourses and causing flooding.	Paynter and Barton, 2008.
Species diversity	-	H	Field horsetail can form pure stands in a range of damp habitats, preventing native seedlings from establishing.	Paynter and Barton, 2008.
Threatened species	-	H	Field horsetail can form pure stands in a range of damp habitats, preventing native seedlings from establishing including, potentially, threatened species.	Paynter and Barton, 2008.
Social/cultural				
Human health	-	-	Field horsetail is used medicinally but can be toxic in large doses.	Paynter and Barton, 2008.

Category	Current	Potential	Comment	Source
Recreation	-	M	Field horsetail can block watercourses, impeding access.	
Māori culture	-	M	Impacts upon native/taonga species and access to waterways.	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	Field horsetail is only present in very small amounts in Northland. If neighbouring regions were relied on to control the species there would be no economic cost to the Northland region. It is already banned from sale and is included in the National Pest Plant Accord.	There would be limited public awareness of field horsetail and a risk that it would be intentionally introduced for medicinal purposes. If it is not in the pest management plan there would be no rules to prevent possession of the species in Northland.	Medium-high. Without education and regulation there is a medium-high risk that field horsetail could establish and spread in Northland.
Exclusion programme	Not applicable.	Not applicable.	Field horsetail is already present in Northland.
Eradication programme	Field horsetail is currently known from only one site in Northland, however, it is likely to be present in other sites. If the species could be eradicated before it spreads elsewhere, it would prevent long-term impacts and financial costs.	Eradication of field horsetail would not require a large investment of resources because the species is not known to be widespread in Northland.	Low-moderate. There is a low risk that eradication of the known infestation would fail. However, there is a moderate risk that the species exists at other unknown locations.
Progressive containment programme	Not applicable.	Not applicable.	There is only one known site in Northland and it is very small.
Sustained control programme	Not applicable.	Not applicable.	There is only one known site in Northland and it is very small.
Site-led pest programme	Not applicable.	Not applicable.	There is only one known site in Northland and it is very small.
Summary of alternative assessments and preferred option:	Eradication programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for field horsetail. In terms of alternative approaches assessed, under no regional intervention (or do nothing), over time there would be unacceptable loss of biodiversity and production values. There would also be moderate public and political concerns		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	as the effects of this pest plant are quite widely known from around the North Island (where equisetum species are declared pests in a number of regions). Further, without any intervention the gains made in surveillance/controlling this plant in Northland would be lost. Progressive containment or sustained control approaches would not be appropriate as field horsetail is thought to occupy only a fraction of the areas suitable in Northland. It would be risky relying on 'lesser' control options when eradication or zero density is considered achievable. Horsetail species are all notoriously difficult to control and often prove costly once control commences. These control situations require a high level of regional intervention (through professional surveillance and direct control approaches). It would be an unacceptable risk to rely only on landowners to control infestations and landholder control is unlikely to be very successful. These operational risks would compromise the outcomes sought and would ultimately fail to contain the spread of field horsetail. Eradication is the preferred outcome and is realistic given the limited current distribution. It is not impossible that other unknown infestations exist in the region. However, the costs involved under an eradication programme are still relatively minor and are not expected to adversely affect control outcomes.		

Firethorn

Pyracantha angustifolia

Also known as orange or yellow firethorn; Pyracantha.

(Family: Rosaceae)

Status in New Zealand

Firethorn is listed as an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Firethorn is a large spiny shrub growing 2-5m tall and spreading up to 5m across. Its stems are densely hairy and grey or whitish when young, turning reddish-brown or darker grey as they mature. Short side-branches are formed off the main branches which bear most of the elongated entire leaves. The upper leaf surfaces are dark green, almost hairless and shiny, while their undersides are densely hairy and whitish. Its white flowers (8-12mm across) have five petals and are borne in dense clusters. Its small berry-like fruit (5-9mm across) turn yellow or orange when ripe.
Habitat	This species invades open woodlands, forests, urban bushland, coastal scrub, waterways, roadsides and grasslands in temperate and sometimes sub-tropical regions. Prefers moist soil and can withstand strong wind but not maritime exposure. Grows in semi shade and a wide range of soil types. Preference for soils with high calcium content. In South Africa, firethorn is invading areas of degraded native forest with deep, high clay content and slightly acidic soils. In Queensland, firethorn seems to prefer relatively cool upland areas and is generally absent from warmer subtropical lowland areas. It is possible that parts of Northland are too warm for firethorn to thrive.

Regional distribution	Regional distribution is currently limited and includes wild populations on roads and pasture in the far north at Umawera and on Poutu Rd south of Dargaville.
Competitive ability	Competes with and replaces indigenous species. Dense stands are virtually impenetrable and restrict access to grazing by domestic and wild animals. Indigenous birds might neglect the dispersal of indigenous plant species in preference for the fruits of this alien species. Native to south-western China. Naturalised countries include Australia, South Africa, Argentina, south-western USA and Hawaii, as well as New Zealand.
Reproductive ability	Flowers generally appear in spring and summer and fruits develop from late summer to autumn. Berries are produced in large numbers with up to 1000 seeds per square metre of soil surface recorded. Each fruit contains five seeds. Firethorn reproduces entirely from seed. Short seed retention in bird gut. Winter fruit more sought after by birds. Vectors of spread: Seeds are mainly dispersed by birds and other animals including possums and rats, but may also spread by water or in dumped garden waste.
Resistance to control	Controlled by Metsulfuron-methyl at gorse rates.
Benefits	Has been cultivated as a garden ornamental.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	Low	High
Sheep and beef	Low	High
Forestry	-	Low
Horticulture	-	-
Native bush or forests	Low	High (in shrublands)
Urban	Low	Low
Coastal	Low	High
Estuarine and marine	-	-
Freshwater/Wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				

Category	Current	Potential	Comment	Source
Dairy	L	M	Plants unable to be eaten by hoofed animals. Invades grasslands (one of the top 10 invaders of grassland in southern Africa). Could reduce pasture productivity and impede the movement of grazing animals.	Tecco et al 2006; Henderson 2007; Csurhes et al., 2011.
Sheep and beef	L	M	Plants unable to be eaten by hoofed animals. Invades grasslands (one of the top 10 invaders of grassland in southern Africa). Could reduce pasture productivity and impede the movement of grazing animals.	Tecco et al 2006; Henderson 2007; Csurhes et al., 2011.
Forestry	-	L	Can invade open or disturbed moist forest areas.	
Horticulture	-	-		
Other	-	M	Invades post-disturbance. Both native and exotic species richness have been found to be higher under firethorn in Argentina where it has naturalised. It particularly enhances recruitment of other exotic woody species, such as tree privet.	Tecco et al 2006; Giantomasi et al., 2008
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	L	M	Invades post-disturbance. Both native and exotic species richness have been found to be higher under firethorn in Argentina where it has naturalised. It particularly enhances recruitment of other exotic woody species, such as tree privet.	Tecco et al 2006; Giantomasi et al., 2008; Owen and Sheldon, 1996; Williams, 2011.

Category	Current	Potential	Comment	Source
			There is a lack of information about the impacts of firethorn in New Zealand. It is not yet widespread, but has been identified as a species that may occur as the dominant (<80% cover) species in patches covering at least 0.25 ha in the next 30 years. Thought to have the potential to affect sites with high natural values	
Threatened species	-	M	As above.	
Social/cultural				
Human health	L	M	Sharp thorns	
Recreation	L	M	Sharp throns and dense stands can impede access.	
Māori culture	L	M	Potential impacts on native/taonga species.	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs to the council associated with this species.	Firethorn is an invasive species that has the potential to form dense stands and impact on a variety of habitats including pasture and native forest. If no action is taken, the number and extent of infestations is likely to increase with consequent adverse effects on the environment. Future control costs would also increase.	High. Firethorn is an invasive species. If no action is taken, the number and extent of infestations is likely to increase with consequent adverse effects on the environment, and increased control costs in future.
Exclusion programme	Not applicable	Not applicable	Exclusion is not an option because firethorn is already present in Northland.
Eradication programme	Firethorn is known to be an invasive species that is currently limited to only a limited number of wild sites in	Eradication will require a short to medium-term investment of control effort.	Moderate. Firethorn is present at only a limited number of wild sites in Northland, but may be

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	Northland. If these sites could be eradicated, its potential to spread within Northland will be virtually eliminated, avoiding environmental and economic impacts (including long-term control costs if it spreads further).		present in gardens or other unknown sites. Eradication is may be feasible if all infestations are treated and followed-up. It is possible that parts of Northland are too warm for firethorn to thrive (Csurhes et al., 2011).
Progressive containment programme	When compared to an eradication programme, a progressive containment programme would incur lower financial cost to the council in the short-term. A progressive containment programme would aim to prevent firethorn establishing new infestation sites, and aim to gradually decrease the amount of firethorn in Northland.	Firethorn is an invasive species primarily spread by birds and other animals. The time-frame of a progressive containment programme would potentially provide the species with the opportunity (that is, time) to spread.	Moderate. There is a risk that a progressive containment programme will not prevent firethorn from spreading within Northland.
Sustained control programme	When compared to an eradication programme, a sustained control programme would incur lower financial cost to the council in the short-term. A sustained control programme would aim to restrict the spread and impacts of firethorn and prevent it from having increasingly severe impacts on the environment.	Firethorn is an invasive species primarily spread by birds and other animals. The time-frame and aims of a sustained control programme would potentially provide the species with the opportunity (that is, time) to spread.	High. There is a high risk that a sustained control programme will not prevent firethorn from spreading within Northland.
Site-led pest programme	Not applicable	Not applicable	Firethorn is present in low numbers at widely separated sites across Northland so is not a suitable candidate for a site-led programme.
Summary of alternative assessments and preferred option:	**Eradication programme** In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for firethorn. In terms of alternative approaches assessed, under <u>no regional intervention</u> (or do nothing) there would be undesirable loss of both production and biodiversity values. There would be low level public or political concerns as this pest plant is not widely known in the region and its impacts in New Zealand are not fully understood. However, given the history of weed incursions and what is known about this pest in the Far North and Dargaville to date, it would be folly to have no management measures available. <u>Progressive containment or sustained control</u> approaches would not be appropriate as the plant is of limited distribution in Northland. It would be risky to Council to rely on 'lesser' control options when eradication or zero density seems achievable. Although spread across		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	the region would be quite sporadic (being bird spread), infestations along coastal areas and in grasslands could become more prolific. These situations require a high level of regional intervention (through professional surveillance and direct control approaches). It would be an unacceptable risk to rely only on occupiers to control infestations, given its relative unfamiliarity to most land occupiers. Occupier control is therefore unlikely to be successful. These operational risks would compromise the outcomes sought and would ultimately fail to contain its spread. Eradication is the preferred outcome and it is realistic given the current limited extent of infestations. It is unlikely but not impossible that other unknown infestations could exist in the region, essentially in private gardens. There is some risk that dumped garden refuge could spread this pest further than the current distribution. However, even if more sites were found the costs involved under an eradication programme are still relatively minor and are not expected to adversely affect overall management outcomes.		

Furcraea

Furcraea species including: Furcraea foetida, Furcraea longaeva, Furcraea parmentieri and Furcraea selloa.

(Family: Agavaceae)

Status in New Zealand

Naturalising.

Relevant biology

Form	Fleshy or leathery leaves held in a rosette, with or without a basal trunk. The leaf margins may or may not have conspicuous spines or minute teeth. Grows up to 3m tall. Flowers are bisexual and occur on flower spikes up to 12m tall. Bulbils (small bulb-like structures which may fall to form a new plant) often replace flowers in the axils of leaves. Some species produce seed (flat, black), others only reproduce via bulbils.
Habitat	Preferred habitat includes open or semi-open coastal areas, including banks, cliffs and rocky outcrops, and other disturbed or open sites such as pasture, wastelands, railways and roadsides. Tolerates semi-shade, therefore can invade open coastal pohutukawa forest, and other forests via canopy gaps, landslide scars and river banks. May have higher survival in semi-shade than full sun in very hot regions. Wide soil type tolerance including clay, sandy and rocky soils. Very tolerant of saline coastal conditions.
Regional distribution	Off shore islands including Kawau and Aotea, Omaha, Leigh Habour, Scandrett Regional Park, Pakiri, Parnell, Massey. Being controlled to zero density at Mahurangi East. Need Northland distribution data. Known to be in the dunes in Bream Bay. Widespread but scattered throughout Northland.
Competitive ability	History of invasiveness overseas. Capable of forming localised mono-cultures which exclude most other plant species.
Reproductive ability	Reproduces by vegetative spread. Bulbil production can be in the order of thousands per plant under favourable conditions, leading to the formation of dense, monospecific stands around the parent plant. The original plants themselves may also spread from

	the base. In addition to predictable spread radiating from parent plant, some jump dispersal occurs via sea water dispersal and human-assisted movement.
Resistance to control	Relatively easy to control due to localised spread and lack of seed bank.
Benefits	Grown as an ornamental.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	Low
Sheep and beef	-	Low
Forestry	-	-
Horticulture	-	-
Native bush or forests	-	High
Urban	Low	High
Coastal	Low	High
Estuarine and marine	-	Low
Freshwater/Wetland	-	Low

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	L	History of invading pasture overseas.	Flora of NZ fact sheet; Queensland Government factsheet.
Sheep and beef	-	L	History of invading pasture overseas.	
Forestry	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		

Category	Current	Potential	Comment	Source
Water quality	-	-		
Species diversity	L	M	Formation of monocultures in coastal ecosystems has potential to exclude native plant species and alter habitat structure for native animals. Associated with reduced species richness, diversity and cover of native plants overseas. Paucity of empirical evidence regarding ecosystem processes but impacts probable due to lack of functionally equivalent native species.	Barbosa et al., 2013; Baret et al., 2006; Crouch and Smith, 2011; Schofield, 1989; West, 1996;
Threatened species	-	L-M	See 'Species diversity'.	
Social/cultural				
Human health	-	-		
Recreation	-	L	Potential to restrict access to some coastal areas. Some unwanted naturalisation in gardens.	
Māori culture	-	L	See 'Species diversity' and 'Threatened species'.	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council under the RPMP in relation to this species. Rather than applying a programme under the Regional Pest Management Plan, the species could come under a 'Connecting Communities' programme outside the pest management plan, where advice and support are provided for specific sites. This will provide	Furcraea species are already present in Northland but are not usually seen dominating large areas. If no action is taken it may spread, with consequent environmental impacts and future control costs.	Low. If no action is taken, existing infestations of Furcraea species may expand and it may spread to new sites.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	support to communities as and where the species is having impacts.		
Exclusion programme	Not applicable.	Not applicable.	Furcraea species is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Furcraea species is present throughout the region so would not be suitable for an eradication programme.
Progressive containment programme	Not applicable.	Not applicable.	Furcraea species is present throughout the region so would not be suitable for a progressive containment programme.
Sustained control programme	Furcraea species could be included in a sustained control programme. As declared pests they would be banned from sale under the Biosecurity Act. This could help reduce the risk of spread over time.	Century plant is already banned from sale and distribution in Northland and has been for a number of years so would be no costs to plant retail outlets from a ban. Plant retail outlets are inspected regularly by council staff checking for many different plants.	Moderate. Furcraea species could still spread and become more common.
Site-led pest programme	A site-led programme, where control of century plant is required in defined parts of Northland could reduce the impacts of this species within the programme area(s). This could include at risk dune areas, and could include rules requiring Furcraea species to be controlled on properties in these areas to provide a buffer area.	A site-led programme would require an investment of time and resources by the council and affected landowners. It would not reduce or restrict the impacts of Furcraea species in areas that are not identified as being of high priority.	Moderate. A site-led programme could effectively reduce or eliminate local adverse effects of Furcraea species.
Summary of alternative assessments and preferred option:	Sustained controlprogramme With regard to section 6(1) of the NPD a low-level analysis was considered appropriate for furcraea. In terms of alternative approaches assessed, under a do-nothing approach there would be no ability for Council to prevent the formal (nursery trade) or informal (fairs and on-line marketing) trade or circulation of this pest. Furcraea is already naturalised in Northland and its distribution and assessment of effects mean that eradication and progressive containment programmes are not realistic or affordable. Site-led management would control some plants at some sites, but ultimately this approach would also be unsustainable. Sustained control is the preferred outcome and most viable option. Declaring furcraea formally as a pest in the Plan automatically triggers sections 52 and 53 of the Biosecurity Act, banning the pest from sale, propagation and distribution in Northland. This plant is not covered in the current National Pest Plant Accord (NPPA) which has over 150 plants listed, banning		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	them from sale, propagation and distribution nationally. However, the NPPA is nationally focused and doesn't necessarily account for regional differences. The risks of this plant have been evaluated specifically in terms of its effects in Northland. It is important to recognise the wide climate and temperature ranges in New Zealand and that some pests require regional based initiatives based on these factors. Accordingly, furcraea is one of 32 pest plants banned from sale, propagation and distribution in the Northland region. This designation recognises that generally they are a lower risk to the regions' values compared with other more invasive species. Council wishes to take a more proactive stance over their management, as opposed to disregarding them under a do-nothing scenario, while acknowledging it must operate within a finite budget and limited resources. Nurseries in general support the concept of the NPPA and the outcomes being sought.		

G - L plant pests

German ivy

Delairea odorata

Also known as: *Senecio mikanoides,* African ivy, climbing groundsel.

(Family: Asteraceae)

Status in New Zealand

Naturalised.

Relevant biology

Form	German Ivy is a scrambling or climbing vine that can reach heights of 5m. It has thin, weak, green stems and thin, soft, glossy leaves that are ivy-shaped and clammy to the touch. It is in the same family as ragwort, and has ragwort-like yellow flowers during May to October, that go on to form fluffy seeds.
Habitat	German ivy grows well in open environments such as forest margins and scrub. It is also found on roadsides and in quarries, farm hedges, wasteland and house gardens. Natural areas that are at risk of invasion by German ivy include forest margins, coastal communities and the edges of wetlands.
Regional distribution	German ivy is widespread in Northland, particularly on roadsides and at coastal sites.
Competitive ability	German ivy is fast-growing and has a dense, smothering habit. It prefers open, damp sites but is partially tolerant to shade and drought and will grow in most soil types. It produces large number of wind-blown seeds.
Reproductive ability	German ivy produces large number of seeds and can also regrow from fragments of stems and roots. Vectors of spread: The seeds of German ivy are spread by wind. Seeds and plant fragments may also be spread in dumped garden waste or soil or spread intentionally by gardeners, for ornamental purposes.
Resistance to control	It is easiest to control German ivy when it is flowering, because it is so conspicuous.
Benefits	Ornamental.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	Low	Low

Land use type	Current land use infested	Potential land use
Horticulture	-	-
Native bush or forests	Low	High
Urban	Low	High
Coastal	Low	High
Estuarine and marine	-	-
Freshwater/Wetland	-	Low

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-	German ivy is suspected of being toxic to mammals and aquatic organisms, but evidence is inconclusive.	Invasive Species Compendium; Webb et al.,1988.
Sheep and beef	-	-	German ivy is suspected of being toxic to mammals and aquatic organisms, but evidence is inconclusive.	Invasive Species Compendium; Webb et al.,1988.
Forestry	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	L	M	German ivy smothers underlying vegetation, reducing species diversity, seedling abundance, and understorey composition.	Alvarez, 1999; Invasive Species Compendium.
Threatened species	L	M	German ivy can smother threatened native plant species and prevent seed germination.	Alvarez, 1999; Invasive Species Compendium.
Social/cultural				

Category	Current	Potential	Comment	Source
Human health	-	L	German ivy is suspected of being toxic to mammals and aquatic organisms, but evidence is inconclusive.	Invasive Species Compendium; Webb et al.,1988.
Recreation	-	L	German ivy can reduce the aesthetic appeal of natural areas and impede access to recreational areas.	
Māori culture	L	M	Impacts upon native/taonga species.	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council through the RPMP in relation to this species. Rather than applying a programme under the Regional Pest Management Plan, the species could come under a 'Connecting Communities' programme outside the pest management plan, where advice and support are provided for specific sites. This will provide support to communities as and where the species is having impacts.	German ivy is already present in Northland but is not usually seen dominating large areas. If no action is taken it may spread, with consequent environmental impacts and future control costs.	Low. If no action is taken, existing infestations of German ivy may expand and it may spread to new sites.
Exclusion programme	Not applicable.	Not applicable.	German ivy is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	German ivy is present throughout the region so would not be suitable for an eradication programme.
Progressive containment programme	Not applicable.	Not applicable.	German ivy is present throughout the region so would not be suitable for an progressive containment programme.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Sustained control programme	German ivy could be included in a sustained control programme. As a declared pest it would be banned from sale under the Biosecurity Act. This could help reduce the risk of spread over time.	German ivy is already banned from sale and distribution in Northland and has been for a number of years so there would be no costs to plant retail outlets from a ban. Plant retail outlets are inspected regularly by council staff checking for many different plants.	Moderate. German ivy could still spread and become more common.
Site-led pest programme	A site-led programme, where control of German ivy is required in defined parts of Northland could reduce the impacts of this species within the programme area(s).	A site-led programme would require an investment of time and resources by the council and affected landowners. It would not reduce or restrict the impacts of German ivy in areas that are not identified as being of high priority.	Moderate. A site-led programme could effectively reduce or eliminate the adverse effects of German ivy.
Summary of alternative assessments and preferred option:	Sustained control programme With regard to section 6(1) of the NPD a low-level analysis was considered appropriate for German ivy. In terms of alternative approaches assessed, under a do-nothing approach there would be no ability for Council to prevent the formal (nursery trade) or informal (fairs and on-line marketing) trade or circulation of this pest. German ivy is already naturalised in Northland and its distribution and assessment of effects mean that eradication and progressive containment programmes are not realistic or affordable. Site-led management would control some plants at some sites, but ultimately this approach would also be unsustainable. Sustained control is the preferred outcome and most viable option. Declaring German ivy formally as a pest in the Plan automatically triggers sections 52 and 53 of the Biosecurity Act, banning the pest from sale, propagation and distribution in Northland. This plant is not covered in the current National Pest Plant Accord (NPPA) which has over 150 plants listed, banning them from sale, propagation and distribution nationally. However, the NPPA is nationally focused and doesn't necessarily account for regional differences. The risks of this plant have been evaluated specifically in terms of its effects in Northland. It is important to recognise the wide climate and temperature ranges in New Zealand and that some pests require regional based initiatives based on these factors. Accordingly, German ivy is one of 32 pest plants banned from sale, propagation and distribution in the Northland region. This designation recognises that generally they are a lower risk to the regions' values compared with other more invasive species. Council wishes to take a more proactive stance over their management, as opposed to disregarding them under a do-nothing scenario, while acknowledging it must operate within a finite budget and limited resources. Nurseries in general support the concept of the NPPA and the outcomes being sought.		

Giant hogweed

Heracleum mantegazzianum

Also known as: wild rhubarb, cartwheel flower, wild parsnip, cow parsnip.

(Family: Apiaceae)

Status in New Zealand

Giant hogweed is listed as an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Giant hogweed is a perennial herb that can grow up to 6m tall and has large serrated leaves up to 50cm long. It has stout dark reddish-purple stems, and spotted leaf stalks with sturdy bristles. The stems are 5-10cm in diameter, hollow, grooved and covered in fine bristles and red-purple spots. When the plant is two to three years old it produces large, umbrella-like clusters of greenish-white flowers.
Habitat	Giant hogweed usually grows on the banks of rivers or creeks.
Regional distribution	Giant hogweed is not known to be in Northland.
Competitive ability	Giant hogweed can compete with and exclude native vegetation that grows along the banks of rivers or streams. It forms dense colonies that suppress the growth of native plants and grasses. When it dies down in winter it leaves infested banks bare of vegetation and liable to erosion or to invasion by weeds. It is also poisonous to humans.
Reproductive ability	One plant can produce up to 50,000 viable seeds. Vectors of spread: seeds are scattered around the parent plant and are spread by water.
Resistance to control	Due to its toxicity, it is extremely important to wear protective clothing when undertaking any control work. Plants can be hand pulled, cut down or sprayed.
Benefits	

Land uses occupied

Land use type	Current land use infested	Potential land use infested
Dairy	-	-
Sheep and beef	-	-
Forestry	-	-
Horticulture	-	-
Native	-	High
Urban	-	Low
Coastal	-	-
Estuarine and marine	-	-
Freshwater/wetland	-	High

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-	Grazing with domestic livestock is an effective method for controlling giant hogweed. Evidence for the effects of grazing came mostly from the use of sheep, but giant hogweed is also very palatable to cattle.	Nielsen et al., 2005.
Sheep and beef	-			
Forestry	-			
Horticulture	-	L	Giant hogweed is not normally a weed of crops but there are reports of its encroachment into crop fields, such as potatoes in Sweden.	Invasive Species Compendium.
Other	-			
International trade	-			
Environment				
Soil resources	-	L	When giant hogweed dies down in winter it leaves infested banks bare of vegetation and liable to erosion.	Invasive Species Specialist Group.
Water quality	-	L	When giant hogweed dies down in winter it leaves infested banks bare of vegetation and liable to erosion.	Invasive Species Specialist Group.
Species diversity	-	M	Giant hogweed forms dense colonies that suppress the growth of native plants.	Weedbusters website.
Threatened species	-	L	Giant hogweed forms dense colonies that suppress the growth of native plants, potentially including threatened species.	Weedbusters website.
Social/cultural				
Human health	-	H	Giant hogweed is poisonous to humans. It exudes a watery sap, which causes sensitivity to sunlight and can result in painful burns and blisters. Even small particles of giant hogweed sap or dust can irritate skin. Contact with the eyes can lead to temporary or permanent blindness.	Greater Wellington Regional Council.
Recreation	-	H	Due to its toxicity, giant hogweed has the potential to reduce the recreational values of natural areas and obstruct access to waterways.	Invasive Species Compendium.

Category	Current	Potential	Comment	Source
Māori culture	-	H	Due to its toxicity, giant hogweed has the potential to reduce the recreational values of natural areas and obstruct access to waterways. It also has adverse effects on native/taonga species.	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	Giant hogweed is not known to be in Northland. If neighbouring regions were relied on to control the species there would be no economic cost to the Northland region.	There would be limited public awareness of giant hogweed and a risk that it would be intentionally or accidentally introduced. If it is not in the regional pest management plan there would be no rules to prevent possession of the species in Northland.	Medium. Without education and regulation there is a moderate risk that giant hogweed could arrive and establish in Northland.
Exclusion programme	Public awareness and education about the risks and impacts of giant hogweed and a rule banning possession of the species in Northland could prevent it from establishing in the region. If it is included in the pest management plan there is the ability to respond immediately if an infestation is detected in Northland.	Low. There is already educational material available for giant hogweed. Excluding this species would prevent expenditure on its control if/when it invades Northland.	Low. People will be aware of giant hogweed and its potential impacts. There will be a rule banning possession of the species in Northland, which could help discourage people from bringing it to Northland and allow immediate control should any be found.
Eradication programme	Not applicable	Not applicable	Giant hogweed is not known to be present in Northland.
Progressive containment programme	Not applicable	Not applicable	Giant hogweed is not known to be present in Northland.
Sustained control programme	Not applicable.	Not applicable.	Giant hogweed is not known to be present in Northland.
Site-led pest programme	Not applicable.	Not applicable.	Giant hogweed is not known to be present in Northland.
Summary of alternative assessments	Exclusion programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for giant hogweed. In terms of alternative approaches assessed, under no regional intervention (or do nothing) there would be a moderate risk of public and political		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
and preferred option:	criticism of Northland Regional Council for not being more proactive over giant hogweed management, as it is already known in other North Island regions. Biodiversity values (particularly along stream sides) would potentially be impacted if giant hogweed was discovered and no intervention measures were available. As giant hogweed is not currently known in Northland an exclusion programme outcome is the only appropriate option available. There is a medium to high risk that giant hogweed will be introduced to Northland and advocacy around its toxicity to humans (can cause dermatitis) will help reduce this possibility. Further, an exclusion programme focusing on a comprehensive surveillance programme (looking for giant hogweed and other undesirable pest plants) will help to mitigate these risks by detecting any infestations very early on. Inclusion in the Plan will permit the council to fund and undertake control of giant hogweed.		

Giant knotweed

Fallopia sachalinensis

Also known as: *Reynoutria sachalinensis, Polygonum sachalinense.*

(Family: Polygonaceae)

Status in New Zealand

Giant knotweed is listed as an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Giant knotweed is a large, thicket-forming herb that can grow up to 4m tall. It has large (up to 30cm long), heart-shaped leaves that are smooth on top and sometimes covered in fine hairs underneath. The stems are thick, hollow, often green to reddish-brown and die back to the root base in winter. It has a thick root mass with creeping underground stems. The flowers are greenish-white in dense drooping clusters near the end of stems.
Habitat	Giant knotweed can grow in gardens, river and stream edges, forest margins and any waste areas. It tolerates wet to moderately dry conditions and warm to cold temperatures, but is intolerant of shade.
Regional distribution	Giant knotweed is not currently known to be present in Northland.
Competitive ability	Giant knotweed forms dense long-lived thickets, which shade and crowd out other species. Although native to Japan, giant knotweed is now invasive in the USA, Europe, Canada, Australia and New Zealand.
Reproductive ability	Giant knotweed does not produce seed in New Zealand but even a small piece of the plant's root or stem can grow into a new plant. It spreads extensively from rhizomes (roots). Vectors of spread: pieces of giant knotweed may be spread by water, wind, machinery, wildlife and people (for example, dumping of garden waste).

Resistance to control	Giant knotweed is difficult to control because stem fragments and rhizomes re-sprout. Therefore, plant waste must be disposed of carefully and three-monthly follow-up control is required for at least two years.
Benefits	Giant knotweed has a history as an ornamental garden plant.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	-	-
Horticulture	-	-
Native bush or forests	-	Low
Urban	-	High
Coastal	-	Low
Estuarine and marine	-	-
Freshwater/wetland	-	High

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-	Giant knotweed is usually associated with gardens, river and stream edges, forest margins and waste areas. Therefore, it is unlikely to establish in pasture but may grow on adjacent roadsides and riparian margins.	Greater Wellington Regional Council; Invasive Species Compendium.
Sheep and beef	-	-	Giant knotweed is usually associated with gardens, river and stream edges, forest margins and waste areas. Therefore, it is unlikely to establish in pasture but may grow on adjacent roadsides and riparian margins.	Greater Wellington Regional Council; Invasive Species Compendium.
Forestry	-	L	Giant knotweed is usually associated with gardens, river and stream edges, forest margins and waste areas.	Greater Wellington Regional Council; Invasive Species Compendium.

Category	Current	Potential	Comment	Source
			Therefore, it is unlikely to invade production forests but could colonise their margins, adjacent roadsides and riparian margins.	
Horticulture	-	-	Giant knotweed is usually associated with gardens, river and stream edges, forest margins and waste areas. Therefore, it is unlikely to invade horticultural land.	Greater Wellington Regional Council; Invasive Species Compendium.
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	M	Giant knotweed is associated with river and stream edges and forest margins and reduces species diversity in these areas.	Greater Wellington Regional Council; Invasive Species Compendium; Gerber et al., 2008.
Threatened species	-	M	Giant knotweed is associated with river and stream edges and forest margins and has the potential to exclude threatened species from these sites.	Greater Wellington Regional Council; Invasive Species Compendium; Gerber et al., 2008.
Social/cultural				
Human health	-	-		
Recreation	-	M	Giant knotweed has the potential to reduce aesthetic or recreational enjoyment of natural areas.	
Māori culture	-	M	Potential impacts on native/taonga species.	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	Giant knotweed is not known to be in Northland.	There would be limited public awareness of giant knotweed	Medium-high. Without education and regulation there

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	If neighbouring regions were relied on to control the species there would be no economic cost to the Northland region.	and a risk that it would be intentionally or accidentally introduced. If it is not in the Regional Pest Management Plan there would be no rules to prevent possession of the species in Northland.	is a medium-high risk that giant knotweed could arrive and establish in Northland.
Exclusion programme	Public awareness and education about the risks and impacts of giant knotweed and a rule banning possession of the species in Northland could prevent it from establishing in the region. If it is included in the pest management plan there is the ability to respond immediately if an infestation is detected in Northland.	Low. There is already educational material available for giant knotweed. Excluding this species would prevent expenditure on its control if/when it invades Northland.	Low. People will be aware of the species and its potential impacts. There will be a rule banning possession of the species in Northland, which could help discourage people from bringing it to Northland and allow immediate control should any be found.
Eradication programme	Not applicable	Not applicable	Giant knotweed is not known to be present in Northland.
Progressive containment programme	Not applicable	Not applicable	Giant knotweed is not known to be present in Northland.
Sustained control programme	Not applicable	Not applicable	Giant knotweed is not known to be present in Northland.
Site-led pest programme	Not applicable	Not applicable	Giant knotweed is not known to be present in Northland.
Summary of alternative assessments and preferred option:	Exclusion programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for giant knotweed. In terms of alternative approaches assessed, under no regional intervention (or do nothing) there would be a significant risk of public and political criticism of Northland Regional Council for not being more proactive while knowing giant knotweed was already established in neighbouring regions. Although this plant is principally found in disturbed areas, roadsides and river banks, regional biodiversity and production values would potentially be impacted if giant knotweed was discovered and no intervention measures were available. As giant knotweed is not currently found in Northland an exclusion programme outcome is the only appropriate option available. There is a low overall risk associated with this approach, but a very high risk if it were to establish. Knotweeds in general are very tough (rhizomes are able to penetrate just about any natural or man-made surface structure) and are notoriously difficult to control. An exclusion programme focusing on a comprehensive surveillance programme (looking for giant knotweed and other undesirable pest plants) will help to mitigate these risks by detecting any infestations very early on.		

Giant reed

Arundo donax

(Family: Poaceae)

Status in New Zealand

Giant reed is an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Giant reed is a very tall, bamboo-like grass that can grow to 8 m tall. It has a very strong, dense root structure that spreads outwards and downwards. The bluish-green or white-striped leaves are 30-90cm long and 5cm wide. Fluffy seedheads grow at the tops of the stems.
Habitat	Giant reed prefers areas where the soil does not dry out completely. It can grow on a range of soil types and from freshwater to semi-saline conditions on the banks of estuaries, ditches, streams, rivers and lakes. It can occur in moist forest communities, shrublands, roadsides, hedges, wastelands, domestic gardens, and coastal areas.
Regional distribution	Giant reed is widespread but scattered in Northland. It has been sold as an ornamental plant and used for erosion control, particularly on riverbank slips near roads. The largest infestations in Northland are in the Kohukohu, Rawene, Waiharara and Omapere areas.
Competitive ability	Giant reed is a very fast-growing, aggressive species that can out-compete native plant species and form dense stands. It can dramatically alter ecological and successional processes and change habitats. It is tolerant to different climates and can survive and grow at almost any time under a wide variety of environmental conditions. It has been successfully introduced into all the subtropical and warm temperate areas of the world.
Reproductive ability	The horizontal rhizomes (roots) of giant reed give rise to many-stemmed, hollow, cane-like clumps which allow it to grow outwards to form large colonies that are many metres across. It can also grow from plant fragments. The importance of sexual reproduction, seed viability, dormancy, germination and seedling establishment have yet to be studied. Vectors of spread: root and stem fragments may be spread by water, machinery or in soil. The plant may also be deliberately spread by humans, for erosion control or ornamental purposes.
Resistance to control	In theory, giant reed can be controlled using herbicide, fire and/or mechanical methods, but in practice it is very challenging. Mechanical control can be very difficult as the roots readily resprout. The key to controlling giant reed is killing the root mass which requires the use of a systemic herbicide. An American study into the ecology of giant reed suggests that the most effective method of control is a post-flowering and pre-dormancy application of 2-5%glyphoste at a rate of 0.5 to 1L per hectare. Trials of this method indicate an almost 100% control of giant reed. Landcare research are currently preparing an application to the Environmental Protection Authority to request permission to release a gall-forming wasp and a scale insect for giant reed. These agents have both been established for this purpose in the USA and Mexico.

Benefits	Giant reed growth and productivity is being studied to assess its suitability for the production of biomass for energy, paper pulp, and the construction of building materials. It is also widely used as an ornamental plant and for erosion control.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	-	-
Horticulture	-	-
Native bush or forests	Low	Low
Urban	Low	Low
Coastal	-	-
Estuarine and marine	Low	Low
Freshwater/wetland	Low	High

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	L	Giant reed can block waterways and cause flooding.	Williams, 2008.
Sheep and beef	-	L	Giant reed can block waterways and cause flooding.	Williams, 2008.
Forestry	-	-		
Horticulture	L	L	Giant reed is not usually a weed of crops. However, it can block waterways and cause flooding.	Invasive Species Compendium; Williams, 2008.
Other	-	L	Giant reed is extremely flammable and can create intense fires. This is yet to be a problem in New Zealand.	Scott, 1994; Williams, 2008.
International trade	-	-		

Category	Current	Potential	Comment	Source
Environment				
Soil resources	-	-		
Water quality	-	L	Giant reed can choke water channels. Its vertical growth form does not shade waterways, which may result in a rise in water temperatures and lowered oxygen levels. It uses more water than native plants, and can lower groudwater tables.	Invasive Species Compendium; Williams, 2008.
Species diversity	L	M	Giant reed can displace native plants and alter habitat for wildlife. It can crowd out smaller native species but this has not been a large problem in New Zealand to date because it tends to occupy disturbed habitats. However, overseas it has become a threat to native riparian habitats, dramatically altering ecological and successional processes and altering habitats. It may also outcompete native species in the access to soil-water.	Invasive Species Compendium; Williams, 2008.
Threatened species	-	M	Giant reed can displace native species and alter aquatic habitats.	Invasive Species Compendium, Williams, 2008.
Social/cultural				
Human health	-	-		
Recreation	-	M	Because of its large size, giant reed is a visually intrusive plant.	Williams 2008
Māori culture	L	M	Impacts upon native/taonga species.	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs under the RPMP by the council in relation to this species. Rather than applying a programme under the Regional Pest Management Plan, the species could come under a 'Connecting Communities' programme outside of the pest management plan, where advice and support are provided for sites of interest to communities. This will provide support to communities as and where the species is having impacts.	Giant reed is already present in Northland and if no action is taken it is likely to spread, with consequent environmental and economic impacts.	High. There are many stands of giant reed in Northland, from which further spread can occur, and many areas of potential habitat.
Exclusion programme	Not applicable.	Not applicable.	Giant reed is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Giant reed is scattered throughout the region, and resources to eradicate it are not currently available, so it would not be suitable for an eradication programme.
Progressive containment programme	A progressive containment programme would incur lower financial cost to council in the short-term, than an eradication programme. It would aim to confine the distribution of giant reed to currently infested areas, and reduce the distribution over time. However, very limited progress has been made on similar objectives under the current RPMS due to limited resources.	A progressive containment programme would require an investment of time and resources from council and affected landowners. It would not aim to eradicate the species, so control costs would be on-going.	High. Giant reed spreads readily from fragments of roots and stems, there is plenty of potential habitat in Northland, and it is difficult to control. To have a chance of success, a progressive containment programme would require a large and sustained input of effort. Giant reed was a containment species in the RPMS 2010-2015. A survey was undertaken during this time to better understand the distribution of giant reed, but no resources were available to undertake any other work.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Sustained control programme	Giant reed could be included in a sustained control programme. The council could include a rule banning giant reed from sale, distribution and propagation which could help reduce the spread of giant reed. However, giant reed is already an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012, so there would be limited value in including it in the RPMP unless other additional rules are required.	A sustained control programme would require an investment of time and resources by council and affected landowners. It would not aim to eradicate or contain the species, so control costs would be on-going and the opportunity to contain the species may be lost.	Moderate. If a sustained control programme focused on identifying and controlling "new" infestations of this species, it may be feasible to prevent it from spreading.
Site-led pest programme	The council could specify high value dune lakes and wetlands as site-led programmes. These areas are often sites of high biodiversity value in low nutrient systems, and an incursion at these sites could have significant impacts. Giant reed could be listed as progressive containment or eradication species in these areas, so that if a new incursion is detected through regular surveillance we are ready to act.	Rules would only be applicable in the areas defined as site led programmes and could not be enforced elsewhere. Education, publicity, responding to reports, response to new incursions, enforcing rules.	Low - efforts could be targeted to protecting and responding to incursions in the highest value sites in Northland.
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that giant reed does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be no regional intervention for giant reed, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding. While giant reed has not been afforded pest status in Northland, it may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes.		

Giant rhubarb

Gunnera manicata

(Family: Gunneraceae)

Status in New Zealand

Exotic (naturalised).

Relevant biology

Form	Giant rhubarb is a clump-forming, herbaceous summer-green perennial growing to 3m in height. It features stout horizontal rhizomes, with pinnately lobed leaves up to 2 x 2.5m on sturdy petioles up to 2.5m long. Stems and leaf veins are covered in short rubbery reddish prickles. Flowers occur in summer on loose openly branched conical panicles 1-2m long arising from the base of the leaves. Up to five flower heads are produced per plant, each containing highly numerous and densely-packed individual flowers, green to rusty red in colour. Flowers are predominantly hermaphrodite near the apex of the panicle and female at the base. Fruit are 2-3mm in diameter, red-green, rounded, each containing a single seed. Up to 80,000 seeds may be produced per seed head.
Habitat	Most commonly naturalises in areas such as stream-sides and riparian areas, wetlands and coastal areas and cliffs. It can grow to at least 380m above sea level in New Zealand, and is relatively tolerant to low temperatures and hardy to frost to -10°C. It prefers moderate temperatures and moderate to high rainfall, and is able to tolerate wet soils and seasonal waterlogging. It is less common where drainage is too high and able to grow on a wide variety of soil substrates. Very tolerant of salinity and salt spray and can grow right down to the high tide mark in coastal areas.
Regional distribution	Giant rhubarb is not common in Northland. Known in gardens at Matapouri and Waimamaku, and likely to be elsewhere. No known naturalised sites in Northland.
Competitive ability	Lower competitive ability than similar species Chilean rhubarb, which has been attributed to a slower rate of vegetative increase and poorer reproductive ability. It is competitive with native species in disturbed sites and other open areas. Giant rhubarb can reduce native biodiversity and will shade out native regeneration. Symbiosis occurs with the nitrogen-fixing cyanobacterium *Nostoc punctiforme* L. and allows the plant to colonise areas with very poor soils, including gravel and other non-organic soils.
Reproductive ability	Plants flower after 4-5 years. Hymenopterous insects, particularly bees, are probably the main pollinators. Each plant can produce up to a quarter of a million fruit/seeds per season. Seeds are short-lived (less than two years) and therefore there is low seed bank formation. Vectors of spread: seeds are dispersed primarily by water movement but also by wind, birds or livestock. It grows readily from rhizome fragments, which are commonly transported by water movement and erosion, or by human-mediated means.
Resistance to control	Manual control is possible but even small pieces of rhizome left in the soil can regenerate. Larger plants are difficult to control by chemical means due to the large quantity of chemical required to kill the stout rhizome.
Benefits	Planted as an ornamental species.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	Low
Sheep and beef	-	-
Forestry	-	-
Horticulture	-	-
Native bush or forests	-	-
Urban	Low	Low
Coastal	-	High
Estuarine and marine	-	-
Freshwater/wetland	-	High

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	L	Although nitrogen-fixing due to symbiosis with cyanobacterium, it does not appear to alter soil nitrogen content. May contribute to erosion, particularly on slip-prone banks.	Williams et al., 2005. Law, 2003; Weedbusters, 2015.
Water quality	-	L	Can impede or block drains and streams and may increase risk of flooding.	Armstrong et al., 2009.

Category	Current	Potential	Comment	Source
Species diversity	-	L-M	More recently naturalised than Chilean rhubarb and so far has a lower level of impact on native biodiversity. However, it does compete with native species and can reduce natural biodiversity. The large leaves can prevent native species from growing underneath them and it may also form dense stands.	Taranaki educational resource: research analysis and information network, 2015;Williams et al., 2005.
Threatened species	-	-		
Social/cultural				
Human health	-	-		
Recreation	-	L	Can obstruct access to natural and recreational areas.	
Māori culture	-	L	Potential threat to culturally important plants harakeke (flax) and watercress. Watercress is for culinary and medicinal purposes. Harakeke is traditionally used for many purposes including medicinal, culinary, weaving, construction, fishing and hunting, dyes and other domestic purposes.	Pfeiffer and Voeks, 2008; Weedbusters, 2015.

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Can find g.tinctoria being sold as g.manicata so allowing g.manicata to be sold may be aiding spread of g.tinctoria.

"The few records of these putative G. manicata naturalisation events may represent a lag phase of establishment, similar to that observed for Chilean rhubarb in the 1960s. This strongly suggests that all large-leaved Gunnera species should be banned from propagation and sale in New Zealand." Williams et al., 2005.

Tarinaki Regional Council and Waikato Regional Council both ban both species. Both require landowners to destroy/control on their properties. Both banned from sale. Waikato - prog containment. "Reduce the amount of giant gunnera and limit the locations that have it."

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs to the council under the RPMP associated with this species.	Giant rhubarb has a very limited distribution in Northland but it appears to have recently naturalised in other parts of New Zealand	High. If giant rhubarb is not managed the species has the potential to spread to additional sites in Northland and for its impacts to

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
		and is deliberately spread and cultivated for ornamental purposes. The economic and environmental costs of waiting and controlling larger/more infestations is potentially considerable.	increase at sites where it is already present. It could be spread deliberately for cultivation as an ornamental garden plant.
Exclusion programme	Not applicable.	Not applicable.	Exclusion is not an option because giant rhubarb is already present in Northland.
Eradication programme	Giant rhubarb is currently present at a reasonably limited number of known sites. It is more of a risk in high rainfall areas, and could be included in an eradication programme in those areas. This could include a rule banning possession of the species in those areas. This would significantly reduce the risks posed by giant rhubarb.	Eradication of giant rhubarb at high risk sites would require an investment of resources to control known plants and undertake on-going surveys to ensure all plants have been removed and there is no regrowth. This would help avoid long-term economic and environmental impacts in high risk areas.	Moderate. There is a moderate risk of the programme being unsuccessful if inadequate resources are allocated for control and surveillance or if there are undetected infestations or plantings.
Progressive containment programme	A progressive containment programme would incur lower financial cost to the regional council in the short-term and would aim to confine the impacts of giant rhubarb to current infestation areas, and gradually reduce the population. Initial focus could be on the high rainfall areas.	Giant rhubarb is an invasive species that is already present in Northland. If/when it does become more widely established, eradication and containment may no longer be options and there will be long-term financial and environmental costs associated with the species. Council resources would be required to undertake surveys and control outside of the containment zone/s.	Moderate. There is a moderate to high risk that a progressive containment programme will not prevent giant rhubarb from spreading within Northland. It produces large numbers of viable seeds and is also spread by humans, both deliberately and inadvertently.
Sustained control programme	A sustained control programme would incur lower financial cost to the regional council in the short-term, and would aim to restrict the spread and impacts of giant rhubarb. This could include a boundary control rule, requiring clearance a certain distance from property boundaries where the neighbouring property is clear or being cleared.	A sustained control programme would not aim to remove giant rhubarb from the sites where it is already present. If/when it does become more widely established, eradication and containment may no longer be options and there will be long-term financial and environmental costs associated with the species. Council resources would be required	High. Giant rhubarb is an invasive species and a sustained control programme may not be aggressive enough to prevent the spread of this species, including by gardeners. It produces large numbers of viable seeds and is also spread by humans, both deliberately and inadvertently.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
		to follow up on boundary control complaints.	
Site-led pest programme	The council could specify high value wetlands and dune lakes as site-led programmes. These areas are often sites of high biodiversity value in low nutrient systems, and an incursion at these sites could have significant impacts. Giant rhubarb could be listed as a progressive containment or eradication species in these areas, so that if a new incursion is detected through regular surveillance we are ready to act.	Rules would only be applicable in the areas defined as site led programmes and could not be enforced elsewhere. Education, publicity, responding to reports, response to new incursions, enforcing rules.	Moderate - efforts could be targeted to protecting and responding to incursions in the highest value sites in Northland, but giant rhubarb could still spread elsewhere.
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that giant rhubarb does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be no regional intervention for giant rhubarb, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding. While giant rhubarb has not been afforded pest status in Northland, it may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes.		

Gorse

Ulex spp.

(Family: Fabaceae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Gorse is a deep-rooted, woody perennial shrub that can grow to 4m tall. It has densely spined branches and is woody when mature. Gorse has bright yellow flowers from May to November, and black seed pods in summer. Gorse seed reserves in the soil are long-lasting and abundant under and near established infestations.
Habitat	Gorse grows well on a variety of soil types including light sands, heavy clays and disturbed soils. It usually grows where rainfall is evenly distributed throughout the year and in the range of 650-900mm. Its habitat includes river-beds, pasture, scrubland, forest margins and waste land.
Regional distribution	Affects large areas of land throughout Northland.
Competitive ability	Gorse has the ability to occupy a wide range of soil types, and recovers quickly after burning. It very quickly colonises new areas, forming dense thickets. The plant invades pasture land and roadsides as well as low growing or regenerating native vegetation. It can act as a nurse crop for the regeneration of native bush if left for long periods.
Reproductive ability	An established hedge can produce up to 6 million seeds per hectare per year. Flowering begins when the plant is around 18 months old, with flowering usually occurring in spring and autumn. In cold climates flowering may only occur once a year, but flowers can remain year-round when conditions are favourable. Bushes can live for up to 30 years. It forms a persistent seedbank. Vectors of spread: the primary dispersal mechanism for gorse is ballistic dispersal – a mechanical process where the seed pods explode and disperse seed – which can project seeds up to 5m. More than 95% of seeds are dispersed in this manner. Seeds may be carried vast distances fluvially – by water – if a watercourse is nearby. Machinery, footwear, and the movement of soil can also be responsible for seed spread.
Resistance to control	Once established gorse can be very difficult to eradicate, recovering quickly from slashing and burning, and requiring several years of follow-up treatments. Use of biological control has had some success with the gorse seed weevil (*Apion ulicis*) reducing seed production, but much seed survives. The gorse spider mite (*Tetranychus lintearius*) has established well in some areas, but predatory insects can reduce its effectiveness.
Benefits	Gorse may act as a nurse crop for the regeneration of native bush if left long enough (can take 30 years).

Land uses occupied

Land use type	Current land use infested*	Potential land use infested*
Dairy	High	High
Sheep and beef	High	High
Forestry	High	High
Horticulture	Low	Low
Native	High	High

Land use type	Current land use infested*	Potential land use infested*
Urban	Low	Low
Coastal	Low	Low
Estuarine and marine	-	-
Freshwater	-	-

* High = Most infested/preferred, Low = Less infested/preferred

** True = Most 'at risk' or impacted land use(s), False = Less 'at risk' or impacted land use(s). Based upon qualitative impact assessment below.

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	M	H	Can be invasive to pasture and restrict the movement of stock. Established on thousands of hectares of hill and less intensively farmed country in New Zealand. Despite expenditure of millions of dollars on herbicides, dicing, and slashing and burning, gorse is still a huge and expensive problem.	Popay et al., 2010.
Sheep and beef	M	H	Can be invasive to pasture and restrict the movement of stock. Established on thousands of hectares of hill and less intensively farmed country in New Zealand. Despite expenditure of millions of dollars on herbicides, dicing, and slashing and burning, gorse is still a huge and expensive problem.	Popay et al., 2010.
Forestry	M	M	Establishes on forest margins and low growing or regenerating vegetation. Can be a major weed of plantations, particularly between rotations when the seedlings are planted.	Williams and Timmins, 2002.
Horticulture	L	M	Can harbour pests such as rabbits that can in turn impact horticulture.	Invasive Species Specialist Group.
Other	L	L	Infestations occur along road and rail corridors. It can create a fire hazard due to its oily, highly flammable foliage and seeds, and abundant dead material. This fire risk can increase threats on the margins of native vegetation.	Invasive Species Specialist Group.
International trade	-	-		
Environment				

Category	Current	Potential	Comment	Source
Soil resources	L	L	Alters soil conditions by fixing nitrogen and acidifying the soil.	Invasive Species Specialist Group.
Water quality	-	-		
Species diversity	L	L	Can affect native flora, especially understorey species. Can invade regenerating native vegetation but may also act as a nurse crop for regeneration of native bush. Some invasive species can play positive roles in restoration, although they may lead to unexpected outcomes. Gorse shades out the invasive grass sward, creating suitable microsites for the regeneration of native woody species. However, plant succession under gorse follows a different trajectory from that occurring under the native kanuka, at least during the early stages of forest development, with a lower species richness of native forest species and an absence of some native species that are present in comparable kanuka successions. Furthermore, gorse-dominated successions are more invaded by bird-dispersed exotic woody plants.	Invasive Species Specialist Group; Popay et al., 2010; Norton, 2009.
Threatened species	-	-		
Social/cultural				
Human health	L	L	Has sharp thorns.	
Recreation	L	M	Restricts the movement of people.	
Māori culture	M	H	Restricts the movement of people and is invasive to unused land and native vegetation.	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred in relation to this species.	Gorse is already widespread within Northland. It is often an agricultural weed and usually controlled by land occupiers as part of normal land management practices.	Moderate. Gorse is already widespread in Northland, and many occupiers already control it to prevent impacts on land they occupy. However, where it is not controlled it can impose costs on neighbours who are undertaking control but whose land is being re-infested.
Exclusion programme	Not applicable.	Not applicable.	Gorse is widespread throughout Northland.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Eradication programme	Not applicable.	Not applicable.	Gorse is widespread throughout Northland.
Progressive containment programme	Not applicable.	Not applicable.	Gorse is widespread throughout Northland.
Sustained control programme	A sustained control programme would aim to assist land occupiers whose control efforts are compromised by inaction of neighbours. It would include a good neighbour rule requiring boundary clearance. This would reduce costs to land occupiers incurred through the inaction of others.	A sustained control programme would require an investment of time and resources by the regional council and affected landowners. Costs would include publicity and education, responding to complaints and enforcement action	Low. Rules would be enforced on complaint. Land occupiers who are incurring unreasonable costs through the inaction of others have an avenue to address the issue.
Site-led pest programme	Not applicable.	Not applicable.	Gorse is widespread throughout Northland.
Summary of alternative assessments and preferred option:	Sustained control programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for gorse. In terms of alternative approaches assessed, under no regional intervention (or do nothing), maintaining the gains of previous, long-standing control programmes would be lost and control would become voluntary and unenforceable. This would be unacceptable for many land occupiers and communities, with moderate to high political and landowner concerns likely to be expressed. Due to the widespread nature of gorse, eradication is not technically feasible or realistic and the control costs that would be imposed on landowners (and council through wide-scale enforcement) would be inappropriate and unsustainable. Progressive containment and site led control may potentially be achieved in some areas (with defensible boundaries from reinvasion and concerted control efforts) but on a region-wide scale these options too would be onerous, costly and ultimately unsustainable. Sustained control, with a 10m boundary clearance 'good neighbour' rule (activated by a valid complaint) is a pragmatic way to address most landowner concerns and is the preferred option. It recognises the intractable nature of gorse and that some landowners will 'choose' to have gorse on their properties, while ensuring that a robust process is available (via the Biosecurity Act) to reduce externality effects on landowners who want to actively control gorse. Natural mitigation measures exist in 'non-boundary control areas', in that gorse provides an excellent nursery crop for the regeneration of native seedlings and plants which will eventually succeed the gorse. Further mitigation is provided in terms of one of the main pathways of gorse spread, with the boundary clearance rule for quarries increasing from 10m to 50m. Proposed GNR: "Land occupiers within Northland shall destroy all gorse within 10m of an adjacent property, where the adjacent land occupier is taking reasonable measures to manage gorse or its impacts on pastoral production or environmental values. This rule will be enforced on receipt of a complaint from a directly affected land occupier."		

Good neighbour rule test

Before a rule can be identified as a good neighbour rule in a RPMP, the regional council must be satisfied of the matters in subclause (a), (c), and (d) and must comply with the requirements in subclause (b) and (e):	
Tests	
In the absence of the rule, the pest would: • spread to land that is adjacent or nearby within the life of the plan; and • cause unreasonable costs to an occupier of that land.	The primary dispersal mechanism for gorse is ballistic dispersal (>95% of seeds dispersed in this manner) which can project seeds up to 5 meters. It has the ability to occupy a wide range of soil types and very quickly colonises new areas, forming dense thickets. Gorse threatens production land, residential land and areas of regenerating native vegetation. It invades pasture land, blocking access and preventing movement of stock, and harbours other pests. Its ability to spread rapidly could incur considerable cost to some landowners.
In determining whether the pest would spread as described in subclause (a) the regional council must consider: • the proximity and characteristics of the adjacent or nearby land; and • the biological characteristics and behaviour of the particular pest (the greater the distance between properties, the more difficult to satisfy the test in subclause (a)).	Gorse is able to quickly establish on a wide variety of land types. Due to its limited dispersal distance (<5m) it would need to be quite close to a property boundary to spread, however there is a small chance of spread of much greater distances through water and other dispersal mechanisms.
The land that is adjacent or nearby, as described in subclause (a), must be clear from a pest or, if the pest is present on that land, the occupier of that land must be taking measures to manage the pest or its impacts	In order for the good neighbour rules in the RPMP to apply, it is a requirement that the neighbouring property owner or occupier be undertaking gorse control to manage impacts of gorse.
The rule must not set a requirement on an occupier that is greater than that required to manage the spread of the pest.	The buffer requirement in the rule sets a reasonable requirement that does not require control of an entire property and addresses only the area of risk to neighbouring properties.
In determining the rules to be set to manage the costs to an occupier of land that is adjacent or nearby, of the pest spreading, the regional council must consider: • the biological characteristics and behaviour of the particular pest; and • whether the costs of compliance with the rule are reasonable, relative to the costs that such an occupier would incur, from the pest spreading, in the absence of a rule.	Gorse is able to disperse the majority of its seeds within a 5 meter range, and is able to establish rapidly. The costs posed by establishment of the pest is significant, and the cost of occupier control of boundary is not considered to be excessive.
Proposed Good neighbour rule:	

"Land occupiers within Northland shall destroy all gorse within 10m of an adjacent property, where the adjacent land occupier is taking reasonable measures to manage gorse or its impacts on pastoral production or environmental values. This rule will be enforced on receipt of a complaint from a directly affected land occupier."

Quantitative analysis

The medium level analysis for the proposed sustained control programme was undertaken using the GNR model for pest plants developed for regional councils (Harris et al., 2017) and adapted for the Northland situation. The model undertakes both the cost benefit and reasonableness assessments required under sections 6 and 8 respectively of the NPD. In terms of the cost benefit analysis, the model focuses on identifying the boundary distance between two properties that creates a net benefit, i.e. where the costs of introducing a GNR (the sum of the costs of control on the source property, the costs of inspection and the costs the receptor still bears due to seed bank net of any benefit the source property owner receives from controlling the plant pest) is less than the costs that the receptor bears in the absence of a GNR. For the reasonableness assessment, the model compares the costs of control imposed on the source property owner by the GNR with the additional costs of control that the receptor property faces in the absence of the GNR, and reports this as a ratio between the two.

The following two tables contain the specific pest, programme and monetary assumptions that were inputted for gorse in Northland into the GNR model. The benefits from controlling the plant pest for each land use type was calculated based on the potential impact of the pest on the land use as described in the qualitative impact assessment above.

Pest and programme assumptions

Pest assumptions	Values	Programme assumption	Values
Seed bank included	Yes	Proposed boundary width	10 metres
Pest abundance	Locally common	Proposed inspection required	Once (over life of plan)
Density of source infestations	Scattered	Cost of inspection	$500 per property

Land use specific assumptions ($/ha/annum)

Variable	Dairy	S&B intensive	Arable	Horticulture	Hill country	Hard hill country	Conservation	Forestry	Non-productive
Benefits from controlling the plant pest ($/ha/year)	$646	$163	$40	$637	$100	$74	$15	$43	$11
Land occupier costs of controlling scattered infestations ($/ha/year)	$200	$200	$200	$200	$250	$300	$300	$300	$300

The following two tables present the results of the model. In terms of the cost benefit assessment, the results show that when the source infestation is scattered plants, there is likely to be a net benefit from introducing a 10m GNR for gorse when the source land use is dairy, sheep and beef intensive, arable, horticulture and hill country. When the source land use is hard hill country, conservation, forestry or non-productive, the costs imposed by a GNR are likely to be more than the costs of the situation without the GNR, i.e. there is no net benefit. A 10m GNR for gorse is very likely to create a net benefit when the receptor land use is dairy, sheep and beef intensive, arable, horticulture, hill country, hard hill country, conservation, forestry and non-productive.

Cost benefit assessment: Length of boundary required for there to be a net benefit (metres)

		Receptor land use							
Source land use		Dairy	S&B intensive	Arable	Horticulture	Hill country	Hard hill country	Conservation	Fores
	Dairy	50	50	50	50	40	40	40	40
	Sheep and beef intensive	300	300	300	300	200	150	150	15
	Arable	C > B	C > B	C > B	C > B	1840	460	460	46
	Horticulture	50	50	50	50	50	40	40	40
	Hill country	C > B	C > B	C > B	C > B	>2000m	480	480	48
	Hard hill country	C > B	C > B	C > B	C > B	C > B	C > B	C > B	C >
	Conservation	C > B	C > B	C > B	C > B	C > B	C > B	C > B	C >
	Forestry	C > B	C > B	C > B	C > B	C > B	C > B	C > B	C >
	Non-Productive	C > B	C > B	C > B	C > B	C > B	C > B	C > B	C >

C > B = There is no net benefit. The costs imposed by the GNR are always greater than the costs without the GNR. Blank = no costs for receptor landholder

Reasonableness assessment: Ratio of costs for source landholder to the costs for the receptor landholder

		Receptor Land use								
Source Land use		Dairy	S&B intensive	Arable	Horticulture	Hill country	Hard hill country	Conservation	Forestry	Non-P
	Dairy	1.00	1.00	1.00	1.00	0.80	0.67	0.67	0.67	
	Sheep and beef Intensive	1.00	1.00	1.00	1.00	0.80	0.67	0.67	0.67	
	Arable	1.00	1.00	1.00	1.00	0.80	0.67	0.67	0.67	
	Horticulture	1.00	1.00	1.00	1.00	0.80	0.67	0.67	0.67	
	Hill country	1.25	1.25	1.25	1.25	1.00	0.83	0.83	0.83	
	High country	1.50	1.50	1.50	1.50	1.20	1.00	1.00	1.00	
	Conservation	1.50	1.50	1.50	1.50	1.20	1.00	1.00	1.00	

	Forestry	1.50	1.50	1.50	1.50	1.20	1.00	1.00	1.00	
	Non Productive	1.50	1.50	1.50	1.50	1.20	1.00	1.00	1.00	

In terms of reasonableness, when the source infestation is scattered plants the cost of compliance with the rule for the source landowner is between 0.67 and 1.5 times the cost for the occupier who would otherwise be affected.

Gravel groundsel

Senecio skirrhodon

Note: The taxonomy of *Senecio skirrhodon* is complex and not totally resolved. The *S. madagascariensis* complex may include *S. skirrhodon* (Landcare Research 2014).

(Family: Asteracaeae)

Status in New Zealand

No legal status.

Relevant biology

Form	Gravel groundsel is a member of the daisy family. It is a bushy plant that grows up to 50cm tall and has stems that curve upwards. Its flowers are bright yellow, about 3cm across and grow individually at the tips of the stems, not in groups. The fleshy leaves are up to 6cm long and 1cm wide. They are sometimes toothed or lobed and are usually hairless. Gravel groundsel is an annual or short-lived perennial plant.
Habitat	Preferred habitats of gravel groundsel include pasture, coastal areas, waste areas, roadsides and beside railway lines. *S. Madagascariensis*, which may include gravel groundsel, is usually found in disturbed areas. It is opportunistic plant with the ability to colonise a wide range of habitats and substrates but it grows best in well-drained, fertile, disturbed soils.
Regional distribution	In Northland, gravel groundsel is found in localised areas. In recent years populations have increased significantly, particularly in the Far North.
Competitive ability	Gravel groundsel grows vigorously, is tolerant to a wide range of habitats and substrates and produces large number of seeds. It is an aggressive invader of grasslands and is not eaten by cattle because of its toxicity.
Reproductive ability	Gravel groundsel grows quickly and flowers during December and January. It produces very large numbers of small seeds that are attached to silky threads. Plants may also grow from root fragments. Vectors of spread: The primary mechanism of seed dispersal is the wind, which can disperse the downy seeds several kilometres. Seeds may also be spread by water and in hay and soil. Root fragments may also be spread in soil.
Resistance to control	Gravel groundsel is herbicide resistant and an aggressive invader on clear pasture limiting the selection of herbicides for control.
Benefits	Not applicable

Land uses occupied

Land use type	Current land use infested	Potential land use infested
Dairy	Low	Low
Sheep and beef	Low	High
Forestry	Low	Low
Horticulture	-	-
Native	-	-
Urban	Low	High
Coastal	High	High
~~Estuarine and marine~~	~~-~~	~~-~~
Freshwater	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	L	M	Gravel groundsel can invade pasture and is toxic to stock.	Invasive Species Compendium. ~~Mattocks 1986~~
Sheep and beef	L	M	Gravel groundsel can invade pasture and is toxic to stock.	Invasive Species Compendium. Mattocks 1986
Forestry	-	-		
Horticulture	-	-	Gravel groundsel is not usually a weed of crops.	Invasive Species Compendium
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	-		
Threatened species	-	-		

Category	Current	Potential	Comment	Source
Social/cultural				
Human health	-	L	The *Senecio madagascariensis* complex, which may include gravel groundsel, contains alkaloids that are highly toxic to animals and humans.	Mattocks 1986
Recreation	-	-		
Māori culture	-	-		

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred in relation to this species.	Gravel groundsel is already widespread within Northland. It is often an agricultural weed and usually controlled by land occupiers as part of normal land management practices.	Moderate. Gravel groundsel is already widespread in Northland, and many occupiers already control it to prevent impacts on land they occupy. However, where it is not controlled it can impose costs on neighbours who are undertaking control but whose land is being re-infested.
Exclusion programme	Not applicable.	Not applicable.	Gravel groundsel is widespread throughout Northland.
Eradication programme	Not applicable.	Not applicable.	Gravel groundsel is widespread throughout Northland.
Progressive containment programme	Not applicable.	Not applicable.	Gravel groundsel is widespread throughout Northland.
Sustained control programme	A sustained control programme would aim to assist land occupiers whose control efforts are compromised by inaction of neighbours. It would include a good neighbour rule requiring boundary clearance. This would reduce costs to land occupiers incurred through the inaction of others.	A sustained control programme would require an investment of time and resources by the regional council and affected landowners. Costs would include publicity and education, responding to complaints and enforcement action	Low. Rules would be enforced on complaint. Land occupiers who are incurring unreasonable costs through the inaction of others have an avenue to address the issue.
Site-led pest programme	Not applicable.	Not applicable.	Gravel groundsel is widespread throughout Northland.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Summary of alternative assessments and preferred option:	Sustained control programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for gravel groundsel. In terms of alternative approaches assessed, under <u>no regional intervention</u> (or do nothing), maintaining the gains of previous control programmes would be lost and control would become voluntary and unenforceable, although many occupiers would continue its control. This would be unacceptable for many farming communities, particularly in the Far North, where it is spreading. There would be moderate to high political risks to council in not having gravel groundsel declared a pest and concerns would be voiced from the agricultural industry. Due to the widespread nature of gravel groundsel, <u>eradication</u> is not technically feasible or realistic and the control costs that would be imposed on landowners (and council through enforcement across entire properties and the region) would be inappropriate and unsustainable. <u>Progressive containment and site led</u> control may be achievable in some areas (with defensible boundaries from reinvasion and concerted control efforts) but on a region-wide scale these options would be costly and ineffective, particularly due to its opportunistic ability to spread along transport corridors, coastal areas and into waste areas. <u>Sustained control,</u> with a 50m boundary clearance 'good neighbour' rule (activated by a valid complaint from a directly affected nearby owner) is a pragmatic way to address most landowner concerns and is the preferred option. It recognises the widespread nature of this weed while ensuring that a robust process is available (via the Biosecurity Act) to reduce externality effects on landowners who want to actively control it. Further mitigation is provided for in terms of one of the main pathways of gravel groundsel spread, with an additional clearance rule for quarries (the working face extraction areas) plus a 50m buffer around this area. Proposed GNR: "Land occupiers within Northland shall destroy all gravel groundsel within 50m of an adjacent or nearby property, where the adjacent or nearby land occupier is taking reasonable measures to manage gravel groundsel or its impacts on pastoral production or environmental values. This rule will be enforced on receipt of a complaint from a directly affected land occupier."		

Good Neighbour Rule Test

Before a rule can be identified as a good neighbour rule in a RPMP, the regional council must be satisfied of the matters in subclause (a), (c), and (d) and must comply with the requirements in subclause (b) and (e):	
Tests	
In the absence of the rule, the pest would: • spread to land that is adjacent or nearby within the life of the plan; and • cause unreasonable costs to an occupier of that land.	With dispersal distances by wind or water of up to several kilometres, the likelihood of Gravel groundsel spreading to adjacent land is high. Of particular concern is the risk of transferral between pasture land, as the plant invades and establishes quickly, and the risk of transferral to carriageways that may carry the spread to adjacent areas. Once introduced to pasture land Gravel groundsel establishes quickly and reduces pasture productivity. It is not eaten by cattle. The rapid rate of growth from germination to seeding combined with the wide dispersal distances can make the plant difficult and expensive to control once established.

In determining whether the pest would spread as described in subclause (a) the regional council must consider: • the proximity and characteristics of the adjacent or nearby land; and • the biological characteristics and behaviour of the particular pest (the greater the distance between properties, the more difficult to satisfy the test in subclause (a)).	Gravel groundsel has a very wide dispersal distance and is able to establish quickly on grasslands. The plant prefers to establish in open areas such as waste land and pasture, so where there are areas of pasture without several kilometres of dense vegetation to separate them, there is a very high risk of the pest spreading and establishing over significant distances. If the plant was to become established on a carriageway, this may lead to spread along this carriage way and in to adjacent areas.
The land that is adjacent or nearby, as described in subclause (a), must be clear from a pest or, if the pest is present on that land, the occupier of that land must be taking measures to manage the pest or its impacts.	In order for the proposed good neighbour rule to apply, it is a requirement that the neighbouring property be clear of gravel groundsel. In managing spread to carriageways it is required that this land be within 50m of a property free of the plant.
The rule must not set a requirement on an occupier that is greater than that required to manage the spread of the pest.	The buffer requirement in the rule sets a reasonable requirement that does not require control of an entire property and addresses only the area of risk to neighbouring properties.
In determining the rules to be set to manage the costs to an occupier of land that is adjacent or nearby, of the pest spreading, the regional council must consider: • the biological characteristics and behaviour of the particular pest; and • whether the costs of compliance with the rule are reasonable relative to the costs that such an occupier would incur, from the pest spreading, in the absence of a rule.	Gravel groundsel is able to be dispersed for several kilometres and once established will continue to spread rapidly, particularly through pasture. The costs posed by establishment of the pest are significant due to its ability to spread rapidly and reduce pasture productivity. The plant is The cost of occupier control of a 50 metre buffer when the plant is not on neighbouring land is not considered to be excessive.
Proposed Good neighbour rules: Land occupiers within Northland shall destroy all gravel groundsel within 50m of an adjacent or nearby property, where the adjacent or nearby land occupier is taking reasonable measures to manage gravel groundsel or its impacts on pastoral production or environmental values. This rule will be enforced on receipt of a complaint from a directly affected land occupier.	

Quantitative analysis

The medium level analysis for the proposed sustained control programme was undertaken using the GNR model for pest plants developed for regional councils (Harris et al., 2017) and adapted for the Northland situation. The model undertakes both the cost benefit and reasonableness assessments required under sections 6 and 8 respectively of the NPD. In terms of the cost benefit analysis, the model focuses on identifying the boundary distance between two properties that creates a net benefit, i.e. where the costs of introducing a GNR (the sum of the costs of control on the source property, the costs of inspection and the costs the receptor still bears due to seed bank net of any benefit the source property owner receives from controlling the plant pest) is less than the costs that the receptor bears in the absence of a GNR. For the reasonableness assessment, the model compares the costs of control imposed on the source property owner by the GNR with the additional costs of control that the receptor property faces in the absence of the GNR, and reports this as a ratio between the two.

The following two tables contain the specific pest, programme and monetary assumptions that were inputted for gravel groundsel in Northland into the GNR model. The benefits from controlling the plant pest for each land use type was calculated based on the potential impact of the pest on the land use as described in the qualitative impact assessment above. As gravel groundsel was not one of the pest plants included in the GNR model, ragwort was considered as the plant species most similar in terms of dispersal.

Pest and programme assumptions

Pest assumptions	Values	Programme assumption	Values
Seed bank included	Yes	Proposed boundary width	50 metres
Pest abundance	Locally common	Proposed inspection required	Once (over life of plan)
Density of source infestations	Scattered	Cost of inspection	$500 per property

Land use specific assumptions ($/ha/annum)

Variable	Dairy	S&B intensive	Arable	Horticulture	Hill country	Hard hill country	Conservation	Forestry	Non-productive
Benefits from controlling the plant pest ($/ha/year)	$151	$38	$0	$0	$23	$17	$0	$0	$0
Land occupier costs of controlling scattered infestations ($/ha/year)	$120	$120	$120	$120	$150	$200	$200	$200	$200

The following two tables present the results of the model. In terms of the cost benefit assessment, the results show that when the source infestation is scattered plants, there is likely to be a net benefit from introducing a 10m GNR for gravel groundsel when the land use being affected is in dairy, sheep and beef intensive, arable, horticulture, hill country, hard hill country, conservation, forestry and non-productive. However, when the source land use is hard hill country, conservation, forestry or non-productive, the costs imposed by a GNR for grave groundsel are likely to be more than the costs of the situation without the GNR, i.e. there is no net benefit.

Cost benefit assessment: Length of boundary required for there to be a net benefit (metres)

		Receptor land use							
Source land use		Dairy	S&B intensive	Arable	Horticulture	Hill country	Hard hill country	Conservation	Fores
	Dairy	40	40	40	40	40	30	30	30
	Sheep and beef intensive	C > B	C > B	C > B	C > B	240	80	80	80
	Arable	C > B	C > B	C > B	C > B	C > B	250	250	25
	Horticulture	C > B	C > B	C > B	C > B	C > B	250	250	25

	Hill country	C > B	C > B	C > B	C > B	C > B	500	500	50
	Hard hill country	C > B	C > B	C > B	C > B	C > B	C > B	C > B	C >
	Conservation	C > B	C > B	C > B	C > B	C > B	C > B	C > B	C >
	Forestry	C > B	C > B	C > B	C > B	C > B	C > B	C > B	C >
	Non-Productive	C > B	C > B	C > B	C > B	C > B	C > B	C > B	C >

C > B = There is no net benefit. The costs imposed by the GNR are always greater than the costs without the GNR. Blank = no costs for receptor landholder

Reasonableness assessment: Ratio of costs for source landholder to the costs for the receptor landholder

		Receptor Land use								
Source Land use		Dairy	S&B intensive	Arable	Horticulture	Hill country	Hard hill country	Conservation	Forestry	Non-P
	Dairy	1.00	1.00	1.00	1.00	0.80	0.60	0.60	0.60	
	Sheep and beef Intensive	1.00	1.00	1.00	1.00	0.80	0.60	0.60	0.60	
	Arable	1.00	1.00	1.00	1.00	0.80	0.60	0.60	0.60	
	Horticulture	1.00	1.00	1.00	1.00	0.80	0.60	0.60	0.60	
	Hill country	1.25	1.25	1.25	1.25	1.00	0.75	0.75	0.75	
	High country	1.67	1.67	1.67	1.67	1.33	1.00	1.00	1.00	
	Conservation	1.67	1.67	1.67	1.67	1.33	1.00	1.00	1.00	
	Forestry	1.67	1.67	1.67	1.67	1.33	1.00	1.00	1.00	
	Non Productive	1.67	1.67	1.67	1.67	1.33	1.00	1.00	1.00	

In terms of reasonableness, when the source infestation is scattered plants the cost of compliance with the rule for the source landowner is between 0.6 and 1.67 times the cost for the occupier who would otherwise be affected.

Greater bindweed

Calystegia silvatica

(Family: Convolvulaceae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Greater bindweed is a scrambling, twining vine. From October to May it produces white, trumpet-like flowers that are up to 9cm in diameter. The large, arrow-shaped leaves are arranged alternately along the stems and usually die back during winter. It has thick, white roots that can spread out over wide distances.
Habitat	Greater bindweed is common in New Zealand and can be found in gardens, road sides,waste places, forest edges, and wetlands.
Regional distribution	Greater bindweed is widespread in Northland.
Competitive ability	With its extensive root system, greater bindweed spreads easily . It scrambles up and over other plants and outcompetes them by smothering.
Reproductive ability	Greater bindweed has an extensive underground root system which enables it to spread outwards. Fragments of the roots can re-grow. It produces low numbers of viable seeds, so most of its reproduction is from roots and root fragments. Vectors of spread: Seed can be spread by gravity. Seeds and root fragments can be spread in dumped vegetation and in soil.
Resistance to control	Greater bindweed can be controlled with herbicides, but herbicides need to kill both the leaves and roots. Extreme care must be taken when disposing of any plant waste because root fragments can re-grow.
Benefits	

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	Low	Low
Horticulture	-	-
Native bush or forests	Low	High
Urban	High	High
Coastal	Low	High
Estuarine and marine	-	-
Freshwater/Wetland	High	High

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	L	M	Greater bindweed can establish on forest margins and riparian areas (including those within plantation forests).	Wilson-Davey et al., 2009.
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	L	M	Greater bindweed is a significant threat to the establishment and survival of native species on riparian margins. This can have consequences for water quality in streams because riparian vegetation prevents erosion and filters runoff.	Wilson-Davey et al., 2009.
Species diversity	L	M	Greater bindweed is a threat to the establishment and survival of native species on streambanks and forest margins and in wetlands. It can smother planted seedlings.	Wilson-Davey et al., 2009.
Threatened species	L	M	Greater bindweed can smother native plants including threatened species.	Wilson-Davey et al., 2009.
Social/cultural				
Human health	-	-		
Recreation	L	L	Greater bindweed can reduce the aesthetic values of natural areas and impede access.	
Māori culture	L	H	Impacts upon native/taonga species.	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council in relation to this species. Rather than applying a programme under the Regional Pest Management Plan, the species could come under a 'Connecting Communities' programme outside the pest management plan, where advice and support are provided for specific sites. This will provide support to communities as and where the species is having impacts.	Greater bindweed is already present in Northland but is not usually seen dominating large areas. If no action is taken it may spread, with consequent environmental impacts and future control costs.	Low. If no action is taken, existing infestations of great bindweed may expand and it may spread to new sites.
Exclusion programme	Not applicable.	Not applicable.	Greater bindweed is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Greater bindweed is present throughout the region so would not be suitable for an eradication programme.
Progressive containment programme	Not applicable.	Not applicable.	Greater bindweed is present throughout the region so would not be suitable for an progressive containment programme.
Sustained control programme	Greater bindweed could be included in a sustained control programme. As a declared pest it would be banned from sale under the Biosecurity Act. This could help reduce the risk of spread over time.	Greater bindweed is already banned from sale and distribution in Northland and has been for a number of years so there would be no costs to plant retail outlets from a ban. Plant retail outlets are inspected regularly by council staff checking for many different plants.	Moderate. Greater bindweed could still spread and become more common.
Site-led pest programme	A site-led programme, where control of greater bindweed is required in defined parts of Northland could reduce the impacts of this species within the programme area(s).	A site-led programme would require an investment of time and resources by the council and affected landowners. It would not reduce or restrict the impacts of greater	Moderate. A site-led programme could effectively reduce or eliminate the adverse effects of great bindweed.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
		bindweed in areas that are not identified as being of high priority.	
Summary of alternative assessments and preferred option:	Sustained control programme With regard to section 6(1) of the NPD a low-level analysis was considered appropriate for Greater bindweed. In terms of alternative approaches assessed, under a do-nothing approach there would be no ability for Council to prevent the formal (nursery trade) or informal (fairs and on-line marketing) trade or circulation of this pest. Greater bindweed is already naturalised in Northland and its distribution and assessment of effects mean that eradication and progressive containment programmes are not realistic or affordable. Site-led management would control some plants at some sites, but ultimately this approach would also be unsustainable. Sustained control is the preferred outcome and most viable option. Declaring Greater bindweed formally as a pest in the Plan automatically triggers sections 52 and 53 of the Biosecurity Act, banning the pest from sale, propagation and distribution in Northland. This plant is not covered in the current National Pest Plant Accord (NPPA) which has over 150 plants listed, banning them from sale, propagation and distribution nationally. However, the NPPA is nationally focused and doesn't necessarily account for regional differences. The risks of this plant have been evaluated specifically in terms of its effects in Northland. It is important to recognise the wide climate and temperature ranges in New Zealand and that some pests require regional based initiatives based on these factors. Accordingly, great bindweed is one of 32 pest plants banned from sale, propagation and distribution in the Northland region. This designation recognises that generally they are a lower risk to the regions' values compared with other more invasive species. Council wishes to take a more proactive stance over their management, as opposed to disregarding them under a do-nothing scenario, while acknowledging it must operate within a finite budget and limited resources. Nurseries in general support the concept of the NPPA and the outcomes being sought.		

Gypsywort

Lycopus europaeus

(Family: Lamiaceae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Gypsywort is an emergent perennial herb up to approximately 1m tall. It lacks the characteristic minty smell of similar species. Stems are square, leaves toothed and up to 3 x 8.5cm. Flowers small, white to pale pink/purple, and borne summer-autumn. Seeds (nutlets) are minute, and borne summer-autumn.
Habitat	It occurs in the margins of lakes, rivers, ponds and other water bodies, in drainage ditches, damp pasture and waste land. Some salinity tolerance (co-occurs with spartina in estuarine marshes overseas, but this habitat is likely of marginal suitability). Some shade tolerance.

Regional distribution	Apparently restricted to one site in Northland at Te Werahi lagoon. A follow up survey in 2016 failed to find any live plants.
Competitive ability	Invasive in Waikato and overseas. Fast growing.
Reproductive ability	Substantial seed-set. Seeds are highly buoyant, and can be dispersed by water movement. Seed is also dispersed as a contaminant on machinery or footwear, and following ingestion and defecation by livestock. Seed can remain viable after floating for 15 months. Some light exposure required for germination, therefore unlikely to germinate when buried in soil. Localised spread via stolons. Vectors of spread: Seeds can be dispersed by water movement, as contaminant on machinery or footwear, and following ingestion and defecation by livestock. Localised spread via stolons.
Resistance to control	Unknown.
Benefits	Sometimes grown as medicinal herb.

Water bodies occupied

Water body type	Current water body infested	Potential water body infested
Lakes	-	Low
Rivers and streams	-	High
Wetlands	Low	High
Ponds and dams	-	Low
Drains and canals	-	High
Troughs	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	Nil-L	Can colonise damp pasture, and cattle will readily consume it and spread it in faeces. Impact on desirable pasture plants and cattle nutrition both data deficient.	Cosyns et al. 2005 Williams and Haynes 2007
Sheep and beef	-	Nil-L	As above.	
Forestry	-	-		
Horticulture	-	-		

Category	Current	Potential	Comment	Source
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-	Data deficient.	
Water quality	-	-	Data deficient.	
Species diversity	Nil-L	M	Invasive in Waikato and overseas. Can spread rapidly via water movement once in a catchment followed by localised vegetative spread. Abundance at a site may be presumed to displace native vegetation, but this and other potential biodiversity impacts are data deficient.	Delisle et al. 2003 Lachance and Lavoie 2002 NIWA n.d.
Threatened species	-	M	As above.	
Social/Cultural				
Human health	-	-		
Recreation and aesthetics	-	-		
Maori culture	-	L-M	Potential impacts on mauri of wai māori.	

L = low M= moderate H = high - = no impact + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial cost to the council associated with control of this species.	Gypsywort is currently known from only one site in Northland. If it spreads from these locations to infest the margins of lakes, wetlands, rivers ponds, dams, there could be significant environmental impacts. The economic cost of delaying control until there are larger/more infestations is potentially considerable.	High. Without education and regulation there is a high risk that gypsywort could spread and have significant impacts on freshwater habitats.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Exclusion programme	Not applicable.	Not applicable.	Gypsywort is already present in Northland.
Eradication programme	Only one site of gypsywort is currently known from Northland, so costs of implementing a control programme now would be less than leaving it to spread. An eradication programme would raise public awareness and education about the risks and impacts of this species. A rule banning possession of the species in Northland could prevent it from establishing more widely.	Publicity and eduction. Responding to reports. Survey. Eradication will require a short- to medium-term investment of control effort.	Low. People will be aware of the species and its potential impacts. There will be a rule banning possession of the species in Northland, which could help discourage people from bringing it to the region and allow immediate control should any be found. However, there is a risk that an eradication programme could fail because there may be undiscovered infestations.
Progressive containment programme	The council could define a progressive containment area around the current infestation, and aim to control any infestations outside of this. A progressive containment programme would require less resources in the short term.	Publicity and education. Responding to reports. Control of any new infestations.	Moderate - The original infestation is more likely to grow and spread, and may reach a size where eradication or progressive containment is no longer a feasible option. The economic cost of control should this happen may be considerable.
Sustained control programme	Not applicable.	Not applicable.	Gypsywort is not common or widespread in Northland, so a sustained control programme is not appropriate.
Site-led pest programme	The council could define a site-led programme around the current infestation, and aim to control the infestation. As only one site of gypsywort is currently known from Northland, costs of implementing a control programme now would be less than leaving it to spread.	Control costs.	High - There would be no rules or control programme elsewhere in the region should other sites be detected.
Summary of alternative assessments and preferred option:	Eradication programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for gypsy wort. In terms of alternative approaches assessed, under <u>no regional intervention</u> (or do nothing), there would potentially be unacceptable loss of biodiversity values (riparian plant communities) as there are many marginal wetland habitats for it to thrive in in Northland. Currently, gypsy wort is very limited in distribution, at one known site. There is less likelihood of significant public or political concerns as this pest plant is not widely known, although it does occur in neighbouring regions. Under a no intervention approach, NRC could rely on non-regulatory methods such as advocacy, education and site-led management, but loses the ability to undertake direct action and the tools to impose penalties for possession of or deliberate liberations of this pest.		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	Progressive containment or sustained control approaches would not be appropriate as gypsy wort is very uncommon in Northland. It would be highly risky of Council to rely on 'lesser' control options when eradication or zero density is achievable. It would be an unacceptable risk to bank on landowners to control infestations as control of any aquatic pests with herbicides is usually difficult and expensive. Additionally, as the sites involve treatment close to and at times over water, permissions to use herbicides are required through the Environmental Protection Agency (EPA). These situations require a high level of regional intervention (through professional surveillance and direct control approaches). These operational risks would compromise the outcomes sought if landowners were responsible for control work, therefore council service delivery is the most appropriate control measure. Eradication is the preferred outcome and is realistic given the current infestations and the technical challenges involved. There is some level of risk that gypsy wort will be introduced to Northland or unknown infestations are found. NRC intends to undertake direct control of gypsy wort wherever it occurs in the region. The costs involved under an eradication programme are minor (compared with the risks of doing nothing and allowing it to spread) and provides Council with some regulatory tools to incentivise water users such as boaties, eel fishermen, anglers, and fowl shooters (particularly those outside the region) to stop the spread of wetland and semi-aquatic pests to new areas. The benefits of inclusion in the Plan are that significant wetlands and riparian areas around waterways would in the long-term remain free of this pest. The value is difficult to estimate but would be significant, given the high public interest in maintaining wetlands and aquatic ecosystems in a natural state.		

Hakea spp.

Willow-leaved hakea (Hakea salicifolia), prickly hakea (H. sericea), downy hakea (H. gibbosa) and fork-leaved hakea (Hakea drupacea)

(Family: Proteaceae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Willow-leaved hakea is a fast-growing, upright shrub that can grow up to 5m tall. The flat and elliptical leaves are widest in the middle and can grow up to 12cm long. New growth is rose coloured. During the spring it has pale yellow to white flowers which appear in small dense clusters among the leaves. Prickly hakea, as the name suggests is a very prickly shrub or tree up to 5m high with numerous branches starting at the base. Young twigs are covered in short, fine hairs, older stems are smooth. The leaves are dark green to grey-green, smooth, and needle-shaped. It has small, cream flowers from June to September, and wooden fruit capsules which are purplish-brown with paler markings. Downy hakea is a spreading shrub, hairy in most of its parts. The shoots are round, shaggy and hairy, and leaves are simple, round (30-80 x 8-1.5mm) hairy at first and some hairs remain rigid and spiny. Flowers are solitary and few in bunches. Flower stems are hairy 3-5mm long, and it has white flowers from June-August. Fruit are 3.7-4.3 x 3~3.5cm knobbly and shortly beaked. Seeds are 30-33 x 10-14mm with black wings extending down both margins.

	Fork-leaved hakea is a large, rather erect shrub or tree 1 - 4m tall with variable leaves. Leaves can be either simple (a single leaf blade) or compound (with several leaflets) 3 - 13cm long and 1 - 1.6mm wide. It has sweetly scented white flowers in clusters, during April - August. The woody fruits are egg-shaped and shiny brown, tapering to a small beak, and seeds are small, winged and black.
Habitat	Hakea grows on thin poor soils, including gumlands, scrub, open hillsides and sandy soils, and can form dense populations. It is often found in dunes and dune lake areas, on roadsides, and in gumlands. Hakea are early succession species and may be replaced by natives or other species if no further disturbance events occur (that is, fires) in invaded areas. Hakea are slightly tolerant of shade and frost, highly tolerant to drought and intolerant to poor drainage.
Regional distribution	All species are scattered throughout Northland particularly in gumland areas. Willow leafed hakea is at the south end of Ninety Mile Beach, and it has long been naturalised on the gumlands of North Auckland. Downy hakea is most common in the Te Paki area, with some scattered populations around Dargaville and Poutō peninsula. Prickly hakea is common to abundant in the North, including at Kai iwi lakes and Lake Te Kahika. Fork-leaved hakea is the least common of the species, but is still present in the far north and Whangarei areas.
Competitive ability	All hakeas are adapted to fire and low soil nutrients assisting them to become aggressive competitors in sandy and other low nutrient soils. In South Africa, prickly hakea is highly invasive, downy hakea and fork-leaved hakea are moderately invasive and willow leafed hakea is not invasive.. These species have also established and become invasive in other countries such as Portugal.
Reproductive ability	A seed bank is maintained in the canopy. Winged seeds, two per fruit, are released on death of adult plant. Prickly hakea produces a much larger seed bank than the other species. Fork-leaved hakea has a long juvenile period (6 years) and lower seed production than prickly hakea, so is not usually as invasive. Vectors of spread: gravity and wind dispersed seeds that are released after fire, but some are also released continuously. These plants do not establish below their own canopy.
Resistance to control	Controlled by Metsulfuron-methyl at gorse rates.
Benefits	

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	Low
Forestry	Low	Low
Horticulture	-	-
Native bush or forests	Low	High

Land use type	Current land use infested	Potential land use
Urban	-	-
Coastal	Low	High
Estuarine and marine	-	-
Freshwater/wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	L	Prickly hakea, downy hakea and fork-leaved hakea can invade pasture areas and are unpalatable to stock.	
Sheep and beef	-	L	Prickly hakea, downy hakea and fork-leaved hakea can invade pasture areas and are unpalatable to stock.	
Forestry	L	M	Invasion into non riverine land and shrublands in South Africa is dominated by pine and hakea.	Read et al., 2006; Richardson and Cowling, 1992.
Horticulture	-	-	Not banned from sale but not usually found in Northland plant outlets.	
Other				
International trade				
Environment				
Soil resources	L	M	The phosphorus reserve in prickly hakea seeds provides a competitive advantage in sandy soils. Proteoid, or cluster roots increase competitive advantage by increasing absorption of phosphorus and iron. Hardened leaves as an adaptive feature to water deficit, high solar radiation and low nutrients provides a competitive advantage in low nutrient soils.	Lamont, 1972.; Mitchell and Allsop, 1984; Williams, 1992.

Category	Current	Potential	Comment	Source
			Willow-leaved hakea is invading Abel Tasman National Park in areas of poorer soils.	
Water quality	-	L	Hakea species have been found to reduce water yield from catchment areas in South Africa.	Le Maitre et al., 1996
Species diversity	L	M	Prickly hakea has impacts on diversity in native shrublands in northern New Zealand (and in South Africa) because of its dense growth and rapid spread. It may disrupt vegetation successions and ecosystem processes. However, prickly hakea need not be controlled where native vegetation is growing in beneath the canopy of the prickly hakea, as native succession will occur over time. It should be controlled where fires would encourage its spread into herbaceous vegetation of high conservation value.	Richards et al., 1987; Williams, 1992.
Threatened species	-	M	Unknown but grows in low fertility areas often associated with threatened species	
Social/cultural				
Human health	L	L	Sharp thorns	
Recreation	L	L	Sharp thorns	
Māori culture		M	Impacts if invasive in native species habitat.	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	Rather than applying a programme under the Regional Pest Management Plan, the species could come under a 'Connecting Communities' programme outside of the pest management plan, where advice and support are provided for	There would be no immediate costs to council under the pest management plan. However, costs in future could be greater if the species continues to spread.	High. By not applying a programme and rules to the species, there would be no provisions under the pest management plan to manage inappropriate practises that are exacerbating the spread.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	sites of interest to communities. This will provide support to communities as and where the species is having impacts. People would still be encouraged not to dump garden waste and to be careful not to move pests around.		
Exclusion programme	Not applicable.	Not applicable.	Hakea are already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Hakea is already scattered throughout the region so would not be suitable for an eradication programme.
Progressive containment programme	Not applicable.	Not applicable.	Hakea is already scattered throughout the region so would not be suitable for a progressive containment programme.
Sustained control programme	Hakea could be included in a sustained control programme. The council could include a rule banning hakea from sale, distribution and propagation which could help reduce the spread of hakea.	Education, publicity, responding to reports, enforcement action.	Moderate - although these measures may help, hakea could still spread in Northland and infest high value areas.
Site-led pest programme	The council could specify high value dune, dune lake systems and gumlands as site-led programmes. These areas are often sites of high biodiversity value in low nutrient systems, and an incursion at these sites could have significant impacts. Hakea could be listed as progressive containment or eradication species in these areas, so that if a new incursion is detected through regular surveillance we are ready to act.	Rules would only be applicable in the areas defined as site led programmes and could not be enforced elsewhere. Education, publicity, responding to reports, response to new incursions, enforcing rules.	Low - efforts could be targeted to protecting and responding to incursions in the highest value sites in Northland.
Summary of alternative assessments and preferred option:	Sustained control programme With regard to section 6(1) of the NPD a low-level analysis was considered appropriate for hakea species. In terms of alternative approaches assessed, under a do-nothing approach there would be no ability for Council to prevent the formal (nursery trade) or informal (fairs and on-line marketing) trade or circulation of this pest. Hakea species is already naturalised in Northland and its distribution and assessment of effects mean that eradication and progressive containment programmes are not realistic or affordable. Site-led management		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	would control some plants at some sites, but ultimately this approach would also be unsustainable. Sustained control is the preferred outcome and most viable option. Declaring hakea species formally as a pest in the Plan automatically triggers sections 52 and 53 of the Biosecurity Act, banning the pest from sale, propagation and distribution in Northland. This plant is not covered in the current National Pest Plant Accord (NPPA) which has over 150 plants listed, banning them from sale, propagation and distribution nationally. However, the NPPA is nationally focused and doesn't necessarily account for regional differences. The risks of this plant have been evaluated specifically in terms of its effects in Northland. It is important to recognise the wide climate and temperature ranges in New Zealand and that some pests require regional based initiatives based on these factors. Accordingly, hakea is one of 32 pest plants banned from sale, propagation and distribution in the Northland region. This designation recognises that generally they are a lower risk to the regions' values compared with other more invasive species. Council wishes to take a more proactive stance over their management, as opposed to disregarding them under a do-nothing scenario, while acknowledging it must operate within a finite budget and limited resources. Nurseries in general support the concept of the NPPA and the outcomes being sought.		

Himalayan fairy grass

Miscanthus nepalensis

Also known as: Himalayan fairy grass

(Family: Poaceae)

Status in New Zealand

No legal status

Relevant biology

Form	Himalayan fairy grass is a tall perennial grass that forms tufted clumps that are 1-2m tall. It has long, stiff leaf blades that are 4-10mm wide and mid-green in colour with a white mid-rib. The drooping, fan-shaped, golden-brown flower heads grow on a long stem that is purple-green to yellow-green. Chinese fairy grass (*Miscanthus sinensis*) also cultivated and grows wild in New Zealand but it has a creamy-brown flower and is a larger plant that grows to more than 2m tall.
Habitat	Himalayan fairy grass is a light-demanding species and is not tolerant of sites that are very poorly drained (i.e. wet ground). It grows in sunny areas such as roadsides, waste areas, forest margins, cliffs, and disturbed sites.
Regional distribution	Himalayan fairy grass is uncommon in Northland Region. NRC has recorded a large infestation at Tikipunga (Whangarei) and small numbers of plants scattered elsewhere. The Department of Conservation has recorded and/or treated infestations at Matapouri/Marua road, Ngunguru, Whangaruru, Abbey Caves Road and Parihaka Mountain Bike Park (Whangarei), where the largest infestation was found.
Competitive ability	Himalayan fairy grass produces large numbers of wind-dispersed seeds and grows in dense clumps that can become extensive infestations. It crowds out other plants and can prevent the germination, growth and establishment of native species. It will rapidly

	colonise disturbed or open areas, such as burned sites and exposed soil on road cuttings.
Reproductive ability	Himalayan fairy grass produces large numbers of small, wind-dispersed seeds. It can also reproduce vegetatively through its shallow root system and by movement of root fragments. Vectors of spread: The fluffy seeds are spread by the wind. Seeds and root fragments can also be moved by human activities such as in soil or garden waste, on tyres, shoes or clothing. It is also spread intentionally, as an ornamental garden plant.
Resistance to control	Burning Himalayan fairy grass will increase the growth and seed production of the plant. Flowers and seed heads must be removed to avoid spread during removal, and the entire plant and root system dug out. The extensive root system can make the species difficult to control.
Benefits	Ornamental.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	-	-
Horticulture	-	-
Native bush or forests	Low	Low
Urban	Low	High
Coastal	Low	Low
Estuarine and marine	-	-
Freshwater/wetland areas	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-	Himalayan fairy grass is not known to have any effects on agriculture.	Williams 2008
Sheep and beef	-	-	Himalayan fairy grass is not known to have any effects on agriculture.	Williams 2008

Category	Current	Potential	Comment	Source
Forestry	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	L-M	Himalayan fairy grass can occupy the habitats of low-growing native species such as orchids.	Williams 2008
Threatened species	-	L	Himalayan fairy grass can occupy the habitats of low-growing native species such as orchids.	Williams 2008
Social/cultural				
Human health	-	-		
Recreation	-	-		
Māori culture	-	L	Impacts upon native/taonga species	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council through the RPMP in relation to this species.	Himalayan fairy grass is already present in Northland but is present at only a small number of sites. If no action is taken it may spread, with consequent environmental impacts and future control costs.	High. Himalayan fairy grass is already present in Northland and there are large areas of available habitat into which it could spread (Williams 2008).
Exclusion programme	Not applicable	Not applicable	Himalayan fairy grass is already present in Northland.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Eradication programme	Himalayan fairy grass is currently present at a reasonably limited number of known sites but has the potential to spread much further. Eradication would enable long-term economic and environmental impacts to be avoided. As a declared pest, Himalayan fairy grass would be banned from sale under the Biosecurity Act.	Eradication of Himalayan fairy grass would require an investment of resources to control known plants and undertake on-going surveys to ensure all plants have been removed and there is no regrowth.	Moderate. There is a moderate risk of eradication being unsuccessful if inadequate resources are allocated for control and surveillance or if there are undetected infestations or plantings.
Progressive containment programme	A progressive containment programme would incur lower financial cost to the regional council in the short-term. It would aim to confine the impacts of Himalayan fairy grass to current infestation areas and gradually reduce the population. As a declared pest, Himalayan fairy grass would be banned from sale under the Biosecurity Act.	Council resources would be required to undertake surveys and control. Himalayan fairy grass is uncommon in Northland but has the potential to spread into large areas of available habitat. If/when it does become more widely established, eradication and containment may no longer be options and there will be long-term financial and environmental costs associated with the species.	Moderate. There is a moderate risk that a progressive containment programme will not prevent Himalayan fairy grass from spreading within Northland. It produces large numbers of viable seeds and is also spread by humans, both deliberately and inadvertently.
Sustained control programme	A sustained control programme would incur lower financial cost to the regional council in the short-term, and would aim to restrict the spread and impacts of Himalayan fairy grass. As a declared pest, Himalayan fairy grass would be banned from sale under the Biosecurity Act.	A sustained control programme would not aim to remove Himalayan fairy grass from all the sites where it is present. If/when it does become more widely established, eradication and containment may no longer be options and there will be long-term financial and environmental costs associated with the species.	Moderate-High. Himalayan fairy grass produces large quantities of wind-blown seed, so a sustained control programme may not be aggressive enough to prevent the spread of this species.
Site-led pest programme	A site-led programme, where control of Himalayan fairy grass is required in defined parts of Northland could reduce the impacts of this species within the programme area(s).	A site-led programme would require an investment of time and resources by the council and affected landowners. It would not reduce or restrict the impacts of Himalayan fairy grass in areas that are not identified as being of high priority.	Moderate-High. A site-led programme could effectively reduce or eliminate specific infestations of Himalayan fairy grass but would not provide for the control of outlying infestations of this wind-dispersed species.
Summary of alternative assessments	**Sustained control programme - Banned from Sale & Distribution** With regard to section 6(1) of the NPD a low-level analysis was considered appropriate for Himalayan fairy grass. In terms of alternative approaches assessed, under a do-nothing		

Plant pests

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
and preferred option:	approach there would be no ability for Council to prevent the formal (nursery trade) or informal (fairs and on-line marketing) trade or circulation of this pest. Himalayan fairy grass is already naturalised in Northland and its distribution (although it is not that common) and assessment of effects mean that eradication and progressive containment programmes are not realistic or affordable. Site-led management would control some plants at some sites, but ultimately this approach would also be unsustainable. Sustained control is the preferred outcome and most viable option. Declaring Himalayan fairy grass formally as a pest in the Plan automatically triggers sections 52 and 53 of the Biosecurity Act, banning the pest from sale, propagation and distribution in Northland. This plant is not covered in the current National Pest Plant Accord (NPPA) which has over 150 plants listed, banning them from sale, propagation and distribution nationally. However, the NPPA is nationally focused and doesn't necessarily account for regional differences. The risks of this plant have been evaluated specifically in terms of its effects in Northland. It is important to recognise the wide climate and temperature ranges in New Zealand and that some pests require regional based initiatives based on these factors. Accordingly, Himalayan fairy grass is one of 32 pest plants banned from sale, propagation and distribution in the Northland region. This designation recognises that generally they are a lower risk to the regions' values compared with other more invasive species. Council wishes to take a more proactive stance over their management, as opposed to disregarding them under a do-nothing scenario, while acknowledging it must operate within a finite budget and limited resources. Nurseries in general support the concept of the NPPA and the outcomes being sought.		

Himalayan honeysuckle

Leycesteria formosa

(Family: Caprifoliaceae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Himalayan honeysuckle is a shrub that grows up to 2m tall (it is not a vine, like Japanese honeysuckle). It has straight, hollow stems and heart-shaped leaves that are 4-14cm long and 1.5-8cm wide. From December to May, drooping spikes of white and reddish-purple flowers grow from the tips of the branches. They are followed by juicy, dark brownish-purple or red berries (7-10mm diameter).
Habitat	Himalayan honeysuckle is a plant of coastal and lowland habitats. It favours damper habitats and can be found beside streams and in riverbeds, shrubland, and forest margins. It is also found within native forests and plantation forests, where it colonises clearings and canopy gaps caused by slips, tree-falls and tracks.
Regional distribution	Himalayan honeysuckle is widespread in Northland.
Competitive ability	Himalayan honeysuckle grows rapidly to produce dense thickets that replace and exclude other species. It prefers sunny sites but can tolerate shade, frost, physical damage, damp, and most soils. However, it is not long-lived.

Reproductive ability	After flowering, Himalayan honeysuckle produces numerous berries that contain high numbers of seeds. **Vectors of spread:** Seeds are dispersed by water and birds.
Resistance to control	Cut stumps of Himalayan honeysuckle can resprout, so follow-up control is required.
Benefits	Ornamental.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	Low	High
Horticulture	-	-
Native bush or forests	Low	High
Urban	High	High
Coastal	Low	Low
Estuarine and marine	-	-
Freshwater/Wetland	Low	Low

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	L	M	Himalayan honeysuckle occurs in plantation forests, along logging tracks and in clearings.	Roy *et al.* 1998; Veitch, 1995.
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				

Category	Current	Potential	Comment	Source
Soil resources	-	-		
Water quality	-	-		
Species diversity	M	M	Himalayan honeysuckle forms dense thickets that prevent the regeneration of native species.	Timmins and MacKenzie, 1995.
Threatened species	L	M	Himalayan honeysuckle forms dense thickets that prevent the regeneration of native species.	Timmins and MacKenzie, 1995.
ultural				
Human health	L	L	Himalayan honeysuckle may be poisonous.	Timmins and MacKenzie, 1995.
Recreation	L	L	Himalayan honeysuckle may reduce the aesthetic appeal of natural areas and dense thickets may impede access.	
Māori culture	L	M	Impacts upon native/taonga species.	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council in relation to this species. Rather than applying a programme under the Regional Pest Management Plan, the species could come under a 'Connecting Communities' programme outside the pest management plan, where advice and support are provided for specific sites. This will provide support to communities as and where the species is having impacts.	Himalayan honeysuckle is already present in Northland but is not usually seen dominating large areas. If no action is taken it may spread, with consequent environmental impacts and future control costs.	Low. If no action is taken, existing infestations of Himalayan honeysuckle may expand and it may spread to new sites.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Exclusion programme	Not applicable.	Not applicable.	Himalayan honeysuckle is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Himalayan honeysuckle is present throughout the region so would not be suitable for an eradication programme.
Progressive containment programme	Not applicable.	Not applicable.	Himalayan honeysuckle is present throughout the region so would not be suitable for an progressive containment programme.
Sustained control programme	Himalayan honeysuckle could be included in a sustained control programme. As a declared pest it would be banned from sale under the Biosecurity Act. This could help reduce the risk of spread over time.	Himalayan honeysuckle is already banned from sale and distribution in Northland and has been for a number of years so there would be no costs to plant retail outlets from a ban. Plant retail outlets are inspected regularly by council staff checking for many different plants.	Moderate. Himalayan honeysuckle could still spread and become more common.
Site-led pest programme	A site-led programme, where control of Himalayan honeysuckle is required in defined parts of Northland could reduce the impacts of this species within the programme area(s).	A site-led programme would require an investment of time and resources by the council and affected landowners. It would not reduce or restrict the impacts of Himalayan honeysuckle in areas that are not identified as being of high priority.	Moderate. A site-led programme could effectively reduce or eliminate the adverse effects of Himalayan honeysuckle in local areas.
Summary of alternative assessments and preferred option:	Sustained control programme - Banned from Sale & Distribution With regard to section 6(1) of the NPD a low-level analysis was considered appropriate for Himalayan honeysuckle. In terms of alternative approaches assessed, under a do-nothing approach there would be no ability for Council to prevent the formal (nursery trade) or informal (fairs and on-line marketing) trade or circulation of this pest. Himalayan honeysuckle is already naturalised in Northland and its distribution and assessment of effects mean that eradication and progressive containment programmes are not realistic or affordable. Site-led management would control some plants at some sites, but ultimately this approach would also be unsustainable. Sustained control is the preferred outcome and most viable option. Declaring Himalayan honeysuckle formally as a pest in the Plan automatically triggers sections 52 and 53 of the Biosecurity Act, banning the pest from sale, propagation and distribution in Northland. This plant is not covered in the current National Pest Plant Accord (NPPA) which has over 150 plants listed, banning them from sale, propagation and distribution nationally. However, the NPPA is nationally focused and doesn't necessarily account for regional differences. The risks of this plant have been evaluated specifically in terms of its effects in Northland. It is important		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	to recognise the wide climate and temperature ranges in New Zealand and that some pests require regional based initiatives based on these factors. Accordingly, Himalayan honeysuckle is one of 32 pest plants banned from sale, propagation and distribution in the Northland region. This designation recognises that generally they are a lower risk to the regions' values compared with other more invasive species. Council wishes to take a more proactive stance over their management, as opposed to disregarding them under a do-nothing scenario, while acknowledging it must operate within a finite budget and limited resources. Nurseries in general support the concept of the NPPA and the outcomes being sought.		

Holly-leaved senecio

Senecio glastifolius

Also known as: Pink ragwort

(Family: Asteraceae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Holly-leaved senecio is an erect perennial herb that grows up to 1.5m high. It has oval leaves, which are coarsely toothed, and holly-like. The leaf's length is approximately 1.5 times its width and they decrease in length from 10 - 5cm at the base of the plant to 3 - 5cm near the top of the stems. They also become less serrate. The flowers are purple, mauve or pink and occur in clusters. It can be mistaken for purple groundsel (*Senecio elegans*), an introduced plant that grows in sand dunes and also has a purple-crimson flower.
Habitat	In New Zealand, holly-leaved senecio is found growing wild in the Wellington, Wairarapa, Gisborne and Motueka districts. It mainly grows near the coast and is primarily a plant of partially stabilised sand dunes and other coastal sites, particularly disturbed sites. It can grow on rocky banks, coarse river gravel, coastal scree, sandy substrates and soils. In addition to sand dunes, it has also been recorded in waste places, hillsides, rough grassland, scrubland, and road cuttings.
Regional distribution	There are no known infestations of holly-leaved senecio in Northland.
Competitive ability	Holly-leaved senecio is an aggressive invader that is a threat to dune and coastal sites. Evidence from South Africa and Whanganui suggests it has some tolerance of high soil moisture, at least for limited periods, and grows successfully in sand dune swales and swamp margins but is unlikely to tolerate permanently saturated soils. At Motueka, it shows some tolerance for salinity.
Reproductive ability	Holly-leaved senecio reproduces by seed from flowers, which are produced over a short period in October. A few plants have a second, smaller burst of flowering in January/February and set seed in March. Vectors of spread: the small, light seeds are dispersed by wind and gravity.

Resistance to control	Unknown.
Benefits	Ornamental.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	Low
Forestry	-	-
Horticulture	-	-
Native	-	Low
Urban	-	High
Coastal	-	High
Estuarine and marine	-	-
Freshwater/wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-	In New Zealand, holly-leaved senecio is primarily a plant of partially stabilised sand dunes and other coastal sites. It has not been recorded in pasture. Therefore, it is unlikely to invade intensively managed dairy pasture.	Williams *et al.*, 1999.
Sheep and beef	-	L	In New Zealand, holly-leaved senecio is primarily a plant of partially stabilised sand dunes and other coastal sites. It has not been recorded in pasture. Therefore, it is unlikely to invade intensively managed dairy pasture.	Williams et al., 1999.
Forestry	-	-	In New Zealand and its native South Africa, holly-leaved senecio favours disturbed or open sites with high light levels.	Williams et al., 1999.

Category	Current	Potential	Comment	Source
			Therefore, it has limited potential to invade forestry but it has been recorded in recently harvested forest.	
Horticulture	-	-	In New Zealand, holly-leaved senecio is primarily a plant of partially stabilised sand dunes and other coastal sites. It has not been recorded in pasture. Therefore, it is unlikely to have large impacts in horticultural areas.	Williams et al., 1999.
Other	-			
International trade	-			
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	M	Impacts, such as invading sites where native species might otherwise establish, or invading and displacing native species, seems to depend on site factors. However, it has shown its ability to invade sites that have indigenous biodiversity values.	Williams *et al.*, 1999.
Threatened species	-	M	Holly-leaved senecio has invaded sites near Whanganui where there are threatened plant species.	Williams *et al.*, 1999.
Social/cultural				
Human health	-	-		
Recreation	-	M	Holly-leaved senecio may reduce aesthetic values of otherwise natural areas.	
Māori culture	-	M	Potential impacts on native species.	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	Holly-leaved senecio is not known to be in Northland. If neighbouring regions were relied on to control it there would be no economic cost to the Northland region.	There would be limited public awareness of holly-leaved senecio and a risk that it would be intentionally introduced for ornamental reasons. If it is not in the pest management plan there would be no rules to prevent possession of the species in Northland.	Low. Without education and regulation there is a medium-high risk that holly-leaved senecio could arrive and establish in Northland.
Exclusion programme	Public awareness and education about the risks and impacts of holly-leaved senecio and a rule banning possession of the species in Northland could prevent it from establishing in the region. If it is included in the pest management plan there is the ability to respond immediately if an infestation is detected in Northland.	Low. There is already educational material available for holly-leaved senecio. Excluding this species would prevent expenditure on its control if/when it invades Northland.	Low. People will be aware of the species and its potential impacts. There will be a rule banning possession of the species in Northland, which could help discourage people from bringing it to Northland and allow immediate control should any be found.
Eradication programme	Not applicable	Not applicable	Holly-leaved senecio is not known to be present in Northland.
Progressive containment programme	Not applicable	Not applicable	Holly-leaved senecio is not known to be present in Northland.
Sustained control programme	Not applicable	Not applicable	Holly-leaved senecio is not known to be present in Northland.
Site-led pest programme	Not applicable	Not applicable	Holly-leaved senecio is not known to be present in Northland.
Summary of alternative assessments and preferred option:	Exclusion programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for holly-leaved senecio. In terms of alternative approaches assessed, under no regional intervention (or do nothing) there would be a moderate risk of public and political criticism of Northland Regional Council for not being more proactive over holly-leaved senecio management, as it is already known in eastern North Island regions. Biodiversity values (particularly in coastal sites and along stream sides) would potentially be impacted if holly-leaved senecio was detected and no intervention measures were available. As holly-leaved senecio is not currently known in Northland an exclusion programme outcome is the only appropriate option available. There is a medium to high risk that holly-leaved senecio will be introduced to Northland and advocacy and awareness around its spread threat will help reduce this possibility. Further, an exclusion programme focusing on a comprehensive surveillance programme (looking for holly-leaved senecio and other		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	undesirable pest plants) will help to mitigate these risks by detecting any infestations very early on. Inclusion in the Plan will permit the council to fund and undertake control of holly-leaved senecio if it ever turned up in Northland.		

Houttuynia

Houttuynia cordata

Also known as: chameleon plant, ground ivy

(Family: Saururaceae)

Status in New Zealand

Houttuynia is listed as an unwanted organism under the Biosecurity Act 1993, and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Houttuynia grows as a dense groundcover that spreads rapidly. The leaves are heart-shaped and up to 7cm long. They are usually multi-coloured in shades of green, cream, bronze, and scarlet, but may be plain green. When the leaves are crushed they smell of pepper, coriander, or orange. Houttuynia produces clusters of small white flowers.
Habitat	Houttuynia favours damp, shady sites in wetlands, gardens, riparian margins, forest, and shrubland. It can live in water as well as in soil. To date, in New Zealand houttuynia has been found only gardens but it is believed to have the potential to spread into a range of habitats.
Regional distribution	Houttuynia has been found in cultivation in Northland, but is thought to have been eradicated. It is possible that there are other, unidentified sites.
Competitive ability	Houttuynia grows rapidly to form a dense groundcover. Its rampant growth can rapidly displace native plants in forest and wetland ecosystems.
Reproductive ability	Cuttings and fragments of houttuynia can easily take root and form new infestations. Once established, houttuynia can cover large areas assisted by creeping stems and an extensive root system. Houttuynia will also set viable seed in New Zealand. Vectors of spread: the most likely vector of spread is the indiscriminate dumping of garden refuse. It may also spread from seed and could also be introduced to a site intentionally for ornamental or medicinal purposes.
Resistance to control	Plant fragments of houttuynia can re-grow, so waste must be disposed of appropriately. There is limited information available on herbicide control for houttuynia.
Benefits	The leaves, juice and young shoots of houttuynia are used as a medicinal and culinary herb. It is also grown for ornamental reasons.

Land uses occupied

Land use type	Current land use infested	Potential land use infested
Dairy	-	-
Sheep and beef	-	-
Forestry	-	Low
Horticulture	-	-
Native	-	High
Urban	-	High
Coastal	-	-
Estuarine and marine	-	-
Freshwater	-	High

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-	Houttuynia favours damp, shady sites in wetlands, gardens, riparian margins, forest, and shrubland. Therefore, it is unlikely to invade grazed pasture.	New Zealand Plant Conservation Network; Williams and Champion 2008.
Sheep and beef	-	-	Houttuynia favours damp, shady sites in wetlands, gardens, riparian margins, forest, and shrubland. Therefore, it is unlikely to invade grazed pasture.	New Zealand Plant Conservation Network; Williams and Champion 2008.
Forestry	-	L	Houttuynia favours damp, shady sites. Therefore, it has the potential to invade the margins of production forests.	New Zealand Plant Conservation Network; Williams and Champion 2008.
Horticulture	-	-	Houttuynia favours damp, shady sites in wetlands, gardens, riparian margins, forest, and shrubland. Therefore, it is unlikely to invade horticultural land.	New Zealand Plant Conservation Network; Williams and Champion 2008.
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		

Category	Current	Potential	Comment	Source
Water quality	-	-		
Species diversity	-	H	Houttuynia could displace native plants in forest and wetland ecosystems.	Bay of Plenty Regional Council; Williams and Champion 2008.
Threatened species	-	H	Houttuynia could displace native plants in forest and wetland ecosystems, including threatened species.	Bay of Plenty Regional Council; Williams and Champion 2008.
			Social/cultural	
Human health	-	+	Houttuynia is used as a medicinal herb.	Kumar and Prasad, 2014.
Recreation	-	L	Houttuynia may reduce the aesthetic or recreational values of natural areas.	
Maori culture	-	M	Potential impact on native/taonga species.	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	Houttuynia is not known to be in Northland. If neighbouring regions were relied on to control the species there would be no economic cost to the Northland region in the short-term.	There would be limited public awareness of houttuynia and a risk that it would be intentionally introduced for ornamental or medicinal use. If it is not in the pest management plan there would be no rules to prevent possession of the species in Northland.	Medium-high. Without education and regulation there is a medium-high risk that houttuynia could arrive and establish in Northland.
Exclusion programme	Public awareness and education about the risks and impacts of houttuynia in Northland, and a rule banning possession of the species could prevent it from re-establishing in the region. If it is included in the pest management plan there is the ability to respond immediately if an infestation is detected.	Low. There is already educational material available for houttuynia. Excluding this species would prevent expenditure on its control if/when it invades Northland.	Medium. People will be aware of the species and its potential impacts. There will be a rule banning possession of the species in Northland, which could help discourage people from bringing it to Northland. However, houttuynia has been recorded in Northland in the past and there may be unrecorded infestations present.
Eradication programme	Not applicable	Not applicable	Houttuynia is not currently known to be present in Northland.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Progressive containment programme	Not applicable	Not applicable	Houttuynia is not currently known to be present in Northland.
Sustained control programme	Not applicable	Not applicable	Houttuynia is not currently known to be present in Northland.
Site-led pest programme	Not applicable	Not applicable	Houttuynia is not currently known to be present in Northland.
Summary of alternative assessments and preferred option:	**Exclusion programme** In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for houttuynia. In terms of alternative approaches assessed, under no regional intervention (or do nothing) there would be a moderate to high risk of public and political criticism of the council for not being more proactive over houttuynia management, as it has been previously recorded in Northland. Biodiversity values would be impacted if houttuynia was detected and no intervention measures were available. Although essentially a bog plant, it forms dense ivy-like groundcover and would potentially threaten forests, wetlands and other natural areas throughout the region. As houttuynia is not currently known in Northland, and isn't thought to be naturalised in the country, an exclusion programme outcome is the only appropriate option available. There is a medium to high risk that houttuynia will be re-introduced to Northland through informal garden plant exchanges or dumped garden rubbish where houttuynia had been prior. Targeted advocacy and awareness programmes around its spread threat will help reduce this possibility. Further, an exclusion programme focusing on a comprehensive surveillance programme (looking for houttuynia and other high threat pest plants) will help to mitigate the risks by detecting any infestations very early on. Inclusion in the Plan will permit the council to fund and undertake control of houttuynia if it ever turned up in Northland again.		

Jasmine

Jasminum polyanthum

(Family: Oleaceae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Jasmine is a vigorous scrambling climber that forms large, dense mats. It can climb up trees, and produce underground runners that begin new patches. It is evergreen, but is frost tender. Leaves are opposite, usually with seven long-stalked, spear- or egg-shaped leaflets. Flowers are white and very fragrant, and occur in groups of more than 10 forming large branching clusters.
Habitat	Prefers forest margins, forest gaps, shrubland margins, general shrubland and forest, farm hedges, roadsides, abandoned houses and gardens and waste places.
Regional distribution	Common in warmer frost-free areas in Northland.

Competitive ability	Rapid growth, forms dense long-lived masses. In riparian zones and clearings it competes with slower-growing native species, particularly when these are at the juvenile stage. Moderately resistant to high salt concentrations in the soil. Quite tolerant of poor drainage and a range of soil types. Not tolerant of very heavy frosts. Highly shade tolerant.
Reproductive ability	Jasmine does not often produce seed, which is probably the biggest reason this plant is not more widespread and a greater nuisance. The fruit are small enough to be distributed by a range of birds. Grows readily from pieces of the runners. Vectors of spread: Mainly vegetatively through human mediated movement. Garden dumping is the main source of new infestations.
Resistance to control	Very difficult to kill by mechanical means because of the long runner, and it readily regrows if pieces are left. Herbicides can be used, but the plant is very difficult to control and requires repeated treatments.
Benefits	Commonly cultivated. Popular ornamental plant.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	-	-
Horticulture	-	-
Native bush or forests	Low	Low
Urban	High	High
Coastal	Low	Low
Estuarine and marine	-	-
Freshwater/Wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-	No known effects on agriculture.	
Sheep and beef	-	-	No known effects on agriculture.	
Forestry	-	-		
Horticulture	-	-		

Category	Current	Potential	Comment	Source
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	L	M	Forms dense sprawling mats covering low-growing native species especially along margins of forests, light scrub, gullies and some revegetation plantings. Smothers and kills plants from ground level to medium to high canopy, and prevents establishment of native plant seedlings. Blocks light and restricts growth. Also, potentially serious weed on riparian areas.	Queensland Government; Weedbusters; Williams, 2008.
Threatened species	L	M	As above.	
Social/cultural				
Human health	L	L	May cause contact dermatitis in some people.	
Recreation	L	L	Can block tracks and require clearing.	Williams, 2008.
Māori culture	L	M	Impacts upon native/taonga species.	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council under the RPMP in relation to this species.	Jasmine is already present in Northland but is not usually seen dominating large areas. If no action is taken it may spread, with consequent environmental impacts and future control costs.	Low. If no action is taken, existing infestations of jasmine may expand and it may spread to new sites.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	Rather than applying a programme under the Regional Pest Management Plan, the species could come under a 'Connecting Communities' programme outside the pest management plan, where advice and support are provided for specific sites. This will provide support to communities as and where the species is having impacts.		
Exclusion programme	Not applicable.	Not applicable.	Jasmine is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Jasmine is present throughout the region so would not be suitable for an eradication programme.
Progressive containment programme	Not applicable.	Not applicable.	Jasmine is present throughout the region so would not be suitable for an progressive containment programme.
Sustained control programme	Jasmine could be included in a sustained control programme. As a declared pest it would be banned from sale under the Biosecurity Act. This could help reduce the risk of spread over time.	Jasmine is already banned from sale and distribution in Northland and has been for a number of years so there would be no costs to plant retail outlets from a ban. Plant retail outlets are inspected regularly by council staff checking for many different plants.	Moderate. Jasmine could still spread and become more common.
Site-led pest programme	A site-led programme, where control of jasmine is required in defined parts of Northland could reduce the impacts of this species within the programme area(s).	A site-led programme would require an investment of time and resources by the council and affected landowners. It would not reduce or restrict the impacts of jasmine in areas that are not identified as being of high priority.	Moderate. A site-led programme could effectively reduce or eliminate the adverse effects of jasmine in local areas.
Summary of alternative assessments and preferred option:	Sustained control programme - Banned from Sale & Distribution With regard to section 6(1) of the NPD a low-level analysis was considered appropriate for jasmine. In terms of alternative approaches assessed, under a do-nothing approach there would be no ability for Council to prevent the formal (nursery trade) or informal (fairs and on-line marketing) trade or circulation of this pest. Jasmine is already naturalised in Northland and its distribution and assessment of effects mean that eradication and progressive		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	containment programmes are not realistic or affordable. Site-led management would control some plants at some sites, but ultimately this approach would also be unsustainable. Sustained control is the preferred outcome and most viable option. Declaring jasmineformally as a pest in the Plan automatically triggers sections 52 and 53 of the Biosecurity Act, banning the pest from sale, propagation and distribution in Northland. This plant is not covered in the current National Pest Plant Accord (NPPA) which has over 150 plants listed, banning them from sale, propagation and distribution nationally. However, the NPPA is nationally focused and doesn't necessarily account for regional differences. The risks of this plant have been evaluated specifically in terms of its effects in Northland. It is important to recognise the wide climate and temperature ranges in New Zealand and that some pests require regional based initiatives based on these factors. Accordingly, jasmine is one of 32 pest plants banned from sale, propagation and distribution in the Northland region. This designation recognises that generally they are a lower risk to the regions' values compared with other more invasive species. Council wishes to take a more proactive stance over their management, as opposed to disregarding them under a do-nothing scenario, while acknowledging it must operate within a finite budget and limited resources. Nurseries in general support the concept of the NPPA and the outcomes being sought.		

Kangaroo acacia

Acacia paradoxa

Also known as: hedge wattle.

(Family: Mimosaceae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Kangaroo acacia is a perennial shrub up to approximately 3m tall. The leaves are reduced to flattened leaf stalks (phyllodes), up to approximately 8 x 18mm. Spines are up to 10mm long. Clusters of many yellow flowers are borne between July and October. Elongated seed pods are up to 4x60mm, usually with 5 seeds per pod.
Habitat	Open or disturbed sites including roadsides, farms, scrubland, banks, coastal areas, forest margins, waste places. It will grow under at least partial canopy cover. Kangaroo acacia tolerates drought, salt, frosts, low fertility soils and a range of soil moisture levels.
Regional distribution	Widespread scattered distribution across the region.
Competitive ability	Invasive overseas. Several related taxa invasive in New Zealand. Stress tolerant. Forms dense thickets of up to 20 plants/m2. Nitrogen fixer.
Reproductive ability	Reach reproductive maturity rapidly (recorded setting seed at 15cm tall, probably equates to first year). Produces numerous seeds with a hard seed coat, which probably remain viable for a long time (more than 1 year). Seed banks in the invasive range have been recorded at 1000 seeds/m2.

	Vectors of spread: Seeds are dispersed locally via gravity, and pods are possibly also dispersed by water movement. It is intentionally spread by people as a hedge plant.
Resistance to control	Substantial and probably long-lived seed bank and disturbance adapted germination; recruits plentifully following control of adults. Re-sprouts following manual control.
Benefits	Grown as a hedge plant.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	Low
Forestry	-	
Horticulture	-	
Native bush or forests	Low	Low
Urban	High	High
Coastal	Low	High
Estuarine and marine	-	-
Freshwater/Wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	L	Occasionally present on farms. Unlikely to be palatable to livestock due to numerous sharp spines.	
Forestry	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				

Category	Current	Potential	Comment	Source
Soil resources	Nil-L	L-M	Nitrogen-fixer, therefore potential to alter soil fertility and nutrient cycling dynamics.	Zenni et al., 2009
Water quality	-	-		
Species diversity	Nil-L	M	Data deficient. Can form extremely dense stands, therefore probable impacts on native plants via competitive exclusion. Possible risk of altering plant community composition and favouring other exotics via nitrogen fixation. Open coastal ecosystems such as salt marshes may be most at risk.	Zenni et al., 2009
Threatened species	-	L	Depends on ecosystems invaded.	
Social/cultural				
Human health	-	L	Sharp spines.	
Recreation	-	L	Sharp spines, therefore potential to impede access to natural areas and/or cause minor injuries.	
Māori culture	-	M	Potential impacts on mauri of invaded ecosystems (see 'Soil resources' and 'Species diversity').	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council under the RPMP in relation to this species. Rather than applying a programme under the Regional Pest Management Plan, the species could come under a 'Connecting Communities' programme	Kangaroo acacia is already present in Northland but is not usually seen dominating large areas. If no action is taken it may spread, with consequent environmental impacts and future control costs.	Low. If no action is taken, existing infestations of kangaroo acacia may expand and it may spread to new sites.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	outside the pest management plan, where advice and support are provided for specific sites. This will provide support to communities as and where the species is having impacts.		
Exclusion programme	Not applicable.	Not applicable.	Kangaroo acacia is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Kangaroo acacia is present throughout the region so would not be suitable for an eradication programme.
Progressive containment programme	Not applicable.	Not applicable.	Kangaroo acacia is present throughout the region so would not be suitable for an progressive containment programme.
Sustained control programme	Kangaroo acacia could be included in a sustained control programme. As a declared pest it would be banned from sale under the Biosecurity Act. This could help reduce the risk of spread over time.	Kangaroo acacia is already banned from sale and distribution in Northland and has been for a number of years so there would be no costs to plant retail outlets from a ban. Plant retail outlets are inspected regularly by council staff checking for many different plants.	Moderate. Kangaroo acacia could still spread and become more common.
Site-led pest programme	A site-led programme, where control of kangaroo acacia is required in defined parts of Northland could reduce the impacts of this species within the programme area(s).	A site-led programme would require an investment of time and resources by the council and affected landowners. It would not reduce or restrict the impacts of kangaroo acacia in areas that are not identified as being of high priority.	Moderate. A site-led programme could effectively reduce or eliminate the adverse effects of kangaroo acacia in local areas.
Summary of alternative assessments and preferred option:	Sustained control programme - Banned from Sale and Distribution With regard to section 6(1) of the NPD a low-level analysis was considered appropriate for kangaroo acacia. In terms of alternative approaches assessed, under a do-nothing approach there would be no ability for Council to prevent the formal (nursery trade) or informal (fairs and on-line marketing) trade or circulation of this pest. Kangaroo acacia is already naturalised in Northland and its distribution and assessment of effects mean that eradication and progressive containment programmes are not realistic or affordable. Site-led management would control some plants at some sites, but ultimately this approach would also be unsustainable.		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	Sustained control is the preferred outcome and most viable option. Declaring kangaroo acacia formally as a pest in the Plan automatically triggers sections 52 and 53 of the Biosecurity Act, banning the pest from sale, propagation and distribution in Northland. This plant is not covered in the current National Pest Plant Accord (NPPA) which has over 150 plants listed, banning them from sale, propagation and distribution nationally. However, the NPPA is nationally focused and doesn't necessarily account for regional differences. The risks of this plant have been evaluated specifically in terms of its effects in Northland. It is important to recognise the wide climate and temperature ranges in New Zealand and that some pests require regional based initiatives based on these factors. Accordingly, kangaroo acacia is one of 32 pest plants banned from sale, propagation and distribution in the Northland region. This designation recognises that generally they are a lower risk to the regions' values compared with other more invasive species. Council wishes to take a more proactive stance over their management, as opposed to disregarding them under a do-nothing scenario, while acknowledging it must operate within a finite budget and limited resources. Nurseries in general support the concept of the NPPA and the outcomes being sought.		

Lantana (all varieties)

Lantana camara (all varieties)

(Family: *Verbenaceae*)

Status in New Zealand

Lantana is listed as an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Lantana is a prickly, multi-stemmed, evergreen shrub that grows to 2-4m tall. It has a strong odour of blackcurrant. The small flowers grow in clusters, often with more than one colour in a single cluster, for example, yellow and pink. *Lantana camara* var. *aculeata* is the most common variety of lantana in New Zealand and it has small cream and pink flowers. Other varieties have other flower colours, such as orange. The flowers are followed by small blue-black fruits.
Habitat	Lantana can grow in agricultural areas, coast land, natural forests, planted forests, riparian zones, disturbed habitats, scrub, shrublands, urban areas and wetlands.
Regional distribution	In 1992, lantana was found occasionally around major townships and Whāngārei Harbour, fairly common in the Hokianga region, and extended as far north as Houhora. The stands in Hokianga region covered some tens of hectares (at least) of coastal land. Lantana is now found throughout Northland with the worst infestations located around the Hokianga and Whangaroa harbours. A lantana control programme is underway and progressing well in the Far North, on the upper Aupōuri Peninsula.
Competitive ability	Lantana produces many well-dispersed seeds, is long-lived, and forms dense thickets that exclude other species. It is also allelopathic, that is, it produces toxins that poison the soil around it so other species cannot replace it. Lantana is extremely versatile in its habitat preferences and tolerates drought, moderate shade, fire and a range of soil types. It is susceptible to hard frost. Lantana can tolerate some shade but does not flower readily under these conditions.

Reproductive ability	Pollination of lantana has been studied in India, where plants were found to be highly self compatible but usually required an insect for pollination. Projections of seed survival indicate that lantana seeds could survive for up to 11 years under natural rainfall conditions in Australia. **Vectors of spread:** the fruit is dispersed by silver-eyes but larger birds, such as blackbirds and mynahs, are probably more effective. It is also deliberately spread by humans, for ornamental purposes.
Resistance to control	Repeated control of regrowth is critical. Control of new infestations should be a priority because the species is able to expand its range during good seasons.
Benefits	Lantana was introduced for ornamental purposes and is used as a herbal medicine in India.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	Low
Sheep and beef	-	Low
Forestry	High	High
Horticulture	Low	Low
Native bush or forests	High	High
Urban	High	High
Coastal	Low	Low
Estuarine and marine	-	-
Freshwater/wetland	Low	Low

1 = Preferred land use; 2 = Less preferred land use

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	L	Lantana is unlikely to invade intensively grazed pasture. The blue-black fruit have poisoned stock.	New Zealand Plant Conservation Network, 2015.
Sheep and beef	-	L	Lantana is unlikely to invade intensively grazed pasture. The blue-black fruit have poisoned stock. Pieces of leaves and twigs are sticky and can stick to wool.	New Zealand Plant Conservation Network, 2015. Williams and Champion, 2008.

Category	Current	Potential	Comment	Source
Forestry	L	H	The allelopathic qualities of lantana can reduce plant growth. In disturbed or establishing forests, lantana can become the dominant under-storey species.	Invasive Species Compendium, 2015.
Horticulture	-	L	The allelopathic qualities of lantana can reduce productivity in orchards.	Invasive Species Compendium, 2015.
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	L	H	The allelopathic qualities of lantana can reduce plant growth and prevent seedling establishment. In disturbed native forests, lantana can become the dominant under-storey species, disrupting succession, preventing regeneration and decreasing biodiversity. In natural areas, lantana benefits from the destructive foraging of introduced vertebrates. As the density of lantana in forest increases, species richness decreases.	Invasive Species Compendium, 2015.
Threatened species	-	M	Lantana can prevent regeneration and seedling establishment and reduce species diversity. This has the potential to impact on threatened species.	Invasive Species Compendium, 2015.
Social/cultural				
Human health	-	L	The blue-black fruit has poisoned children.	Williams, 2008(a).
Recreation	-	M	Lantana forms dense, prickly thickets that may prevent human access. It may also reduce the aesthetic values of natural areas.	

Category	Current	Potential	Comment	Source
Māori culture	L	H	Impacts upon native/taonga species.	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Do nothing	If no management action is undertaken there will be no short-term financial costs incurred by the council in relation to this species.	Lantana is a serious environmental weed with the ability to invade a range of habitat types. It is already widespread in Northland and if no action is taken, the population of this species will continue to increase and have adverse effects on the environment.	High. Lantana is invasive, is spread via bird-dispersed seeds and people (for ornamental purposes) and can establish in a range of habitats. If no action is taken it will continue to spread and have increasingly serious environmental impacts.
Exclusion programme	Not applicable.	Not applicable.	Lantana is already present in Northland
Eradication programme	Lantana is a serious environmental weed that can establish in a range of indigenous habitats. If it could be eradicated, the adverse effects of this species would be prevented and the long-term costs of control would be avoided.	Eradication of lantana would require a large and sustained investment of resources.	High. Lantana is reasonably widespread in Northland and is abundant in a number of areas. Given the abundance and widespread distribution of this species and the longevity of both plants and seeds, eradication is probably unachievable.
Progressive containment programme	When compared to an eradication programme, a progressive containment programme would incur lower financial cost to the council and land owners. It would aim to confine or reduce the distribution of this aggressive species and reduce its adverse effects on the environment.	This type of programme would require continuation of the investment of time and resources from council and affected landowners. The programme would not aim to eradicate the species, so control costs would be on-going.	Moderate. Lantana is already present in much of Northland. In the short to medium-term a progressive containment programme has a moderate chance of failing to reduce the impact of this species but would be more successful if sustained for the long-term.
Sustained control programme	When compared to an eradication programme, a sustained control programme would incur lower short-term financial cost to council and landowners. It would aim to restrict the spread and impacts of lantana and	This type of programme would require a smaller investment of time and resources by council and affected landowners. It would not aim to eradicate or contain the species, so control costs would be on-going.	High. Lantana is widespread in Northland, is long-lived, has bird-dispersed seeds and the potential to have increasingly serious impacts on the environment, agriculture, forestry and horticulture. A sustained control programme is unlikely to be aggressive

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	prevent it from having increasingly severe impacts on the environment.		enough to effectively manage the adverse effects of this species.
Site-led pest programme	A site-led programme, where control of lantana is required in defined parts of Northland where there are high environmental values, would reduce the impact of this species in high priority areas.	A site-led programme would require an investment of time and resources by council and affected landowners. It would not reduce or restrict the impacts of lantana in areas that are not identified as being of high enough priority to be part of the site-led programme.	Moderate. There is a moderate risk that site-led programmes could fail in areas where lantana is already abundant. Low-moderate. There is a low to moderate risk that site-led programmes could fail in areas where lantana has established only recently and is still present in relatively low numbers. High. There is a high risk that lantana will continue to spread in areas that are not subject to a site-led programme.
Summary of alternative assessments and preferred option:	Progressive containment programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for lantana. In terms of alternative approaches assessed, under no regional intervention (or do nothing), there would be unacceptable loss of biodiversity, economic and public health values. Under the 'do nothing' scenario NRC would rely on voluntary control by occupiers and the community and lantana would continue to spread. Given its profile in the region previously, there would be high public and political concern and consequences if there were no Plan provisions. Eradication of lantana is not considered feasible because it is present in much of Northland already at varying densities. Eradication would not be a cost-effective option to adopt as the full cost of land occupier compliance and NRC resources to monitor and enforce control would likely exceed the benefits. A sustained control or site led approach would also be unacceptable as it would be viewed as a lesser management option and one which would allow lantana to spread further. A more forceful approach, to limited spread into areas currently free of lantana is appropriate. The option considered to carry the least risk is progressive containment. NRC intends to direct land occupiers with infestations outside the containment area to control infestations and will approve all subsequent management plans for larger properties and require total clearance from smaller properties (essentially urban and lifestyle). The biggest risk under this scenario is with land occupiers not adhering to the control requirements and NRC needing to expend a lot of effort with enforcement powers to achieve control. However, these operational risks are considered relatively minor and are not expected to adversely affect management outcomes. Progressive containment offers a cost beneficial alternative to doing nothing that is more affordable in the short to medium term of the Plan. The Plan is more appropriate than relying on voluntary action because the effects of lantana tend to be in the public interest more than the private interest to manage, yet the pest are prevalent on private land.		

Lesser knotweed

Aconogonon campanulatum

Also known as: *Persicaria campanulata, Polygonum campanulatum.*

(Family: Polygonaceae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Lesser knotweed is a perennial herb that can grow to 1m tall. The leaves are 8-15cm long and 3-5cm wide and are hairy on both sides. The tips of the branches are also slightly hairy towards the tip and are grooved. The flowers are pinkish or white and grow in bunches.
Habitat	Lesser knotweed is native to the Himalayas. It was introduced to Britain as an ornamental garden plant, has spread from root fragments and now forms dense patches in waste areas, rail corridors, damp roadsides, hedges and streamsides. Advice for the cultivation of this species suggests it prefers damp, shady sites but will tolerate drought and full sun when established.
Regional distribution	There is one known infestation of lesser knotweed in Northland Region: 4-5 small but dense patches beside a rail line in Kamo.
Competitive ability	Lesser knotweed spreads readily from rhizome (root) fragments. In Britain it is a vigorous coloniser that grows in dense patches and suppresses other plants.
Reproductive ability	Lesser knotweed can be propagated from stem cuttings and dividing the underground rhizomes (roots). Its ability to produce viable seed in New Zealand is unknown. Vectors of spread: In the UK, lesser knotweed is spreading from discarded rhizome (root) fragments. It may be spread inadvertently in soil of garden waste or intentionally, for ornamental purposes.
Resistance to control	Unknown. Regular glyphosate does not control the rhizomes.
Benefits	Ornamental.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	-	-
Horticulture	-	-
Native bush or forests	-	Low
Urban	Low	High

Land use type	Current land use infested	Potential land use
Coastal	-	-
Estuarine and marine	-	-
Freshwater/Wetland	-	Low

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	L-M	Little is known about the habitat preferences and potential impacts of lesser knotweed in New Zealand. However, it is a vigorous coloniser of damp, shady sites such as riparian margins and may suppress native plants in these habitats. The site in Northland was in Kamo, by the railway line.	Online Atlas of the British and Irish Flora.
Threatened species	-	L-M	Little is known about the habitat preferences and potential impacts of lesser knotweed in New Zealand. However, it is a vigorous coloniser of damp, shady sites such as riparian margins and may suppress native plants in these areas.	Online Atlas of the British and Irish Flora.
Social/cultural				
Human health	-	-		

Category	Current	Potential	Comment	Source
Recreation	-	-		
Māori culture	-	L-M	Impacts upon native/taonga species.	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the regional council in relation to this species.	There would be limited public awareness of lesser knotweed and a risk that it would be intentionally spread for ornamental reasons. If it is not in the pest management plan there would be no rules to prevent possession of the species in Northland.	Medium-High. Without education and regulation there is a medium-high risk that lesser knotweed could spread further within Northland.
Exclusion programme	Not applicable.	Not applicable.	Exclusion is not an option because lesser knotweed is already present in Northland.
Eradication programme	Lesser knotweed is known to be growing at one location in Northland. If the species could be eradicated before it spreads elsewhere, it would prevent long-term financial costs and environmental impacts.	Eradication of lesser knotweed would require an investment of resources to control the known infestation, undertake on-going surveys to ensure all plants have been controlled and surveillance to detect and control any infestations that may establish.	Low-medium. Successful eradication would require a sustained, co-ordinated approach and careful implementation. Eradication has the potential to fail in the short to medium-term if there are undetected infestations at other sites.
Progressive containment programme	Not applicable.	Not applicable.	As there is only one known site in Northland, this type of programme is not applicable.
Sustained control programme	Not applicable.	Not applicable.	As there is only one known site in Northland, this type of programme is not applicable.
Site-led pest programme	Not applicable.	Not applicable.	As there is only one known site in Northland, this type of programme is not applicable.
Summary of alternative assessments and preferred option:	Eradication programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for lesser knotweed. In terms of alternative approaches assessed, under no regional intervention (or do nothing), over time there would be unacceptable loss of biodiversity values. There would also be high to moderate public and political concerns of doing nothing, as the effects of knotweeds in general are widely known in New Zealand and from Britain where they are highly invasive.		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	Progressive containment or sustained control approaches would not be appropriate as lesser knotweed is only known at one site and occupies only a fraction of the areas suitable in Northland. It would be risky relying on 'lesser' control options when eradication or zero density is thought to be achievable. Knotweed species are all notoriously difficult to control (lesser knotweed spreads through rhizomes) and often prove costly once control commences. These control situations require a high level of regional intervention (through professional surveillance and direct control approaches). It would be an unacceptable risk to rely only on landowners to control infestations and 'non-professional' control is unlikely to be successful. These risks would compromise the outcomes sought and would ultimately fail to contain the spread of lesser knotweed. Eradication is the preferred outcome and is realistic given the very limited current distribution in and around Kamo. It is not impossible that other unknown infestations exist in the region. However, the costs involved under an eradication programme are still relatively minor and are not expected to adversely affect control outcomes.		

Lily of the valley vine

Salpichroa origanifolia

(Family: Solanaceae)

Also known as: pampas lily of the valley.

Status in New Zealand

Naturalised.

Relevant biology

Form	Lily of the valley vine is a scrambling, fast-growing perennial herb. It has numerous stems growing form the perennial rootstock. The stems are erect at first then grow outwards trailing for up to 3m. Leaves are produced singly or in pairs and each pair is unequal in size. The leaves are oval shaped, 0.5-5cm long, and hairy. Flowers occur between December and January. They are bell-shaped, white or cream, and up to 1cm long. Berries are pale yellow when ripe, 1-2cm long ovoid, smooth and contain up to 20 seeds. Extensive underground system of suckering roots.
Habitat	Disturbed habitats including scrub, roadsides, waste places, gardens, river banks, coastal ecosystems. Mainly found near populated or urban areas. It is drought tolerant and prefers mainly alkaline sandy soils in warm and often semi-arid situations. Susceptible to frost. Overseas it invades dry coastal vegetation, heathland, heathy woodland, lowland grassland, grassy woodland, dry sclerophyll forest, damp sclerophyll forest and riparian vegetation.
Regional distribution	Lily of the valley vine is not widespread in Northland. It is widely distributed in Henderson and Te Atatu South in Auckland, and is currently being controlled on Mt Eden.
Competitive ability	Invasive overseas. It is native to the temperate regions of South America, but has naturalised in Europe, USA, Australia and New Zealand. Prolific scrambling ground-cover growth smothers other plant species. It can kill large shrubs and fruit trees, and make vegetable Produces chemicals which repel some invertebrate herbivores. It has a rapid growth rate from around two years after germination.

Reproductive ability	Lily of the valley vine reproduces from roots and by seed. It usually produces about 100 berries per plant, with 20 seeds per berry. **Vectors of spread:** It can be associated with garden waste dumping sites and be spread by cultivation equipment. Bird dispersed.
Resistance to control	Regenerates from extensive root system, making control difficult. May not be readily controlled by glyphosate. Burt control with glyphosate (at 2%) or Triclopyr (at 0.6%) has shown good initial success treating an infestation in Auckland. Ongoing control is required due to regrowth from root rhizomes.
Benefits	Sometimes grown as an ornamental.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	-	-
Horticulture	-	Low
Native bush or forests	-	Low
Urban	Low	High
Coastal	-	Low
Estuarine and marine	-	-
Freshwater/Wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	Nil- L	Unpalatable to livestock.	
Sheep and beef	-	Nil-L	Unpalatable to livestock.	
Forestry	-	-		
Horticulture	L	L-M	Capable of smothering fruit trees and vegetable crops and obstructing cultivation.	Victoria Department of Environment and Primary Industries 2014
Other	-	-		

Category	Current	Potential	Comment	Source
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	L	L-M	Capable of smothering native vegetation. Empirical data deficient.	Victoria Department of Environment and Primary Industries 2014
Threatened species	-	-	Capable of smothering native vegetation. Empirical data deficient.	Victoria Department of Environment and Primary Industries 2014
Social/cultural-				
Human health	-	L	Contains toxic compounds and may be poisonous to humans but no known records of poisonings.	Bado et al 2004 Victoria Department of Environment and Primary Industries 2014
Recreation	L	L	Suckering roots cause nuisance in lawns and gardens.	Esler 1988
Māori culture	-	L-M	Very invasive on some maunga in Auckland region, smothering other vegetation. See also 'Species diversity'	M. Harrison, Auckland Council, pers. comm.

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	Rather than applying a programme under the pest management plan, the species could come under a 'council supported management' programme, where advice and support are provided for specific species. This will provide support to communities as and where the species is having local impacts.	By not applying a programme and rules to the species, there would be no provisions under the pest management plan to manage inappropriate practises that are exacerbating the spread. Does not appear to be particularly invasive.	Low. Without education and regulation there is a low risk that lily of the valley vine could spread further within Northland.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Exclusion programme	Not applicable.	Not applicable.	Lily of the valley vine is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Lily of the valley vine is present in the region so would not be suitable for an eradication programme.
Progressive containment programme	Not applicable.	Not applicable.	Lily of the valley vine is scattered around the region so would not be suitable for a progressive containment programme.
Sustained control programme	Lily of the valley vine could be included in a sustained control programme. As a declared pest it would be banned from sale under the Biosecurity Act, and subject to rules about distribution. This could help reduce the risk of spread over time.	A sustained control programme would require an investment of time and resources by the council and affected landowners, and plant nurseries.	Low. Lily of the valley vine may still spread and become more common.
Site-led pest programme	A site-led programme, where control of lily of the valley vine is required in defined parts of Northland, for example some high value areas, could reduce the impacts (no assessments of impacts available) of this species within the programme area(s).	A site-led programme would require an investment of time and resources by the council and affected landowners. It would not reduce or restrict the impacts of lily of the valley vine in areas that are not identified as being of high priority.	Moderate. A site-led programme may reduc the adverse effects of lily of the valley vine in some areas.
Summary of alternative assessments and preferred option:	Sustained control programme - Banned from Sale & Distribution With regard to section 6(1) of the NPD a low-level analysis was considered appropriate for lily of the valley. In terms of alternative approaches assessed, under a do-nothing approach there would be no ability for Council to prevent the formal (nursery trade) or informal (fairs and on-line marketing) trade or circulation of this pest. Lily of the valley is already naturalised in Northland and its distribution and assessment of effects mean that eradication and progressive containment programmes are not realistic or affordable. Site-led management would control some plants at some sites, but ultimately this approach would also be unsustainable. Sustained control is the preferred outcome and most viable option. Declaring lily of the valley formally as a pest in the Plan automatically triggers sections 52 and 53 of the Biosecurity Act, banning the pest from sale, propagation and distribution in Northland. This plant is not covered in the current National Pest Plant Accord (NPPA) which has over 150 plants listed, banning them from sale, propagation and distribution nationally. However, the NPPA is nationally focused and doesn't necessarily account for regional differences. The risks of this plant have been evaluated specifically in terms of its effects in Northland. It is important to recognise the wide climate and temperature ranges in New Zealand and that some pests require regional based initiatives based on these factors.		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	Accordingly, lily of the valley is one of 32 pest plants banned from sale, propagation and distribution in the Northland region. This designation recognises that generally they are a lower risk to the regions' values compared with other more invasive species. Council wishes to take a more proactive stance over their management, as opposed to disregarding them under a do-nothing scenario, while acknowledging it must operate within a finite budget and limited resources. Nurseries in general support the concept of the NPPA and the outcomes being sought.		

Lobelia

Lobelia purpurascens

Also known as: white root, *Pratia purpurascens*

(Family: Campanulaceae)

Status in New Zealand

No legal status

Relevant biology

Form	White root is a small scrambling or creeping herb that can reach. It has thin, hairless stems that are often purplish in colour. The leaves are usually 2-3 cm long with a pointed tip and slightly serrated edges. The undersides are usually purplish in colour. The white underground runners (rhizomes) exude a milky sap and give the plant its common name of 'white root'. It produces flowers that are approx. 10mm across and are mostly white, flushed with lavender or pink. The fruits are round or egg-shaped, fleshy and 3–10 mm long.
Habitat	White root is native to eastern Australia where it is widespread in open Eucalypt forests and is also a weed of lawns, footpaths and cultivation. It grows in damp, shady areas.
Regional distribution	Herbarium records show that white root is growing in the wild in Northland. It is known as a garden escape around Kerikeri where it has been found growing in association with eucalyptus. It has also been found growing under trees and shrubs towards Okaihau, in mixed native-exotic scrub near Russell and in a relatively remote location at Te Paki, under wild eucalyptus and pine trees.
Competitive ability	White root can form spreading mats that smother the ground and climb over low-growing vegetation up to heights of at least 30cm. The dense mats probably prevent seeds from germinating and/or seedlings from establishing.
Reproductive ability	White root can produce from seeds or from plant fragments. Vectors of spread: Fruit and plant fragments can be spread by humans, for example in garden waste, soil or potted plants. It may also be shifted deliberately. Seeds may also be spread by birds.
Resistance to control	White root is difficult to control. It may be possible to remove small patches but this is difficult because the plant breaks off, leaving pieces of root in the ground.
Benefits	Ornamental ground cover.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	Low
Sheep and beef	-	Low
Forestry	-	-
Horticulture	-	-
Native bush or forests	Low	High
Urban	Low	High
Coastal	-	Low
Estuarine and marine	-	-
Freshwater/Wetland	-	Low

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	L	In Australia, white root is regarded as being toxic to stock. It contains the alkaloid lobeline.	Williams 2013; New South Wales Flora Online
Sheep and beef	-	L	In Australia, white root is regarded as being toxic to stock. It contains the alkaloid lobeline.	Williams 2013; New South Wales Flora Online
Forestry	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	M-H	White root is already known as a weed of lawns and gardens.	Moreton Bay Council;

Category	Current	Potential	Comment	Source
			In Northland it has been recording growing in the wild, in exotic and mixed native-exotic vegetation where it forms thick, spreading mats that may exclude other species.	Cooperative Research Centre for Australian Weed Management; New South Wales Flora Online
Threatened species	-	M	White root may exclude or smother small threatened plants, such as orchids and herbs.	
Social/cultural				
Human health	-	L	White root has been called puke-weed, vomit-wort and gag-root due to the effects it can cause when ingested. It contains the alkaloid lobeline.	Williams 2013; New South Wales Flora Online
Recreation	-	M	White root is a weed of lawns and gardens.	Moreton Bay Council; Cooperative Research Centre for Australian Weed Management; New South Wales Flora Online
Māori culture	-	M	Impacts upon native/taonga species.	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council through the RPMP in relation to this species.	White root is already present in Northland, in cultivation and in the wild. If no action is taken it may spread, with consequent environmental impacts and future control costs.	Moderate - High. White root has many of the traits of an invasive species and is there are large areas of habitat into which it could spread.
Exclusion programme	Not applicable	Not applicable	White root is already present in Northland.
Eradication programme	There are only a few known infestations of white root in Northland but it has the potential to spread to more sites. Eradication would	Eradication of white root would require an investment of resources to remove all plants in the Region.	Moderate-High. There is a moderate to high risk of eradication being unsuccessful because the distribution and

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	enable long-term economic and environmental impacts to be avoided. As a declared pest, white root would be banned from sale under the Biosecurity Act.		abundance of white root in Northland is poorly understood.
Progressive containment programme	A progressive containment programme would incur lower financial cost to the regional council in the short-term. It would aim to confine the impacts of white root to current infestation areas, and gradually reduce the population. As a declared pest, it would be banned from sale under the Biosecurity Act.	Resources would be required to undertake surveys and control.	Moderate - High. A progressive containment programme, targeting known infestations has a moderate chance of failure because white root is difficult to control. However, if white root is more widespread and abundant than it is currently thought to be, there is a high chance of failure.
Sustained control programme	A sustained control programme would incur lower financial cost to the regional council in the short-term, and would aim to restrict the spread and impacts of white root. Educational material could be developed to encourage people to remove white root from their gardens. As a declared pest, white root would be banned from sale under the Biosecurity Act.	Resources will be required to develop educational material, undertake surveillance and control any infestations that are found. A sustained control programme would not aim to remove white root from all the sites where it is present. Therefore, if/when it does become more widely established, eradication and containment may no longer be options and there will be long-term financial and environmental costs associated with the species.	Low-Moderate. White root was first recorded growing wild in Northland in 1982 and it does not appear to have become widespread in the intervening years. However, it is readily spread from fragments and seeds (reaching even Te Paki), grows vigorously and is difficult to control. It is a nuisance weed in gardens and lawns and is able to establish and grow within areas of native vegetation. A sustained control programme would enable white root to be banned from sale. This would prevent it from being sold and planted at new sites and prevent it from being inadvertently spread in potted plants from nurseries. Components of a sustained control programme for this species would include production and distribution of educational material, surveillance to identify any additional infestations and, potentially, trials to identify the most effective control methods.
Site-led pest programme	A site-led programme, where control of white root is required in defined parts of	A site-led programme would require an investment of time and	High. A site-led programme is not recommended for white root because its distribution and

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	Northland could reduce the impacts of this species within the programme area(s).	resources by the council and affected landowners. It would not reduce or restrict the impacts of white root in areas that are not identified as being of high priority.	abundance are not well understood.
Summary of alternative assessments and preferred option:	No regional interention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that lobelia does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be no regional intervention for lobelia, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding. While lobelia has not been afforded pest status in Northland, it may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes.		

M - R plant pests

Manchurian wild rice

Zizania latifolia

Also known as: Manchurian rice grass.

(Family: Poaceae)

Status in New Zealand

Manchurian wild rice is listed as an unwanted organism under the Biosecurity Act 1993, is a notifiable organism (Biosecurity (Notifiable Organisms) Order 2010), and is listed in the National Pest Plant Accord 2012. It is also one of 11 pest species that are part of the National Interest Pests Response (NIPR). Management of this pest plant is funded by the Ministry for Primary Industries and in Northland the programme is managed by the Northland Regional Council.

Relevant biology

Form	Manchurian wild rice is a giant grass that grows up to 4m high. It has harsh, dull green leaves that are 1-2cm wide and grow in fans. The purplish or red-brown flower heads are 40-60cm long and are produced from November to December. Manchurian wild rice is often confused with native raupō and flax, but raupō is slightly smaller, has bluish-green leaves and dies back in winter. Flax leaves are much smoother and shinier.
Habitat	In New Zealand, Manchurian wild rice has been recorded from lagoons, river banks, tidal flats, roadside ditches, damp pasture and cropping land. It is a relatively hardy plant that can grow in both fresh and salt water.
Regional distribution	Manchurian wild rice is found primarily in the Kaipara area, especially along the banks of the Northern Wairoa River, where it is widespread and forms dense, continuous infestations. There are other small infestations in the Kaipara, Far North and Whāngārei districts.
Competitive ability	Manchurian wild rice forms dense stands in aquatic or semi-terrestrial situations. It is very invasive and quickly spreads on land that is not grazed. It is tolerant of drought, frost and poor drainage but does not tolerate shade. Regrowth from underground rhizomes occurs after physical damage, such as fire and grazing.
Reproductive ability	Manchurian wild rice reproduces through seed and through its rhizomes (roots), which spread slowly outwards. Vectors of spread: the seeds and root fragments can be spread via water, livestock, machinery, dumping of green waste, eel nets, boats and trailers and clothing. The seeds are also dispersed by birds.
Resistance to control	Manchurian wild rice is difficult to eradicate because any root fragments will regrow. Herbicides are the most effective control measure, but use of these is restricted because many chemicals can affect waterways. Ongoing, repeated treatments are necessary for several years.
Benefits	Manchurian wild rice is often cultivated as a food crop in East Asia.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	High	High
Sheep and beef	Low	Low
Forestry	-	-
Horticulture	-	High
Native	-	High
Urban	-	-
Coastal	-	Low
Estuarine and marine	-	Low
Freshwater	High	High

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	L	M	Manchurian wild rice can invade pasture, where its dense growth excludes other species. Its abrasive leaves cause woody tongue and ill thrift in livestock.	Williams and Champion, 2008; Ministry for Primary Industries.
Sheep and beef	L	M	Manchurian wild rice can invade pasture, where its dense growth excludes other species. Its abrasive leaves cause woody tongue and ill thrift in livestock.	Williams and Champion, 2008; Ministry for Primary Industries.
Forestry	-	-		
Horticulture	-	M	Manchurian wild rice can invade cropping land.	Champion and Hofstra, 2010.
Other	-	-		
International trade	-	-		
Environment				
Soil resources	L	M	Dense stands of Manchurian wild rice cause silt to accumulate.	Weedbusters

Category	Current	Potential	Comment	Source
Water quality	L	M	Manchurian wild rice can invade drainage channels, preventing access, impeding water flow and increasing the likelihood of flooding.	Williams and Champion, 2008.
Species diversity	L	H	Manchurian wild rice can crowd out native water-side vegetation by displacing shorter species and enveloping taller species. It also causes silt to accumulate, destroying habitat for aquatic fauna and flora.	Ministry for Primary Industries; Weedbusters; Williams and Champion, 2008.
Threatened species	L	M	Manchurian wild rice can crowd out native species and has been recorded impacting upon threatened plants (for example, *Thelypteris confluens*) and birds (for example, fernbird).	Williams and Champion, 2008.
Social/cultural				
Human health	-	-		
Recreation	L	M	Manchurian wild rice may impede access to water bodies.	Williams and Champion, 2008.
Māori culture	L	M	Impacts on native/taonga species.	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council in relation to this species.	Manchurian wild rice has the potential to become a serious weed along waterways and in low-lying pasture and cropping land. If no action is taken it is likely to spread, with consequent environmental and economic impacts.	High. If no action is taken, Manchurian wild rice is likely to spread to other catchments within Northland. There are large areas of available habitat in the upper reaches of harbours and on the margins of water bodies.
Exclusion programme	Not applicable.	Not applicable.	Manchurian wild rice is already present in Northland.
Eradication programme	Manchurian wild rice is an invasive weed that impacts on the environment and reduces the production of pasture and cropland. If it	Eradication of Manchurian wild rice would require an even larger investment of resources to control the known infestations, undertake	High. Infestations of Manchurian wild rice are concentrated in Kaipara district, near Dargaville but it also occurs elsewhere in

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	could be eradicated, the adverse effects of this species would be prevented and the long-term costs of control would be avoided.	surveillance to ensure control has been successful, and carry out surveys to identify any additional infestations. If the species is not eradicated there will be on-going control costs.	Northland. This species is difficult to eradicate once established. At present the population of Manchurian wild rice is too large and widespread for eradication to be an option in the short to medium term.
Progressive containment programme	When compared to an eradication programme, a progressive containment programme would incur lower financial cost to the ministry and the council in the short-term. It would aim to confine or reduce the distribution of Manchurian wild rice.	A progressive containment programme would require an investment of time and resources from the ministry and the council and affected landowners. It would not aim to eradicate Manchurian wild rice in the short to medium term, so control costs would be on-going.	Medium. Manchurian wild rice is an invasive species with the potential to be spread by water, machinery, birds and farm animals. Therefore, there is some risk that a progressive containment programme will fail to confine the spread and the economic impacts of this species. However, this species has been under this type of programme since 2008/09 and significant progress has already been made.
Sustained control programme	When compared to an eradication programme, a sustained control programme would incur lower financial cost in the short-term. It would aim to restrict the spread and impacts of Manchurian wild rice.	This type of programme would require an investment of time and resources and would not aim to eradicate or contain the species, so control costs would be on-going. If the species was to spread, the opportunity to eradicate or contain it may be lost.	High. There is a risk that a sustained control programme will fail to manage the spread and the economic costs of this species.
Site-led pest programme	A site-led programme, where control of Manchurian wild rice is required in defined parts of Northland (for example, Kaipara district), would reduce the impact of this species in high priority areas.	A site-led programme would require an investment of time and resources and would not reduce or restrict the impacts of Manchurian wild rice in geographical areas that are not identified as being of high priority.	High. With adequate input of resources there is a medium risk that a site-led programme would fail within the target area. However, there is a higher risk that it could fail outside the site-led area.
Summary of alternative assessments and preferred option:	Progressive containment programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for Manchurian wild rice (MWR). In terms of alternative approaches assessed, under no regional intervention (or do nothing) there would be unacceptable loss of biodiversity and economic values in the regions' waterways (and spread into paddocks) if MWR range was left to expand uncontrollably. There would be significant public and political concerns and consequences if no support was provided by NRC to control or limit distribution and stop it spreading further into the vast areas of available habitat. The risk of MWR spreading inadvertently to significant waterways is likely to be higher without a Plan in place, as a lack of a regional support or regulatory tools could engender complacency. Once established,		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	the control of MWR is an expensive business, so voluntary action to clear waterways once infested is not assured. MPI currently contributes funding for managing this pest in the region and NRC implements control operations, in an 8-year collaborative programme to date. Under 'do nothing' this relationship would diminish, although the MPI contribution may continue in the absence of the Plan. There would probably be no direct cost on regional occupiers as MWR is part of a national programme. However, which agency would be left to manage operations would be unclear. Further, under a 'do nothing' scenario, NRC could rely on current non-regulatory methods such as advocacy and education and site-led management, but loses the tool to impose penalties for deliberate spread of MWR, for example, to areas outside of the MPI funded programme. Eradication of MWR is not technically feasible, due to the extent of the current infestations, mainly the biggest site near Dargaville. However, much of the region is free of the pest and some sites may achieve zero density over time. The key is to stop MWR spreading to uninfested areas through pathway management measures. There would be political risks associated with seeking region-wide eradication and then being unable to achieve that goal. A sustained control or site led approach would be unpalatable and seen as a lesser management option and one which would allow MWR to spread into new areas, when it is quite feasible to curb its spread. The option considered to carry the least risk and highest chances of achievement is progressive containment. NRC undertakes direct control of MWR through its service delivery programme and will work with others on control strategies. Any operational risks are deemed low to moderate and depend very much on the individual sites, the deepness of rhizomes and ability to translocate enough herbicide into the root mass. There may be future (but minimal) aversion to using existing herbicide spraying methods and the parties are seeking new control technologies. The overall probability of success for this option is moderate to high, based on the current gains made. The biggest risk to achieving a progressive containment outcome is: MPI withdrawing funding, herbicide control not being effective and/or people not being motivated to report any sightings outside the containment zone.		

Mexican feather grass

Nassella tenuissima

Also known as: fine-stemmed needle grass.

(Family: Poaceae)

Status in New Zealand

Mexican feather grass is listed as an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Mexican feather grass is a densely tufted, perennial tussock grass that grows up to 70cm tall. It flowers between October and December, and the feathery flower head is erect when young and weeping when mature. Each plant can produce huge numbers of rough-coated seeds, each with a tufted hair at the base.
Habitat	Mexican feather grass prefers a dry, temperate climate. It is most likely to invade pastures, grasslands, grassy open woodlands, disturbed sites, road sides and waste areas. It can become dominant under continual heavy grazing pressure.

Regional distribution	There are 39 sites currently known in Northland, and there are likely to be other, as yet undiscovered, sites.
Competitive ability	Mexican feather grass crowds out pasture species and reduces productivity because it is a low protein, high fibre grass that has no grazing value. It also replaces native species in open and coastal areas.
Reproductive ability	Mexican feather grass produces masses of viable seeds that last up to four years in the soil. Vectors of spread: seeds are dispersed by wind and water, by sticking to animal pelts and clothing and in contaminated soil (for example, on boots or machinery).
Resistance to control	The seeds of Mexican feather grass can remain viable in the soil so follow-up surveillance and control is required.
Benefits	Ornamental.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	High
Sheep and beef	-	High
Forestry	-	-
Horticulture	-	Low
Native	-	Low
Urban	Low	Low
Coastal	-	Low
Estuarine and marine	-	-
Freshwater/wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	H	Mexican feather grass is a weed of agricultural areas and can become dominant under continual, heavy grazing pressure. It is a low protein, high fibre grass that has no grazing value.	Csurhes, 2008.

Category	Current	Potential	Comment	Source
Sheep and beef	-	H	Mexican feather grass is a weed of agricultural areas and can become dominant under continual, heavy grazing pressure. It is a low protein, high fibre grass that has no grazing value.	Csurhes, 2008.
Forestry	-	-	Mexican feather grass is most likely to invade pastures, grasslands, grassy open woodlands, disturbed sites, roadsides and waste areas. Therefore, it is unlikely to invade production forests.	Brisbane City Council.
Horticulture	-	M	Mexican feather grass is most likely to invade pastures and grasslands but has also been recorded as weed in vineyards.	Stuff.co.nz.
Other	-	-		
International trade				
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	M	Mexican feather grass is most likely to invade pastures, grasslands, and disturbed sites. Therefore, it is not very likely to invade native vegetation and reduce biodiversity values.	Brisbane City Council.
Threatened species	-	M	Mexican feather grass is most likely to invade pastures, grasslands, and disturbed sites. Therefore, it is not very likely to invade native vegetation or habitats of threatened species.	Brisbane City Council.
Social/cultural				
Human health	-	-		
Recreation	-	-		
Māori culture	-	-		

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful *
No regional intervention	If no management action is undertaken there will be no short-term financial costs to council associated with this species.	The Mexican feather grass sites in Northland are currently very small, and have been part of a control programme. There may also be other undiscovered infestations. It is an invasive species with the potential to spread through pastoral land causing loss of production. The long-term economic costs of failing to detect and control this species are potentially considerable.	High. There is a high risk that there are existing undiscovered infestations or that the species will be deliberately transported to Northland as an ornamental plant.
Exclusion programme	Not applicable.	Not applicable.	An exclusion programme is not an option because Mexican feather grass is already present in Northland.
Eradication programme	Mexican feather grass has probably been eradicated from Northland but there is a risk that there are undiscovered infestations. If the species is included in the Regional Pest Management Plan there is the ability to respond immediately if an infestation is detected. Public awareness and education about the risks and impacts of Mexican feather grass and a rule banning possession of the species in Northland could prevent it from establishing in the region.	Long-term eradication of Mexican feather grass would require an investment of resources to undertake on-going surveys. This would ensure that all previously known infestations have been eradicated and there is no regrowth. Surveillance to detect any additional infestations would also be required.	Low. Known Mexican feather grass sites in Northland are well controlled but there is a risk that there are undiscovered infestations. However, previous control operations have proven to be successful, that is, infestations have been eradicated.
Progressive containment programme	When compared to an eradication programme, a progressive containment programme would incur lower financial cost to the council in the short-term. A progressive containment programme would aim to prevent Mexican feather grass establishing new infestation sites.	Mexican feather grass is an invasive species with the potential to spread rapidly. The time-frame of a progressive containment programme would potentially provide the species with the opportunity (that is, time) to spread.	High. There is a high risk that a progressive containment programme will not prevent Mexican feather grass from spreading within Northland.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful *
Sustained control programme	When compared to an eradication programme, a sustained control programme would incur lower financial cost to the council in the short-term. A sustained control programme would aim to restrict the spread and impacts of the species and prevent it from having increasingly severe impacts on the environment.	Mexican feather grass is an invasive species with the potential to spread rapidly. The time-frame of a sustained control programme would provide the species with the opportunity (that is, time) to spread.	High. There is a high risk that a sustained control programme will not prevent Mexican feather grass from spreading within Northland.
Site-led pest programme	Not applicable.	Not applicable.	Mexican feather grass is present in low numbers at widely separated sites across Northland so is not a suitable candidate for a site-led programme which is about protecting values in places.
Summary of alternative assessments and preferred option:	**Eradication programme.** In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for Mexican feather grass. In terms of alternative approaches assessed, under <u>no regional intervention</u> (or do nothing), there could be unacceptable loss of production values in dryland farming areas as well as potential threats to biodiversity values. As nassella species are well-known and high-profile pastoral pests in many other parts of the country, there would be substantial political risk and heightened farming concerns if this invasive tussock species was not managed. Further, maintaining the gains of previous concerted management efforts would be wasted if regional intervention was not available. <u>Progressive containment or sustained control</u> approaches would not be appropriate as the plant is thought to occupy only a fraction of the areas suitable in the drier eastern Northland locations. It would be risky relying on 'lesser' control options when eradication/zero density is achievable, despite the number of current/historical sites. It would be an unacceptable risk to rely only on land occupiers to control infestations – grasses can be very cryptic in nature and difficult to identify at low densities and to effectively control. The operational risks of imposing landowner/occupier control rules would compromise the overall outcomes sought. <u>Eradication</u> is the preferred outcome and is realistic given its relatively limited distribution. NRC intends to undertake direct control of Mexican feather grass wherever it occurs in the region (through its surveillance and service delivery programme) and needs to be able to respond with immediate effect. The costs involved under an eradication programme are minor (compared with the risks of doing nothing and allowing it to spread) and are not expected to adversely affect control outcomes.		

Mickey Mouse plant

Ochna serrulata

Also known as: bird's eye bush.

(Family: Ochnaceae)

Status in New Zealand

Mickey Mouse plant is listed as an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Mickey Mouse plant is a shrub that is usually 1-2m tall and has pimply-textured bark. Its name is due to the appearance of its fruit, which resemble the face of Mickey Mouse because the black berry-like fruits are attached to red sepals. It has oval leaves that are 13-50mm long and have finely-toothed margins. The young spring leaves are pinkish-bronze and mature to glossy green. It has bright yellow flowers about 20mm across, which precede the fruit.
Habitat	In New Zealand, Mickey Mouse plant is an urban weed of gardens, derelict building sites and the under-storey and edges of forest. It is easily dispersed, and could spread from urban areas to other habitats. It is widespread in eastern Australia where it has invaded road sides, disturbed sites, waste areas, forests, forest margins, and riparian areas that are close to habitation. In Hawaii it is known to spread from initial plantings via bird-dispersed fruits.
Regional distribution	Mickey Mouse plant is present in and around Whāngārei, Dargaville and Kaitāia. Most of the 311 currently known and controlled sites are in gardens.
Competitive ability	Mickey Mouse plant can form a dense monoculture that prevents regeneration of native species. However, it does not tolerate frost.
Reproductive ability	Mickey Mouse plant reproduces mainly by seed. Germination experiments have suggested that although birds are important for dispersal, they are not essential for germination. Seed persistence is low, with less than 1% of seed remaining viable in the soil after six months. Vectors of spread: the brightly coloured fruit are readily eaten and dispersed by birds and may also be dispersed in dumped garden waste or intentionally, by gardeners.
Resistance to control	Mickey Mouse plant has a deep tap root, which makes it very difficult to remove manually.
Benefits	Mickey Mouse plant is cultivated for its ornamental values.

Land uses occupied

Land use type	Current land use infested	Potential land use infested
Dairy	-	-
Sheep and beef	-	-
Forestry	-	Low
Horticulture	-	-
Native	-	High
Urban	Low	High

Land use type	Current land use infested	Potential land use infested
Coastal	-	Low
Estuarine and marine	-	-
Freshwater/wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-	Mickey Mouse plant is not known to have adverse effects on agriculture.	Williams, 2008.
Sheep and beef	-	-	Mickey Mouse plant is not known to have adverse effects on agriculture.	Williams, 2008.
Forestry	-	M	Mickey Mouse plant has been recorded in forests and on forest margins, so could invade production forests in Northland.	Weeds of Australia.
Horticulture	-	-	Mickey Mouse plant is known to invade road sides, disturbed sites, waste areas, forests, forest margins, and riparian areas. Therefore, it is unlikely to invade horticultural land.	Weeds of Australia.
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	H	In eastern Australia, Mickey Mouse plant has invaded forests, forest margins and riparian areas where it occupies the under-storey or open sites. It has not been found growing in the forest under-storey in New Zealand but has the potential to spread into these habitats in Northland, reducing species diversity.	Williams, 2008; Weeds of Australia.
Threatened species	-	M	In eastern Australia, Mickey Mouse plant has invaded forests, forest margins, and riparian areas. It has the potential to spread into these habitats in Northland, with adverse effects on threatened species	Weeds of Australia.
Social/cultural				
Human health	-	-		

Category	Current	Potential	Comment	Source
Recreation	-	M	Mickey mouse plant may reduce the recreational or aesthetic enjoyment of natural areas.	
Māori culture	-	M	Potential impacts on native/taonga species.	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council associated with this species.	Mickey Mouse plant is an invasive species that is cultivated as an ornamental plant and has the ability to spread by bird-dispersed seed. Currently known sites are part of a control programme, which is progressing well. If no action is taken, the species may spread out of urban areas and into natural areas, with consequent adverse effects on the environment.	High. Mickey Mouse plant is an attractive plant for gardeners and there is a high potential for it to be intentionally spread. It also spreads by bird-dispersed seed. If no action is taken, the number and extent of infestations is likely to increase, with consequent adverse effects on the environment.
Exclusion programme	Not applicable.	Not applicable.	Exclusion is not an option because Mickey Mouse plant is already present in Northland.
Eradication programme	Mickey Mouse plant is currently known to be present in urban areas of Whāngārei, Dargaville and Kaitāia. If the species could be eradicated before it spreads elsewhere, it would prevent long-term impacts.	Eradication of Mickey Mouse plant would require an investment of resources to control 311 known infestation sites, undertake on-going surveys to ensure all plants have been removed, and implement a surveillance plan to detect any infestations that are currently unknown.	Low-medium. There is a moderate risk of an eradication programme failing in the short-medium term due to the difficulty of locating all infestation sites.
Progressive containment programme	When compared to an eradication programme, a progressive containment programme would incur lower financial cost to council in the short-term. Currently, the main method by which this species is spreading in Northland is through intentional introductions by gardeners. If education was integrated into a	The aim of a progressive control programme is not to eradicate a species from Northland in the short to medium-term. A progressive containment programme would aim to restrict the geographical distribution of Mickey Mouse plant. It is cultivated and transported by gardeners however, and could be intentionally transported out of the urban containment areas. Seeds may also be dispersed by	High. There is a high risk that a sustained control programme will not prevent Mickey Mouse plant from spreading to new sites because it has bird-dispersed seeds and is an attractive garden plant that may be spread intentionally.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	progressive containment programme, it would reduce the likelihood of this species spreading.	birds so this type of programme could give Mickey Mouse plant the opportunity (that is, time) to spread.	
Sustained control programme	When compared to an eradication programme, a sustained control programme would incur lower financial cost to council in the short-term. It would aim to restrict the spread and impacts of Mickey Mouse plant and prevent it from having increasingly severe impacts on the environment.	Mickey Mouse plant is an invasive species with the potential to spread widely. The aim of a sustained control programme is not to eradicate the species so could give Mickey Mouse plant the opportunity (that is, time) to spread to more sites in Northland.	High. There is a high risk that a sustained control programme will not prevent Mickey Mouse plant from spreading to new sites, particularly with or close to urban areas.
Site-led pest programme	If Mickey Mouse plant was the target of a site-led programme it could raise awareness of the species.	Site-led programmes are more likely to aim to suppress populations rather than remove them. Mickey Mouse plant occurs in urban areas in Northland, and sites are fairly widespread, so it would be extremely difficult to determine all of the areas a site-led programme would need to define with sufficient certainty. A site-led programme is unlikely to be effective and would present logistical or organisational challenges If the programme does not eradicate Mickey Mouse plant, it could spread to more sites in Northland.	Moderate. The risks of a site-led programme failing depend upon the goal of the programme, how it is initiated and implemented, and the level of support within the community. If the site-led programme fails to eradicate the species, it has the potential to be spread to new sites by birds.
Summary of alternative assessments and preferred option:	Eradication programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for Mickey Mouse plant. In terms of alternative approaches assessed, under <u>no regional intervention</u> (or do nothing) there would be undesirable loss of biodiversity values and increasing infestations of urban gardens. There would be low to moderate public concerns around doing nothing as this pest plant is probably not widely known in the region. Given that the number of sites are over 300 it would be unwise of council to have no management measures available. Also, doing nothing would be counter-productive to prior surveillance and control efforts. <u>Progressive containment or sustained control</u> approaches would not be appropriate as the plant is still of limited distribution in Northland. It would be risky to Council to rely on 'lesser' control options when eradication or zero density seems currently achievable. Although spread across the region would be quite sporadic (being bird spread) a high level of regional intervention (through professional surveillance planning and direct control approaches) is required. It would be a high-risk strategy to rely only on occupiers to control infestations, given its relative unfamiliarity to many. Occupier control is therefore unlikely to be successful.		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	These risks would compromise the outcomes sought and would ultimately fail to contain its spread. Eradication is the preferred outcome and it is realistic given the current limited infestations. It is not impossible that other unknown infestations exist in the region, essentially in private gardens. There is some risk that birds could spread this pest further than the current distribution. However, even if more sites were found the costs involved under an eradication programme are still relatively minor and are not expected to adversely affect overall management outcomes.		

Mile-a-minute

Dipogon lignosus

Also known as: Cape sweet pea.

(Family: Fabaceae)

Status in New Zealand

Mile-a-minute is listed as an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Mile-a-minute is an evergreen climbing vine. Each leaf is made up of three, roughly triangular to heart-shaped leaflets. Each leaflet is 3-9cm long. Between July and January it produces attractive, pea-type flowers that range in colour including white, red, pink, and purple. The flowers are followed by sickle-shaped seed pods that are 30-40mm long.
Habitat	Within its natural range in the Cape region of South Africa, mile-a-minute is usually found along forest margins and stream banks where it scrambles over other shrubs and trees. It tolerates dappled shade and poor soil. In New Zealand it occupies similar habitat in open sun.
Regional distribution	Mile-a-minute is present in Northland but currently has a limited distribution. Most of the infestations are in gardens (particularly historic gardens), on roadsides and in locations where garden waste has been dumped. There is a large site in Kaimaumau wetland.
Competitive ability	Mile-a-minute is a fast-growing vine. It grows and seeds vigorously, rapidly smothering native vegetation, weighing it down and causing plants to break. It also grows over the ground, smothering native groundcover plants.
Reproductive ability	Mile-a-minute produces large quantities of viable seed. Its rapid growth rate also allows an infestation to grow and spread over a wide area.
Resistance to control	Stumps re-sprout very quickly if not treated with herbicide and, due its dense growth, it can be difficult to locate all stems/roots.
Benefits	Ornamental.

Land uses occupied

Land use type	Current land use infested	Potential land use infested
Dairy	-	-
Sheep and beef	-	-
Forestry	-	Low
Horticulture	-	-
Native	-	High
Urban	Low	High
Coastal	-	Low
Estuarine and marine	-	-
Freshwater/wetland	Low	Low

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-	Mile-a-minute is usually found along forest margins, stream banks and roadsides where it scrambles over other shrubs and trees. Therefore, it is unlikely to invade pasture.	South African National Biodiversity Institute; New Zealand Plant Conservation Network.
Sheep and beef	-	-	Mile-a-minute is usually found along forest margins, stream banks and road sides where it scrambles over other shrubs and trees. Therefore, it is unlikely to invade pasture.	South African National Biodiversity Institute; New Zealand Plant Conservation Network.
Forestry	-	L	Mile-a-minute is usually found along forest margins, stream banks and road sides where it scrambles over other shrubs and trees. It has the potential to invade the margins of production forests in Northland.	South African National Biodiversity Institute; New Zealand Plant Conservation Network.
Horticulture	-	-	Mile-a-minute is usually found along forest margins, stream banks and road sides where it scrambles over other shrubs and trees.	South African National Biodiversity Institute;

Category	Current	Potential	Comment	Source
			Therefore, it is unlikely to invade horticultural land but may become established in roadside shelter belts.	New Zealand Plant Conservation Network.
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	M	Being a leguminous plant, mile-a-minute has nitrogen-fixing bacteria that enrich the soil. This effect is limited to the area over which the roots of mile-a-minute extend.	South African National Biodiversity Institute.
Water quality	-	L	Being a leguminous plant, mile-a-minute has nitrogen-fixing bacteria that enrich the soil. Large infestations occupying a high proportion of a catchment have the potential to alter in-stream water quality within that catchment.	South African National Biodiversity Institute.
Species diversity	L	H	In Northland, mile-a-minute has already infested a natural area with high ecological values (that is, Kaimaumau Wetland) and has the potential to spread further at this site, reducing species diversity. It also has the potential to invade forest margins and indigenous scrub and shrublands, smothering native plants and reducing species diversity.	
Threatened species	L	M	Mile-a-minute smothers and kills native vegetation. It is already present in Northland and has the potential to invade sites that are habitats of threatened species.	South African National Biodiversity Institute.
Social/cultural				
Human health	-	-		
Recreation	-	L	Mile-a-minute has the potential to reduce aesthetic enjoyment of natural areas.	
Māori culture	-	L	Potential impacts upon native/taonga species.	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council in relation to this species.	Mile-a-minute is an invasive species that is cultivated as an ornamental plant. If no action is taken, gardeners may spread it and existing infestations may increase in extent, with consequent adverse effects on the environment.	High. If mile-a-minute is not managed, the density of the species within the existing infestation areas is likely to increase and it may spread to new sites.
Exclusion programme	Not applicable.	Not applicable.	Exclusion is not an option because mile-a-minute is already present in Northland.
Eradication programme	If mile-a-minute was eradicated before it spreads further within Northland, it would prevent long-term impacts and financial costs.	Mile-a-minute is currently present at multiple sites and in a variety of habitats in Northland, but a control programme is in progress. Eradication would require labour and materials to control the species at all of these sites, with follow-up surveillance to ensure there is no re-growth. Surveys will also be required to identify any infestations that haven't been recorded.	Medium. There is a risk of an eradication programme failing due to the difficulty of locating all plants in multiple infestation areas. A number of the known sites are on DOC land, and DOC have advised council that they are undertaking control on these sites.
Progressive containment programme	When compared to an eradication programme, a progressive containment programme would incur lower financial cost to the council in the short-term. The main method of long-distance dispersal for this species is transport by humans so, if education was integrated into a progressive containment programme, it may prevent the species from spreading while containment is undertaken.	The aim of a progressive control programme is not to eradicate a species from Northland in the short to medium-term. This programme would aim to restrict the geographical distribution of mile-a-minute but it is an attractive plant that is cultivated and transported by gardeners and could be intentionally transported out of the urban containment areas. This would result in additional financial and environmental costs.	Moderate. There is a moderate risk that a progressive containment programme will not prevent mile-a-minute from spreading to new sites or increasing in density and impacting on the existing infestation areas.
Sustained control programme	When compared to an eradication programme, a sustained control programme would incur lower financial cost to the council in the short-term.	The aim of a sustained control programme is not to eradicate mile-a-minute from Northland. This programme would aim to restrict the spread and impacts of mile-a-minute but it is an attractive plant that is cultivated and transported by gardeners so	High. There is a high risk that a sustained control programme will not prevent mile-a-minute from spreading to new sites or increasing in density within the existing infestation areas.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
		plants could be intentionally transported out of the urban containment areas. Currently, mile-a-minute has a restricted distribution so more intensive management is still an option for this species. If/when it becomes more established, this may no longer be an option.	
Site-led pest programme	A site-led pest programme would enable control efforts to be focused on sites that are a priority because they have natural values that are being adversely affected by mile-a-minute.	If a site-led pest programme was focused only on high value natural areas (that is, Kaimumau Wetland) mile-a-minute could spread further within the existing urban infestation areas and be intentionally transported to new sites.	Moderate. Mile-a-minute could be eradicated from Kaimaumau Wetland but the species is likely to be spread from existing urban infestations to new sites, either deliberately (for cultivation) or inadvertently (for example, in garden waste).
Summary of alternative assessments and preferred option:	Progressive containment programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for mile-a-minute. In terms of alternative approaches assessed, under <u>no regional intervention</u> (or do nothing) there would be unacceptable loss of biodiversity values over time. Under the 'do nothing' scenario NRC would rely on voluntary control by occupiers and mile-a-minute would likely continue to spread to new areas and invade forest margins, scrubland and along roadsides. There would be moderate public and political concerns and consequences if there were no Plan provisions for this invasive and vigorous growing vine. Although of limited distribution in the region, <u>eradication</u> of mile-a-minute is not considered feasible due to the nature and extent of infestations inside the Far North containment zone and the complexities of and ability to destroy all the plants, especially those well-established on public conservation land. In other parts of the region NRC would carry out direct control measures (service delivery) to remove plants. Eradication would carry a degree of political risk associated with it, in terms of stating region-wide eradication and then being unable to achieve that goal. A <u>sustained control or site led approach</u> would also be undesirable as it would be viewed as a lesser management option and one which would allow mile-a-minute to spread further and quicker than it otherwise might. A more active management approach to limit spread into the large parts of the region currently free of mile-a-minute is required. The option considered to carry the least risk is <u>progressive containment.</u> NRC intends to control infestations within the containment zone, to reduce the pest over time, and will undertake active surveillance and control across the rest of the region. The biggest risk under this scenario is with land occupiers not being able to identify the pest plant and if correctly identified, reporting its presence as required. However, these operational risks are relatively minor and are not expected to adversely affect the management outcomes. Progressive containment offers a cost beneficial and realistic alternative to doing nothing and is an affordable option for council.		

Monkey musk

Erythranthe guttata

Also known as monkey flower, *Mimulus guttatus.*

(Family: Phrymaceae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Monkey musk is a soft herb that grows up to 60cm tall, forming bright-green leafy clumps or large masses. It has thick stems that are occasionally branched. The oval leaves are opposite, up to 12 x 8cm long, usually hairless, and bright green with toothed edges. Monkey musk has yellow flowers with red spots on the bearded lower lip. Seed capsules are 1cm long, with many patterned seeds.
Habitat	Monkey musk is a wetland plant. It grows along the margins of streams, rivers, drains, lakes and wetlands but it can also grow partially submerged in water, with its foliage floating on the water surface. It will also occur on damp, disturbed ground away from wetlands. Due to its relatively high light demand, it is out-competed by taller perennial or woody plants.
Regional distribution	Monkey musk is present in Northland, along riparian margins near Parua Bay and Whāngārei.
Competitive ability	Monkey musk can significantly alter the structure of riparian plant communities. It may out-compete native plants and has the potential to choke channels and impede drainage.
Reproductive ability	Monkey musk readily breaks in fast-flowing water and even small fragments have high survival, regeneration and colonisation rates. It produces large numbers of small seeds, which germinate readily both in water and on sand. Monkey musk can become dominant in an area and spread widely due to its ability to propagate from both plant fragments and seed, and for both of these methods to occur at different times during the year. Vectors of spread: seed is transported by wind and water. Plant fragments can be spread in water or soil.
Resistance to control	Monkey musk can re-grow from even the smallest fragments so extreme care must be taken not to release fragments into waterways during control operations. Plant waste must be disposed of appropriately.
Benefits	Ornamental.

Land uses occupied

Land use type	Current land use infested	Potential land use infested
Dairy	-	-
Sheep and beef	-	-

Land use type	Current land use infested	Potential land use infested
Forestry	-	-
Horticulture	-	-
Native	Low	High
Urban	Low	High
Coastal	-	-
Estuarine and marine	-	-
Freshwater/wetland	Low	High

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-	Monkey musk is a wetland plant. It grows along the margins of streams, rivers, drains, lakes and wetlands or partially submerged in water. Therefore, it is unlikely to invade pasture.	Popay et al., 2010.
Sheep and beef	-	-	Monkey musk is a wetland plant. It grows along the margins of streams, rivers, drains, lakes and wetlands or partially submerged in water. Therefore, it is unlikely to invade pasture.	Popay et al., 2010.
Forestry	-	-	Monkey musk is a wetland plant. It grows along the margins of streams, rivers, drains, lakes and wetlands or partially submerged in water. Therefore, it is unlikely to invade production forests.	Popay et al., 2010.
Horticulture	-	-	Monkey musk is a wetland plant. It grows along the margins of streams, rivers, drains, lakes and wetlands or partially submerged in water. Therefore, it is unlikely to invade horticultural land.	Popay et al., 2010.
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-	Total carbon and nitrogen, and soil moisture, were marginally higher in invaded disturbed sediment plots as opposed to those that had not been invaded.	Truscott et al., 2006.
Water quality	-	-	Monkey musk can slow water movement in small waterways.	Williams and Champion, 2008.

Category	Current	Potential	Comment	Source
Species diversity	L	H	Monkey musk significantly alters the structure of plant communities and reduces species diversity, and replacing native species.	Truscott et al., 2006; Weedbusters.
Threatened species	-	H	Monkey musk significantly alters the structure of plant communities, replacing native species - potentially including threatened species.	Truscott et al., 2006; Weedbusters.
Social/cultural				
Human health	-	-		
Recreation	-	L	Monkey musk could reduce the recreational enjoyment of waterways if channels become choked.	
Māori culture	-	M	Potential impacts on native/taonga species.	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial cost to the council associated with this species.	Monkey musk is currently known from two areas in Northland, and is part of an ongoing eradication programme. It is an invasive species with the potential to spread further along waterways and into wetlands if left uncontrolled. The environmental and economic costs of delaying control until there are larger/more infestations is potentially considerable.	High. If monkey musk is not managed, the existing infestation area will increase in size and it is likely to spread to new sites.
Exclusion programme	Not applicable.	Not applicable.	Exclusion is not an option because monkey musk is already present in Northland.
Eradication programme	Monkey musk is currently present at two known locations in Northland. If the species could be eradicated before it spreads elsewhere, it would prevent long-term financial costs and environmental impacts.	Eradication of monkey musk would require an investment of resources to control the known infestations, undertake on-going surveys to ensure all plants have been controlled and surveillance to detect and control any infestations that may establish from seed or plant fragments at or downstream of the infestation sites.	Low-medium. Successful eradication would require a sustained, co-ordinated approach and careful implementation to prevent the species re-establishing from fragments or seed. Eradication has the potential to fail in the short to medium-term if there are undetected infestations at other sites.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Progressive containment programme	When compared to an eradication programme, a progressive containment programme would incur lower financial cost to council in the short-term. The main method by which this species is likely to spread in Northland is through intentional introductions by gardeners. If education was integrated into a progressive containment programme, it would reduce the likelihood of this species spreading.	The aim of a progressive control programme is not to eradicate a species from Northland in the short to medium-term. A progressive containment programme would aim to restrict the geographical distribution of monkey musk. It may be cultivated and transported by gardeners, and could be intentionally transported.. Seeds may also be dispersed by wind or water so this type of programme could give monkey musk the opportunity (that is, time) to spread.	High. There is a high risk that a sustained control programme will not prevent monkey muck from spreading to new sites because it has wind and water dispersed seeds and is an attractive garden plant that may be spread intentionally.
Sustained control programme	When compared to an eradication programme, a sustained control programme would incur lower financial cost to council in the short-term. It would aim to restrict the spread and impacts of monkey musk and prevent it from having increasingly severe impacts on the environment.	Monkey musk is an invasive species with the potential to spread widely. The aim of a sustained control programme is not to eradicate the species so could give monkey muck the opportunity (that is, time) to spread to more sites in Northland.	High. There is a high risk that a sustained control programme will not prevent monkey musk from spreading to new sites, particularly with or close to urban areas.
Site-led pest programme	If monkey musk was the target of a site-led programme it could raise awareness of the species.	Site-led programmes are more likely to aim to suppress populations rather than remove them. Monkey musk occurs in only two known areas in Northland, but may also occur at other unknown sites as this is an ornamental species. A site-led programme is unlikely to be effective and would present logistical or organisational challenges, especially if other sites were found outside the defined site-led programme areas. If the programme does not eradicate monkey musk, it could spread to more sites in Northland.	Moderate. The risks of a site-led programme failing depend upon the goal of the programme, how it is initiated and implemented, and the level of support within the community. If the site-led programme fails to eradicate the species, it has the potential to be spread to new sites by birds.
Summary of alternative assessments	Eradication programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for monkey musk. In terms of alternative approaches assessed, under		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
and preferred option:	no regional intervention (or do nothing) there would potentially be unacceptable loss of biodiversity values (riparian plant communities) as there are many marginal wetland habitats for it to thrive in in Northland. Currently, monkey musk is limited in its regional distribution. Under a no intervention approach, NRC could rely on non-regulatory methods such as advocacy, education and site-led management, but loses the ability to undertake direct action (for current and any new infestations) and the tools to impose penalties for possession of or deliberate liberations of this pest. Progressive containment or sustained control approaches would not be appropriate as monkey musk is uncommon in Northland. It would be highly risky of Council to rely on 'lesser' control options when eradication or zero density is achievable. It would also be an unacceptable risk to bank on landowners to control infestations as control of any aquatic pests with herbicides is usually difficult and expensive. Additionally, as the sites involve treatment close to and at times over water, permissions to use herbicides are required through the Environmental Protection Agency (EPA). These situations require a high level of regional intervention (through professional surveillance and direct control approaches). These operational risks would compromise the outcomes sought if landowners were responsible for control work, therefore council service delivery is the most appropriate control measure. Eradication is the preferred outcome and is realistic given the current infestations and the technical challenges involved. There is some level of risk that monkey musk will be introduced to Northland or unknown infestations are found. NRC intends to undertake direct control of monkey musk wherever it occurs in the region. The costs involved under an eradication programme are minor (compared with the risks of doing nothing and allowing it to spread) and provides Council with some regulatory tools to incentivise water users such as boaties, eel fishermen, anglers, and fowl shooters to stop the spread of wetland and semi-aquatic pests to new areas. The benefits of inclusion in the Plan are that significant wetlands and riparian areas around waterways would in the long-term remain free of this pest. The value is difficult to estimate but would be significant, given the high public interest in maintaining wetlands and aquatic ecosystems in a natural state.		

Moth plant

Araujia hortorum

Also known as: moth vine, *Araujia sericifera.*

(Family: Asclepiadaceae)

Status in New Zealand

Moth plant is listed as an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Moth plant is a fast-growing vine that can reach 10m tall. The twining stems release a milky sap when they're broken. The leaves are arranged in opposite pairs along the stems and are dark green with greyish-downy undersides. The white flowers are bell-shaped, white, and about 25mm across. It produces very distinctive, large (approx. 10cm long), pear-shaped pods full of tiny seeds that are attached to long, silken hairs.
Habitat	Moth plant can grow in almost any frost-free habitat, including intact and disturbed forest, forest margins, tracks, cliffs, riparian margins, shrublands, and islands. It is also

	a problem in urban reserves and gardens where it can spread quickly. It prefers loose, fertile soils in warm, wet areas. It establishes most freely in semi-shade but will tolerate exposure to full light once it reaches the canopy of shrubs, hedges, or trees.
Regional distribution	Moth plant is present in Northland and it is generally acknowledged that this plant is spreading and becoming more abundant.
Competitive ability	Moth plant is a fast-growing vine that can rapidly smother and replace native vegetation. Moth plant climbs over shrubs and small trees, smothering and breaking them down. It also spreads over the ground, smothering seedlings and native plants of small stature.
Reproductive ability	Moth plant produces large numbers of wind-borne seeds. When the fruit dries out and splits open it releases large numbers of seeds attached to silky threads. Vectors of spread: the plant spreads mainly by wind-borne seeds that can easily spread up to 100 metres. Seeds can also be spread on animals and on peoples' clothing.
Resistance to control	The sap irritates some people's skin so gloves should be worn when handling it.
Benefits	Moth plant was originally introduced as an ornamental garden plant.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	High	High
Horticulture	Low	Low
Native bush or forests	High	High
Urban	High	High
Coastal	Low	Low
Estuarine and marine	-	-
Freshwater/wetland	Low	Low

High = Preferred land use; Low = Less preferred land use

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-	Moth plant has not been recorded as a weed in pasture. It does not establish in full sun.	Hill & Gourlay, 2014.

Category	Current	Potential	Comment	Source
Sheep and beef	-	-	Moth plant has not been recorded as a weed in pasture. It does not establish in full sun.	Hill & Gourlay, 2014.
Forestry	L	M	Moth plant establishes in semi-shade in habitats that include forest and forest margins. This species is still spreading and has the potential to become a more serious weed in production forests.	Hill & Gourlay, 2014.
Horticulture	-	L	Moth plant has not been recorded as a horticultural weed and it does not establish in full sun. It may establish within shelter belts or on the growing supports of kiwifruit, grapevines etc.	
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	L	H	Moth plant climbs over shrubs and small trees, smothering and breaking them down. It also spreads over the ground, smothering native plants of small stature and regenerating seedlings. Butterflies, moths and bees are attracted to its flowers and become trapped in them but the importance of this on biodiversity values is uncertain.	Hill & Gourlay, 2014.
Threatened species	L	M	Moth plant climbs over shrubs and small trees and also spreads over the ground. It has the potential to smother threatened species of plants.	Hill & Gourlay, 2014.
Social/cultural				
Human health	L	L	Moth plant has a milky sap, which irritates some people's skin. Ingestion of the foliage can cause nausea, vomiting and	Hill & Gourlay, 2014.

Category	Current	Potential	Comment	Source
			diarrhoea. However, it is not often consumed.	
Recreation	-	M	Moth plant has the potential to reduce the aesthetic and recreational values of natural areas.	
Māori culture	-	H	Impacts on native/taonga species.	

L = low, M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Do nothing	If no management action is undertaken there will be no short-term financial costs to council incurred in relation to this species.	Moth plant is a serious environmental weed that is spreading within Northland. If no action is taken, the population of this species will continue to increase, with consequent adverse effects on the environment.	High. Moth plant is highly invasive and spreads via wind-dispersed seeds. If no action is taken moth plant will spread, its numbers will increase and its environmental impacts will become more severe.
Exclusion programme	Not applicable.	Not applicable.	Moth plant is already present within Northland.
Eradication programme	Moth plant is a serious environmental weed and is also an economic weed of production forests. It has the potential to spread within Northland, with consequent environmental and economic impacts. If it could be eradicated, these impacts would be avoided.	Eradicating this species would require a considerable long-term input of resources.	High. Given the widespread distribution of moth plant, eradication is unachievable.
Progressive containment programme	Moth plant is a serious environmental weed that has not yet occupied all available habitat. It is spreading and becoming more abundant. If moth plant could be contained, the adverse effects of this species would be removed and the long-term costs of control would be avoided.	A progressive containment programme would require a significant investment of time and resources from the council and affected landowners. It would not aim to eradicate the species, so control costs would be on-going.	High. Moth plant is widely distributed in Northland and becoming more common, so a progressive containment programme is not practical and is unlikely to reduce the impact of this species.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Sustained control programme	When compared to an eradication programme, a sustained control programme would incur lower short-term financial cost to the council and landowners. It would aim to restrict the spread and impacts of moth plant and prevent it from having increasingly severe impacts on the environment.	A sustained control programme would require an investment of time and resources from the council and affected landowners. It would not aim to eradicate or contain the species, so control costs would be ongoing and containment may not be an option in future, if the population of this species increases.	Moderate-high. Moth plant is distributed throughout Northland and produces wind-blown seeds. Any control implemented under a sustained control programme is unlikely to be aggressive enough to effectively reduce the adverse effects of this species or to prevent it from spreading further.
Site-led pest programme	A site-led programme, where control of moth plant is required in defined parts of Northland could reduce the impacts of this species within the programme area(s).	A site-led programme would require an investment of time and resources by the council and affected landowners. It would not reduce or restrict the impacts of moth plant in areas that are not identified as being of high priority.	Moderate. A site-led programme could effectively reduce or eliminate the adverse effects of moth plant in local areas.
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that moth plant does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be <u>no regional intervention</u> for moth plant, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding. While moth plant has not been afforded pest status in Northland, it may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes. Good neighbour rule test A GNR test was carried out for Moth plant. In the previous RPMS Moth plant was listed as a CPCA species. The GNR test failed for this species.		

Good neighbour rule test

Before a rule can be identified as a good neighbour rule in a RPMP, the regional council must be satisfied of the matters in subclause (a), (c), and (d) and must comply with the requirements in subclause (b) and (e):	
Tests	
In the absence of the rule, the pest would: • spread to land that is adjacent or nearby within the life of the plan; and • cause unreasonable costs to an occupier of that land.	Moth plant produces large quantities of wind-blown seeds. It is present throughout Northland but is not yet common and there are many suitable habitats that it could invade. Controlling moth plant requires a combination of physical and chemical methods. If there is a constant rain of seed from adjacent/nearby properties the long-term cost to the affected landowner can be considerable, particularly if they are managing a natural area (e.g. secondary forest) where access may be challenging and damage to non-target species must be avoided.
In determining whether the pest would spread as described in subclause (a) the regional council must consider: • the proximity and characteristics of the adjacent or nearby land; and • the biological characteristics and behaviour of the particular pest (the greater the distance between properties, the more difficult to satisfy the test in subclause (a)).	Moth plant can can produce large numbers of wind-dispersed seeds that are normally blown up to 100 metres from the parent plant (WRC 2014). It has the ability to grow in a wide range of habitats, particularly in semi-shaded sites.
The land that is adjacent or nearby, as described in subclause (a), must be clear from a pest or, if the pest is present on that land, the occupier of that land must be taking measures to manage the pest or its impacts	In order for the good neighbour rules in the RPMP to apply, it is a requirement that the neighbouring property from where the complaint arises be clear of moth plant or, if moth plant is present, it is actively being controlled.
The rule must not set a requirement on an occupier that is greater than that required to manage the spread of the pest.	The seeds of moth plant can normally be expected to be dispersed up to 100m from the parent plant. Depending on the terrain, vegetation and wind-strength it can be transported much further.
In determining the rules to be set to manage the costs to an occupier of land that is adjacent or nearby, of the pest spreading, the regional council must consider: • the biological characteristics and behaviour of the particular pest; and • whether the costs of compliance with the rule are reasonable relative to the costs that such an occupier would incur, from the pest spreading, in the absence of a rule.	Moth plant is an invasive weed that can establish in a range of indigenous habitats. If a landowner does not control it, it can degrade natural areas and provide a seed source for new invasions. In considering the dispersal capabilities and current distribution of moth plant, a GNR alone would not create a marked difference for populations of moth plant. The species is listed within the NPPA (banned for sale and distribution) A GNR for moth plant would need to be in excess of 100m based on the wind dispersal range.

Proposed Good neighbour rules discussion: Current RPMS category: CPCA species. Proposed RPMP rule: No regional intervention - Failed GNR test

Nassella tussock

Nassella trichotoma

Also known as: serrated tussock.

(Family: Poaceae)

Status in New Zealand

Nassella tussock is listed as an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Nassella tussock is a perennial tussock-forming grass with fine-bladed, wiry leaves. It grows up to one metre high and one metre across. The extremely tough, thin, round blades that do not break when pulled. They are rough to the touch and are light green. The drooping seed heads have a purplish tinge.
Habitat	Nassella tussock establishes in open sites in pasture, disturbed shrubland, tall and short tussockland, bare land, river systems, and rocky and coastal areas. In New Zealand it occurs most frequently in drought-prone grasslands, particularly in South Canterbury and Otago.
Regional distribution	Nassella tussock has a limited distribution in Northland and, due to the ongoing eradication programme, each infestation has a low number of plants. It is found in dry farmland along the east coast with the main infestations occurring at Taupō Bay, Whananaki, Matapōuri, Urquharts Bay, Topuni, Tahere and Mangapai.
Competitive ability	Nassella tussock is tolerant to drought, fire and grazing but does not tolerate shade, salinity or water-logging. It can form pure stands in low-growing plant communities such as pasture, preventing other species from establishing.
Reproductive ability	Nassella tussock reproduces by seed and each mature plant can produce more than 100,000 seeds per year. Vectors of spread: seeds are dispersed by wind up to 20km from the mother plant. They have bristles that allow them to hook onto animal pelts and clothing and are also spread on machinery, in hay, mud and the droppings of animals.
Resistance to control	The prolific seeding and relatively long seed life make it difficult to eradicate. Herbicide treatment alone usually results in re-infestation from seed in the soil, so it is important to incorporate other control methods in an integrated management strategy. Livestock should be excluded to prevent them from spreading seed.
Benefits	Ornamental.

Land uses occupied

Land use type	Current land use infested	Potential land use infested
Dairy	-	Low
Sheep and beef	Low	High
Forestry	-	-
Horticulture	-	Low
Native	-	-
Urban	-	Low
Coastal	-	-
Estuarine and marine	-	-
Freshwater/wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	M	Dense infestations may completely dominate pasture, making large areas incapable of supporting livestock. Nassella tussock has no grazing value because it is unpalatable so infestations result in a significant loss in livestock production. Nassella tussock prefers drier, drought-prone areas.	Australian Government Department of the Environment, 2004; Williams and Champion, 2008.
Sheep and beef	L	H	Dense infestations may completely dominate pasture, making large areas incapable of supporting livestock. Nassella tussock has no grazing value because it is unpalatable so infestations result in a significant loss in livestock production.	Australian Government Department of the Environment, 2004; Williams and Champion, 2008.
Forestry	-	-	Nassella tussock establishes in open sites in pasture, disturbed shrubland, tall and short tussockland, bare land, river systems, and rocky and coastal areas. Therefore, it is unlikely to invade production forests.	Weedbusters.
Horticulture	-	L	Nassella tussock establishes in open sites in pasture, disturbed shrubland, tall and short tussockland, bare land, river systems, and rocky and coastal areas. Therefore, it may invade	Weedbusters.

Category	Current	Potential	Comment	Source
			open sites in horticultural land, such as mown grassland within olive groves or orchards.	
Other	-	-		
International trade				
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	L	In Northland, nassella tussock currently occurs only in exotic grassland but there is potential for it to invade low-growing indigenous communities such as coastal cliffs and dunes and reduce species diversity at these sites.	Williams and Champion, 2008.
Threatened species	-	L	In Northland, nassella tussock currently occurs only in exotic grassland but there is potential for it to invade low-growing indigenous communities, such as coastal cliffs and dunes, and impact on threatened species at these sites.	Williams and Champion, 2008.
Social/cultural				
Human health	-	-		
Recreation	-	-		
Māori culture	-	-		

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management is undertaken there will be no short-term financial cost to the council associated with this species.	Nassella tussock currently has a limited distribution in Northland but it is an invasive species with the potential to spread through pastoral land causing loss of production. The economic costs of lost production and delaying control until there are larger/more infestations is potentially considerable.	High. If nassella tussock is not managed its density within the infestation area is highly likely to increase and it may spread to new sites.
Exclusion programme	Not applicable.	Not applicable.	Exclusion is not an option because nassella tussock is already present in Northland.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Eradication programme	Nassella tussock has a limited distribution in Northland and its population is steadily declining as a result of control work undertaken by the council. If the species could be eradicated, it would prevent long-term environmental impacts and financial costs associated with loss of production and control costs.	Eradication of nassella tussock requires an investment of resources to control the known infestations and undertake on-going surveillance. If the species is not eradicated there will be on-going costs of control and indirect costs due to loss of production.	Low. The population of nassella tussock in Northland is steadily decreasing as a direct consequence of control efforts (Brill, 2015), and eradication appears to be feasible. However, eradication hasn't been successful in the South Island despite being worked towards since 1946 (Lamoureaux and Bourdôt) so there is still a chance that it may fail.
Progressive containment programme	Not applicable.	Not applicable.	There are only a few well controlled sites known in Northland due to the ongoing eradication programme, therefore a progressive containment programme is not appropriate.
Sustained control programme	Not applicable.	Not applicable.	There are only a few well controlled sites known in Northland due to the ongoing eradication programme, therefore a sustained control programme is not appropriate.
Site-led pest programme	Not applicable.	Not applicable.	There are only a few well controlled sites known in Northland due to the ongoing eradication programme, therefore a site-led programme is not appropriate.
Summary of alternative assessments and preferred option:	Eradication programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for nassella tussock. In terms of alternative approaches assessed, under <u>no regional intervention</u> (or do nothing), there could be unacceptable loss of production values in dryland farming areas. As it is a well-known and high-profile pastoral pest in many other parts of the country, there would be substantial political and farming concerns if this tussock species was not managed. Further, maintaining the gains of previous management efforts would be wasted if regional intervention was not instigated. <u>Progressive containment or sustained control</u> approaches would not be appropriate as the plant is thought to occupy only a fraction of the areas suitable in the drier eastern Northland locations. It would be risky relying on 'lesser' control options when eradication/zero density is achievable. It would be an unacceptable risk to rely only on landowners to control infestations – grasses can be very cryptic in nature and difficult to identify at low densities and to effectively control. The operational risks through imposing landowner/occupier control rules could compromise the outcomes sought. <u>Eradication</u> is the preferred outcome and is realistic given its limited distribution. NRC intends to undertake direct control of this pest plant wherever it occurs in the region (through its service delivery programme). The costs involved under an eradication programme are minor		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	(compared with the risks of doing nothing and allowing it to spread) and are not expected to adversely affect control outcomes.		

Nodding thistle

Carduus nutans

(Family: Asteraceae)

Status in New Zealand

Relevant biology

Form	Nodding thistle is a biennial plant that grows from over-wintering rosettes and has a long, fleshy taproot. The flowering stems grow up to 1.5m tall bearing red-purple or, occasionally, white flowers that droop or nod when mature. Sharp spines densely cover the stems and leaf margins.
Habitat	Nodding thistle is predominantly a weed of pasture (particularly pasture grazed by sheep) and also invades roadsides, wasteland and crops such as lucerne. It will grow in most soil types but does not grow well in excessively wet, dry, or shady conditions and does best under higher soil fertility.
Regional distribution	The population of nodding thistles in Northland is not large. It is most commonly found on Poutō Peninsula and occurs elsewhere as isolated invasions. There are approximately 155 known sites of nodding thistle in Northland, most of which are small.
Competitive ability	Nodding thistle is considered to be the most aggressive thistle in New Zealand. It can invade pastures at all stages of development, particularly those grazed by sheep, and quickly establish in pastures suffering from summer drought. Its main economic impact is that it prevents stock from eating plants growing in the vicinity of the thistle, replaces desirable vegetation and hinders stock movement.
Reproductive ability	Nodding thistle reproduces by seed. Approximately 200 seeds are produced per flower, of which two-thirds are viable. Seed may lay dormant in the soil for up to 20 years. Vectors of spread: seed is dispersed locally by wind but 91% of seed falls within 1-2 metres of the plant. It is also spread in mud, water, machinery, fodder and contaminated agricultural seed. Wet seeds produce a sticky coating allowing them to attach to people and animals.
Resistance to control	Nodding thistle can be controlled by physical, chemical and biological methods. It can also be excluded by good pasture management. There are three biocontrol agents currently available for nodding thistles: • Nodding thistle crown weevil (*Trichosirocalus spp.*) - Larval feeding in the the crown of the plant usually kills the plant. Reports of good levels of control elsewhere in New Zealand. Has been released in Northland but no established populations currently known.

	• Nodding thistle receptacle weevil (*Rhinocyllus conicus*) - larvae feed on seeds in the seedhead. Found in Ngawha, Whangarei, Dargaville area and Pouto. No significant impact on thistle populations. • Green thistle beetle (*Cassida rubiginosa*) - Adults make some holes in the leaves but the main damage is caused by the larvae which can defoliate plants. The beetle prefers Californian thistle (*Cirsium arvense*) but is likely to attack all thistles to some extent. Released at Oneriri in November 2013 but not recovered there in December 2015. Reports of beetle outbreaks on thistles have been reported elsewhere in NZ, such as in the Wairarapa.
Benefits	Thistles are used as both food and medicine.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	Low	Low
Sheep and beef	Low	High
Forestry	-	-
Horticulture	-	Low
Native bush or forests	-	-
Urban	-	-
Coastal	-	-
Estuarine and marine	-	-
Freshwater/wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	L	L	Nodding thistle is typically found in pastures grazed by sheep rather than cattle. It is a problem because it competes with pasture plants and hinders the movement of livestock.	Global invasive Species Database; Invasive Species Compendium.
Sheep and beef	L	M	Nodding thistle is typically found in pastures grazed by sheep rather than cattle. It is a problem because it competes with pasture plants and hinders the movement of livestock. The	Global invasive Species Database; Invasive Species Compendium; Williams and Champion, 2008.

Plant pests

Category	Current	Potential	Comment	Source
			spiny vegetation catches in the wool of sheep, reducing the value of the wool.	
Forestry	-	-		
Horticulture	-	L	Nodding thistle is sometimes found in crops, but it is primarily a weed of grasslands.	Invasive Species Compendium; Williams and Champion, 2008.
Other	-	L	The presence of nodding thistle seed in pasture and crop seed generally prevents certification of the seed.	Global invasive Species Database.
International trade	-	L	The presence of the seed in pasture and crop seed generally prevents certification of the seed.	Global invasive Species Database.
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	-	Nodding thistle has not been recorded impacting on natural areas in Northland.	Williams and Champion, 2008.
Threatened species	-	-		
Social/cultural				
Human health	-	-		
Recreation	-	-		
Māori culture	-	-		

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the regional	Nodding thistle has the potential to become a serious weed of pasture and horticultural land. If no action	Low. Nodding thistle is a weed of pasture and, as such, there is an incentive for landowners to control it.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	council under the pest management plan in relation to this species.	is taken it may spread to new sites, with consequent loss of production and increased control costs. However, due to the impacts on agricultural land it is generally dealt with by occupiers as part of usual land management practise. There are also effective biocontrol agents now available.	Therefore, uncontrolled spread is unlikely.
Exclusion programme	Not applicable.	Not applicable.	Nodding thistle is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Nodding thistle is widely scattered at multiple sites across the region and there is a high chance that there are unrecorded infestations.
Progressive containment programme	A progressive containment programme would incur some short-term financial cost to the council and landowners, but would aim to confine or reduce the distribution of nodding thistle to current areas over the duration of the plan.	A progressive containment programme would require an ongoing investment of time and resources from the council and affected landowners. This programme would not aim to eradicate the species, so control costs would be on-going.	Low. Nodding thistle is an invasive species that primarily spreads vegetatively. Therefore, there is a low risk that a progressive containment programme will fail to confine the spread and the economic impacts of nodding thistle.
Sustained control programme	A sustained control programme would incur lower short-term financial cost to the council and landowners. It would aim to restrict the spread and impacts of nodding thistle through rules requiring land occupier control.	This programme would require an investment of time and resources by the council and affected landowners. It would not aim to eradicate the species, so control costs would be on-going and, in future, eradication or containment may no longer be options.	Low. There is some risk that a sustained control programme will fail to manage the spread and the economic costs of this species.
Site-led pest programme	Not applicable.	Not applicable.	Nodding thistle is present at many scattered sites so is not a suitable candidate for a site-led programme.
Summary of alternative assessments and preferred option:	**No regional intervention** Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate.		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	Resulting from this process, the council is of the opinion that nodding thistle does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be no regional intervention for nodding thistle, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding. While nodding thistle has not been afforded pest status in Northland, it may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes. Good neighbour rule test In the previous RPMS a GNR was included for Nodding thistle, however the GNR test for this species failed due to the cost it would place versus the benefits achieved.		

Good neighbour rule test

Before a rule can be identified as a good neighbour rule in a RPMP, the regional council must be satisfied of the matters in subclause (a), (c), and (d) and must comply with the requirements in subclause (b) and (e):	
Tests	
In the absence of the rule, the pest would: • spread to land that is adjacent or nearby within the life of the plan; and • cause unreasonable costs to an occupier of that land.	Nodding thistles produce large quantities of viable seeds. Most falls within 1-2 metres of the parent plant but it can be spread much further by wind, on machinery, in hay etc. Therefore, if an infestation is not controlled there is a high chance that the species will spread. An invasion of nodding thistle will accrue costs to a landowner associated with weed control and lost production. Nodding thistle prevents stock from eating plants growing in the vicinity of the thistle, replaces desirable vegetation and hinders stock movement.
In determining whether the pest would spread as described in subclause (a) the regional council must consider: • the proximity and characteristics of the adjacent or nearby land; and • the biological characteristics and behaviour of the particular pest (the greater the distance between	Nodding thistle is predominantly a weed of pasture (particularly pasture grazed by sheep) but can also invade roadsides and some croplands. Seed is dispersed locally by wind but 91% of seed falls within 1-2 metres of the plant.

properties, the more difficult to satisfy the test in subclause (a)).	
The land that is adjacent or nearby, as described in subclause (a), must be clear from a pest or, if the pest is present on that land, the occupier of that land must be taking measures to manage the pest or its impacts	In order for the good neighbour rules in the RPMP to apply, it is a requirement that the neighbouring property from where the complaint arises be clear of nodding thistle or, if nodding thistle is present, it is actively being controlled.
The rule must not set a requirement on an occupier that is greater than that required to manage the spread of the pest.	Given the potential for nodding thistle to disperse over long distances, it is unreasonable that landowners remove all infestations of this species to prevent it from spreading to neighbouring properties.
In determining the rules to be set to manage the costs to an occupier of land that is adjacent or nearby, of the pest spreading, the regional council must consider: • the biological characteristics and behaviour of the particular pest; and • whether the costs of compliance with the rule are reasonable relative to the costs that such an occupier would incur, from the pest spreading, in the absence of a rule.	Nodding thistle is considered to be the most aggressive thistle in New Zealand. It prevents stock from eating plants growing in its vicinity, replaces desirable vegetation and hinders stock movement. It spreads by wind-dispersed seed, though most of the seed falls close to the parent plant. If a landowner does not control nodding thistle they will incur costs as a result of lost production. This may motivate landowners to control nodding thistle for their own benefit, a good neighbour rule however would place an unfair cost on landowners for the potential benefit.
Proposed Good neighbour rules discussion: Current RPMS rule: Occupiers are required to kill all individuals of nodding thistle wherever they occur on the property. Proposed RPMP rule: Failed GNR test.	

Noogoora bur

Xanthium strumarium

Also known as: Noogoora bur, rough cockle bur

(Family: Asteraceae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Noogoora bur is a fast-growing summer annual that can reach heights of 2m - 2.5m. Its is named for the clusters of distinctive, egg-shaped burs that contain seeds. The burs are 10-25mm long and covered in hooked spines with two thick spines at the tip. The plant can grow with a single stem or as a multi-stemmed bush. The leaves

	are dark green above, paler below and irregularly lobed with purplish veins. The stems are rough to the touch and streaked with purple.
Habitat	Noogoora bur favours fertile soils and is often found close to water. It usually grows on arable land and in paddocks but it is also found on disturbed ground, stream banks, and other riparian areas.
Regional distribution	Noogoora bur is not known to be present in Northland Region.
Competitive ability	Noogoora bur contains chemicals that can impede the growth and germination of neighbouring plants. It produces large quantities of seeds that germinate into a fast growing and highly competitive weed that can cause significant losses in many crops.
Reproductive ability	A single plant can produce 10,000 seeds, which are contained inside burs. The seeds may remain dormant in the soil for many years. Vectors of spread: The seeds are contained in the burs which spread by attaching to animals, clothing and agricultural machinery. They may also be spread in seed, feed, gravel and soil and float, so can be spread by water.
Resistance to control	Seed may remain dormant in the soil for many years.
Benefits	

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	High
Sheep and beef	-	Low
Forestry	-	-
Horticulture	-	High
Native bush or forests	-	-
Urban	-	-
Coastal	-	-
Estuarine and marine	-	-
Freshwater/Wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				

Category	Current	Potential	Comment	Source
Dairy	-	M	Noogoora but competes with pasture species and the seeds and very young plants are toxic to stock, particularly pigs and cattle.	Lamb 2006
Sheep and beef	-	M	Noogoora but competes with pasture species and the seeds and very young plants are toxic to stock, particularly pigs and cattle. The burs attach to sheep fleeces, devaluing the wool.	Lamb 2006
Forestry	-	-		
Horticulture	-	M	Noogoora bur can carry fungal diseases that are capable of infecting horticultural plants. It contains chemicals that can impede the growth and germination of neighbouring plants.	Lamb 2006 AgPest
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	L	Noogoora bur can become established on stream margins and suppress native vegetation.	AgPest
Threatened species	-	-		
Social/cultural				
Human health	-	L	The burs can irritate the skin.	
Recreation	-	-		
Māori culture	-	-		

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	Noogoora bur is not known to be in Northland. If neighbouring regions were relied on to control the species there would be no economic cost to the Northland region.	There would be limited public awareness of Noogoora bur and a risk that it would be accidentally introduced. If it is not in the pest management plan there would be no rules to manage the species in Northland.	Medium. Without education and regulation there is a medium risk that Noogoora bur could arrive and establish in Northland.
Exclusion programme	Public awareness and education about the risks and impacts of Noogoora bur and a rule banning possession of the species in Northland could prevent it from establishing in the region. If it is included in the pest management plan there is the ability to respond immediately if an infestation is detected. This would include a rule requiring land owners or occupiers to destroy Noogoora bur on land that they occupy.	Low. There is already educational material available for Noogoora bur. Excluding this species would prevent expenditure on its control if/when it invades Northland.	Low. People will be aware of the species and its potential impacts. There will be a rule banning possession of the species in Northland and allow immediate control should any be found.
Eradication programme	Public awareness and education about the risks and impacts of Noogoora bur and a rule banning possession of the species in Northland could prevent it from establishing in the region. If it is included in the pest management plan there is the ability to respond immediately if an infestation is detected. This would include a rule requiring land owners or occupiers to destroy Noogoora bur on land that they occupy.	Low. There is already educational material available for Noogoora bur. Excluding this species would prevent expenditure on its control if/when it invades Northland.	Low. There are no currently known sites of Noogoora bur in Northland, but it is possible that it is already here. People will be aware of the species and its potential impacts. There will be a rule banning possession of the species in Northland and allow immediate control should any be found.
Progressive containment programme	Not applicable	Not applicable	Noogoora bur is not known to be present in Northland.
Sustained control programme	Not applicable	Not applicable	Noogoora bur is not known to be present in Northland.
Site-led pest programme	Not applicable	Not applicable	Noogoora bur is not known to be present in Northland.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Summary of alternatives assessed and preferred option:	Exclusion programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for Noogoora bur. In terms of alternative approaches assessed, under no regional intervention (or do nothing) over time there would be unacceptable loss of production values if this pest established in the region. Some residual effects would also occur on horticultural and biodiversity values. There would also be political risks to Council of doing nothing as the effects of this plant are widely known among arable farmers. Further, without any intervention ability the opportunity of immediately being able to control Noogoora bur would be lost. Progressive containment or sustained control approaches would not be appropriate as Noogoora bur is not formally known in Northland, despite a possibility that it is but not yet detected. It would be risky relying on 'lesser' management options when eradication would be desirable. Either approach could see spread of this pest occur at a quicker rate, would compromise the outcomes sought and would ultimately fail to contain the spread of Noogoora bur. Exclusion is the preferred outcome and a total property clearance rule on all occupiers is considered realistic. Under this approach, Council requires the ability to have a Plan rule in place and to direct land occupiers to respond quickly and effectively, while acknowledging that affected occupiers (e.g. crop farmers) are best placed to control Noogoora bur should the need arise. It is not impossible that infestations exist in the region and arable farmers are generally well engaged about this pest and its effects, therefore the overall risk in adopting a regulatory approach is low.		

Norfolk Island hibiscus

Lagunaria patersonia

Also known as: white oak; whitewood; pyramid tree.

(Family: Malvaceae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Norfolk Island hibiscus is a long-lived, medium to large tree which can reach about 12-20m in height. It has dense, greyish-green leaves which are oval shaped to about 100mm long and covered in soft hairs when young. The pink flowers are of typical hibiscus shape and appear in spring and summer. They are generally a pink to mauve but deeper coloured forms are in cultivation. The flowers are followed by brown capsules containing a number of black seeds. The capsules contain white fibres, which are can be very irritating if they get on the skin. These give rise to other common names for the plant such as itch tree and cow itch tree.
Habitat	This hardy plant for a range of climates and soils is widely planted in coastal gardens in northern New Zealand. It is widely grown in tropical, sub-tropical and temperate areas of both coast and inland. It is hardy to salt spray and does well in coastal gardens. It performs best in well drained soils in a sunny position.

Regional distribution	Planted as hedges in many areas, sometimes trimmed. Records in 3 coastal areas of sites of naturalised plants in Ruakaka, Auckland and Great Barrier Island.
Competitive ability	Salt, wind and drought tolerant. Fast growing once established. Seeds long-lived. Cold tolerant. Norfolk Island hibiscus is becoming naturalised in many parts of southern Australia and is regarded as an environmental weed or potential environmental weed in some parts of New South Wales, Victoria, South Australia and Western Australia, where it has escaped gardens and invaded native vegetation, particularly in coastal areas. A fungal pathogen of *Hoheria* and *Plagianthus* (*Nectria hoheriae*) has jumped to Norfolk Island hibiscus in New Zealand, specifically in the Nelson and Wellington areas, at the southern fringe of the area in which Norfolk Island hibiscus is hardy. It is also attacked by is attacked by olive scale or black scale (*Saissetia oleae*).
Reproductive ability	Reproduces from seed and in good conditions it can start to flower within four years of germination. Seed is long-lived, forming a seed bank with seed only germinating when conditions are suitable. Propagation from seed is relatively easy, and no special pre-treatment is needed. Vectors of spread: Mainly spread by inappropriate coastal plantings, careless discard of garden clippings and down water courses near which it has been planted. The seeds are enclosed in somewhat buoyant pods. Cuttings also strike readily.
Resistance to control	Seedlings can be hand pulled, and mature plants felled. Stems can be injected with 50% glyphosate, or if stems are less than 30 cm diameter, herbicide with triclopyr and pichloram can be applied to basal bark.
Benefits	Popular garden plant because it is very fast growing and, once established, wind, salt and drought tolerant. Fire resistant.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	-	-
Horticulture	-	-
Native bush or forests	-	Low
Urban	High	Low
Coastal	-	Low
Estuarine and marine	-	-
Freshwater/Wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	L	Regarded as an environmental weed in some parts of southern Australia, where it has escaped gardens and invaded native vegetation, particularly in coastal areas. No information on impacts could be found. This species appears to have very few naturalised seedlings in Northland (or indeed New Zealand) at this stage.	Hinsley, 2003.
Threatened species	-	-		
Social/cultural				
Human health	L	L	Care needs to taken in removing seed from the capsules so that the irritant fibres do not come in contact with the skin. Seed is poisonous if ingested.	Hinsley, 2003.
Recreation	-	-		
Māori culture	-	-		

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial cost to council associated with the control of this species.	There will be no costs to council if this species is not included in a management programme.	Low - Norfolk Island hibiscus is already present in gardens throughout Northland, but there are few examples of naturalised seedlings.
Exclusion programme	Not applicable.	Not applicable.	Norfolk Island hibiscus is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Norfolk Island hibiscus is present in gardens throughout the region so would not be suitable for an eradication programme.
Progressive containment programme	Not applicable.	Not applicable.	Norfolk Island hibiscus is present in gardens throughout the region so would not be suitable for an progressive containment programme.
Sustained control programme	Norfolk Island hibiscus could be included in a sustained control programme. The council could include a rule banning dumping/deliberate spread within the Northland region and ban the plant from sale.	Education, publicity, responding to reports, enforcement action. Costs to nurseries selling the plant.	Low - however, given the lack of data regarding impacts it is difficult to justify banning it from sale.
Site-led pest programme	The council could specify high value coastal areas as site-led programmes, as an incursion at these sites could have significant impacts. We could also consider introducing rules about the species people are allowed in gardens in these areas.	Rules would only be applicable in the areas defined as site led programmes and could not be enforced elsewhere. Education, publicity, responding to reports, response to new incursions, enforcing rules.	Low - efforts could be targeted to protecting and responding to incursions in the highest value sites in Northland. However, given the lack of data regarding impacts it is difficult to justify this.
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that Norfolk Island hibiscus does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be no regional intervention for Norfolk Island hibiscus, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding. While Norfolk Island hibiscus has not been afforded pest status in Northland, it may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes.		

Nutgrass

Cyperus rotundus

Also known as purple nut sedge.

(Family: Cyperaceae)

Status in New Zealand

Not applicable.

Relevant biology

Form	Nutgrass is a colony-forming perennial with a grass-like appearance that grows approximately 30cm in height. The term nut sedge or nutgrass originates from the nut-shaped roots of the plant, which are also the primary mechanism by which it spreads. Native to tropical Eurasia, it is now a weed in more than 90 countries, and has been described as one of the 'world's worst weeds' based on its distribution and effect on crops. Leaves are linear and glossy with a prominent mid-rib, and are arranged in sets of three from a central base, growing to between 5-20cm long. Flowering stems are triangular in cross-section and produce a group of up to seven red-purple flower heads made up of narrow flattened flower spikes. The flower stalk is supported by three to six long grass-like leaves. Flowering can be erratic and may not occur after a growth period. Nutgrass produces an extensive underground network of very fibrous roots, basal bulbs, creeping stems (rhizomes) and tubers. The network branches prolifically in shallow soil, with 95% of tubers growing in the top 12cm of soil. The species rarely reproduces by seed and grows mainly from these horizontally spreading tubers.
Habitat	Nutgrass will inhabit both wet and dry areas, and almost every soil type, but will grow and reproduces more slowly in cool or waterlogged soils. Prefers farmland, coast land, riparian areas and water courses but will also tolerate drier sites such as roadsides and cropping land. Will inhabit waste areas, grasslands, forest edges and disturbed areas. Species can present a threat to agricultural areas, particularly irrigated fields.
Regional distribution	One small site was confirmed in Kerikeri during 2016. It is present in many other North Island regions, particularly Waikato.

Competitive ability	Nutgrass will compete with other plants for ground resources and is also allelopathic, with the roots releasing substances into the soil that can be harmful to other plants. It is difficult to control with any breakage of the roots resulting in further reproduction. Has been documented as having serious impacts on agriculture across the southernmost United States.
Reproductive ability	The species can produce a small dry fruit with one seed, however this is rare and the seeds have low rates of viability. The primary mechanism of reproduction is by way of tuber and rhizome spread. Young plants produce white fleshy rhizomes that grow in chains horizontally in shallow soil, then grow upward and form a bulb-like tuber, which produces its own roots and new rhizomes. Vectors of spread: mainly spread through human activity associated with agriculture and gardening, including vehicle movement, soil movement or ploughing, soil and crop sharing. Can be distributed with commercial root crops, seeds, and feeds.
Resistance to control	Nutgrass can be very difficult to control. It is resistant to most herbicides and cannot be stopped with plastic mulch. Its extensive network of tubers will quickly regrow if disturbed, with new plants able to grow from small fragments.
Benefits	Can be eaten, and is used in some herbal medicines.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	High
Sheep and beef	-	High
Forestry	-	Low
Horticulture	-	High
Native bush or forests	-	Low
Urban	-	Low
Coastal	-	Low
Estuarine and marine	-	Low
Freshwater/wetland areas	-	Low

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	M	Will compete with other plants for resources, and could result in a reduction of grass growth due to allelopathy.	Invasive Species Specialist Group (ISSG) website.

Category	Current	Potential	Comment	Source
Sheep and beef	-	M	Will compete with other plants for resources, and could result in a reduction of grass growth due to allelopathy.	Invasive Species Specialist Group (ISSG) website.
Forestry	-	-		
Horticulture	-	H	Can result in a significant reduction in production of crops due to density and allelopathy, and may contaminate stock of root crop. Documented having serious impacts on agriculture in the United States.	Invasive Species Specialist Group (ISSG) website; Schonbeck, M. 2015.
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	-		
Threatened species	-	-		
Social/cultural				
Human health	-	-		
Recreation	-	M	Density and allelopathy can impact plants in domestic gardens.	Invasive Species Specialist Group (ISSG) website.
Māori culture	-	-		

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	Nutgrass is only present at one known site in Northland, but there may be other unidentified sites. If neighbouring regions were relied on to control the species there would be no	There would be limited public awareness of nutgrass and therefore a greater risk that it would be accidentally introduced. If it is not in the pest management plan there	High. Without education and regulation there is a high risk that nutgrass could establish and spread widely in Northland.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	economic cost to the Northland region.	would be no rules to prevent possession of the species in Northland.	
Exclusion programme	Not applicable.	Not applicable.	Nutgrass is present in Northland.
Eradication programme	Public awareness and education about the risks and impacts this species could have in Northland, and a rule banning possession of the species in Northland could prevent it from establishing in the region. As well as control of any infestations found.	There is only one known site in Northland discovered during 2016 which is now part of a control programme. Eradicating this species would prevent greater expenditure on its control in the future.	Medium-low. People will be aware of the species and its potential impacts. There will be a rule banning possession of the species in Northland, which could help discourage people from bringing it to Northland and allow immediate control should any further infestations be found. There is a risk that there are other unknown sites already present in Northland.
Progressive containment programme	Not applicable.	Not applicable.	There is only one known site of nutgrass in Northland, so a progressive containment programme is not appropriate.
Sustained control programme	Not applicable.	Not applicable.	There is only one known site of nutgrass in Northland, so a sustained control programme is not appropriate.
Site-led pest programme	Not applicable.	Not applicable.	There is only one known site of nutgrass in Northland, so a site-led programme is not appropriate.
Summary of alternatives assessed and preferred option:	Eradication programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for nutgrass. In terms of alternative approaches assessed, under no regional intervention (or do nothing) over time there would be unacceptable loss of production values if nutgrass established in the region. There would also be moderate political risks to Council of doing nothing as nutgrass is known among arable farmers. Further, without any intervention ability the opportunity of immediately being able to control nutgrass would be lost. Progressive containment or sustained control approaches would not be appropriate as nutgrass has a very limited distribution (one known site) in Northland, despite a possibility that it is but not yet detected in other areas. It would be risky relying on 'lesser' management options when eradication is both desirable and achievable. Either approach would likely see spread of this pest occur at a quicker rate, would compromise the outcomes sought and would ultimately fail to contain the spread of nutgrass. Eradication is the preferred outcome and a total property clearance rule on all occupiers is considered realistic. Under this approach, Council requires the ability to have a Plan rule in place and to direct land occupiers to respond quickly and effectively and acknowledges that affected occupiers (e.g. crop farmers) are best placed to control nutgrass. The overall risk in adopting a regulatory approach is considered medium/low, with operational risks over its control (very diffcult and resistant to herbicides) and spread potential (via machinery). However,		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	arable farmers are generally well informed about nutgrass as it is one of the world's worst pest plants. The costs involved under an eradication programme (e.g. inspections and advocacy) are relatively minor and are not expected to adversely affect control outcomes.		

Old man's beard

Clematis vitalba

Also known as: traveller's joy.

(Family: Ranunculaceae)

Status in New Zealand

Old man's beard is listed as an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Old man's beard is a deciduous climbing vine that grows up to 20m tall. It has woody stems with six prominent ribs and pale bark that rubs off easily. The leaves are arranged in opposite pairs along the stems, and each is made up of five leaflets. The thin leaflets are sparsely hairy and have bluntly toothed or smooth edges. Fragrant, creamy-white flowers are produced from December to May. Flowers are followed by dense, fluffy clusters of seeds, which persist over winter. Old man's beard is sometimes confused with native clematis but all native species are evergreen, have three leaflets (not five), unfurrowed stems, and flower from August to December.
Habitat	Old man's beard is a light-demanding species. It grows in low forest, scrub, shrubland, riparian margins and in forests with well-lit margins, wide tracks, waterways or clearings.
Regional distribution	Old man's beard has been recorded on roadsides near Puketi Forest but has been eradicated from all known sites. There is a possibility of undiscovered infestations.
Competitive ability	Old man's beard is a fast-growing vine with the ability to climb up into the canopy. It smothers and collapses even tall trees and can reduce a forest to an impenetrable, low-growing infestation of the vine. It moves into established forest over the canopy by layering.
Reproductive ability	Old man's beard produces huge amounts of seed, which initially have a high viability rate. Seed viability declines rapidly but some seed is retained in the soil for up to five years. It also reproduces vegetatively from rooting stem fragments and vines that touch the ground can take root. Vectors of spread: seeds are dispersed by wind, gravity, water, humans, and soil movement. Plant fragments may be spread in garden waste or intentionally spread for ornamental reasons.
Resistance to control	Old man's beard can be controlled by a combination of physical, chemical and biological methods. It can re-grow from plant fragments, roots, or hanging vines so follow-up control is necessary and plant waste must be disposed of appropriately.

Benefits	Old man's beard was originally brought to New Zealand for ornamental purposes.

Land uses occupied

Land use type	Current land use infested	Potential land use infested
Dairy	-	-
Sheep and beef	-	-
Forestry	-	High
Horticulture	-	-
Native	-	High
Urban	-	High
Coastal	-	Low
Estuarine and marine	-	-
Freshwater/wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-	Old man's beard grows in forest, scrub, shrubland, and riparian margins. Therefore, it is unlikely to invade pasture.	West, 1991.
Sheep and beef	-	-	Old man's beard grows in forest, scrub, shrubland, and riparian margins. Therefore, it is unlikely to invade pasture.	West, 1991.
Forestry	-	M	Old man's beard grows in forest but requires relatively high light levels. Therefore, it may invade forest margins, clearings and recently planted areas within production forests.	West, 1991.
Horticulture	-	-	Old man's beard grows in forest, scrub, shrubland, and riparian margins. Therefore, it is unlikely invade to horticultural land but may become established in shelterbelts and has been recorded as a minor weed of vineyards.	West, 1991; Invasive Species Compendium.
Other	-	-		
International trade	-	-		

Category	Current	Potential	Comment	Source
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	H	Old man's beard grows in forest, scrub, shrubland, and riparian margins. It smothers vegetation, shading both the canopy and under storey to the extent that it can kill native trees and prevent seedling establishment. In Northland, it has been recorded near Puketi Forest.	West, 1991; Ogle et al., 2000; Williams and Champion, 2008.
Threatened species	-	H	Old man's beard has excluded threatened plant species from forests in New Zealand.	Ogle et al., 2000.
Social/cultural				
Human health	-	L	Old man's beard is toxic to humans if eaten.	Global invasive species database.
Recreation	-	M	Old man's beard has the potential to reduce the aesthetic and recreational values of natural areas and dense infestations may prevent access.	
Māori culture	-	M	Potential impact on native species.	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs to the council associated with this species.	Old man's beard has probably been eradicated from Northland but there may be undiscovered infestations. It is an invasive species with the potential to spread to a range of habitats in Northland. The long-term environmental and economic costs of failing to detect and control this species are potentially considerable.	High. There is a high risk that there are existing undiscovered infestations or that the species will be deliberately transported to Northland as an ornamental plant or unintentionally with other ornamental plants
Exclusion programme	Old man's beard has been eradicated from all known sites in Northland but there is a risk that there are undiscovered infestations. If the species is included in the Regional Pest Management Strategy, there is the ability	Long-term eradication of old man's beard would require an investment of resources to undertake on-going surveys. This would ensure that all previously known infestations have been eradicated and there is no regrowth.	Low. Old man's beard has probably been eradicated from Northland but there is a risk that there are undiscovered infestations.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	to respond immediately if an infestation is detected. Public awareness and education about the risks and impacts of old man's beard and a rule banning possession of the species in Northland could prevent it from establishing in the region.	Surveillance to detect any additional infestations would also be required.	
Eradication programme	Not applicable.	Not applicable.	Old man's beard has probably been eradicated from Northland.
Progressive containment programme	Not applicable.	Not applicable.	Old man's beard has probably been eradicated from Northland.
Sustained control programme	Not applicable.	Not applicable.	Old man's beard has probably been eradicated from Northland.
Site-led pest programme	Not applicable.	Not applicable.	Old man's beard has probably been eradicated from Northland.
Summary of alternative assessments and preferred option:	Exclusion programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for old man's beard. In terms of alternative approaches assessed, under no regional intervention (or do nothing) there would be a very high risk of political and public criticism of Northland Regional Council for not being more proactive. Old man's beard is among the most damaging pest plants ever to have been introduced to New Zealand and probably has the highest public profile of any pest plant. Therefore, there is little or no likelihood of management programmes being contentious or controversial for the public, stakeholders or wider community. Old man's beard has been previously recorded in Northland and there may still be undetected infestations. However, an exclusion programme outcome is the only appropriate option available. Finding it and destroying it before it can naturally establish would be imperative. Operationally, it can be relatively easily distinguished from native clematis species, but like most vigorous growing exotic vines, successful control is problematic and requires multiple visits to the same sites. An exclusion programme focusing on a comprehensive surveillance programme will help to mitigate any future technical control risks by detecting any infestations very early on.		

Oxylobium

Callistachys lanceolata

(Family: Fabaceae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Oxylobium is a tall evergreen shrub (3-8m high) with densely hairy angular stems. Leaves are oval- shaped, narrow and 30-80mm long, silky when young and hairless and smooth when mature. Dense terminal flower clusters of yellow/orange pea-like flowers (each 10-15mm long) appear in spring. Seedpods are densely silky initially but become hairless, hard and ribbed when mature (13-17mm long, containing 6-8 reddish black seeds).
Habitat	Shrubland, grassland, tussock, seasonal wetlands, wasteland and disturbed areas. Prefers dry and sandy coastal areas. Tolerant of hot, dry, wind, salt, damage and low nutrient soils. Intolerant of moderate shade. Benefits from fire and physical disturbance.
Regional distribution	Oxylobium is widespread and scattered throughout Northland. Densities are higher in the far north, particularly around dune lakes and plantation forests, in sandy soils.
Competitive ability	Invasive overseas. Fast growing, thicket forming species that colonises rapidly after disturbance. Germination is improved by fire. Rapid growth and ability to increase soil nitrogen can enable it to out-compete other plants, particularly low growing shrubs and ground cover species.
Reproductive ability	Seed remains viable in the soil for long time. Vectors of spread: It can be spread by movement of soil on machinery, vehicles and stock. Oxylobium is also spread by water and dumped garden waste.
Resistance to control	May be difficult to eradicate once established due to long-lived soil seed bank.
Benefits	Ornamental.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	Low	Low
Horticulture	-	-
Native bush or forests	Low	Low
Urban	High	High
Coastal	Low	High
Estuarine and marine	-	-
Freshwater/Wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	L	L	Oxylobium is present in coastal plantation forests in the far north, but it is not clear what impacts it might have.	
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	L	L-M	Data deficient, but as a nitrogen fixer there is potential to alter soil nutrient levels and cycles	Weedbusters.
Water quality	-	-		
Species diversity	-	L-M		
Threatened species	-	L-M	Empirical evidence lacking but thickets may crowd and shade out rare short-range endemics. Increases in soil nutrient levels may be detrimental to low nutrient specialists such as orchids and ferns.	Biosecurity Queensland 2011; Weedbusters.
Social/cultural				
Human health	-	-		
Recreation	-	-		
Māori culture	-	L-M	See 'species diversity' and 'threatened species'	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council under the RPMP in relation to this species. Rather than applying a programme under the Regional Pest Management Plan, the species could come under a 'Connecting Communities' programme outside the pest management plan, where advice and support are provided for specific sites. This will provide support to communities as and where the species is having impacts.	Oxylobium is already present in Northland but is not usually seen dominating large areas. If no action is taken it may spread, with consequent environmental impacts and future control costs.	Low. If no action is taken, existing infestations of oxylobium may expand and it may spread to new sites.
Exclusion programme	Not applicable.	Not applicable.	Oxylobium is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Oxylobium is present throughout the region so would not be suitable for an eradication programme.
Progressive containment programme	Not applicable.	Not applicable.	Oxylobium is present throughout the region so would not be suitable for an progressive containment programme.
Sustained control programme	Oxylobium could be included in a sustained control programme. As a declared pest it would be banned from sale under the Biosecurity Act. This could help reduce the risk of spread over time.	Oxylobium is already banned from sale and distribution in Northland and has been for a number of years so there would be no costs to plant retail outlets from a ban. Plant retail outlets are inspected regularly by council staff checking for many different plants.	Moderate. Oxylobium could still spread and become more common.
Site-led pest programme	A site-led programme, where control of oxylobium is required in defined parts of Northland could reduce the impacts of this species within the programme	A site-led programme would require an investment of time and resources by the council and affected landowners. It would not reduce or restrict the impacts of oxylobium in	Moderate. A site-led programme could effectively reduce or eliminate the adverse effects of oxylobium in local areas.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	area(s). This could be beneficial in dune lake areas in particular.	areas that are not identified as being of high priority.	
Summary of alternative assessments and preferred option:	Sustained control programme - Banned from Sale & Distribution With regard to section 6(1) of the NPD a low-level analysis was considered appropriate for oxylobium. In terms of alternative approaches assessed, under a do-nothing approach there would be no ability for Council to prevent the formal (nursery trade) or informal (fairs and on-line marketing) trade or circulation of this pest. Oxylobium is already naturalised in Northland and its distribution and assessment of effects mean that eradication and progressive containment programmes are not realistic or affordable. Site-led management would control some plants at some sites, but ultimately this approach would also be unsustainable. Sustained control is the preferred outcome and most viable option. Declaring oxylobium formally as a pest in the Plan automatically triggers sections 52 and 53 of the Biosecurity Act, banning the pest from sale, propagation and distribution in Northland. This plant is not covered in the current National Pest Plant Accord (NPPA) which has over 150 plants listed, banning them from sale, propagation and distribution nationally. However, the NPPA is nationally focused and doesn't necessarily account for regional differences. The risks of this plant have been evaluated specifically in terms of its effects in Northland. It is important to recognise the wide climate and temperature ranges in New Zealand and that some pests require regional based initiatives based on these factors. Accordingly, oxylobium is one of 32 pest plants banned from sale, propagation and distribution in the Northland region. This designation recognises that generally they are a lower risk to the regions' values compared with other more invasive species. Council wishes to take a more proactive stance over their management, as opposed to disregarding them under a do-nothing scenario, while acknowledging it must operate within a finite budget and limited resources. Nurseries in general support the concept of the NPPA and the outcomes being sought.		

Pampas species

Cortaderia jubata and Cortaderia selloana

(Family: Poaceae)

Status in New Zealand

Pampas is listed as an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Pampas is a perennial, tussock-like grass. There are two species present in Northland (*Cortaderia jubata* and *Cortaderia selloana*). Both have coarse abrasive leaves that are bluish green above and dark-green below, with a conspicuous midrib. It grows 2-3m high and has flowering stems, which can be up to 5m high, have distinctive, erect, fluffy white or pinky-purple flower heads. Pampas may be confused with the three native toe toe species which have more creamy-yellow flower heads. The pampas species also have dead leaf bases which spiral, resembling wood shavings.

Habitat	Pampas inhabits a range of areas including dunelands, plantation forests, quarries, roadsides, and disturbed native forests. It will establish most easily in wet, sandy, bare soil. Tolerant of drought once established. In some areas of Northland infestations along the road or rail corridor are the main or only infestations.
Regional distribution	Widespread throughout Northland.
Competitive ability	Pampas plants are highly competitive once seedlings are established, and can out compete native plants. Very invasive forming dense, often impenetrable, stands. Colonises and becomes dense quickly, suppressing the growth of other vegetation including groundcovers, shrubs and ferns. Often followed by weedy vines. The rapid growth and accumulation of biomass above and below ground results in a domination of light, moisture and nutrient supply. In plantation forests, much of the fertiliser applied to trees is consumed by Pampas. Also forms habitat for pests such as rats, rabbits and possums which may have a detrimental impact on surrounding vegetation.
Reproductive ability	Produces flowering stems of up to 5m in the summer period from January to March (*C. jubata*), and in Autumn from March to May (*C. selloana*). Produces a very large amount of seeds (up to 100,000 with one plant able to produce millions of seeds over 10 - 15 years) that are predominantly dispersed by wind up to 50 kilometres. Seeds do not require fertilisation, and as such all seeds produced are viable and can result in the growth of a large number of seedlings. Vectors of spread: Predominantly spread by wind, which disperses seeds far and wide. Also spread by human activities including soil movement, vegetation dumping and on machinery.
Resistance to control	Can be controlled by manual removal and treatment with glyphosate. Treatment often needs to be ongoing, as plants can re-sprout. Dying plants present a fire hazard.
Benefits	Not applicable.

Land uses occupied

Land use type	Current land use infested	Potential land use infested
Dairy	-	-
Sheep and beef	-	-
Forestry	High	High
Horticulture	Low	Low
Native	Low	Low
Urban	-	-
Coastal	High	High
Estuarine and marine	-	-
Freshwater	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-			
Sheep and beef	-			
Forestry	M	H	Causes greater damage to the growth of pine tree crops than weeds such as gorse and broom. On plantation lands it can compete with planted seedlings, hinder access and provide a fire risk.	Global invasive species database.
Horticulture	L	L	Seed can create problems for kiwifruit growers	
Other	M	H	Infestations along road or rail corridors are significant in some areas, and quarries are a high risk area.	
International trade	L	L	Seeds can stick to and spoil kiwifruit for export	Knowles and Tombleson, 1987.
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	L	M	Suppresses the growth of other species and acquires available resources. Pampas has been listed as a wetland weed and a threat to the forest mire and forest-ecotone associations. It is reported to have the potential to invade scrub and forest margins and saline wetland habitats. *C. selloana* is known to affect the structure, species composition or regeneration of several sites with high conservation value. It has the potential to dominate sites and limit natural regeneration. This is especially so on islands and dunelands. It can disrupt vulnerable ecosystems and replace native vegetation especially on islands, island sea cliffs and dunelands.	Global invasive species database.
Threatened species	L	L	Can be particularly dominating in coastal dune habitats.	
Social/Cultural				
Human health	L	L	Presents an increased fire risk.	
Recreation	L	M	Can rapidly colonise dune areas and restrict movement. Encroachment onto walking and mountain biking tracks.	
Maori culture	M	H	Potential impacts on native/taonga species and habitats.	

L = low M= moderate H = high - = No impact + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	Rather than applying a programme under the Regional Pest Management Plan, the species could come under a 'Connecting Communities' programme outside of the pest management plan, where advice and support are provided for sites of interest to communities. This will provide support to communities as and where the species is having impacts.	There would be no immediate costs to council under the pest management plan, but there would be under the 'connecting communities' However, control costs in future could be greater if the species continues to spread.	Moderate. Pampas is already widespread and is banned from sale and distribution under the NPPA.
Exclusion programme	Not applicable.	Not applicable.	Pampas is already widespread in Northland.
Eradication programme	Not applicable.	Not applicable.	Pampas is already widespread in Northland.
Progressive containment programme	Not applicable.	Not applicable.	Pampas is already widespread in Northland.
Sustained control programme	Pampas could be included in a sustained control programme, with rules for quarries and possibly a good neighbour rule with specified boundary clearances (difficult though as wind dispersed seed).	Education, publicity, responding to reports, enforcement action.	Moderate - although these measures may help, pampas is still widespread in Northland. However, these rules could help reduce the impacts on neighbours.
Site-led pest programme	The council could specify high value dune, dune lake systems and gumlands as site-led programmes. These areas are often sites of high biodiversity value in low nutrient systems, as an incursion at these sites could have significant impacts.	Rules would only be applicable in the areas defined as site led programmes and could not be enforced elsewhere. Education, publicity, responding to reports, response to new incursions, enforcing rules.	Moderate - efforts could be targeted to protecting and responding to incursions in the highest value sites in Northland.
Summary of alternative assessments and preferred option:	No regional intervention With regard to section 6(1) of the NPD a low-level analysis was considered appropriate for pampas. In terms of alternative approaches assessed, under a do-nothing approach the species is still listed under the NPPA and therefor is already nationally banned from sale and distribution. Pampas is already naturalised in Northland and its distribution and assessment		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	of effects mean that eradication and progressive containment programmes are not realistic or affordable. Site-led management would control some plants at some sites, but ultimately this approach would also be unsustainable. A do nothing approach is the preferred outcome and most viable option as the species is listed a a NPPA species. Declaring pampas formally as a pest in the NPPA triggers sections 52 and 53 of the Biosecurity Act, banning the pest from sale, propagation and distribution in Northland. Nurseries in general support the concept of the NPPA and the outcomes being sought. Good neighbour rule test In the previous RPMS a GNR was included for pampas, however the GNR test for pampas failed due to the unreasonable cost it would place on landowners compared to the environmental benefit.		

Good neighbour rule tests

Before a rule can be identified as a good neighbour rule in a RPMP, the regional council must be satisfied of the matters in subclause (a), (c), and (d) and must comply with the requirements in subclause (b) and (e):	
Tests	
In the absence of the rule, the pest would: • spread to land that is adjacent or nearby within the life of the plan; and • cause unreasonable costs to an occupier of that land.	Vast numbers of pampas seeds are easily spread up to 50 kilometres by wind, meaning that neighbouring land is at high risk of invasion if the receiving habitat is suitable. Pampas establish quickly in exposed soils such as dunelands, quarries, roadsides, disturbed areas of forests and plantation forests, and the likelihood of these types of receiving environments being within a 50 kilometre range of each other in Northland are high, leading to a high risk of spread. If the spread of Pampas to road and rail corridors is not managed, these could become corridors of pest spread. Material being moved from quarries to other areas has the potential to distribute pampas allowing it to establish in new areas. Pampas establish rapidly and can present ongoing maintenance issues when being controlled. For some landowners there will be a considerable cost associated with this pest.
In determining whether the pest would spread as described in subclause (a) the regional council must consider:	The land most suited to the establishment of Pampas is associated with quarry work, road, and rail. Plants located in close proximity to these areas pose a high risk of spread via wind dispersal of seed. Pampas can be spread up to 50 kilometres, however a clearance zone of such a distance would be inappropriate.

• the proximity and characteristics of the adjacent or nearby land; and • the biological characteristics and behaviour of the particular pest (the greater the distance between properties, the more difficult to satisfy the test in subclause (a)).	
The land that is adjacent or nearby, as described in subclause (a), must be clear from a pest or, if the pest is present on that land, the occupier of that land must be taking measures to manage the pest or its impacts	In order for a good neighbour rule to apply, it is a requirement that the nearby land occupier to the road or rail reserve be clear of pampas.
The rule must not set a requirement on an occupier that is greater than that required to manage the spread of the pest.	As areas of road and rail are most suited to establishment of Pampas, management of these land types will be covered by the proposed road and rail rules. Applying a rule to all landowners for control of pampas would place a onerous requirement on adjacent properties that may not provide enough environmental benefit compared to the cost for the landowner.

Proposed Good neighbour rules discussion:

Current relevant RPMS rules:

1. Land occupiers must:
   a. destroy all pampas within 10 metres of a property boundary where the boundary adjoins a road or rail reserve clear of pampas;
   b. destroy all pampas in the operational areas of a quarry; and i) a 50 metre strip of land around the operation areas of a quarry, or; ii)where existing vegetation reduces the risk of pampas spreading, the 50 metre buffer zone may be reduced by written agreement with the NRC.

2. Every road or rail controlling authority shall implement a control programme aimed at progressively controlling pampas on formed road or rail reserves under their jurisdiction where adjoining land is clear or only sparsely infested with pampas, in accordance with a five year management plan which shall be negotiated with, and agreed to by, the NRC.

Proposed GNR: failed GNR for all landowners, Pampas is a NPPA species and would be managed in accordance with the NPPA.

Paperbark poplar

Melaleuca quinquinervia

(Family: Myrtaceae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Paperbark poplar is an evergreen tree up to approximately 20-30m tall. The bark is shed in pale, papery layers. Leaves are aromatic, simple, and up to 12cm long. It has prolific roots capable of penetrating to depths of over 1m. When inundated, it produces a fibrous sheath of roots around the base of the trunk. Flowers are white with pronounced stamens. Seeds are minute, borne in woody capsules.
Habitat	Wetlands, including freshwater and saline, and open canopy terrestrial habitats including grasslands and open forest. It tolerates a wide range of soil types and conditions. Inundation and exposed ground are tolerated, but it prefers moist soils or fluctuating hydrology to either sustained drought or immersion. Native and exotic range includes tropical and subtropical locations. It is frost sensitive, though it can tolerate occasional light frost. Limited shade tolerance.
Regional distribution	Planted in high risk sites (wet areas), but not particularly common in Northland as yet.
Competitive ability	Invasive overseas in a variety of ecosystems. The deep and extensive root system provides a competitive advantage in accessing water under fluctuating hydrological conditions. Foliage is highly flammable and can fuel fires which may damage co-occurring vegetation; seedlings recruit vigorously following fire. Possibly allelopathic, inhibiting growth of other species.
Reproductive ability	It can reach sexual maturity in under two years, and exhibits multiple flowering episodes within a growing season. Capsules are retained on the tree where seed may remain viable for years. Capsules open in response to frost, fire or desiccation. Therefore a large proportion of seeds will be released synchronously from the canopy seed bank, while the remainder are released in a continuous low level seed rain. The canopy of a mature tree may hold > 56 million seeds. Soil seed bank remains viable for less than two-three years. Recruits dense cohorts of seedlings following disturbance. Germination is favoured by moist soil conditions. Vectors of spread: Seeds are dispersed by wind and water.
Resistance to control	
Benefits	Can be grown as an ornamental and for forestry.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	High
Sheep and beef	-	High
Forestry	-	Low
Horticulture	-	Low
Native bush or forests	-	Low
Urban	-	Low
Coastal	-	Low

Land use type	Current land use infested	Potential land use
Estuarine and marine	-	Low
Freshwater/Wetland	-	High

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	-		
Horticulture	-	-		
Other	-	L	High concentrations of essential oils make foliage highly flammable, burning at very high temperatures. Damage to infrastructure and other economic losses from large fires can be substantial.	Martin et al., 2009; Mazzotti et al., 2014; Turner et al., 1998.
International trade	-	-		
Environment				
Soil resources	-	L-M	Capable of altering patterns of litter accumulation, decomposition, nutrient cycling and soil microbial biomass nutrient concentrations.	Greenway, 1994; Martin et al., 2009; Rayamajhi et al., 2006; Serbesoff-King, 2003.
Water quality	-	-		
Species diversity	-	H (under climate change)	Auckland and Northland are not predicted to be climatically suitable under current conditions, but are predicted to become optimal habitat under climate change. Capable of displacing native plants in wetlands (freshwater and saline) and open terrestrial ecosystems. Forms dense monospecific forests with sparse understory, thus altering vegetation structure and	Dray et al., 2006; Martin et al., 2009; Porazinska et al., 2007; Rayamajhi et al., 2009; Serbesoff-King, 2003; Turner et al., 1998; Watt et al., 2009.

Category	Current	Potential	Comment	Source
			reducing plant species diversity. Probable impacts on macrofauna resulting from altered vegetation structure. Associated with reductions in abundance and diversity of soil nematodes, and changes in functional group and community composition. Changes in soil microbial biomass nutrient concentration following invasion are suggestive of impacts on soil microbial community composition.	
Threatened species	-	-		
Social/cultural				
Human health	-	L	Potential health risks associated with increased fire regime. Debate over allergenicity, but probably not a major pollen allergen.	
Recreation	-	L-M	Could impede access to some ecosystems, and reduce enjoyment of natural environment. Estimated to cause billions of dollars of losses to Florida tourism industry through extensive invasion of natural ecosystems.	
Māori culture	-	M-H	See 'Soil resources', 'Species diversity' and 'Recreation'.	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council under the pest management plant in relation to this species. Rather than applying a programme under the Regional Pest Management Plan, the species	If no action is taken it will continue to spread, with consequent environmental impacts and future control costs.	Low. If no action is taken, existing infestations of paperbark poplar may expand and it may spread to new sites.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	could come under a 'Connecting Communities' programme outside the pest management plan, where advice and support are provided for specific sites. This will provide support to communities as and where the species is having impacts.		
Exclusion programme	Not applicable	Not applicable	Paperbark poplar is already present in Northland.
Eradication programme	Not applicable	Not applicable	Paperbark poplar is present throughout the region so would not be suitable for an eradication programme.
Progressive containment programme	Not applicable	Not applicable	Paperbark poplar is present throughout the region so would not be suitable for a progressive containment programme.
Sustained control programme	Paperbark poplar could be included in a sustained control programme. As a declared pest it would be banned from sale under the Biosecurity Act. This could help reduce the risk of spread over time.	Paperbark poplar is already banned from sale and distribution in Northland and has been for a number of years so would be no costs to plant retail outlets from a ban. Plant retail outlets are inspected regularly by council staff checking for many different plants.	Moderate. Paperbark poplar could still spread and become more common.
Site-led pest programme	A site-led programme, where control of paperbark poplar is required in defined parts of Northland could reduce the impacts of this species within the programme area(s). This could be beneficial in dune lake areas in particular.	A site-led programme would require an investment of time and resources by the council and affected landowners. It would not reduce or restrict the impacts of paperbark poplar in areas that are not identified as being of high priority.	Moderate. A site-led programme could effectively reduce or eliminate the adverse effects of paperbark poplar in local areas.
Summary of alternative assessments and preferred option:	Sustained control programme - Banned from Sale & Distribution With regard to section 6(1) of the NPD a low-level analysis was considered appropriate for paperbark poplar. In terms of alternative approaches assessed, under a do-nothing approach there would be no ability for Council to prevent the formal (nursery trade) or informal (fairs and on-line marketing) trade or circulation of this pest. Paperbark poplar is already naturalised in Northland, although it is not widespread, and its distribution and assessment of effects mean that eradication and progressive containment programmes are not realistic or		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	affordable. Site-led management would control some plants at some sites, but ultimately this approach would also be unsustainable. Sustained control is the preferred outcome and most viable option. Declaring paperbark poplar formally as a pest in the Plan automatically triggers sections 52 and 53 of the Biosecurity Act, banning the pest from sale, propagation and distribution in Northland. This plant is not covered in the current National Pest Plant Accord (NPPA) which has over 150 plants listed, banning them from sale, propagation and distribution nationally. However, the NPPA is nationally focused and doesn't necessarily account for regional differences. The risks of this plant have been evaluated specifically in terms of its effects in Northland. It is important to recognise the wide climate and temperature ranges in New Zealand and that some pests require regional based initiatives based on these factors. Accordingly, paperbark poplar is one of 32 pest plants banned from sale, propagation and distribution in the Northland region. This designation recognises that generally they are a lower risk to the regions' values compared with other more invasive species. Council wishes to take a more proactive stance over their management, as opposed to disregarding them under a do-nothing scenario, while acknowledging it must operate within a finite budget and limited resources. Nurseries in general support the concept of the NPPA and the outcomes being sought.		

Periwinkle

Vinca major

(Family: Apocynaceae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Periwinkle is a scrambling groundcover plant that resembles a vine. The trailing stems can grow more than 2m long and take root where they come in contact with the soil. Its leaves are glossy, 4-10cm long, 3-7cm wide and arranged in opposite pairs on the stem. It produces blue-violet flowers that have 5 petals and are 4-5cm in diameter.
Habitat	Periwinkle is a widespread escape from cultivation. It grows best in moist, shady places such as waste places, riverbanks, roadsides, forest margins, and shrublands.
Regional distribution	Periwinkle is widespread in Northland. It is most common in old gardens and cemeteries and along roadsides.
Competitive ability	Periwinkle is fast-growing, tolerant of shade, and moderately tolerant of dry or wet conditions. Its creeping, layering habit allows it to form dense, long-lived stands. It can regrow after being damaged or grazed.
Reproductive ability	Periwinkle does not usually produce seeds but can regrow from fragments of roots and stems. Vectors of spread: Fragments of periwinkle can be moved to new sites in dumped garden waste and soil, and occasionally by water movement.

Resistance to control	Periwinkle is difficult to control because it can regrow from stem fragments and roots.
Benefits	Ornamental

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	
Sheep and beef	-	-
Forestry	-	-
Horticulture	-	-
Native bush or forests	Low	High
Urban	High	High
Coastal	Low	High
Estuarine and marine	-	-
Freshwater/Wetland	Low	Low

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	L	H	Periwinkle competes with native vegetation by smothering the ground and native groundcover	Global Invasive Species Database

Category	Current	Potential	Comment	Source
			vegetation and preventing the regeneration of trees and shrubs. It is a serious threat to the understorey of forested areas and streamsides.	
Threatened species	L	M	Periwinkle can compete with threatened native plants.	Global Invasive Species Database
Social/cultural				
Human health	-	-		
Recreation	-	-		
Māori culture	L	M	Impacts upon native/taonga species.	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council under the RPMP in relation to this species. Rather than applying a programme under the Regional Pest Management Plan, the species could come under a 'Connecting Communities' programme outside the pest management plan, where advice and support are provided for specific sites. This will provide support to communities as and where the species is having impacts.	Periwinkle is already present in Northland but is not usually seen dominating large areas. If no action is taken it may spread, with consequent environmental impacts and future control costs.	Low. If no action is taken, existing infestations of periwinkle may expand and it may spread to new sites.
Exclusion programme	Not applicable.	Not applicable.	Periwinkle is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Periwinkle is present throughout the region so would not be suitable for an eradication programme.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Progressive containment programme	Not applicable.	Not applicable.	Periwinkle is present throughout the region so would not be suitable for an progressive containment programme.
Sustained control programme	Periwinkle could be included in a sustained control programme. As a declared pest it would be banned from sale under the Biosecurity Act. This could help reduce the risk of spread over time.	Periwinkle is already banned from sale and distribution in Northland and has been for a number of years so there would be no costs to plant retail outlets from a ban. Plant retail outlets are inspected regularly by council staff checking for many different plants.	Moderate. Periwinkle could still spread and become more common.
Site-led pest programme	A site-led programme, where control of periwinkle is required in defined parts of Northland could reduce the impacts of this species within the programme area(s).	A site-led programme would require an investment of time and resources by the council and affected landowners. It would not reduce or restrict the impacts of periwinkle in areas that are not identified as being of high priority.	Moderate. A site-led programme could effectively reduce or eliminate the adverse effects of periwinkle in local areas.
Summary of alternative assessments and preferred option:	Sustained control programme - Banned from Sale & Distribution With regard to section 6(1) of the NPD a low-level analysis was considered appropriate for periwinkle. In terms of alternative approaches assessed, under a do-nothing approach there would be no ability for Council to prevent the formal (nursery trade) or informal (fairs and on-line marketing) trade or circulation of this pest. Periwinkle is already naturalised in Northland and its distribution and assessment of effects mean that eradication and progressive containment programmes are not realistic or affordable. Site-led management would control some plants at some sites, but ultimately this approach would also be unsustainable. Sustained control is the preferred outcome and most viable option. Declaring periwinkle formally as a pest in the Plan automatically triggers sections 52 and 53 of the Biosecurity Act, banning the pest from sale, propagation and distribution in Northland. This plant is not covered in the current National Pest Plant Accord (NPPA) which has over 150 plants listed, banning them from sale, propagation and distribution nationally. However, the NPPA is nationally focused and doesn't necessarily account for regional differences. The risks of this plant have been evaluated specifically in terms of its effects in Northland. It is important to recognise the wide climate and temperature ranges in New Zealand and that some pests require regional based initiatives based on these factors. Accordingly, periwinkle is one of 32 pest plants banned from sale, propagation and distribution in the Northland region. This designation recognises that generally they are a lower risk to the regions' values compared with other more invasive species. Council wishes to take a more proactive stance over their management, as opposed to disregarding them under a do-nothing scenario, while acknowledging it must operate within a finite budget and limited resources. Nurseries in general support the concept of the NPPA and the outcomes being sought.			

Phoenix palm

Phoenix canariensis

Also known as: phoenix palm, Canary Island palm, Canary date palm.

(Family: Arecaceae)

Status in New Zealand

No legal status. Banned from sale in Auckland.

Relevant biology

Form	The phoenix palm is a stocky palm, with a trunk up to 18m tall and 1.2m in diameter. The trunk is covered with leaf scars, giving it a diamond-shaped pattern. The large leaves form a spreading crown at the top of the trunk and there are sharp, shiny spines (5-8cm long) on the leaf stalks. During October and November, branched clusters of creamy-yellow to white flowers occur on a long stem amongst the leaves. The cylinder-shaped berries are 1-5cm long, fleshy, date-like, and orange-yellow to dark purple in summer.
Habitat	The preferred habitats of phoenix palm include coastal cliffs, forest, sand dunes, saline wetlands (mangroves and saltmarshes), urban areas and roadsides. It is capable of invading native bush. Wild populations are found in Northland, Auckland, Waikato, and Bay of Plenty.
Regional distribution	Phoenix palm is widely cultivated as an ornamental in urban gardens and parks. It is increasingly being found growing wild in native bush, sand dunes, roadside vegetation, estuarine environments and coastal cliff areas.
Competitive ability	Phoenix palm tolerates cold and warmth, drought and floods, shade and sun, and salt spray as well as mountain climate. It can be found growing on a wide variety of usually fertile soils. It has an extensive root system, which allows it to explore the surrounding earth to find subterranean water even at long distances. It is also resistant to temporary waterlogging. Seedlings are frost-sensitive but mature trees can withstand light frosts. The phoenix palm can exclude other plant species due to its large size and the spines which are unpalatable to grazing animals. It is native to the Canary Islands and is naturalised and/or invasive in peninsular Spain, Italy, Australia, Bermuda and parts of the United States (Florida, Arizona, Southern Nevada, California and Alabama).
Reproductive ability	The phoenix palm is dioecious, which means that there are separate male plants and female plants. Both plants produces flowers but it is only the female plants that produce fruits and seeds. They begin to fruit at 5-10 years old, are very long-lived and produce abundant seed. Vectors of spread: Seeds are dispersed by birds and gravity and may be washed down watercourses. It is also a possibility that rats disperse seeds by collecting and hoarding them.
Resistance to control	Seedlings are spiny and difficult to remove because they break off when pulled and can regrow from the remaining growing tip left in the ground. Digging out is recommended for seedlings. It is difficult to kill juveniles due to the very sharp spikes on the lower leaves which make chainsawing and drilling very difficult. Mature specimens can be very large and removing them requires costly specialist expertise. Phoenix palms can re-sprout following control.

Benefits	Phoenix palm is grown as an ornamental. In the Canary Islands, the sap is used to make palm syrup.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	Low
Sheep and beef	-	Low
Forestry	-	-
Horticulture	-	-
Native bush or forests	Low	High
Urban	Low	High
Coastal	Low	High
Estuarine and marine	-	Low
Freshwater/Wetland	-	Low

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	L	Phoenix palms are not currently known to have adverse impacts on agriculture. However, their large spikes make them resistant to grazing. Thus, if they establish in pasture they will not be eaten (controlled) by stock.	Williams 2008
Sheep and beef	-	L	Phoenix palms are not currently known to have adverse impacts on agriculture. However, their large spikes make them resistant to grazing. Thus, if they establish in pasture they will not be eaten (controlled) by stock.	Williams 2008
Forestry	-	-		
Horticulture	-	-		
Other	+	+	Phoenix palm is cultivated and sold by nurseries in Northland.	Williams 2008
International trade	-	-		

Category	Current	Potential	Comment	Source
Environment				
Soil resources	L	L-M	The extensive roots of the phoenix palm can lower water tables. They also alter the shape of sand dunes as sand builds up around the roots, with resulting erosion elsewhere.	Weedbusters
Water quality	-	-		
Species diversity	L	H	The phoenix palm can out-compete and exclude native plant species due to its large size and spreading roots. It probably restructures and simplifies invertebrate communities, an impact that has been documented overseas for phoenix palm and similar palm species. It provides habitat, such as roosting and nesting sites, for introduced birds and rats (which eat native birds, invertebrates and the fruit and seeds of native plants). The stumps of fallen leaves create numerous crevices where invasive plants can establish, particularly epiphytes such as climbing asparagus, ladder fern and Morton Bay fig. When the large leaves drop to the ground and decay they are highly likely to affect decomposition and nutrient dynamics, though no empirical data available.	Brockerhoff et al., 2003; Holmquist et al, 2011; Talley et al., 2012.
Threatened species	-	M	Phoenix palm can out-compete native plants, provide habitat for rats, invasive plants and introduced birds, and adversely affect invertebrate communities. This could effect threatened species.	Brockerhoff et al., 2003; Holmquist et al, 2011; Talley et al., 2012.
Social/cultural				
Human health	L-M	H	The sharp spikes of the phoenix palm can cause severe injuries that may require hospitalisation. They contain chemicals which cause inflammation and swelling and residual fragments are notoriously difficult to detect. Children are especially at risk,	Adams et al. 2000; Barrett 1991; Karshner et al., 1953; Johnston 2000; Blanco et al., 1995

Category	Current	Potential	Comment	Source
			with phoenix palms accounting for 8% of admissions for foreign body injuries at Starship Children's Hospital. Some people are allergic to the pollen, which can cause a skin rash, asthma and/or itchy, running eyes. Danger also from dead, fallen leaves.	
Recreation	L	M	Phoenix palm is a conspicuous plant that can reduce the aesthetic values of natural areas and its large size can impede access to recreational areas. The sharp spines can injure people when the leaves fall to the ground and the trees require a lot of maintenance, which can be expensive and also creates a risk of injuries. Falling fronds can be a nuisance and the extensive root systems can block drains.	Johnston 2000; Williams 2008;
Māori culture	L	M	Impacts upon native/taonga species.	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council through the RPMP in relation to this species.	Phoenix palm is already present in Northland, in cultivation and in the wild. If no action is taken it may spread, with consequent environmental impacts and future control costs.	High. Phoenix palm is an invasive species that is already present in Northland. Very large areas of Northland are vulnerable to invasion by phoenix palm, including mainland and island habitats (Williams 2008).
Exclusion programme	Not applicable	Not applicable	Phoenix palm is already present in Northland.
Eradication programme	Phoenix palm is cultivated in Northland and also grows in the wild and has the potential to spread to more sites. Eradication would enable long-term economic and environmental impacts to be avoided. As a declared pest, phoenix palm would be	Eradication of phoenix palm would require a large investment of resources to remove all plants cultivated in gardens throughout the Region, in addition to controlling wild infestations.	High. There is a high risk of eradication being unsuccessful because phoenix palm is widely cultivated. Eradication is not feasible at this time.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	banned from sale under the Biosecurity Act.		
Progressive containment programme	A progressive containment programme would incur lower financial cost to the regional council in the short-term. It would aim to confine the impacts of phoenix palm to current infestation areas, and gradually reduce the population. As a declared pest, it would be banned from sale under the Biosecurity Act.	Phoenix palm is cultivated throughout Northland and large amounts of resources would be required to undertake surveys and control.	High. Phoenix palm is not a suitable candidate for a progressive containment programme because it is widely cultivated in Northland.
Sustained control programme	A sustained control programme would incur lower financial cost to the regional council in the short-term, and would aim to restrict the spread and impacts of phoenix palm. Sites where it is growing in the wild could be targeted for control (as opposed to sites of cultivation). Educational material could be developed to encourage people and agencies to replace cultivated phoenix palms with alternative species that are not invasive. As a declared pest, phoenix palm would be banned from sale under the Biosecurity Act.	Resources will be required to develop educational material, undertake surveillance and control any infestations that are found. A sustained control programme would not aim to remove phoenix palm from all the sites where it is present. Therefore, if/when it does become more widely established, eradication and containment may no longer be options and there will be long-term financial and environmental costs associated with the species.	Low-Moderate. Phoenix palms are a threat to native biodiversity and human health. A sustained control programme would enable wild infestations of phoenix palm to be controlled and prevent the species from being sold. This would prevent it from being planted at new sites that could provide sources of seed for "new" wild infestations. A component of the programme could include information and encouragement for landowners and agencies to remove cultivated phoenix palms and replace them with appropriate, non-invasive species that do not cause injuries. Phoenix palm produces bird-dispersed seed and the programme has a low to moderate chance of preventing this species from spreading to new sites. Phoenix palm has all the hall marks of a highly invasive, long-lived plant at the early stage of naturalisation when steps taken to limit its spread can be the most effective. Stopping the supply of these invasive palms to new gardens and subdivisions will assist in slowing its spread throughout Northland. (Brill 2011b).

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
			Male plants do not produce seeds so it may be possible for nurseries to continue selling these palms by propagating male plants or selling large specimens that are known to be male after the first flowering.
Site-led pest programme	A site-led programme, where control of phoenix palm is required in defined parts of Northland could reduce the impacts of this species within the programme area(s).	A site-led programme would require an investment of time and resources by the council and affected landowners. It would not reduce or restrict the impacts of phoenix palm in areas that are not identified as being of high priority.	High. A site-led programme could effectively reduce or eliminate specific infestations of phoenix palm but the species is widely cultivated and the programme would not provide for the control of outlying infestations.
Summary of alternatives assessed and preferred option:	Sustained control programme- Banned from sale & distribution list In relation to NPD considerations (section 6(1) outlines four criteria) a medium-level analysis was deemed appropriate for phoenix palm. In terms of alternative approaches assessed under no regional intervention (or do nothing), there could be foreseeable impacts from taking no action to address the environmental and health implications of phoenix palms in Northland. As phoenix palm is already present in Northland both cultivated and in the wild, an eradication programme would be unsustainable and have a high risk of failure. A progressive containment approach would also not be appropriate as the plant is widely cultivated throughout Northland. Sustained control (banned from and distribution sale list) is the preferred outcome and is realistic given its limited locations of sale. As a declared pest, phoenix palm would be banned from sale under the Biosecurity Act. A site led approach would also be an option for those community groups that wish to take action against the pest. The costs to council of listing phoenix palm as a sustained control pests under the RPMP are low however there is some degree of socio-political risk of banning the species from sale.		

Quantitative analysis

The high level analysis for phoenix palm was undertaken using a benefit-cost model. The model was developed using a logistic model for spread, per hectare benefit estimates that take into account the ecosystem services of different environments, Northland specific data and NRC staff expertise. The benefit of the alternative programmes assessed are determined, in dollar terms, as the difference between unmanaged and managed risk. An assessment was also made of the potential saving in health related costs due to slowing the spread of phoenix palms.

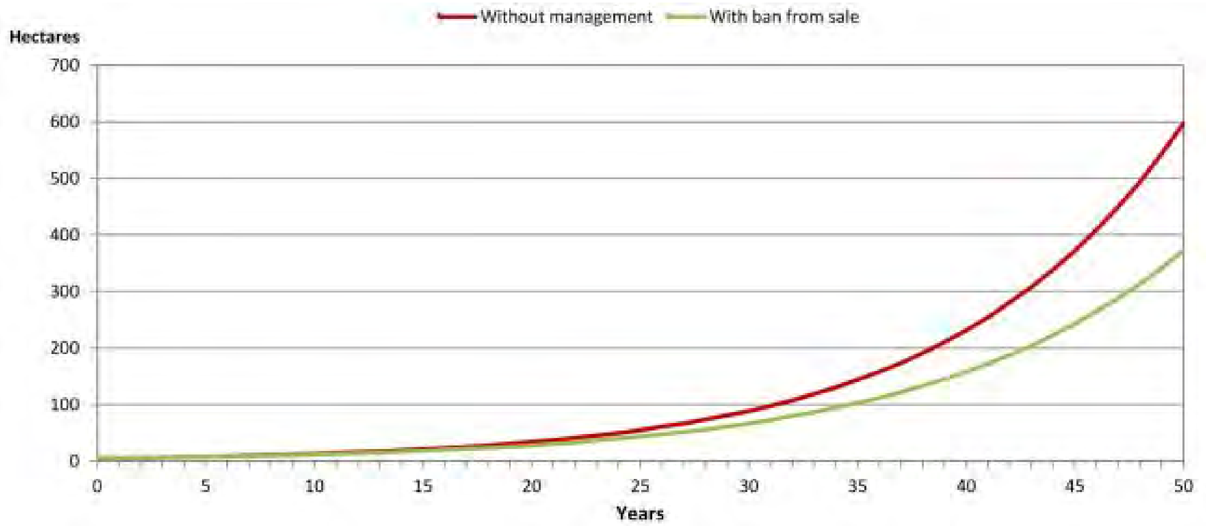
Impact evaluation

The following table outlines the specific programme assumptions that have been used in the benefit cost analysis for phoenix palm. The council costs are based on the total annual cost of nursery inspection ($5,000). While phoenix palm will be one of 33 specifically banned plants in the plan that will be subject to inspection, the analysis allocates 10% of the total inspection cost to phoenix palm. The occupier compliance cost is based on a survey of Northland nurseries which indicated the revenue from phoenix palm sales in Northland of approximately $14,000. The profit margin on the revenue earned from the sales is assumed to be 50%. The health care costs are estimated on the assumption that the current level of infestation results in three persons each year requiring hospital treatment at a cost of $3,000 each. The likelihood of programme failure has been rated as low (1-9% chance of failure).

Programme specific assumptions

Variables for analysis	Ban from sale
Council costs ($/pa)	$500
Occupier compliance costs ($/pa)	$7,000
Cost of hospital treatment ($/pa/ha)	$1,800
Reduction in spread rate	10%
Likelihood of programme failure	Low
Likelihood of programme failure	5%

The graph below projects the invasion trajectory of phoenix palm without any regional intervention and with the implementation of banning the species from sale. Over a 50 year time period, the difference in management regimes is significant.

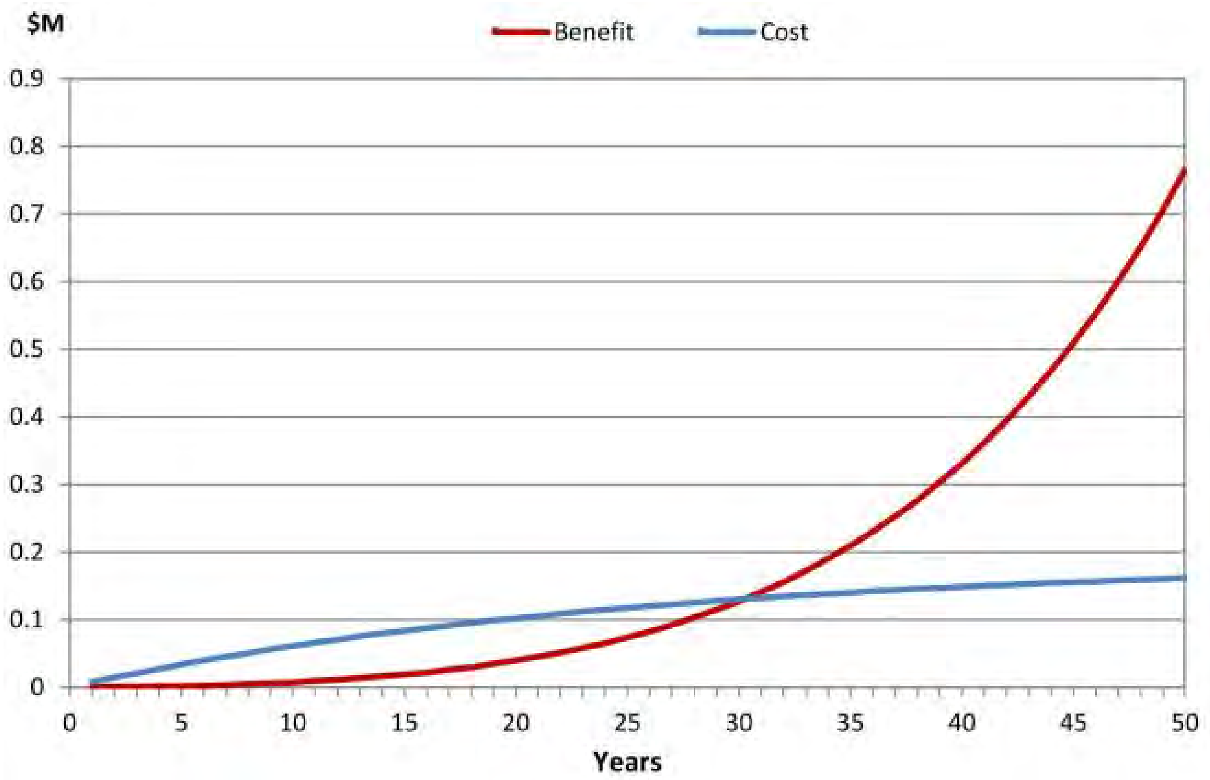


The following table summarises the benefits and costs of banning phoenix palm from sale over a ten year and fifty year time frame. In both scenarios banning phoenix palm from sale returns a net negative result, indicating that the programme is not worthwhile. However as mentioned in the qualitative analysis one of the more critical reasons for banning phoenix palm from sale is the impact the plant has on human health. Once these health care costs are taken into account, the proposed ban on the sale of phoenix palms yields a positive net benefit over a fifty year period. This positive net benefit result remains in place under a variety of assumptions (sensitivity analysis).

Cumulative present value of additional benefits and costs of phoenix ban from sale ($m)				
	Without consideration of health care costs		With consideration of health care costs	
	Ten years	Fifty years	Ten years	Fifty years

Benefit ($M)	$0.00	$0.06	$0.01	$0.76
Cost ($M)	$0.06	$0.16	$0.06	$0.16
Net benefit (B-C) ($M)	-$0.06	-$0.10	-$0.05	$0.60

The following figure shows the cumulative value of benefits and costs for the ban on phoenix palm sales over time taking into consideration health care costs. It shows that benefits will be greater than costs from year 30 onwards.



Assumptions and sensitivity of the model

Sensitivity analysis		
Fifty year cumulative net present value of phoenix ban from sale		
	$M	
Change in assumption (all other variables remain constant)	Without consideration of health care costs	With consideration of health care costs
Baseline	-$0.10	$0.60
Discount rate doubled to 8%	-$0.08	$0.09
Years to reach 90% of maximum area 50% longer	-$0.15	$0.00
Reduction in spread rate achieved by programme halved	-$0.13	$0.26

Dollar value of benefit halved	-$0.13	$0.57
Private cost double	-$0.25	$0.45

Standard assumptions of the model

Data to input into benefit cost analysis	
Invasion Trajectory Without Management	
Initial area infested (ha):	5
Maximum area that could become infested (ha):	27,456
Time for infestation to reach 90% of maximum:	113
Spread rate	10%
Benefits	
Discount rate:	4%
Value of land ($ per ha):	$501
Reduction in value caused by the weed / pest:	30%

Phragmites

Phragmites australis

(Family: Poaceae)

Status in New Zealand

Phragmites is listed as an unwanted organism under the Biosecurity Act 1993, is a Notifiable Organism (Biosecurity (Notifiable Organisms) Order 2010) and is listed in the National Pest Plant Accord 2012. It is also one of eleven pest species that are part of the National Interest Pests Response (NIPR). Management of this pest plant is led by MPI.

Relevant biology

Form	Phragmites is a perennial grass that grows up to 3m tall on water margins. It has bamboo-like stems which carry long, wide, flat leaves that taper to a point. Deciduous, with a period of low activity in autumn and winter. It has large, fluffy, purplish flower heads, and seed grain which is covered in silky hairs.
Habitat	Prefers margins of still or slow moving water bodies, including fresh and brackish wetlands and drainage ditches. Less salt tolerant than Spartina. Tolerant of fluctuating water levels and can grow away from water. Tolerates mesotrophic to eutrophic water quality, benefits from nutrient addition.
Regional distribution	Not present in Northland.

Competitive ability	History of invasiveness overseas. Rated as the worst potential aquatic weed in New Zealand. More competitive than Manchurian wild rice. Increased competitiveness in high nutrient environments. Dense litter accumulation leads to low light penetration to ground level, suppressing other plant species. Allelopathic, inhibiting growth of other species.
Reproductive ability	Vegetative spread locally from creeping rhizomes and can establish from rhizome fragments. Spread along roading corridors overseas known to be an important component of landscape-scale spread. Not known to set seed in New Zealand. **Vectors of spread:** Vegetative spread via fragments, so can be accidentally moved and dispersed easily by people.
Resistance to control	Vegetative spread via fragments therefore mechanical control/disturbance has potential to exacerbate spread.
Benefits	Grown as ornamental pond and garden plant.

Water bodies occupied

Water body type	Current water body infested	Potential water body infested
Lakes	-	Low
Rivers and streams	-	Low
Wetlands	-	High
Ponds and dams	-	High
Drains and canals	-	High
Troughs	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	L	Potential to invade low-lying pasture, displacing valuable forage plants and impeding stock access.	Champion 2006
Sheep and beef	-	L	As above.	
Forestry	-	-		
Horticulture	-	-		
Other	-	L	Rhizomes capable of growing through stop banks, roading material and cracks in concrete.	Champion 2006

Category	Current	Potential	Comment	Source
			Potential to damage infrastructure.	
International trade	-	-		
Environment				
Soil resources	-	L	Alters nutrient cycling regimes.	Findlay et al. 2003
Water quality	-	M	Can block drainage channels, trap and accumulate sediment and exacerbate flooding. Alters nutrient cycling regimes, such as through storage of large amounts of nitrogen in standing biomass.	Champion 2006 Meyerson et al. 2000 Findlay et al. 2003
Species diversity	-	H	Overseas known to displace native vegetation, reducing native plant cover, species richness and diversity. Tall stature and litter accumulation dramatically alter habitat structure of invaded plant communities. Overseas faunal responses vary by taxa, with abundance of some species decreasing and others increasing. Can alter species richness, diversity, trophic and functional group composition of invertebrate assemblages. Impacts in New Zealand likely to be substantial due to lack of structurally similar native plant taxa. Alteration of breeding and foraging habitat for wetland birds. Benefits some species (those adapted to tall reedy vegetation) and disadvantages others (those adapted to short stature vegetation). Implications for New Zealand birds unknown. Most overseas studies have found no evidence of impacts on fish, although effects on abundance detected in some cases.	Champion 2006 Tulbure et al. 2007 Wilcox et al. 2003 Silliman and Bertness 2004 Holdredge and Bertness 2011 Windham 2001 McClary 2004 Meyerson et al. 2000 Gratton and Denno 2005 Yuhas et al. 2005 Rogalski and Skelly 2012 Jivoff and Able 2003 Benoit and Askins 1999 Able and Hagan 2000 Aday 2007 Weinstein and Balleto 1999 Fell et al. 2006 Perez et al. 2006

Category	Current	Potential	Comment	Source
Threatened species	-	M-H	As above.	
Social/Cultural				
Human health	-	L	Moderate pollen allergen.	pollenlibrary.com
Recreation and aesthetics	-	M	Impedes access to water bodies, including fishing and boating access.	biosecurity.govt.nz 2009
Maori culture	-	H	Potentially substantial impacts on mauri of wai māori	

L = low M= moderate H = high - = no impact + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial cost to the council associated with control of this species.	Phragmites is not currently known to be in Northland. There would be no immediate costs to council and phragmites is part of a national interest pest response managed by MPI.	Low-moderate. Without education and regulation there is some high risk that phragmites could arrive in Northland and not be detected, allowing It to spread and have impacts on freshwater habitats.
Exclusion programme	Public awareness and education about the risks and impacts of phragmites and a rule banning possession of the species in Northland could prevent it from establishing in the region. If it is included in the pest management plan there is the ability to respond immediately if an infestation is detected in Northland.	Low. There is already educational material available for phragmites. Excluding this species would prevent/reduce expenditure on its control if it invades Northland.	Low. People will be aware of the species and its potential impacts. There will be a rule banning possession of the species in Northland, which could help discourage people from bringing it to Northland and allow immediate control should any be found.
Eradication programme	Not applicable.	Not applicable.	Phragmites is not known to be present in Northland.
Progressive containment programme	Not applicable.	Not applicable.	Phragmites is not known to be present in Northland.
Sustained control programme	Not applicable.	Not applicable.	Phragmites is not known to be present in Northland.
Site-led pest programme	Not applicable.	Not applicable.	Phragmites is not known to be present in Northland.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Summary of alternative assessments and preferred option:	Exclusion programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for *Phragmites*. In terms of alternative approaches assessed, under no regional intervention (or do nothing) there would be a high risk of public and political criticism of Council for not being more proactive over *Phragmites* management, as it is one of 11 high threat pests in New Zealand on an MPI watch list (for National Interest Pests). Biodiversity values could be impacted if *Phragmites* was discovered and no intervention measures were available to the council. Under a no intervention approach, NRC could rely on MPI solely and non-regulatory methods such as advocacy, education and site-led management, but loses the tools, regionally to impose penalties for deliberate liberations of this pest. As *Phragmites* is not currently known in Northland an exclusion programme outcome is the only appropriate option available. An exclusion programme focusing on a comprehensive surveillance programme (actively looking for *Phragmites* and other undesirable aquatic pest plants) will help to mitigate any risks by detecting any infestations very early on. There is a 'yet undetermined' risk that *Phragmites* will be introduced to Northland. The benefits of inclusion in the Plan are that significant waterways and margins of waterways would in the long-term remain free of this pest. The value is difficult to estimate but would be significant, given the high degree of public interest in keeping recreational lakes free of semi-aquatic weeds and maintaining aquatic ecosystems in a natural state. This approach has very little extra cost to NRC, (over and above what is spent on advocacy and education) and provides Council with some regulatory tools (along with MPI) to incentivise water users such as boaties, eel fishermen, anglers, and fowl shooters (particularly those outside the region) to stop the spread of aquatic pests to new areas.		

Prickly moses

Acacia verticillata (two sub species: A. v. subsp. cephalantha and A. v. subsp. ruscifolia)

(Family: Mimosaceae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Prickly moses is a short-lived (approximately 20-30 years) shrub-small tree. Twigs are ribbed and sparsely to densely hairy. Leaves reduced to flattened leaf stalks (phyllodes) up to 17 x 4mm, and spiked. Flowers are pale yellow and solitary, but grouped on flower heads (inflorescences) that extend beyond the leaves during September-November. Seeds are contained in pod (usually straight), and up to 100 x 4mm.
Habitat	Preferred habitats include roadsides, waste places, scrub, margins of exotic plantation forests, coastal ecosystems. It prefers sandy soils, wetland margins and damp areas.
Regional distribution	Widespread scattered distribution across the region. Locally abundant especially in the far north. Not known from dune lakes at present.
Competitive ability	Nitrogen-fixer, which confers a competitive advantage on poor soils. Spines offer some resistance to vertebrate browsers.
Reproductive ability	Most seed locally dispersed by gravity. Potential for human-mediated seed dispersal in soil movement. Long-lived seed bank, germinates following soil disturbance or fire.

Resistance to control	Persistent seed bank.
Benefits	Grown as a garden ornamental and hedging plant.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	-	Low
Horticulture	-	-
Native bush or forests	Low	Low
Urban	Low	Low
Coastal	Low	High
Estuarine and marine	-	-
Freshwater/Wetland	Low	High

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	L	Nitrogen fixer, therefore potential to alter nutrient cycling regimes.	
Water quality	-	-	Lack of data on potential impacts of nitrogen fixation on nutrient leaching to waterways.	DoC, 2015

Category	Current	Potential	Comment	Source
			Being investigated in central North Island.	
Species diversity	L	L-M	Rated as 'extremely high' invasiveness potential based on history of weediness overseas. Unlikely to invade intact forest, but potential to dominate disturbed ecosystems such as regenerating bush and roadsides. Coastal dune ecosystems may be vulnerable due to frequent disturbance, suitable habitat and a lack of structurally equivalent native taxa. Mass recruitment following fire or soil disturbance can lead to almost impenetrable stands with little understorey. However, it is relatively short-lived, and native shrubs/trees may be able to regenerate through dying stands, provided repeat soil disturbance/fire does not advantage further prickly moses recruitment.	Ashton and Chappill, 1989; Wilson et al., 2011.
Threatened species	-	L	Depends on sites invaded, see 'Species diversity'.	
Social/cultural				
Human health	-	-		
Recreation	-	L	The sharply pointed leaf stalks would make this species unpleasant to brush against while in natural areas (similar to gorse).	
Māori culture	-	L	See 'Species diversity'.	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs	Prickly moses is already present in Northland but is not usually seen dominating	Low. If no action is taken, existing infestations of prickly moses may expand

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	incurred by the council under the RPMP in relation to this species. Rather than applying a programme under the Regional Pest Management Plan, the species could come under a 'Connecting Communities' programme outside the pest management plan, where advice and support are provided for specific sites. This will provide support to communities as and where the species is having impacts.	large areas. If no action is taken it may spread, with consequent environmental impacts and future control costs.	and it may spread to new sites.
Exclusion programme	Not applicable.	Not applicable.	Prickly moses is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Prickly moses is present throughout the region so would not be suitable for an eradication programme.
Progressive containment programme	Not applicable.	Not applicable.	Prickly moses is present throughout the region so would not be suitable for an progressive containment programme.
Sustained control programme	Prickly moses could be included in a sustained control programme. As a declared pest it would be banned from sale under the Biosecurity Act. This could help reduce the risk of spread over time.	Prickly moses is already banned from sale and distribution in Northland and has been for a number of years so there would be no costs to plant retail outlets from a ban. Plant retail outlets are inspected regularly by council staff checking for many different plants.	Moderate. Prickly moses could still spread and become more common.
Site-led pest programme	A site-led programme, where control of prickly moses is required in defined parts of Northland could reduce the impacts of this species within the programme area(s).	A site-led programme would require an investment of time and resources by the council and affected landowners. It would not reduce or restrict the impacts of prickly moses in areas that are not identified as being of high priority.	Moderate. A site-led programme could effectively reduce or eliminate the adverse effects of prickly moses in local areas.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Summary of alternative assessments and preferred option:	Sustained control programme - Banned from sale & distribution With regard to section 6(1) of the NPD a low-level analysis was considered appropriate for prickly moses. In terms of alternative approaches assessed, under a do-nothing approach there would be no ability for Council to prevent the formal (nursery trade) or informal (fairs and on-line marketing) trade or circulation of this pest. Prickly moses is already naturalised in Northland and its distribution and assessment of effects mean that eradication and progressive containment programmes are not realistic or affordable. Site-led management would control some plants at some sites, but ultimately this approach would also be unsustainable. Sustained control is the preferred outcome and most viable option. Declaring prickly moses formally as a pest in the Plan automatically triggers sections 52 and 53 of the Biosecurity Act, banning the pest from sale, propagation and distribution in Northland. This plant is not covered in the current National Pest Plant Accord (NPPA) which has over 150 plants listed, banning them from sale, propagation and distribution nationally. However, the NPPA is nationally focused and doesn't necessarily account for regional differences. The risks of this plant have been evaluated specifically in terms of its effects in Northland. It is important to recognise the wide climate and temperature ranges in New Zealand and that some pests require regional based initiatives based on these factors. Accordingly, prickly moses is one of 33 pest plants banned from sale, propagation and distribution in the Northland region. This designation recognises that generally they are a lower risk to the regions' values compared with other more invasive species. Council wishes to take a more proactive stance over their management, as opposed to disregarding them under a do-nothing scenario, while acknowledging it must operate within a finite budget and limited resources. Nurseries in general support the concept of the NPPA and the outcomes being sought.		

Privet

Ligustrum species

(Family: Oleaceae)

Status in New Zealand

Privet is listed as an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Privet is an evergreen shrub or tree, and four species are found in New Zealand: tree privet (*Ligustrum lucidum),* Chinese privet *(Ligustrum sinense),* privet *(Ligustrum ovalifolium)* and common privet *(Ligustrum vulgare)*. Tree and Chinese privet are common in Northland. Tree privet is a small-to-large evergreen, hairless tree up to 15m tall with distinctive lumpy warts on the stems. It has dark green leaves (5-13 x 3-6cm) that are glossy on the top surface and arranged in opposite pairs on the stems. Tiny fragrant, cream coloured flowers are produced from November to March, followed by bluish or purplish-black berry-like fruit (6 x 5mm).

	Chinese privet is a shrub or small tree that grows to 5+m tall. It is evergreen or semi-deciduous with distinctive warty lumps on stems and densely hairy shoots. Oval, dull green leaves (25-60 x 12-25mm) occasionally have wavy edges. Loose drooping clusters (up to 10cm long) of small, tubular and very fragrant white flowers appear from July to March, followed by round, green berries that mature to dull purplish-black.
Habitat	Generally present in or near sites of human habitation, where they have been planted as hedges or specimen trees. Tree privet inhabits most coastal and lowland forest types (intact and disturbed), shrublands, fernland, cliffs, and coastline. While Chinese privet inhabits forest margins, heavily disturbed bush, shrublands, open stream and alluvial river systems, fernland, rocklands, cliffs, coastal and estuarine areas, and inshore islands.
Regional distribution	Found throughout Northland.
Competitive ability	Privet produces many highly-viable seeds in widely-dispersed berries. It is very dominant, spreading dense carpets of seedlings that displace native shrubs and prevent native plant regeneration. Privet is very tolerant of shade, frost, damage, grazing, all well-drained soil types, high to moderate temperatures, damp or drought conditions, salt and wind. Tree privet is long-lived, and Chinese privet is short-lived but constantly replaced.
Reproductive ability	These species flower at different times of the year between July and March, with the flowers followed by berries that contain high numbers of viable seeds. These berries are dispersed through the autumn and winter months by birds or by falling from the tree. The seeds can germinate without the removal of berry flesh, but have a relatively short seedbank and are not likely to be viable after a year. Vectors of spread: Privet is commonly spread by birds, but also by human activities through vegetation dumping and soil movement.
Resistance to control	Plants can be controlled by physical removal or treatment with herbicide. If not treated, stumps will resprout, and areas of bare land are susceptible to reseeding. Privet sap-sucking lace bugs (*Leptoypha hospita*) were released in Northland during 2016. Both the adults and the nymphs damage privet leaves causing them to yellow and drop off reducing the growth of the plant.
Benefits	Not applicable.

Land uses occupied

Land use type	Current land use infested	Potential land use infested
Dairy	-	-
Sheep and beef	-	-
Forestry	Low	Low

Land use type	Current land use infested	Potential land use infested
Horticulture	-	-
Native	Low	Low
Urban	High	High
Coastal	Low	Low
Estuarine and marine	-	-
Freshwater	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	L	M	Known to invade disturbed and open areas.	Grove and Clarkson, 2005.
Horticulture	-	-		
Other	L	M	Public infrastructure can be affected by the restriction of visibility along roadsides.	
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	L	M	Prevents native plant regeneration. Dense stands prevent the establishment of native plant seedlings and displace vulnerable native shrub species. Poisonous berries may possibly impact on native fauna, especially insects. Tree privet can grow through the understorey to dominate and replace canopy trees in most forest types. Chinese privet can successfully establish in the edge of intact and secondary native lowland forest and wetland habitat, and is capable of forming a mono-specific canopy or subcanopy in less than 15 years following disturbance, such as clearance or	Grove and Clarkson, 2005; Weedbusters; Williams and Timmins, 1990.

Category	Current	Potential	Comment	Source
			grazing, of the native species in these tiers. Growth appears to be primarily limited by light environment, with prolific invasion in highly disturbed sites and at forest edges. Chinese privet seedlings also establish under intact forest canopy but at a slower rate.	
Threatened species	-	-	As above.	
Social/Cultural				
Human health	L	L	Thought that the plant could contribute to respiratory disorders, although possibly not as common as once thought. The highly scented flower is an irritant to most allergy sufferers, but is not a strong allergen. In doing skin prick tests in patients with allergic rhinitis it is very rare to get positive reactions to privet. Most people who think they are allergic to privet are actually allergic to ryegrass, which is not as visible as privet.	Auckland Allergy Clinic; Grove and Clarkson, 2005.
Recreation	L	L	Can form barriers to recreational activities such as tramping.	
Maori culture	L	L	Potential impacts on native/taonga species and habitats.	

L = low M= moderate H = high - = No impact + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	Rather than applying a programme under the Regional Pest Management Plan, the species could come under a 'Connecting Communities' programme outside of the pest management plan, where advice and support are provided for sites of interest to communities. This will provide support to communities as and where the species is having impacts.	There would be no immediate costs to council under the pest management plan, but there would be under the 'connecting communities' programme. However, control costs in future could be greater if the species continues to spread.	Moderate. By not applying a programme and rules to the species, there would be no provisions under the pest management plan to manage inappropriate practises that are exacerbating the spread. However, privet is already widespread and is banned from banned from sale under the NPPA.
Exclusion programme	Not applicable.	Not applicable.	Privet is already widespread in Northland.
Eradication programme	Not applicable.	Not applicable.	Privet is already widespread in Northland.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Progressive containment programme	Not applicable.	Not applicable.	Privet is already widespread in Northland.
Sustained control programme	Privet could be included in a sustained control programme, with a good neighbour rule with specified boundary clearances. The existing clearance requirement for health reasons could be retained.	Education, publicity, responding to reports, enforcement action.	Moderate - although these measures may help, privet is still widespread in Northland. However, these rules could help reduce the impacts on neighbours.
Site-led pest programme	The council could specify particular high value areas as site-led programmes. These areas are often sites of high biodiversity value in low nutrient systems, as an incursion at these sites could have significant impacts.	Rules would only be applicable in the areas defined as site led programmes and could not be enforced elsewhere. Education, publicity, responding to reports, response to new incursions, enforcing rules.	Moderate - efforts could be targeted to protecting and responding to incursions in the highest value sites in Northland.
Summary of alternative assessments and preferred option:	Sustained control In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for the four privet species. In terms of alternative approaches assessed, under no regional intervention (or do nothing) land occupiers who have genuine health related issues because of this pest would have no redress other than relying on voluntary control by the exacerbating land occupier, although the effects of privet pollen and scent being 'the guilty party' are probably diminishing. In terms of environmental impacts, the spread of privet would continue. Due to its widespread nature and ability to proliferate in the region there is a moderate level of risk around political or landowner concerns under a do-nothing scenario. Also due to the widespread extent of privet species, eradication is not deemed feasible, cost effective or realistic and would most definitely fail to be achieved. Privet's widespread nature does not lend itself to progressive containment or site led control, although protection of some sites may potentially be achieved in some areas under a site-led approach. However, on a region-wide scale these options would be onerous, costly to maintain any gains made and ultimately would have a very high risk of failure. Sustained control, with a 10m boundary clearance rule (activated through a good neighbour rule and via a valid health related complaint from a directly affected person) is a pragmatic way to address at least the human health concerns around this pest plant and is the preferred management option. A medical certificate/letter must be provided by the person affected. While privet is both a human health and environmental pest in the region the favoured outcome, which aims to reduce demonstrated human health effects, is the cost effective solution for council to adopt. Proposed GNR		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	"Land occupiers within Northland shall destroy all Privet within 10m of an adjacent or nearby property, where the adjacent or nearby land occupier is taking reasonable measures to manage Privet or its impacts on pastoral production or environmental values. This good neighbour rule will be enforced on receipt of a complaint from a directly affected land occupier."		

Good neighbour rule tests

Before a rule can be identified as a good neighbour rule in a RPMP, the regional council must be satisfied of the matters in subclause (a), (c), and (d) and must comply with the requirements in subclause (b) and (e):	
Tests	
In the absence of the rule, the pest would: • spread to land that is adjacent or nearby within the life of the plan; and • cause unreasonable costs to an occupier of that land.	The primary dispersal mechanism for privet is seed dispersal by bird, and gravity, which means that spread is likely to be prolific in close proximity to an adult plant, but dispersal could occur up to 100 meters or beyond. It is tolerant of a wide range of conditions. The tolerant and dominant nature of privet means that establishment is likely on adjacent land, and could be costly to manage. It has impacts on the regeneration of other plants and may have implications for human health. If established on a road or rail reserve the plant may spread quickly and have impacts on safety.
In determining whether the pest would spread as described in subclause (a) the regional council must consider: • the proximity and characteristics of the adjacent or nearby land; and • the biological characteristics and behaviour of the particular pest (the greater the distance between properties, the more difficult to satisfy the test in subclause (a)).	Dispersal distances of privet can be very vast as they are moved by birds, however distances are most likely to be within 100 metres. The plants are able to establish in a wide variety of receiving environments, and could easily spread along neighbouring properties.
The land that is adjacent or nearby, as described in subclause (a), must be clear from a pest or, if the pest is present on that land, the occupier of that land must be taking measures to manage the pest or its impacts	In order for the good neighbour rules in the proposed pest management plan to apply, it is a requirement that the adjacent property be clear of privet or only sparsely infested with privet.
The rule must not set a requirement on an occupier that is greater than that required to manage the spread of the pest.	The 50 metre distances gives road and rail reserves a reasonable level of protection against gravity and bird dispersal of seed. The required agreements between road and rail controlling authorities and the council that are aimed at progressively controlling privet are subject to negotiation and requirements will be agreed upon to a level that is considered suitable to control the spread of privet.

	The existing requirement to destroy all privet within 50m of an affected individuals residence or fixed workplace where the privet exacerbates human health problems could be retained, but would not be a good neighbour rule as the rule is not about managing spread.
In determining the rules to be set to manage the costs to an occupier of land that is adjacent or nearby, of the pest spreading, the regional council must consider: • the biological characteristics and behaviour of the particular pest; and • whether the costs of compliance with the rule are reasonable relative to the costs that such an occupier would incur, from the pest spreading, in the absence of a rule.	Privet is highly likely to be dispersed within 100 metres of a parent plant and puts all land within this area at risk. It is capable of establishing in a wide variety of receiving environments. The costs associated with the management of new incursions of privet can be significant. Relative to this, the cost of controlling the plant in boundary areas and maintaining control is considered to be reasonable.
Proposed Good neighbour rules discussion: Previous RPMS GNR: 1. Land occupiers must: a) destroy all privet within 10 metres of a property boundary where the boundary adjoins a road or rail reserve clear of privet; Proposed RPMP GNR: "Land occupiers within Northland shall destroy all Privet within 10m of an adjacent or nearby property, where the adjacent or nearby land occupier is taking reasonable measures to manage Privet or its impacts on pastoral production or environmental values. This good neighbour rule will be enforced on receipt of a complaint from a directly affected land occupier."	

Quantitative analysis

The medium level analysis for the proposed sustained control programme was undertaken using the GNR model for pest plants developed for regional councils (Harris et al., 2017) and adapted for the Northland situation. The model undertakes both the cost benefit and reasonableness assessments required under sections 6 and 8 respectively of the NPD. In terms of the cost benefit analysis, the model focuses on identifying the boundary distance between two properties that creates a net benefit, i.e. where the costs of introducing a GNR (the sum of the costs of control on the source property, the costs of inspection and the costs the receptor still bears due to seed bank net of any benefit the source property owner receives from controlling the plant pest) is less than the costs that the receptor bears in the absence of a GNR. For the reasonableness assessment, the model compares the costs of control imposed on the source property owner by the GNR with the additional costs of control that the receptor property faces in the absence of the GNR, and reports this as a ratio between the two.

The following two tables contain the specific pest, programme and monetary assumptions that were inputted for privet in Northland into the GNR model. The benefits from controlling the plant pest for each land use type was calculated based on the potential impact of the pest on the land use as described in the qualitative impact assessment above. As privet is not one of the pest plants included in the GNR model, European larch was considered as the plant species most similar in terms of dispersal.

Pest and programme assumptions

Pest assumptions	Values	Programme assumption	Values
Seed bank included	Yes	Proposed boundary width	10 metres
Pest abundance	Locally common	Proposed inspection required	Once (over life of plan)
Density of source infestations	Scattered	Cost of inspection	$500 per property

Land use specific assumptions ($/ha/annum)

Variable	Dairy	S&B intensive	Arable	Horticulture	Hill country	Hard hill country	Conservation	Forestry	Non-productive
Benefits from controlling the plant pest ($/ha/year)	$0	$0	$0	$0	$0	$0	$41	$43	$30
Land occupier costs of controlling scattered infestations ($/ha/year)	$200	$200	$200	$200	$250	$300	$300	$300	$300

The following two tables present the results of the model. In terms of the cost benefit assessment, the results show that when the source infestation is scattered plants, there may possibly or probably be a net benefit from introducing a 10m GNR for privet when the land use being affected in hill county, hard hill country, conservation, forestry or non-productive uses. If the land use being affected is in dairy, sheep and beef intensive, arable or horticulture, or if the source land use is hard hill country or non-productive, then the costs of introducing a 10m GNR for privet will be greater than the costs without the GNR, i.e. no net benefit.

Cost benefit assessment: Length of boundary required for there to be a net benefit (metres)

		Receptor land use							
Source land use		Dairy	S&B intensive	Arable	Horticulture	Hill country	Hard hill country	Conservation	Fores
	Dairy	C > B	C > B	C > B	C > B	790	300	300	1
	Sheep and beef intensive	C > B	C > B	C > B	C > B	790	300	300	1
	Arable	C > B	C > B	C > B	C > B	790	300	300	1
	Horticulture	C > B	C > B	C > B	C > B	790	300	300	1
	Hill country	C > B	C > B	C > B	C > B	C > B	930	930	9
	Hard hill country	C > B	C > B	C > B	C > B	C > B	C > B	C > B	C
	Conservation	C > B	C > B	C > B	C > B	C > B	>2000	>2000	>

	Forestry	C > B	C > B	C > B	C > B	C > B	>2000	>2000	>20
	Non-Productive	C > B	C > B	C > B	C > B	C > B	C > B	C > B	C >

C > B = There is no net benefit. The costs imposed by the GNR are always greater than the costs without the GNR. Blank = no costs for receptor landholder

Reasonableness assessment: Ratio of costs for source landholder to the costs for the receptor landholder

		Receptor Land use								
Source Land use		Dairy	S&B intensive	Arable	Horticulture	Hill country	Hard hill country	Conservation	Forestry	Non-P
	Dairy	1.00	1.00	1.00	1.00	0.80	0.67	0.67	0.67	
	Sheep and beef Intensive	1.00	1.00	1.00	1.00	0.80	0.67	0.67	0.67	
	Arable	1.00	1.00	1.00	1.00	0.80	0.67	0.67	0.67	
	Horticulture	1.00	1.00	1.00	1.00	0.80	0.67	0.67	0.67	
	Hill country	1.25	1.25	1.25	1.25	1.00	0.83	0.83	0.83	
	High country	1.50	1.50	1.50	1.50	1.20	1.00	1.00	1.00	
	Conservation	1.50	1.50	1.50	1.50	1.20	1.00	1.00	1.00	
	Forestry	1.50	1.50	1.50	1.50	1.20	1.00	1.00	1.00	
	Non Productive	1.50	1.50	1.50	1.50	1.20	1.00	1.00	1.00	

In terms of reasonableness, when the source infestation is scattered plants the cost of compliance with the rule for the source landowner is between 0.67 and 1.5 times the cost for the occupier who would otherwise be affected.

Pulteneaea

Pultenaea daphnoides

Also known as: pea daphne, large-leaf bush pea

(Family: Fabaceae)

Status in New Zealand

Relevant biology

Form	Pultenaea is a medium-sized shrub that grows to 3m tall. It is easily identified by its leaves, which are up to 40mm long, narrow at the base, broad at the top and end in a narrow point. The pea-like flowers are yellow with red-pink markings in the centre, and are followed by flat pods that are 5-7mm long and contain 1-2 seeds.

Habitat	Pultenaea prefers moist to dry, slightly shaded and sheltered positions. It can grow in undergrowth in forest on sandy soils.
Regional distribution	Pultenaea has become naturalised at Mangawhai. It is spreading along approximately 2km of roadsides and on a hillside, where the population size and extent is yet to be determined. It is present in manuka shrubland and on the edges of tracks in native forest.
Competitive ability	Pultenaea is fast-growing but apparently short-lived. It is resistant to drought and frost. Based on observations of the current infestation of pultenaea at Mangawhai, it has the potential to invade gumland, shrubland, open road banks, cliffs and other lower fertility sites.
Reproductive ability	Seed remains viable for a long time at room temperature. Vectors of spread: The pods of pultenaea split open to spill the seeds which are spread by gravity and wind.
Resistance to control	
Benefits	Ornamental

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	-	Low
Horticulture	-	-
Native bush or forests	Low	High
Urban	Low	High
Coastal	-	Low
Estuarine and marine	-	-
Freshwater/Wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		

Plant pests

Category	Current	Potential	Comment	Source
Forestry	-	-	The invasive potential of pultenaea in production forest is not known. It is growing in shrubland in Northland so may be able to invade production forests.	
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	M	Like other members of the pea family, pultenaea fixes nitrogen in the soil.	
Water quality	-	-		
Species diversity	L	M-H	Based on observations of the current infestation of pultenaea at Mangawhai, it has the potential to invade gumland, shrubland, open road banks, cliffs and other lower fertility harder sites.	Brill, S. NRC (pers.comm.)
Threatened species	-	M-H	If Pultenaea invades gumlands, shrubland or coastal cliffs, it has the potential to adversely effect threatened plant species.	
Social/cultural				
Human health	-	-		
Recreation	-	-		
Māori culture	-	M	Potential impacts upon native/taonga species.	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Do nothing	If no management action is undertaken there will be no short-term financial costs associated with this species.	Pultenaea has shown its invasive potential and there are large areas of similar habitat in Northland. If no action is taken, the number and extent of	High. If no action is taken, the number and extent of infestations is likely to increase with consequent adverse effects on the environment

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
		infestations is likely to increase with consequent adverse effects on the environment. Future control costs would also increase.	and increased control costs in future.
Exclusion programme	Not applicable	Not applicable	Pultenaea is already present in Northland.
Eradication programme	Pultenaea is an invasive species that is thought to have a limited distribution in Northland. If it could be eradicated from northland, its potential to spread within the region will be eliminated, avoiding environmental and economic impacts (including long-term control costs if it spreads further).	Eradication will require a short- to medium-term investment of control effort, including response to infestations, surveillance and inspections.	Low. Although pultenaea has a limited distribution in northland, resources are not currently available for an eradication response. Seed is probably long-lived so folllow-up surveillance will be required. There is also a risk that there are additional, unrecorded infestations.
Progressive containment programme	Pultenaea is an invasive species that is thought to have a limited distribution in Northland. There is one reasonably large population near Mangawhai. If it could be contained, and other small outliers eradicated from northland, its potential to spread within the region will be reduced, avoiding environmental and economic impacts (including long-term control costs if it spreads further).	Progressive containment will require a short- to medium-term investment of control effort. Costs will be lower than for an eradication programme	Low-Moderate. Pultenaea has a limited distribution in northland and eradication of outlier infestations should be feasible, while reducing the size of the population within a containment zone. Seed is probably long-lived so folllow-up surveillance will be required. There is also a risk that there are additional, unrecorded infestations.
Sustained control programme	Not applicable	Not applicable	Pultenaea is known from only a few sites in Northland.
Site-led pest programme	Not applicable	Not applicable	Pultenaea is known from only a few sites in Northland.
Preferred option:	Progressive containment Summary of alternative assessments and preferred option: In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for pultenaea. In terms of alternative approaches assessed, under <u>no regional intervention</u> (or do nothing), long term there would be unacceptable loss of biodiversity values and there would be some public and political concerns and consequences, although this pest is not well known.		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	Eradication of pultenaea is not currently feasible within the level of resourcing required in the Mangawhai containment zone, although most of the region is free of the pest. At the time of writing, the full regional status of pultenaea is not known. Consequently, there may be political risks associated with stating a region-wide eradication outcome and then being unable to achieve it. A sustained control or site led approach would be unacceptable as it would be viewed as a lesser management option and one which would allow pultenaea to slowly spread into new areas, originating from the Mangawhai site or from new areas. The option considered to carry the least risk is progressive containment. NRC intends to direct land occupiers with infestations in the containment area to control infestations and will approve all subsequent management plans. In other areas where pultenaea is identified Council will likely undertake direct control. The biggest risk is in land occupiers not adhering to the management plan requirement and NRC needing to use enforcement powers to achieve control, as well as situations of new sites not being reported. Spread along transport corridors from the containment is also of concern. However, any operational risks are relatively minor and are not expected to adversely affect control outcomes.		

Purple loosestrife

Lythrum salicaria

Also known as: bouquet-violet.

(Family: Lythraceae)

Status in New Zealand

Purple loosestrife is listed as an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Purple loosestrife is an erect, summer-green perennial herb that grows 1-2m tall. The woody stems are square in cross-section. It has narrow leaves, which are usually paired and are heart-shaped at the base. From December to February it produces 20-25cm long spikes of purple-magenta flowers. The flowers are followed by blackish seed capsules that are 3-5mm long.
Habitat	Purple loosestrife is capable of invading a variety of wetland habitats, including river and stream banks, pond edges, lakes, road-side ditches, and reservoirs. It primarily threatens wetland and riparian habitats characterised by slack water. Heavily scoured, shaded, isolated streams are relatively safe from invasion. It prefers moist soil but, once established, a population can tolerate a change in soil conditions. Disturbed areas are more prone to invasion because exposed soil is ideal for germination.
Regional distribution	Purple loosestrife is not known to be in Northland.
Competitive ability	Purple loosestrife is a highly aggressive invader of damp ground, wetlands and shallow water. It over-tops native species with its dense, bushy growth and is long-lived. It tolerates hot or cold conditions and low to high nutrient levels, but is intolerant of salt water.

Reproductive ability	Purple loosestrife reproduces mostly by seed but re-growth from plant fragments has also been observed. It produces millions of long-lived, highly viable seeds that can remain viable in the soil for many years. Seeds submerged in water can remain viable for about 20 months. For germination, disturbed sites or open, moist substrates are preferred. **Vectors of spread:** seeds may be transported by water or within soil (for example, on machinery, or the feet of animals) or garden waste. It could also be spread intentionally, for ornamental or medicinal purposes.
Resistance to control	Purple loosestrife can re-grow from fragments, so plant waste must be disposed of appropriately.
Benefits	Purple loosestrife has ornamental and medicinal values.

Water bodies occupied

Water body type	Current water body infested	Potential water body infested
Lakes	-	Low
Rivers and streams	-	Low
Wetlands	-	High
Ponds and dams	-	High
Drains and canals	-	High
Troughs	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-	Purple loosestrife is not generally a weed of agricultural land as it prefers moist to wet habitats, but it may occur at disturbed edges of fields near wetlands.	Invasive Species Compendium.
Sheep and beef	-	-	Purple loosestrife is not generally a weed of agricultural land as it prefers moist to wet habitats, but it may occur at disturbed edges of fields in the vicinity of wetlands.	Invasive Species Compendium.
Forestry	-	-	Purple loosestrife is a wetland species. Therefore, it is unlikely to invade production forests but	Farnsworth & Ellis, 2001.

Category	Current	Potential	Comment	Source
			may establish on riparian margins within forests.	
Horticulture	-	-	Purple loosestrife is a wetland species. Therefore, it is unlikely to invade horticultural land.	Farnsworth & Ellis, 2001.
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	H	Purple loosestrife is a strong competitor relative to other wetland species in a variety of wetland types. Therefore, it has the potential to reduce species diversity at the sites it invades.	Farnsworth & Ellis, 2001.
Threatened species	-	H	Purple loosestrife is a strong competitor relative to other wetland species including, potentially, threatened species.	Farnsworth & Ellis, 2001.
Social/cultural				
Human health	-	-		
Recreation	-	M	Wetlands with tall, dense stands of purple loosestrife can be impenetrable to boats, which reduces recreation opportunities.	Invasive Species Compendium.
Māori culture	-	M	Potential impacts on native/taonga species and habitats.	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	Purple loosestrife is not known to be in Northland. If neighbouring regions were relied on to control the species	There would be limited public awareness of purple loosestrife and a risk that it would be intentionally	Medium-high. Without education and regulation there is a medium-high risk that purple loosestrife

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	there would be no economic cost to the Northland region.	introduced for ornamental or medicinal use. If it is not in the Regional Pest Management Plan there would be no rules to prevent possession of the species in Northland.	could arrive and establish in Northland because it is an attractive plant with medicinal uses.
Exclusion programme	Public awareness and education about the risks and impacts of purple loosestrife in Northland, and a rule banning possession of the species could prevent it from re-establishing in the region. If it is included in the pest management plan there is the ability to respond immediately if an infestation is detected.	Low. There is already educational material available for purple loosestrife. Excluding this species would prevent expenditure on its control if/when it invades Northland.	Low. People will be aware of the species and its potential impacts. There will be a rule banning possession of the species in Northland, which could help discourage people from bringing it to Northland.
Eradication programme	Not applicable.	Not applicable.	Purple loosestrife is not currently known to be present in Northland.
Progressive containment programme	Not applicable.	Not applicable.	Purple loosestrife is not currently known to be present in Northland.
Sustained control programme	Not applicable.	Not applicable.	Purple loosestrife is not currently known to be present in Northland.
Site-led pest programme	Not applicable.	Not applicable.	Purple loosestrife is not currently known to be present in Northland.
Summary of alternative assessments and preferred option:	Exclusion programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for purple loosestrife. In terms of alternative approaches assessed, under no regional intervention (or do nothing) there would be a moderate high risk of public and political criticism of Council for not being more proactive over purple loosestrife management, as it is known in neighbouring regions. Biodiversity values of wetlands in particular could be impacted if purple loosestrife was discovered and no intervention measures were available to the council. Under a no intervention approach, NRC could rely on non-regulatory methods such as advocacy, education and site-led management, but loses the tools, regionally to impose penalties for possession of or deliberate liberations of this pest. As purple loosestrife is not currently known in Northland an exclusion programme outcome is the only appropriate option available. An exclusion programme focusing on a comprehensive surveillance programme (actively looking for purple loosestrife and other undesirable semi-aquatic pest plants) will help to mitigate any risks by detecting any infestations very early on. There is a risk that purple loosestrife will be introduced to Northland. The benefits of inclusion in the Plan are that significant wetlands and margins of waterways would in the long-term remain free of this pest. The value is difficult to estimate but would		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	be significant, given the high degree of public interest in maintaining wetlands and aquatic ecosystems in a natural state. This approach has very little extra cost to NRC, (over and above what is spent on advocacy and education) and provides Council with some regulatory tools to incentivise water users such as boaties, eel fishermen, anglers, and fowl shooters (particularly those outside the region) to stop the spread of wetland pests to new areas.		

Queen of the night

Cestrum nocturnum

Also known as: night-scented jasmine

(Family: Solanaceae)

Status in New Zealand

Queen of the night is listed as an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Queen of the night is a shrub that can grow up to 2.5 m tall. It has oval leaves that are 5-15 cm long and 1.5-6 cm wide and have an unpleasant smell when they are crushed. In summer it produces bunches of greenish-white flowers that release a strong, fragrant scent at night. Glossy white berries that are 5-10mm in diameter follow the flowers.
Habitat	Queen of the night can invade disturbed and open forest, forest margins, secondary forest, streamsides, and shrublands. It prefers damp sites.
Regional distribution	Queen of the night is widespread in Northland. It can be found in many old gardens and along nearby fence lines and bird-perching sites and has also been found in native forest.
Competitive ability	Queen of the night produces many long-lived, widely-dispersed seeds, and forms dense, shady masses. It likes damp conditions, is moderately to highly tolerant of shade and grows in most soil types. The plant is poisonous so is not eaten by animals.
Reproductive ability	Queen of the night reaches maturity 18 months after germinating and produces seeds that can remain dormant in the soil for many years. It also reproduces from creeping roots and stem fragments that can regrow. Vectors of spread: The berries (seeds) are spread by birds. Seeds and plant fragments are spread by flooding, soil movement, and vegetation dumping.
Resistance to control	Stems can resprout and sites can be reinfested by seeds left in the soil. Therefore, it is recommended that bare sites are replanted and checked regularly for seedlings. Care must be taken when disposing of plant material because it can regrow from fragments.
Benefits	Ornamental.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	Low	Low
Sheep and beef	Low	Low
Forestry	-	-
Horticulture	-	-
Native bush or forests	Low	High
Urban	Low	High
Coastal	-	-
Estuarine and marine	-	-
Freshwater/Wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	L	Queen of the night is toxic to livestock.	Williams, 2008.
Sheep and beef	-	L	Queen of the night is toxic to livestock.	Williams, 2008.
Forestry	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-			
Water quality	-			
Species diversity	L	H	Queen of the night prevents native plant seedlings from establishing by forming dense stands. The poisonous berries may affect native wildlife.	MPI; Williams. 2008.
Threatened species	L	M	Queen of the night prevents native plant seedlings from establishing including, potentially, threatened species. The poisonous berries may affect native wildlife.	MPI; Williams, 2008.

Category	Current	Potential	Comment	Source
Social/cultural				
Human health	L	L	Queen of the night may cause hayfever-like symptoms. All parts of the plant are poisonous.	Williams, 2008.
Recreation	L	L	Queen of the night may cause hayfever-like symptoms. All parts of the plant are poisonous.	Williams, 2008.
Māori culture	L	M	Impacts upon native/taonga species.	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council in relation to this species.	Queen of the night is widespread in Northland but if no action is taken it may spread to new sites, with consequent environmental impacts and future control costs.	Moderate. If no action is taken, existing infestations of queen of the night may expand and it may spread to new sites
Exclusion programme	Not applicable.	Not applicable.	Queen of the night is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Queen of the night is already widespread in Northland.
Progressive containment programme	Not applicable.	Not applicable.	Queen of the night is already widespread in Northland.
Sustained control programme	Queen of the night is toxic and can cause hayfever-like symptoms. It could be included in a sustained control programme with a rule requiring clearnce for health reasons.	Education, publicity, responding to reports, enforcement action. Queen of the night is already banned from sale and distribution so there would be no costs to plant retail outlets from including this species as a pest.	Moderate. Queen of the night could still spread and become more common.
Site-led pest programme	A site-led programme, where control of queen of the night is required in defined parts of Northland could reduce the impacts of this species within the programme area(s).	A site-led programme would require an investment of time and resources by the council and affected landowners. It would not reduce or restrict the impacts of queen of the night in areas that are not	Moderate. A site-led programme could effectively reduce or eliminate the adverse effects of queen of the night in sites that have natural values.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
		identified as being of high priority.	
Summary of alternative assessments and preferred option:	Sustained control Programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for queen of the night. In terms of alternative approaches assessed, under no regional intervention (or do nothing) land occupiers who have genuine health issues because of this pest would have no remedy other than relying on voluntary control by the exacerbating land occupier. Due to its widespread but unsurveyed distribution in the region there would be a low level of risk around political or landowner concerns. However, under a do-nothing scenario and in terms of environmental impacts, the spread of queen of the night would continue. Due to the widespread extent of queen of the night, particularly in older established gardens and being primarily bird spread, eradication is not deemed feasible or realistic and this outcome would fail to be achieved. Its distribution would not lend itself to progressive containment or site led control, although protection of some sites may potentially be achieved in some areas under a site-led approach. However, on a region-wide scale these options would be onerous, costly to maintain any gains made and ultimately would have a moderate to high likelihood and risk of failure. Sustained control, with a land occupier total property clearance rule (activated by receipt of a valid health related complaint from a directly affected person) is a more pragmatic way to address human health concerns and is the preferred management option. A medical certificate/letter must be provided by the person affected. While queen of the night is both a human health and environmental pest in the region the favoured outcome, which aims to reduce human health effects, is a cost-effective solution for council to adopt.		

Queensland poplar

Homalanthus populifolius

Also known as: Queensland poplar, bleeding heart tree, poplar-leaved omalanthus, *Omalanthus populifolius*

(Family: Euphorbiaceae)

Status in New Zealand

Queensland poplar is listed as an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Queensland poplar is a shrub or tree that grows up to 5 m tall. It has smooth, heart-shaped leaves that are up to 20cm long and turn red with age. It flowers during September, October, and November. Each flower is very small and they occur in spikes up to 17 cm long. Fruits are up to 1 cm in diameter, made up of two sections with a groove in between and have two small 'antennae' that stick out from the top.
Habitat	Queensland poplar is a pioneer species that grows in gaps or on the margins of rainforests in Australia. It will produce thickets in these situations. It prefers dappled shade but has also been seen growing in quite sunny areas. In Northland it favours regenerating bush, forest margins, gaps within forest, roadsides and waste places.

Regional distribution	Queensland popular is present in Northland. It has been recorded on the east coast but may be present on the west coast. It has a scattered distribution but is common in some areas, particularly around Kerikeri. It can be found in regenerating forest, on forest margins and in damp, disturbed sites, such as the edges of drains.
Competitive ability	Queensland poplar is a weed in Mauritius and South Africa and is becoming weedy in Hawaii and Zimbabwe. It is fast-growing, shade tolerant, and produces large numbers of fertile seeds. However, it is relatively short-lived (approx 20 years).
Reproductive ability	Queensland poplar produces a large number of seeds. Vectors of spread: seeds are spread by birds. Other methods of movement include gravity, water and machinery, especially roadside mowers.
Resistance to control	Queensland poplar can be controlled by physical removal or herbicide application or a combination of these methods e.g. applying herbicide to cut stumps.
Benefits	Queensland poplar is sometimes planted as an ornamental tree. The bark and leaves yield a black dye.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	Low	High
Horticulture	-	-
Native bush or forests	Low	High
Urban	Low	High
Coastal	-	-
Estuarine and marine	-	-
Freshwater/Wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-	The leaves of Queensland poplar are poisonous to cattle.	McIntyre & McIntyre 2014
Sheep and beef	-	-	The leaves of Queensland poplar are poisonous to cattle.	McIntyre & McIntyre 2014

Category	Current	Potential	Comment	Source
Forestry	-	L	Queensland poplar is shade-tolerant and competes with other species for light, nutrients, water and space.	MPI; Weedbusters; Williams 2008
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	L	M	Queensland poplar is shade-tolerant and competes with native species for light, nutrients, water and space. It can form a sub-canopy that displaces native species by shading them out. In particular, it could threaten disturbed forest.	MPI; Weedbusters; Williams 2008; Starr *et al*. 2003
Threatened species	-	M	Queensland poplar competes with native plant species, potentially including threatened species.	MPI; Weedbusters; Williams 2008
Social/cultural				
Human health	-	L	The leaves of Queensland poplar contain a sticky white sap that can cause skin irritation.	McIntyre & McIntyre 2014; Invasive Species South Africa
Recreation	-	-		
Māori culture	-	M	Impacts upon native/taonga species.	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council under the RPMP in relation to this species.	Queensland poplar is already present in Northland and is spreading. If no action is taken to manage this species it will continue to spread, with consequent environmental impacts and future control costs.	High. If no action is taken Queensland poplar is likely to continue to spread.
Exclusion programme	Not applicable.	Not applicable.	Queensland poplar is already present in Northland.
Eradication programme	If Queensland poplar could be eradicated it would prevent long-term impacts and control costs.	Any attempt at eradication would require a large input of resources and is unlikely to be successful because the species is relatively widely distributed.	High. Eradication is not feasible at this time.
Progressive containment programme	When compared to an eradication programme, a progressive containment programme would incur lower financial cost to council in the short-term. It would aim to restrict the geographical distribution of Queensland poplar.	The distribution and numbers of Queensland poplar in Northland are not well-understood. A considerable input of resources would be required to carry out surveillance, followed by control and monitoring.	High. Queensland poplar is relatively widely distributed and the seeds are spread over long distances by birds, so this species is not suitable for a progressive containment programme.
Sustained control programme	When compared to an eradication programme, a sustained control programme would incur lower financial cost to council in the short-term. It would aim to restrict the spread and impacts of Queensland poplar and prevent it from having increasingly severe impacts on the environment.	The aim of a sustained control programme is not to eradicate the species and the opportunity to eradicate the species may be lost.	Moderate. There is a moderate risk that a sustained control programme will not prevent Queensland poplar from spreading to new sites.
Site-led pest programme	Not applicable	Not applicable	Queensland poplar has a scattered distribution and is not a suitable candidate for a site-led programme.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that Queensland poplar does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be no regional intervention for Queensland poplar, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding. While Queensland poplar has not been afforded pest status in Northland, it may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes.		

Ragwort

Jacobaea vulgaris

(Family: Asteraceae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Ragwort is a member of the daisy family. It is an erect, annual to perennial herb and usually grows to 45-70cm tall, but can reach 1.6 metres. It has reddish-purple stems and wrinkled, divided leaves, which are dark green on top with a downy lining. The leaves appear in a rosette that grows into a dense cluster. Ragwort flowers are bright yellow, and appear in clusters. It has downy, parachute-like seeds. In autumn, the flowering stems die back and in undisturbed situations the whole plant may die. In the first year of growth a basal rosette is produced and in the second year the yellow flowers are produced at the top of the flowering stem which grows from the centre of the rosette.

Habitat	Ragwort prefers areas of open space with some area of bare ground for seeds to germinate on, particularly in high rainfall areas. It will invade open forests, riverbeds, swamps, pastures and coastal areas. Ragwort tolerates a wide range of environmental conditions, but only a little shade. Especially abundant in areas of higher rainfall. It can be particularly problematic on dairy farms.
Regional distribution	Found throughout Northland. Infestations are generally found on reverted farmland and land that is unoccupied. The widespread introduction of the flea beetle (biological control agent for ragwort), has resulted in a steady decline of average infestation densities throughout Northland to levels where it is no longer a significant threat on most properties.
Competitive ability	An aggressive, prolific flowering plant that will rapidly colonise in exposed areas. Matures quickly, reduces the productivity of the land and may out-compete native plant seedlings.
Reproductive ability	Flowers from November to April producing large numbers of small seeds. A mature plant is estimated to produce 250,000 seeds per year, 80% of which may be viable. Vectors of spread: seeds are dispersed primarily by wind and gravity, and in some instances by human activities such as soil movement, and farm activities. May be spread rivers or streams if a watercourse is nearby. The majority of seeds have a relatively small dispersal distance of up to 20 m.
Resistance to control	Can be treated with herbicides or manual removal. Seed heads must be removed and burned or buried to avoid reseeding. If manual removal is not undertaken at the right stage (full to late flowering) the roots regrow. Damaged plants can regrow into multi-crown perennial plants, which require tougher herbicides and are therefore more difficult to control. Sheep and goats will often eat ragwort. Biocontrol agents for ragwort include: • Ragwort flea beetle (*Longitarsus jacobaeae*) was released in New Zealand in 1983 has been very successful in controlling ragwort. • Ragwort plume moth (*Platyptilia isodactyla*) was released in 2005 to complement the ragwort flea beetle at wetter sites where it is less effective.
Benefits	

Land uses occupied

Land use type	Current land use infested	Potential land use infested
Dairy	Low	High
Sheep and beef	Low	High
Forestry	Low	Low
Horticulture	Low	Low
Native	Low	Low
Urban	-	-

Land use type	Current land use infested	Potential land use infested
Coastal	Low	Low
Estuarine and marine	-	-
Freshwater	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	M	H	Particularly problematic for dairy farms. Toxic to livestock, particularly cattle and horses, causing liver damage. Can also cause tainted milk. The main problem caused by ragwort is that livestock trying to avoid the weed do not eat the grass and clover growing up through ragwort plants and around them. This leads to poor utilisation of the pasture. Ragwort competes strongly with more desirable plants, reducing pasture productivity and the value of agricultural land. Its high mortality rate after flowering leaves open bare patches on the pasture, allowing invasion of other noxious weeds which may further disrupt the ecological balance.	Agriculture Victoria; AgPest; Global invasive species database; Massey University.
Sheep and beef	M	H	Toxic to livestock, sheep and goats are more resistant, but some deaths still occur. Long-term exposure to ragwort can cause symptoms similar to facial eczema. Its high mortality rate after flowering leaves open bare patches on the pasture, allowing invasion of other noxious weeds which may further disrupt the ecological balance.	Agriculture Victoria; AgPest; Global invasive species database; Massey University.
Forestry	L	L	Known to invade disturbed forests.	
Horticulture	-	-		
Other	L	L	May also be toxic to deer. The toxic alkaloids also cause a taint in honey.	AgPest
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		

Category	Current	Potential	Comment	Source
Species diversity	L	L	Can be invasive in disturbed native forests and shrubland, impacting on biodiversity. May out compete native species.	Agriculture Victoria
Threatened species	-	-		
Social/cultural				
Human health	-	-		
Recreation	-	-		
Māori culture	-	-		

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council in relation to this species. Ragwort is a serious pasture in some parts of New Zealand. It is not currently a particular problem in Northland, and their has been a steady decline in abundance since the introduction of the ragwort flea beetle. The council received two complaints about ragwort on neighbouring properties in 2014 and none in 2015.	Occupier costs to control ragwort where required to avoid impacts on farming land.	Low. Ragwort is a weed of pasture and, as such, there is an incentive for landowners to control it. Therefore, uncontrolled spread is unlikely.
Exclusion programme	Not applicable.	Not applicable.	Ragwort is already widespread in Northland.
Eradication programme	Not applicable.	Not applicable.	Ragwort is already widespread in Northland.
Progressive containment programme	Not applicable.	Not applicable.	Ragwort is already widespread in Northland.
Sustained control programme	Ragwort could be included in a sustained control programme, with rules for quarries and	Education, publicity, responding to reports, enforcement action.	These rules could help reduce the impacts on neighbouring occupiers, particularly where

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	possibly a good neighbour rule with specified boundary clearances.		those occupiers are dairy farming.
Site-led pest programme	Not applicable.	Not applicable.	Ragwort is already widespread in Northland, and is primarily an agricultural pest.
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that ragwort does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be no regional intervention for ragwort, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding. While ragwort has not been afforded pest status in Northland, it may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes. Good neighbour rule test In the previous RPMS a GNR was included for control of Ragwort. In the RPMS a GNR was viable as the flea beetle (biological control agent for Ragwort) was expected to take up to 5 years to have full effect. More recent research has shown the ability of the flea beetle to reduce Ragwort populations and highlight that a GNR which would involve spraying Ragwort in summer which would also harm the biological control agent (BCA) populations. In considering these factors the GNR test for Ragwort failed and the BCA provides more effective control of infestations than would be provided by continuing the GNR. The widespread introduction of the flea beetle (biological control agent for ragwort), has resulted in a steady decline of average infestation densities throughout Northland to levels where it is no longer a significant threat on most properties. Recent research has shown that populations in Northland have reduced from 10,000+ plants per hectare to 10-100 plants per hectare where the beetle has been allowed establish and flourish (Landcare Research 2016).		

Good neighbour rule test

Before a rule can be identified as a good neighbour rule in a RPMP, the regional council must be satisfied of the matters in subclause (a), (c), and (d) and must comply with the requirements in subclause (b) and (e):	
Tests	

Plant pests

In the absence of the rule, the pest would: • spread to land that is adjacent or nearby within the life of the plan; and • cause unreasonable costs to an occupier of that land.	Ragwort is an aggressive, prolific flowering plant. It produces a large number of seeds that are dispersed by wind and gravity up to 36 metres from the plant. It is highly tolerant of environmental conditions and will likely establish on any areas of open ground. Once established, Ragwort can be difficult to control and will spread. Improper removal techniques can result in a plant with increased resistance to further control. The plant can cause serious health issues with stock. Establishment of the plant has the potential to cause considerable ongoing costs to land owners.
In determining whether the pest would spread as described in subclause (a) the regional council must consider: • the proximity and characteristics of the adjacent or nearby land; and • the biological characteristics and behaviour of the particular pest (the greater the distance between properties, the more difficult to satisfy the test in subclause (a)).	Ragwort establishes easily on most areas of open land, and can tolerate most environmental conditions. If seeds reach land is it likely that they will germinate and establish. Most seeds will fall within 36 metres of the adult plant, however there is the potential for wind borne seeds to travel much further.
The land that is adjacent or nearby, as described in subclause (a), must be clear from a pest or, if the pest is present on that land, the occupier of that land must be taking measures to manage the pest or its impacts	In order for the good neighbour rules in the proposed RPMP to apply, it is a requirement that the neighbouring property is clear of ragwort, or that and adjoining carriageway is within 50m of a property free of ragwort.
The rule must not set a requirement on an occupier that is greater than that required to manage the spread of the pest.	The buffer distance of a proposed GNR offer a suitable level of protection to adjoining landowners against almost all wind dispersed ragwort seeds, however in considering this the biocontorl agent is more effective than a GNR in controlling Ragwort.
In determining the rules to be set to manage the costs to an occupier of land that is adjacent or nearby, of the pest spreading, the regional council must consider: • the biological characteristics and behaviour of the particular pest; and • whether the costs of compliance with the rule are reasonable relative to the costs that such an occupier would incur, from the pest spreading, in the absence of a rule.	If a flowering Ragwort plant is present, it is highly likely that the immediate surrounding area will become infested, unless that land has one of the few characteristics that render it unsuitable. Once ragwort is established it can be costly to control and can have serious impacts on the health of stock. However the biocontrol is more effective at controlling the species than spraying or removing seed heads.

Proposed Good neighbour rules discussion:

Current RPMS rule:

1. Land occupiers must:

    a. destroy all ragwort within 50 metres of a property boundary where the neighbouring property is clear of ragwort and is clear within 50 metres of that boundary;

b. destroy all ragwort between their property boundary and the carriageway of any adjoining road, where this land is within 50 m of a property free of ragwort; c. destroy all ragwort in the operational areas of a quarry; and i. a 50 metre strip of land around the operational areas of a quarry. Ii. Where existing vegetation reduces the risk of ragwort spreading, the 50 metre buffer zone may be reduced by written agreement with the NRC. Proposed RPMP rule: No regional intervention - Failed GNR test.

Rhus tree

Toxicodendron succedaneum

(Family: Anacardiaceae)

Also known as: Japanese wax tree, wax tree, Synonym - *Rhus succedanea*

Status in New Zealand:

Naturalised.

Relevant biology

Form	Rhus tree (or Japanese wax tree) is a small deciduous tree or large shrub that is highly toxic and allergy causing. The tree reaches a maximum height of 8-12m and has small branches with leaves arranged in pairs along these branches with one terminal leaf. Leaves are 4-10cm long and 2-3cm wide, and change from their bright green colour to orange/scarlet in autumn. Very small yellow-green flowers form along new leaves in spring and early summer. The plant produces pale brown papery fruit that remain hanging in clusters on the tree through autumn and winter and fall in spring.
Habitat	Most commonly populates areas of coastal indigenous vegetation, urban gardens, and wasteland. Tolerates a wide range of soil types. Can be invasive in disturbed sites, forests, open woodlands, urban bushland, roadsides, gardens and waste areas in temperate and sub-tropical regions. In Australia the tree is known to invade disturbed areas of woodland and roadsides, and spread from domestic gardens into surrounding urban bushland.
Regional distribution	Known to be scattered throughout Northland, particularly in urban gardens. Appears to be naturalising in parts of Northland currently. In the Bay of Islands, it is now growing on roadsides between Haruru Falls and Opua, where there are currently in excess of 50 juvenile and adult trees (approximately 15 adults and 35 juveniles). There are adults and seedlings in gardens in Russell, and it is also starting to occur on roadsides there. It is also present in gardens from Riverside to Onerahi in Whangarei, and seedlings are appearing in other gardens and on roadsides.
Competitive ability	It is considered a noxious weed in some states in Australia, and is no longer sold in nurseries there. It is a serious weed in Sydney, where birds spread the seeds, and thousands of seedlings were found in home gardens, public areas and in urban bushland.
Reproductive ability	Rhus trees produce clusters of brown fruit that contain large numbers of seeds. The seed remains viable for many years, and will germinate readily, with seedlings usually found near the parent tree. The tree may also reproduce vegetatively by suckering.

	Vectors of spread: seeds are primarily bird or gravity-dispersed, and may also be relocated by human movement of soil.
Resistance to control	Trees can be removed manually however suckering will occur at stumps if not fully dug out and/or treated with herbicide. The greatest resistance to control relates to the difficulty in handling the tree, which is extremely toxic, with toxic resin remaining active for months on any equipment used.
Benefits	Ornamental, used to produce lacquer, and is a medicinal plant in India. Used in homeopathy.

Land uses occupied

Land use type	Current land use infested	Potential land use infested
Dairy	-	-
Sheep and beef	-	-
Forestry	Low	Low
Horticulture	-	-
Native	Low	Low
Urban	High	High
Coastal	Low	Low
Estuarine and marine	-	-
Freshwater	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	-		
Horticulture	-	-		
Other	L	M	Potential spread in urban areas	
International trade	-	-		
Environment				

Category	Current	Potential	Comment	Source
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	L	Potential to be weedy in urban bushland areas. It is a serious weed in Sydney, where birds spread the seeds, and thousands of seedlings were found in home gardens, public areas and in urban bushland. Appears to be naturalising in Northland, and it is unclear what the impacts might be.	Derraik, 2007; NRC staff, Lawrence pers. comm., 2016.
Threatened species	-	-		
Social/cultural				
Human health	M	H	Rhus tree is the most allergenic plant species in New Zealand causing contact dermatitis, and is considered to cause public harm. The majority of cases of allergic contact dermatitis that present to hospital are young people affected during outside play, followed by adults who were gardening. It causes severe dermatitis beginning with a rash, redness, itching and blisters wherever skin comes into contact with the plant or its sap. There may also be swelling of the face, arms and legs.	Derraik, 2007. Rademaker and Duffill, 1995.
Recreation	L	M	Presence of the tree may affect people playing or working in gardens.	
Māori culture	-	-		

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	No operational costs. Not particularly competitive so unlikely to have large-scale impacts on the environment, although it is weedy.	No operational costs. Medical costs to public seeking treatment following contact.	Medium. Tree may continue to establish and have ongoing impacts on human health.
Sustained control	By reducing the geographic distribution of the tree, the risk to human health is reduced. It is not listed in the National Pest Plant Accord so may still be sold at	Costs are involved in responding to reports and managing the plant, however the costs for this at this stage are less than if the	Low

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	present, although it is not commonly sold in nurseries. Ministry for Primary Industries recommended that regions consider taking action against this species particularly in public places. Rules prohibiting sale, propagation, distribution and transportation would be appropriate. The council would act on complaint.	tree was to be left unmanaged in Northland.	
Summary of alternative assessments and preferred option:	Sustained control In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for rhus tree. In terms of alternative approaches assessed, under <u>no regional intervention</u> (or do nothing) land occupiers who have genuine health issues because of this tree would have no redress other than relying on voluntary control by the exacerbating land occupier. Rhus tree has a dispersed but unmapped distribution in the region but there would be a high level of political and landowner risk under a do-nothing scenario, primarily due to its high profile being one of the most poisonous trees in New Zealand in terms of human health. Due to the scattered (mostly in urban gardens) extent of rhus, <u>eradication</u> is not deemed feasible or realistic and would likely fail to be achieved should a full survey reveal the true extent of infestations. Its scattered nature does not lend itself to <u>progressive containment or site led control,</u> although protection of some sites may potentially be achieved in some areas under a site-led approach, as rhus tree has 'weedy potential'. However, on a region-wide scale these three options would be onerous, costly to maintain any gains made and ultimately the outcomes sought would have a high risk of failure. <u>Sustained control</u>, with land occupier total property clearance rules (which are activated by either the infestation being a source of wilding rhus trees or a valid health related complaint from a directly affected person) is a pragmatic way to address at least the significant human health concerns around this pest plant and is the preferred management option. A medical certificate/letter must be provided by the person affected. While rhus tree is both a human health and potential environmental pest in the region the favoured outcome, which aims to reduce demonstrated human health effects, is a cost-effective solution for council to adopt.		

Royal fern

Osmunda regalis

(Family: Osmundaceae)

Status in New Zealand

Royal fern is listed as an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Royal fern is a deciduous fern that has large fronds up to 3m long and 75cm wide. The fronds are feather-like, subdivided twice, yellow-green and tough. It produces separate fertile fronds that are brown and resemble tiny bunches of grapes. A short woody trunk grows up to 1.5m high and plants die back to the woody trunk in winter.
Habitat	Royal fern grows in wet, peaty habitats, roadside drains and occasionally on clay banks next to water bodies. It often grows beneath manuka and grey willow. It is tolerant of frost, saturated ground, moderate shade, and poor soils.
Regional distribution	Royal fern is present in Northland but currently has a limited distribution and is mainly confined to land managed by the Department of Conservation (DOC). DOC has reduced the infestation on Pouto Peninsula to zero density but there are smaller infestations elsewhere.
Competitive ability	Royal fern can naturalise and form dense colonies in a range of wetland habitats, especially in disturbed areas and under the shade of willows or manuka. The plants displace other small native wetland plants.
Reproductive ability	Royal fern produces spores (which are a fern's equivalent of seeds). Vectors of spread: The spores are light and can be spread over long distances by wind.
Resistance to control	Royal fern can be controlled manually, mechanically or chemically but it is usually found with a range of low-growing, native, wetland plants so care must be taken not to impact upon these species. In these situations, slashing has been found to be a safe method
Benefits	Royal fern is used as an ornamental plant and as fibre-bearing plant for orchid cultivation.

Water bodies occupied

Water body type	Current water body infested	Potential water body infested
Lakes	Low	Low
Rivers and streams	-	Low
Wetlands	Low	High
Ponds and dams	-	High
Drains and canals	-	High
Troughs	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				

Category	Current	Potential	Comment	Source
Dairy	-	-	Royal ferns grows in wet, peaty habitats. It is unlikely to invade pasture but may colonise dairy farm drains.	New Zealand Plant Conservation Network
Sheep and beef	-	-	Royal ferns grows in wet, peaty habitats and is unlikely to invade pasture.	New Zealand Plant Conservation Network
Forestry	-	-	Royal ferns grows in wet, peaty habitats and is unlikely to invade production forests.	New Zealand Plant Conservation Network
Horticulture	-	-	Royal ferns grows in wet, peaty habitats and is unlikely to invade horticultural land.	New Zealand Plant Conservation Network
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	L	H	Royal fern can form dense colonies in a range of wetland habitats, excluding small native plants, reducing species diversity.	New Zealand Plant Conservation Network
Threatened species	-	H	Royal fern can form dense colonies in a range of wetland habitats and will exclude small native plants, including threatened species.	New Zealand Plant Conservation Network
Social/Cultural				
Human health	-	-		
Recreation	-	-		
Maori culture	L	M	Potential impacts on native species.	

L = low M= moderate H = high - = No impact + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful *
No regional intervention	If no management action is undertaken there will be no short-term financial costs to council associated with this species.	Royal fern currently has a limited distribution in Northland but it is an invasive species with the potential to spread through a range of wetland habitats. The	High. If royal fern is not managed, the density of the species within the existing infestation area is likely to increase and it may spread to new sites.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful *
		environmental and economic costs of delaying control until there are larger/more infestations is potentially considerable.	
Exclusion programme	Not applicable.	Not applicable.	Royal fern is already present in Northland.
Eradication programme	Royal fern currently has a limited distribution in Northland. If the species could be eradicated before it spreads elsewhere, it would prevent long-term impacts and financial costs.	Eradication of royal fern would require an investment of resources to control the known infestations and undertake on-going surveys to ensure all plants have been removed, that there is no regrowth at the known infestation sites and that there are not additional infestation sites.	Moderate. There is a moderate risk of an eradication programme failing in the short-medium term due to the difficulty of locating all the plants. The infestations are on land managed by the Department of Conservation.
Progressive containment programme	When compared to an eradication programme, a progressive containment programme would incur lower financial cost to council in the short-term. It would also have the benefit of confining the impacts of this species to the locations where it is currently present and preventing it from having impacts elsewhere.	Royal fern is an invasive species with the potential to spread widely through its wind-dispersed spores. The potential cost of a progressive containment programme is that it will fail to contain royal fern and it will spread to other sites in Northland, with consequent impacts on the environment and increased control costs in the long-term.	Moderate. Royal fern spreads readily from wind-blown spores and there is a moderate potential that containment will not be feasible. The infestations are on land managed by the Department of Conservation.
Sustained control programme	Not applicable.	Not applicable.	Royal fern is not common or widespread in Northland, so a sustained control programme is not appropriate.
Site-led pest programme	The council could define a site-led programme around the current infestation, and aim to control the infestation. As only a few sites of royal fern are currently known from Northland, costs of implementing a control programme now would be less than leaving it to spread.	Control costs.	High. There would be no rules or control programmes elsewhere in the region should other sites be detected.
Summary of alternative assessments	**Eradication programme** In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for royal fern. In terms of alternative approaches assessed, under <u>no</u>		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful *
and preferred option:	regional intervention (or do nothing) there would potentially be unacceptable loss of biodiversity values (riparian plant communities) as there are many marginal wetland habitats for it to thrive in in Northland. Currently, royal fern is limited in its regional distribution to public conservation land in the main. Under a no intervention approach, NRC could rely on non-regulatory methods such as advocacy, education and site-led management, but loses the ability to undertake direct action (for current and any new infestations) and the tools to impose penalties for possession of or deliberate liberations of this pest. Progressive containment or sustained control approaches would not be appropriate as royal fern is uncommon in Northland. It would be highly risky of Council to rely on 'lesser' control options when eradication or zero density is achievable. It would also be an unacceptable risk to bank on landowners to control infestations as control of any aquatic pests with herbicides is usually difficult and expensive. Additionally, as the sites involve treatment close to and at times over water, permissions to use herbicides are required through the Environmental Protection Agency (EPA). These situations require a high level of regional intervention (through professional surveillance and direct control approaches). These operational risks would compromise the outcomes sought if landowners were responsible for control work, therefore council service delivery is the most appropriate control measure. Eradication is the preferred outcome and is realistic given the current infestations and the technical challenges involved. There is some level of risk that royal fern will be introduced to Northland or unknown infestations are found. NRC intends to undertake direct control of royal fern wherever it occurs in the region. The costs involved under an eradication programme are minor (compared with the risks of doing nothing and allowing it to spread) and provides Council with some regulatory tools to incentivise water users such as boaties, eel fishermen, anglers, and fowl shooters to stop the spread of wetland and semi-aquatic pests to new areas. The benefits of inclusion in the Plan are that significant wetlands and riparian areas around waterways would in the long-term remain free of this pest. The value is difficult to estimate but would be significant, given the high public interest in maintaining wetlands and aquatic ecosystems in a natural state.		

S - Z plant pests

Sea spurge

Euphorbia paralias

(Family: Euphorbiaceae)

Status in New Zealand:

Sea spurge is listed as an unwanted organism under the Biosecurity Act 1993.

Relevant biology

Form	Sea spurge is a long-lived herbaceous coastal plant native to Africa, temperate Asia, and many parts of Europe, and is invasive in Australia. The plant is fleshy and glaucous (bluish grey/green), with stalks that turn reddish brown with age, and grows up to 70cm tall. The stems contain a milky sap that is toxic to people and animals. Leaves are obovate-oblong at the base to ovate at the top of the stems and are approximately 5-20mm long and 2-15mm in width. The leaves are crowded and overlapping on stems that branch from a woody base, and divide into 3-5 flowering branches. It produces a cluster of cup-shaped flower heads on a distinct stalk. Flowers are cyathia ('fake' flowers) consisting of a female flower surrounded by male flowers (reduced to stamen) and four crescent-shaped glands that contain nectar to attract pollinators. Flowers are surrounded by a pair of bracts (modified leaf or scale) measuring approximately 1.5mm long. Capsule-like fruit are produced containing three large seeds that are buoyant and can be carried vast distances by ocean currents. Sea spurge grows from deep tap-roots.
Habitat	The species forms dense infestations in coastal, open sand areas and around beach debris, from the high water flotsam line into the dunes. It is most likely to be found on the west coast of the north and south islands of New Zealand due to seed transferral from Australia, but there is also the possibility of currents moving seeds to northeastern beaches. The New Zealand climate is similar to that of the species native habitat and is not thought to be a barrier to establishment.
Regional distribution	It is not known to be in Northland. One site has been detected in Waikato and is currently part of a Ministry for Primary Industries-led control programme.
Competitive ability	This species forms dense colonies that may alter the natural movement of sand, rendering habitats unsuitable for native species. Its colonies have the potential to overrun and displace native dune species such as spinifex and pingao, and some sea grasses.
Reproductive ability	Produces capsule-like fruit containing three large, buoyant seeds that can be spread vast distances by ocean currents. Seeds can remain viable in sea water for up to six years. Vectors of spread: ocean currents, bilge and ballast water, movement on beaches by people and vehicles.
Resistance to control	Plants can be uprooted and treated with herbicide, however it is difficult to detect seed reservoirs in the sand.

Benefits	Valued by gardeners in some of its native regions, for its tolerance to coastal conditions.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	Low
Sheep and beef	-	Low
Forestry	-	-
Horticulture	-	-
Native bush or forests	-	-
Urban	-	-
Coastal	-	High
Estuarine and marine	-	High
Freshwater/wetland areas	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	L	Dense infestations may invade pastoral land near coastal areas, reducing pasture available for grazing.	Duthie, 2012.
Sheep and beef	-	L	Dense infestations may invade pastoral land near coastal areas, reducing pasture available for grazing.	Duthie, 2012.
Forestry	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	M	Alters natural movement of sand and may exacerbate erosion.	Duthie, 2012.
Water quality	-	-		

Category	Current	Potential	Comment	Source
Species diversity	-	M	Dense infestations alter dune movement, threatening native coastal plants and impacting nesting shore birds.	Duthie, 2012.
Threatened species	-	M	Dense infestations alter dune movement, threatening native coastal plants and impacting nesting shore birds.	Duthie, 2012.
Social/cultural				
Human health	-	M	The plant contains a poisonous latex sap that can irritate skin and eyes.	Duthie, 2012.
Recreation	-	M	Altering of the dune environment, and threat of toxicity may impact on recreational use.	
Māori culture	-	M	Native coastal plants and nesting shore birds may be impacted.	Duthie, 2012.

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	No programme costs. Only one known incursion in New Zealand currently and this is part of a control programme.	None in the short term. However, there would be limited public awareness of sea spurge and a risk that it would be intentionally or accidentally introduced. If it is not in the pest management plan there would be no rules to prevent possession of the species in Northland.	Medium - new incursions are likely as sea spurge has buoyant seeds that can be spread vast distances by ocean currents. Seeds can remain viable in sea water for up to six years.
Exclusion programme	Increase chances of early detection and response, which increases the likelihood of successfully preventing sea spurge from establishing in Northland.	Publicity/education; follow-up on reports; ongoing surveillance.	Low - new incursions likely but more likelihood of detection if in programme.
Eradication programme	Not applicable.	Not applicable.	Eradication is not an option because sea spurge is not present in Northland.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Progressive containment programme	Not applicable.	Not applicable.	Progressive containment is not an option because sea spurge is not present in Northland.
Sustained control programme	Not applicable.	Not applicable.	Sustained control is not an option because sea spurge is not present in Northland.
Site-led pest programme	Not applicable.	Not applicable.	A site-led pest programme is not an option because sea spurge is not present in Northland.
Summary of alternative assessments and preferred option:	Exclusion programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for sea spurge. In terms of alternative approaches assessed, under no regional intervention (or do nothing) there would be a significant risk of public and political criticism of Northland Regional Council for not being more proactive while knowing sea spurge was already detected on the North Island's west coast. Biodiversity values would potentially be impacted if sea spurge was discovered and no intervention was imminent. As sea spurge is not currently found in Northland an exclusion programme outcome is the only appropriate option available. There is a medium to high operational and outcome risk that sea spurge will be carried to Northland on ocean currents and via storm events (from Australia's eastern coast area). These factors are out of Northland Regional Council's ability to control. An exclusion programme focusing on a comprehensive surveillance programme (looking for sea spurge and other undesirable pest plants) will help to mitigate these risks by detecting any infestations very early on.		

Sexton's bride

Rhaphiolepis umbellata

(Family: Rosaceae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Sexton's bride is a perennial shrub up to approximately 3m tall. Flowers are borne in clusters of about 20 from July-December. Petals are white, stamens and sepals pink/red. Fleshy, purple-black fruit approximately 6-12mm diameter, ripen during March-April.
Habitat	Preferred habitats include coastal, urban and cliff areas. It is often an escapee from old hedges and gardens. Also found in transport corridors. It tolerates very hard dry soils, but doesn't colonise damp sites.
Regional distribution	Widespread but patchy distribution.
Competitive ability	History of naturalisation overseas.

Reproductive ability	Presumed bird dispersed.
Resistance to control	Invades coastal cliffs; control can be difficult due to inaccessible nature of sites.
Benefits	Can be valued as garden ornamental.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	-	-
Horticulture	-	-
Native bush or forests	Low	Low
Urban	Low	High
Coastal	Low	High
Estuarine and marine	-	-
Freshwater/Wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-	Data deficient.	
Water quality	-	-		

Category	Current	Potential	Comment	Source
Species diversity	L	L	Data deficient. Coastal cliff habitats most at risk. Presume some displacement of native plants in coastal areas, based on current level of naturalisation.	Herbarium records and staff observations of naturalisation.
Threatened species	-	-	Depends on future habitats colonised.	
Social/cultural				
Human health	-	-		
Recreation	-	-		
Māori culture	-	-	See 'Species diversity'.	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council under the RPMP in relation to this species. Rather than applying a programme under the Regional Pest Management Plan, the species could come under a 'Connecting Communities' programme outside the pest management plan, where advice and support are provided for specific sites. This will provide support to communities as and where the species is having impacts.	Sexton's bride is already present in Northland but is not usually seen dominating large areas. If no action is taken it may spread, with consequent environmental impacts and future control costs.	Low. If no action is taken, existing infestations of Sexton's bride may expand and it may spread to new sites.
Exclusion programme	Not applicable.	Not applicable.	Sexton's bride is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Sexton's bride is present throughout the region so would not be suitable for an eradication programme.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Progressive containment programme	Not applicable.	Not applicable.	Sexton's bride is present throughout the region so would not be suitable for an progressive containment programme.
Sustained control programme	Sexton's bride could be included in a sustained control programme. As a declared pest it would be banned from sale under the Biosecurity Act. This could help reduce the risk of spread over time.	Sexton's bride is already banned from sale and distribution in Northland and has been for a number of years so there would be no costs to plant retail outlets from a ban. Plant retail outlets are inspected regularly by council staff checking for many different plants.	Moderate. Sexton's bride could still spread and become more common.
Site-led pest programme	A site-led programme, where control of sexton's bride is required in defined parts of Northland could reduce the impacts of this species within the programme area(s).	A site-led programme would require an investment of time and resources by the council and affected landowners. It would not reduce or restrict the impacts of sexton's bride in areas that are not identified as being of high priority.	Moderate. A site-led programme could effectively reduce or eliminate the adverse effects of sexton's bride in local areas.
Summary of alternative assessments and preferred option:	Sustained control programme - Banned from Sale & Distribution With regard to section 6(1) of the NPD a low-level analysis was considered appropriate for Sexton's bride. In terms of alternative approaches assessed, under a do-nothing approach there would be no ability for Council to prevent the formal (nursery trade) or informal (fairs and on-line marketing) trade or circulation of this pest. Sexton's bride is already naturalised in Northland and its distribution and assessment of effects mean that eradication and progressive containment programmes are not realistic or affordable. Site-led management would control some plants at some sites, but ultimately this approach would also be unsustainable. Sustained control is the preferred outcome and most viable option. Declaring Sexton's bride formally as a pest in the Plan automatically triggers sections 52 and 53 of the Biosecurity Act, banning the pest from sale, propagation and distribution in Northland. This plant is not covered in the current National Pest Plant Accord (NPPA) which has over 150 plants listed, banning them from sale, propagation and distribution nationally. However, the NPPA is nationally focused and doesn't necessarily account for regional differences. The risks of this plant have been evaluated specifically in terms of its effects in Northland. It is important to recognise the wide climate and temperature ranges in New Zealand and that some pests require regional based initiatives based on these factors. Accordingly, Sexton's bride is one of 32 pest plants banned from sale, propagation and distribution in the Northland region. This designation recognises that generally they are a lower risk to the regions' values compared with other more invasive species. Council wishes to take a more proactive stance over their management, as opposed to disregarding them under a do-nothing scenario, while acknowledging it must operate within a finite budget and limited resources. Nurseries in general support the concept of the NPPA and the outcomes being sought.		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful

Sharp rush

Juncus acutus

(Family: Juncaceae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Sharp rush is a perennial spiny rush forming dense stiff clumps up to 1m tall. Stems are cylindrical and sharp tipped, and rhizomes woody. Clumped green/brown flower heads occur near the end of each stem in summer. Red/brown/orange fruit capsules are present in autumn, with approximately 200 seeds per head.
Habitat	Preferred habitats include the upper reaches of salt marshes, mud flats and ephemeral dune wetlands, plus neighbouring damp scrub, lake margins, damp pasture and roadsides. It favours damp sandy soils without standing water, but tolerates both seasonally dry soils and standing water.
Regional distribution	Present in coastal areas of Northland, Auckland, Waikato and Manawatu. The worst infestations in Northland are around the Whangaroa Harbour and on the Pouto Peninsula, Kaipara Harbour, but it is also present in other areas. It is not known to be present at any of the high value dune lakes, but is present in some wetlands.
Competitive ability	Invasive overseas. Particularly competitive at lower salinity levels. Less competitive in water-logged soils.
Reproductive ability	Sharp rush is sexually mature from about two years and can live up to 30 years. Seed germination is reduced by darkness. Soil disturbance is likely to facilitate establishment. Germination rate and speed decrease with increasing salinity. Long-lived seed bank. Vectors of spread: Seed is dispersed by water, contaminated machinery and soil movement. Vegetative spread via rhizomes.
Resistance to control	Can be controlled manually, mechanically or with herbicide, but can be difficult to control.
Benefits	Grown as an ornamental.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	Low	Low
Sheep and beef	Low	Low
Forestry	-	-

Land use type	Current land use infested	Potential land use
Horticulture	-	-
Native bush or forests		
Urban	-	-
Coastal	Low	Low
Estuarine and marine	Low	High
Freshwater/Wetland	Low	High

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	L	Unpalatable to livestock. Can invade damp pasture, leading to local dominance at the expense of valued pasture species. However only likely to be competitive in poor pasture.	Auckland Museum herbarium records; South Australia Government; Queensland Government, 2011; Williams, 2008.
Sheep and beef	-	L	As above.	
Forestry	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	L	Can obstruct water flow in drain, exacerbating flooding.	Queensland Government, 2011.
Species diversity	L	M	Can form dense monocultural stands which displace native salt marsh vegetation, impair recruitment and may reduce species richness. Can alter salt marsh invertebrate communities, including community homogenisation, reduced species richness and	Harvey et al., 2010; 2011; 2014; Saintilan; South Australian Government; Brown and Bettink, 2006.

Category	Current	Potential	Comment	Source
			diversity, increased or decreased abundance of some invertebrate taxa, and altered trophic structure. Impact on use of wetlands by birds unstudied. Can provide habitat for small mammal pests.	
Threatened species	-	L	As above.	
Social/cultural				
Human health	-	L	Spikes very sharp, unpleasant to walk through, could lead to eye injuries in children.	Keighery and Keighery 2006
Recreation	-	L	Forms dense, impenetrable spiny stands which are unpleasant to walk through and could impede recreational use of waterways.	Keighery and Keighery, 2006; Queensland Government, 2011.
Māori culture	L	M	Potential impacts on the mauri of wai māori, displacement of native species and impeded access.	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	Rather than applying a programme under the Regional Pest Management Plan, the species could come under a 'Connecting Communities' programme outside of the pest management plan, where advice and support are provided for sites of interest to communities. This will provide support to communities as and where the species is having impacts. People would still be encouraged not to dump garden waste and to be careful not to move pests around.	There would be no immediate costs to council under the pest management plan. However, costs in future could be greater if the species continues to spread.	High. By not applying a programme and rules to the species, there would be no provisions under the pest management plan to manage inappropriate practises that are exacerbating the spread.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Exclusion programme	Not applicable.	Not applicable.	Sharp rush is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Sharp rush is already present in many parts of the region so would not be suitable for an eradication programme.
Progressive containment programme	Not applicable.	Not applicable.	Sharp rush is already present in many parts of the region so would not be suitable for a progressive containment programme.
Sustained control programme	Sharp rush could be included in a sustained control programme. The council could include a rule banning sharp rush from sale, distribution and propagation which could help reduce the spread of sharp rush. However, sharp rush is not known to be sold in Northland.	Education, publicity, responding to reports, enforcement action.	Moderate - although these measures may help, sharp rush could still spread in Northland and infest high value areas.
Site-led pest programme	The council could specify particular high value areas as site-led programmes. These areas are often sites of high biodiversity value, and an incursion at these sites could have significant impacts. Sharp rush could be listed as progressive containment or eradication species in these areas, so that if a new incursion is detected through regular surveillance we are ready to act.	Rules would only be applicable in the areas defined as site led programmes and could not be enforced elsewhere. Costs include education, publicity, responding to reports, response to new incursions, enforcing rules.	Low - efforts could be targeted to protecting and responding to incursions in the highest value sites in Northland.
Summary of alternative assessments and preferred option:	Sustained Control If the Council were not to class sharp rush as a pest plant then the spread would be greatly exacerbated without any controls in place. Currently, sharp rush is at low levels regionally, however this would change without legal status as a pest plant and relevant controls. Including sharp rush as a Sustained Control plant will allow for publicity around controlling this pest species at events and for monitoring of currently invaded sites. Other programmes are unsuitable for sharp rush due to its current spread, however Sustained Control would provide the best control without undue cost.		

Spartina

Spartina alterniflora, S. anglica and S. townsendii

Also known as: cord grass or salt grass.

(Family: Poaceae)

Status in New Zealand

Spartina is listed as an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Spartina is an estuarine grass that grows in clumps up 1.5 metres tall. *S. alterniflora* is the most common spartina species in Northland, and is the more robust of the two, with shoots up to 30mm in diameter. *Spartina anglica* is smaller, with shoots up to 8mm in diameter. *S. townsendii* is a rare hybrid plant, rarely found north of the Kaipara Harbour.
Habitat	Spartina grows in soft sediment at wave-protected sites on the edges of estuaries and harbours. It grows in the inter-tidal zone, often with mangroves.
Regional distribution	Spartina is present in many Northland harbours and estuaries, but densities have been greatly reduced due to a long term control programme.
Competitive ability	Spartina is an aggressive and persistent invader of inter-tidal mudflats. It can take over inter-tidal areas, leading to a loss of habitat for shorebirds, recreational fisheries and seafood. The dense growth of spartina traps sediment, which can eventually raise the ground level to a point where the area is no longer inter-tidal. Extensive infestations can cause surface flooding on adjacent land.
Reproductive ability	*Spartina alterniflora* is not known to set seed in New Zealand and *Spartina anglica* produces only small amounts. Both species reproduce vegetatively, from spreading rhizomes (roots). Vectors of spread: broken pieces of rhizome may be transported by water, stock or in soil. The species may also be spread intentionally by humans. Seeds are spread by gravity and water.
Resistance to control	Physical damage and grazing result in the re-sprouting of underground rhizomes so physical control is not generally effective and plant material must be disposed of carefully and stock excluded from control sites. Spartina grows on the margins of estuaries, which are ecologically sensitive areas that present challenges for herbicide application. Biological control has been successful overseas.
Benefits	Spartina has been planted to "reclaim" estuaries for agricultural purposes.

Land uses occupied

Land use type	Current land use infested	Potential land use infested
Dairy	-	-
Sheep and beef	-	-
Forestry	-	-
Horticulture	-	-
Native	Low	High

Land use type	Current land use infested	Potential land use infested
Urban	-	-
Coastal	-	-
Estuarine and marine	Low	High
Freshwater/wetland	-	Low

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	L or +	Spartina has sediment trapping abilities. Spartina can also help prevent erosion, and has been used worldwide as an agent for coastal protection, stabilisation and land reclamation.	Timmins and McKenzie, 1995.
Water quality	L	L	Spartina has sediment trapping abilities. This filtering action could improve the quality of water running off the land and entering estuaries but can also cause flooding and exclude fish and birds from feeding grounds.	Timmins and McKenzie, 1995; Williams and Champion, 2008.
Species diversity	L	H	Spartina can form dense mats, displace native sea grass species and invade saltmarsh, mangroves and mudflats. This can reduce the availability of these habitats for invertebrates and shorebirds.	Timmins and McKenzie, 1995; Williams and Champion, 2008.
Threatened species	L	M	Spartina can displace eelgrass and invade saltmarsh, mangroves and mudflats, reducing the availability of these habitats to invertebrates and shorebirds including, potentially the 'at risk' banded rail.	Global invasive species database; Williams and Champion, 2008.

Category	Current	Potential	Comment	Source
Social/cultural				
Human health	-	-		
Recreation	-	M	Spartina can impede access to and navigation within estuaries.	Williams and Champion, 2008.
Māori culture	L	M	Spartina can reduce the area of habitat available for kaimoana species.	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Do nothing	If no management is undertaken there will be no short-term financial cost to the council associated with this species.	Spartina is an invasive species, which has the potential to spread and fundamentally alter the ecology and hydrology of the inter-tidal zones of estuaries and harbours. The economic costs and environmental impacts of failing to manage this species will be considerable.	High. If spartina is not managed its density and extent within currently infested estuaries and harbours will increase and it may spread to new sites. There are vast areas of suitable habtat for this species within Northland (Williams, 2008(a)). Without a programme to raise and maintain awareness of this species, it may be intentionally spread by people.
Exclusion programme	Not applicable.	Not applicable.	Spartina is already present in Northland.
Eradication programme	Spartina is present in harbours and estuaries throughout Northland. If the species could be eradicated it would prevent long-term environmental impacts and financial costs.	Eradication of spartina requires an investment of resources to control the known infestations and undertake on-going surveillance. If the species is not eradicated there will be ongoing costs of control and adverse impacts on the ecology of estuaries and harbours. Spartina control in the Kaipara Harbour is difficult as it is part in the Northland region and part in the Auckland region.	Low-moderate. The existing control programme is progressing well and the density of spartina within each infestation area has decreased signficantly (Foster, 2015). However, additional sites have been found as the programme has progressed. Spartina control is difficult so there is a chance that eradication may fail in the short to medium-term. It is more likely to succeed in the longer-term if control efforts and surveillance efforts are maintained.
Progressive containment programme	When compared to an eradication programme, a progressive containment	Spartina is an invasive species with the potential to invade large areas within harbours and estuaries. The aim of a progressive control	Moderate. There is a moderate risk that a progressive containment programme will not prevent spartina from spreading to new sites. However, eradication of spartina is

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	programme would incur lower financial cost to the council in the short-term. It would aim to confine the impacts of spartina to the locations where it is currently present and prevent it from having impacts elsewhere.	programme is not to eradicate the species so a it could give spartina the opportunity (that is, time) to spread, with consequent adverse effects on the environment and long-term control costs.	difficult and a long-term programme to contain and reduce spartina populations may be a feasible option.
Sustained control programme	When compared to an eradication programme, a sustained control programme would incur lower financial cost to council in the short-term. However, as the spartina is not generally on private property, it is difficult to see how a sustained control programme would aim to restrict the spread and impacts of spartina and prevent it from having increasingly severe impacts on the environment.	Spartina is an invasive species with the potential to spread widely again. The aim of a sustained control programme is not to eradicate the species so would give would the opportunity (that is, time) to spread to more sites in Northland.	High. There is a high risk that a sustained control programme will not prevent spartina from spreading to re-infest existing sites, as well as new sites.
Site-led pest programme	Not applicable.	Not applicable.	Spartina is present in a number of Northland's estuaries and harbours so is not a suitable candidate for a site-led programme.
Summary of alternatives assessed and preferred option:	Eradication programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for spartina. In terms of alternative approaches assessed, under <u>no regional intervention</u> (or do nothing) there would be unacceptable loss of biodiversity values and serious consequences for the regions' harbours and estuarine habitats. There would also be significant public and political concerns expressed as this pest plant and the current control programmes are widely known and supported around Northland and Auckland. Further, without any regional intervention the gains made over the years in controlling this plant in Northland, and jointly with Auckland Council for the Kaipara Harbour, would be lost. <u>Progressive containment or sustained control</u> approaches would be inappropriate as the plant occupies only a small part of the extensive area of suitable habitat in Northland. It would be very risky relying on 'lesser' control options when zero density is deemed achievable, albeit in the long-term. For example, a progressive containment approach would see reduced resources required and would incur lower costs but overtime spread would continue, just at a slower rate. Under sustained control, spread to new areas and increase in plant density at existing sites would be much faster. This would undo the efforts to date and would be		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	unacceptable in terms of the gains made. Both outcomes would ultimately fail to contain the spread of spartina. Eradication (or at least zero density) is the preferred outcome and is considered realistic given the current infestations and the excellent progress being made over the last few years. Eradication is very much a long-term goal compared with other terrestrial pests where eradication is also the outcome. The risks of not achieving eradication are known to Council and are being addressed. The current control programme is resource intensive and it can be technically challenging at times working in coastal marine environments (for example, EPA permissions are required for applying herbicides into these areas). Overall, Council considers that the benefits to the region exceed the costs and that the risks will not adversely affect control outcomes.		

Sweet pittosporum

Pittosporum undulatum

Also known as: sweet pittosporum, Victorian box, Australian cheesewood

(Family: Pittosporaceae)

Status in New Zealand

Sweet pittosporum is listed as an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Sweet pittosporum is a slender shrub or tree which can grow to 12 m tall and has smooth grey bark. It has shiny leaves that are 6 -15 cm long and 1.5 - 4 cm wide. They are pointed at both ends and have wavy margins. The leaves grow on purplish leaf stems (petioles) and alternate along the stems, but they're often crowded together at the ends of the stems. The plant has fragrant white flowers with five petals which bend downwards at the ends. The fruits are orange capsules that are 1-1.5 cm in diameter and contain sticky, orange seeds.
Habitat	Sweet pittosporum is a great coloniser of open, disturbed habitats. Within its native range in eastern Australia it can tolerate climates from moist sub-tropical to dry temperate. It is found on a range of soil types and old sand dunes, sometimes enduring severe salt spray. It can be found in a variety of habitats, such as rainforest, scrub, shrublands, watercourses, disturbed areas, forest margins, and open forest.
Regional distribution	Sweet pittosporum is present in Northland in low numbers at a limited number of sites e.g. Paroa Bay, Pouto, Cable Bay. Known infestations have been controlled.
Competitive ability	Sweet pittosporum is native to parts of southeastern Australia but is now a serious weed in other parts of Australia and in other parts of the world. It is a great coloniser of open, disturbed habitats but is also very shade tolerant and can invade relatively open forest and form a dense understorey. It is very competitive and shades out other vegetation. It can release chemicals into the soil that inhibit the growth of other plants.

Reproductive ability	Sweet pittosporum can start flowering at around 5 years of age and produces large numbers of fruits and seeds. It creates a dense soil seed bank and dense seedling recruitment. It can re-sprout after cutting or wind damage and cut stems will re-sprout if replanted Vectors of spread: The seeds are spread by birds. Its spread has also been encouraged by gardeners who value its hardiness and sweet perfume.
Resistance to control	Cut stems can re-sprout in the absence of herbicide application.
Benefits	Sweet pittosporum is probably the most widely cultivated *Pittosporum* species in the world. It is grown for its attractive foliage and fragrant flowers.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	-	Low
Horticulture	-	-
Native bush or forests	Low	High
Urban	Low	High
Coastal	Low	High
Estuarine and marine	-	-
Freshwater/Wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	L	Sweet pittosporum can outcompete other plants including, potentially, plantation pines.	Goodland and Healey, 1996 Binggeli and Goodland 1997 Invasive Species Compendium

Category	Current	Potential	Comment	Source
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	M	Sweet pittosporum can release chemicals into the soil that inhibit the growth of other plants (allelopathy).	Goodland and Healey, 1996 Binggeli and Goodland 1997 Invasive Species Compendium
Water quality	-	-		
Species diversity	-	H	Sweet pittosporum can invade native vegetation and out-compete plants through shading, below ground competition, and nutrient cycling. Its leaves contain toxins that can inhibit the growth of other plants.	Goodland and Healey, 1996 Binggeli and Goodland 1997 Invasive Species Compendium
Threatened species	-	M-H	Sweet pittosporum can invade native vegetation and out-compete plants, potentially including threatened species.	Goodland and Healey, 1996 Binggeli and Goodland 1997 Invasive Species Compendium
Social/cultural				
Human health	-	-		
Recreation	-	-		
Māori culture	-	H	Impacts upon native/taonga species.	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is taken there will be no short-term financial costs incurred by the council through the RPMP in relation to this species.	Sweet pittosporum has been found growing wild in Northland at a small number of sites. However, it has the potential to spread and have serious environmental impacts, with consequent future control costs.	High. Sweet pittosporum is cultivated in Northland, produces large numbers of bird-dispersed seed and could invade a range of indigenous habitats.
Exclusion programme	Not applicable	Not applicable	Sweet pittosporum is already present in Northland.
Eradication programme	Sweet pittosporum is currently present at a reasonably limited number of known sites but it has the potential to establish elsewhere. Eradication would enable long-term economic and environmental impacts to be avoided.	Eradication of sweet pittosporum would require an investment of resources to control known plants and undertake on-going surveys to ensure all plants have been removed and there is no regrowth.	Low-Moderate. There is a low to moderate risk of eradication being unsuccessful if inadequate resources are allocated for control and surveillance or if there are undetected infestations. However, known infestations have already been successfully controlled and it takes 5 years for plants in new infestations to start reproducing.
Progressive containment programme	A progressive containment programme would incur lower financial cost to the regional council in the short-term. It would aim to confine the impacts of sweet pittosporum to current infestation areas and gradually reduce the population.	Council resources would be required to undertake surveys and control. Sweet pittosporum is uncommon in Northland but has the potential to spread. If current control efforts are not maintained, eradication and containment may no longer be options and there will be long-term financial and environmental costs associated with the species.	Moderate-High. There is a moderate risk that a progressive containment programme will not prevent sweet pittosporum from spreading within Northland. It produces large numbers of viable seeds and is also spread by humans.
Sustained control programme	A sustained control programme would incur lower financial cost to the regional council in the short-term, and would aim to restrict the spread and impacts of sweet pittosporum.	A sustained control programme would not aim to remove sweet pittosporum from any sites where it becomes established.	Moderate-High. Sweet pittosporum produces large quantities of bird-dispersed seed, so a sustained control programme may not be aggressive enough to prevent the spread of this species.
Site-led pest programme	Not applicable	Not applicable	Sweet pittosporum is present in low numbers at a limited number of sites so it is not a suitable candidate for a site-led programme.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that sweet pittosporum does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be no regional intervention for sweet pittosporum , the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding. While sweet pittosporum has not been afforded pest status in Northland, it may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes.		

Sycamore

Acer pseudoplatanus

(Family: Sapindaceae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Sycamore is a large tree up to 20m tall, with a smooth trunk. It is deciduous but leaf fall is moderately protracted. Leaves are five-lobed, up to 20cm long, green but with reddish petioles up to 15cm long. Dense clusters of small, green flowers occur during October-November, with fruit in late summer-early autumn. Seeds are 0.5-1cm long with wings up to 4cm long.
Habitat	Preferred habitats include open or regenerating forest/scrub and forest margins (including pine plantations as well as native vegetation). Also, short-stature plant communities, and road and rail corridors. It colonises predominantly open sites, growth is slower in shade. High fertility, high pH soils are preferred. It tolerates range of soil moisture from damp gullies to moderate drought, and is fairly frost tolerant.
Regional distribution	Sycamore is present in the region but its distribution has never been formally surveyed.
Competitive ability	Sycamore seedlings grow rapidly, and it is a competitive coloniser of open sites. A persistent seedling bank can form under shade. There is potential for the seedling

	bank to rapidly exploit future canopy openings but growth rates remain very slow under intact canopy. It is less competitive on low fertility soils. Possible allelopathic effect, suppressing other plants.
Reproductive ability	Copious seed production (over 10,000 seeds/tree/year). Synchronous germination in spring; dormancy broken by winter chilling. The seed bank is unlikely to persist beyond a single season. Vectors of spread: Locally wind and gravity dispersed (mostly up to 50-100m), also some downstream dispersal by water.
Resistance to control	Control is labour intensive. Re-sprouts from stumps therefore need to paint with herbicide.
Benefits	Grown as an ornamental and for firewood. Nectar and pollen utilised by honey bees and a diverse range of other insects. Recorded as a host of the native mistletoe *Ileostylus micranthus*.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	-	Low
Horticulture	-	-
Native bush or forests	-	High
Urban	Low	High
Coastal	-	Low
Estuarine and marine	-	-
Freshwater/Wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	L	M	Saplings documented from pine plantations.	Sullivan et al., 2006
Horticulture	-	-		

Category	Current	Potential	Comment	Source
Other	-	-		
International trade	-	-		
Environment				
Soil resources	L	L	Deciduous, does not reabsorb much nitrogen prior to leaf senescence. Likely to accelerate nutrient cycling regimes in situations where it replaces native vegetation characterised by evergreen, structurally fortified species.	Millard and Proe, 1991; Hill et al., 2008.
Water quality	-	-		
Species diversity	L	L-M	May prevent recruitment of native vegetation where sycamore colonises bare ground more rapidly, especially in low stature plant communities and forest margins. However, growth may not necessarily exceed that of native early successional species. Creation of canopy shade may reduce ground-cover vegetation. Forms a persistent seedling bank under shade. Potential for seedling bank to rapidly exploit future canopy openings but growth rates can remain very slow under intact canopy. Therefore highly competitive exploiter of disturbances such as canopy gaps. Documented successfully recruiting under late successional tree species overseas, therefore may be able to invade some intact forest types. Leaves palatable to decomposers, leaf litter capable of supporting abundant and diverse range of decomposers. Possibly allelopathic, suppressing other plants.	Williams, 2011; Cieraad et al., 2015; Pages et al., 2003; Williams, 2011; Martin and Marks, 2006; Webb and Kaunzinger, 1993; Martin, 1999; Hill et al., 2008; Martin, 1999.

Category	Current	Potential	Comment	Source
Threatened species	-	-		
Social/cultural				
Human health	-	-		
Recreation	-	-		
Māori culture	-	L	See 'Species diversity'	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council under the pest management plant in relation to this species. Rather than applying a programme under the Regional Pest Management Plan, the species could come under a 'Connecting Communities' programme outside the pest management plan, where advice and support are provided for specific sites. This will provide support to communities as and where the species is having impacts.	Sycamore is already present in Northland. If no action is taken it will continue to spread, with consequent environmental impacts and future control costs.	Low. If no action is taken, existing infestations of sycamore may expand and it may spread to new sites.
Exclusion programme	Not applicable.	Not applicable.	Sycamore is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Sycamore is present throughout the region so would not be suitable for an eradication programme.
Progressive containment programme	Not applicable.	Not applicable.	Sycamore is present throughout the region so would not be suitable for an progressive containment programme.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Sustained control programme	Sycamore could be included in a sustained control programme. As a declared pest it would be banned from sale under the Biosecurity Act. This could help reduce the risk of spread over time.	Sycamore is already banned from sale and distribution in Northland and has been for a number of years so would be no costs to plant retail outlets from a ban. Plant retail outlets are inspected regularly by council staff checking for many different plants.	Moderate. Sycamore could still spread and become more common.
Site-led pest programme	A site-led programme, where control of sycamore is required in defined parts of Northland could reduce the impacts of this species within the programme area(s).	A site-led programme would require an investment of time and resources by the council and affected landowners. It would not reduce or restrict the impacts of sycamore in areas that are not identified as being of high priority.	Moderate. A site-led programme could effectively reduce or eliminate the adverse effects of sycamore. But sycamore does appear to be having large impacts in Northland at present and the council has not received any calls about this species in the last few years.
Summary of alternative assessments and preferred option:	Sustained control programme - banned from sale & distribution With regard to section 6(1) of the NPD a low-level analysis was considered appropriate for sycamore. In terms of alternative approaches assessed, under a do-nothing approach there would be no ability for Council to prevent the formal (nursery trade) or informal (fairs and on-line marketing) trade or circulation of this pest. Sycamore is already naturalised in Northland and its distribution and assessment of effects mean that eradication and progressive containment programmes are not realistic or affordable. Site-led management would control some plants at some sites, but ultimately this approach would also be unsustainable. Sustained control is the preferred outcome and most viable option. Declaring sycamore formally as a pest in the Plan automatically triggers sections 52 and 53 of the Biosecurity Act, banning the pest from sale, propagation and distribution in Northland. This plant is not covered in the current National Pest Plant Accord (NPPA) which has over 150 plants listed, banning them from sale, propagation and distribution nationally. However, the NPPA is nationally focused and doesn't necessarily account for regional differences. The risks of this plant have been evaluated specifically in terms of its effects in Northland. It is important to recognise the wide climate and temperature ranges in New Zealand and that some pests require regional based initiatives based on these factors. Accordingly, sycamore is one of 33 pest plants banned from sale, propagation and distribution in the Northland region. This designation recognises that generally they are a lower risk to the regions' values compared with other more invasive species. Council wishes to take a more proactive stance over their management, as opposed to disregarding them under a do-nothing scenario, while acknowledging it must operate within a finite budget and limited resources. Nurseries in general support the concept of the NPPA and the outcomes being sought.		

Sydney golden wattle

Acacia longifolia

(Family: Mimosaceae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Sydney golden wattle is a shrub or small tree that grows up to about 10m tall. Its leaves are narrow (approximately 2cm wide and 13cm long) with two prominent veins. It produces spikes of pale- or golden-yellow flowers during July - August and a seed pod up to 120mm long.
Habitat	Sydney golden wattle favours open and/or disturbed habitats including coastal dunes, riparian areas, dry banks, transport corridors, scrub and open forest (e.g. coastal pōhutukawa forest), and "wastelands". It tolerates frost, drought, and salt spray.
Regional distribution	Widespread scattered distribution across the region. There is a large infestation of Sydney golden wattle at Lake Kai Iwi. It has also been recorded at Karikari Peninsula, near Kaitaia, Puketi, South Hokianga and in gardens in Whangarei.
Competitive ability	History of invasiveness overseas. Sydney golden wattle has high growth rates and uses a lot of water, so it can shade-out other species and reduce water availability. Its deep leaf litter layer suppresses the establishment of seedlings and its ability to fix nitrogen from the atmosphere into the soil gives it a competitive advantage in a wide range of soil types. Particularly advantaged following fire. Most susceptible to inter-specific competition during early seedling establishment phase.
Reproductive ability	Sydney golden wattle produces large quantities of seeds that can remain viable in the soil for up to 50 years. Fire and other disturbance can stimulate seed germination. Vectors of spread: the seeds are spread over short distances by wind and gravity. It may also be spread by humans, as a garden plant.
Resistance to control	Seeds of Sydney golden wattle can remain viable in the soil for up to 50 years. Effective biocontrol agent overseas.
Benefits	Ornamental.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	-	Low
Horticulture	-	-
Native bush or forests	Low	High
Urban	Low	Low

Land use type	Current land use infested	Potential land use
Coastal	Low	High
Estuarine and marine	-	-
Freshwater/Wetland	Low	High

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	L	Sydney golden wattle is toxic to livestock. However, it is unlikely to invade managed pasture.	Dynes et al., 2002
Sheep and beef	-	L	Sydney golden wattle is toxic to livestock. However, it is unlikely to invade managed pasture.	Dynes et al., 2002
Forestry	-	L	Sydney golden wattle can establish beneath pine trees, reducing the amount of water available for the pine trees and reducing their growth rates.	Rascher et al., 2011a; 2011b
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	L	M-H	Sydney golden wattle fixes nitrogen from the atmosphere in the soil. This raises the nutrient status of the soil, an effect that is most noticeable in low fertility sites such as sand dunes. The increase in fertility can help other weeds to invade, and alter soil structure, microbial communities, and soil moisture levels.	Hellmann et al., 2011; Le Maitre et al., 2011; Marchante et al., 2004; 2008a; 2008b; 2008c; Morris et al., 2011; Rascher et al., 2008; 2011b; 2012; Rodriguez-Echeverria et al., 2009;
Water quality	L	L	When it grows along stream banks, Sydney golden wattle can reduce stream flows. It may also raise nitrogen levels in waterways because it is able to fix nitrogen from the air into the soil.	DOC, 2015; Prinsloo and Scott, 1999.

Category	Current	Potential	Comment	Source
Species diversity	L	M-H	Sydney golden wattle can form dense stands, excluding other plant species by casting shade and altering the habitat. Its leaf litter suppresses the germination and establishment of other plant species. This reduces the diversity of plants, soil microbes, invertebrates and lizards. Dune systems are particularly at risk.	Hellmann et al., 2011; Marchante et al., 2003; 2004; 2008a; Rascher et al., 2011; Remsburg et al., 2008; Rodriguez-Echeverria et al., 2009; Stellatelli et al., 2013.
Threatened species	-	M	Threatened species of plants, invertebrates and reptiles that inhabit dune communities and other low-stature plant communities are most at risk.	
Social/cultural				
Human health	-	L	The pollen of Sydney golden wattle is a mild allergen.	pollenlibrary.com
Recreation	-	L	Dense thickets of Sydney golden wattle on coastal dunes can impede access and reduce enjoyment of the coastal environment.	
Māori culture	L	M	Impacts on native/taonga species.	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council under the RPMP in relation to this species. Rather than applying a programme under the Regional Pest Management Plan, the species could come under a 'Connecting Communities' programme outside the pest management plan, where advice and support are provided for specific sites. This	Sydney golden wattle is already present in Northland. If no action is taken it will continue to spread, with consequent environmental impacts and future control costs.	Low. If no action is taken, existing infestations of Sydney golden wattle may expand and it may spread to new sites.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	will provide support to communities as and where the species is having impacts.		
Exclusion programme	Not applicable.	Not applicable.	Sydney golden wattle is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Sydney golden wattle is present throughout the region so would not be suitable for an eradication programme.
Progressive containment programme	Not applicable.	Not applicable.	Sydney golden wattle is present throughout the region so would not be suitable for a progressive containment programme.
Sustained control programme	Sydney golden wattle could be included in a sustained control programme. As a declared pest it would be banned from sale under the Biosecurity Act. This could help reduce the risk of spread over time.	Sydney golden wattle is already banned from sale and distribution in Northland and has been for a number of years so there would be no costs to plant retail outlets from a ban. Plant retail outlets are inspected regularly by council staff checking for many different plants.	Moderate. Sydney golden wattle could still spread and become more common.
Site-led pest programme	A site-led programme, where control of Sydney golden wattle is required in defined parts of Northland, e.g. Coastal dune lakes, could reduce the impacts of this species within the programme area(s).	A site-led programme would require an investment of time and resources by the council and affected landowners. It would not reduce or restrict the impacts of Sydney golden wattle in areas that are not identified as being of high priority.	Moderate. A site-led programme could effectively reduce or eliminate the adverse effects of Sydney golden wattle in local areas.
Preferred option:	Sustained control programme - Banned from Sale & Distribution Summary of alternative assessments and preferred option: With regard to section 6(1) of the NPD a low-level analysis was considered appropriate for Sydney golden wattle. In terms of alternative approaches assessed, under a do-nothing approach there would be no ability for Council to prevent the formal (nursery trade) or informal (fairs and on-line marketing) trade or circulation of this pest. Sydney golden wattle is already naturalised in Northland and its distribution and assessment of effects mean that eradication and progressive containment programmes are not realistic or affordable. Site-led management would control some plants at some sites, but ultimately this approach would also be unsustainable.		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	Sustained control is the preferred outcome and most viable option. Declaring Sydney golden wattle formally as a pest in the Plan automatically triggers sections 52 and 53 of the Biosecurity Act, banning the pest from sale, propagation and distribution in Northland. This plant is not covered in the current National Pest Plant Accord (NPPA) which has over 150 plants listed, banning them from sale, propagation and distribution nationally. However, the NPPA is nationally focused and doesn't necessarily account for regional differences. The risks of this plant have been evaluated specifically in terms of its effects in Northland. It is important to recognise the wide climate and temperature ranges in New Zealand and that some pests require regional based initiatives based on these factors. Accordingly, Sydney golden wattle is one of 32 pest plants banned from sale, propagation and distribution in the Northland region. This designation recognises that generally they are a lower risk to the regions' values compared with other more invasive species. Council wishes to take a more proactive stance over their management, as opposed to disregarding them under a do-nothing scenario, while acknowledging it must operate within a finite budget and limited resources. Nurseries in general support the concept of the NPPA and the outcomes being sought.		

Taiwan cherry

Prunus campanulata

(Family: Rosaceae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Deciduous, small, spreading tree usually 3-8m tall when mature. Leaves are hairless, thin, usually 130x60mm with a long tapered tip. Red bell-shaped flowers appear between July-September, hanging in clusters of 2-3 on short stalks. Fruit are scarlet, up to 12x10mm, like a small cherry. Seeds are up to 9mm long.
Habitat	Preferred habitats include native forest, including urban fragments, regenerating secondary bush, and relatively intact forest via canopy gaps, edges and riparian margins. Roadsides. Occasionally occurs as an epiphyte. Tolerates semi-shade. Urban forest fragments are the most invaded, likely due to current propagule pressure more than environmental tolerances.
Regional distribution	Present in gardens across region. Locally abundant throughout Northland.
Competitive ability	Naturalised overseas. Other similar species are also invasive overseas.
Reproductive ability	Can become sexually mature within first 1-2 years. Germination improved by cold scarification. Vectors of spread: Bird dispersed from planted specimens. Also spreads locally via suckering.
Resistance to control	

Benefits	Grown as an ornamental. Attractive to birds.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	L	L
Sheep and beef	L	L
Forestry	L	M
Horticulture	L	M
Native bush or forests	L	M
Urban	L	L
Coastal	L	L
Estuarine and marine	L	L
Freshwater/Wetland	L	M

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-	Data deficient. Potential impacts of deciduous pulses of leaf-litter on nutrient cycling unknown. Related species overseas are associated with altered soil chemistry.	Koutika et al., 2011.
Water quality	-	-		

Category	Current	Potential	Comment	Source
Species diversity	L	L-M	Invades native forest; presumed competition with and displacement of native plant species. Empirical data on impacts are lacking. Related species are highly invasive overseas, and known to reduce plant functional diversity in invaded forests. It is likely that this species is still in a lag phase, with potential to substantially increase in abundance in forest fragments due to bird-dispersed propagule pressure.	Chabrerie et al., 2010; Williams, 2011.
Threatened species	-	M		
Social/cultural				
Human health	-	-		
Recreation	-	-		
Māori culture	L	L-M	See 'Species diversity'.	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council under the pest management plant in relation to this species. Rather than applying a programme under the Regional Pest Management Plan, the species could come under a 'Connecting Communities' programme outside the pest management plan, where advice and support are provided for specific sites. This will provide support to communities as and where the species is having impacts.	Taiwan cherry is already present in Northland. If no action is taken it will continue to spread, with consequent environmental impacts and future control costs.	Low. If no action is taken, existing infestations of Taiwan cherry may expand and it may spread to new sites.
Exclusion programme	Not applicable	Not applicable	Taiwan cherry is present in the region.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Eradication programme	Not applicable	Not applicable	Taiwan cherry is present throughout the region so would not be suitable for an eradication programme.
Progressive containment programme	Not applicable	Not applicable	Taiwan cherry is present throughout the region so would not be suitable for a progressive containment programme.
Sustained control programme	Taiwan cherry could be included in a sustained control programme. As a declared pest it would be banned from sale under the Biosecurity Act. This could help reduce the risk of spread over time.	Sales of Taiwan cherry from nurseries is not extensive. Alternative forms of flowering non weedy cherry trees are available and widely sold. Plant retail outlets are inspected regularly by council staff checking for many different plants.	Moderate, Taiwan cherry would continue to spread to new sites.
Site-led pest programme	A site-led programme, where control of Taiwan cherry is required in defined parts of Northland could reduce the impacts of this species within the programme area(s).	A site-led programme would require an investment of time and resources by the council and affected landowners. It would not reduce or restrict the impacts of Taiwan cherry in areas that are not identified as being of high priority.	Moderate. A site-led programme could effectively reduce or eliminate the adverse effects of Taiwan cherry in local areas.
Summary of alternative assessments and preferred option:	Sustained control programme - Banned from Sale & Distribution Summary of alternative assessments and preferred option: With regard to section 6(1) of the NPD a low-level analysis was considered appropriate for Taiwan cherry. In terms of alternative approaches assessed, under a do-nothing approach there would be no ability for Council to prevent the formal (nursery trade) or informal (fairs and on-line marketing) trade or circulation of this pest. Taiwan cherry is already naturalised in Northland and its distribution and assessment of effects mean that eradication and progressive containment programmes are not realistic or affordable. Site-led management would control some plants at some sites, but ultimately this approach would also be unsustainable. Sustained control is the preferred outcome and most viable option. Declaring Taiwan cherry formally as a pest in the Plan automatically triggers sections 52 and 53 of the Biosecurity Act, banning the pest from sale, propagation and distribution in Northland. This plant is not covered in the current National Pest Plant Accord (NPPA) which has over 150 plants listed, banning them from sale, propagation and distribution nationally. However, the NPPA is nationally focused and doesn't necessarily account for regional differences. The risks of this plant have been evaluated specifically in terms of its effects in Northland. It is important to recognise the wide climate and temperature ranges in New Zealand and that some pests require regional based initiatives based on these factors. Accordingly, Taiwan cherry is one of 32 pest plants banned from sale, propagation and distribution in the Northland region. This designation recognises that generally they are a lower risk to the regions' values compared with other more invasive species. Council wishes to take a more proactive stance over their management, as opposed to disregarding them under a do-nothing scenario, while acknowledging it must operate within a finite budget		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	and limited resources. Nurseries in general support the concept of the NPPA and the outcomes being sought.		

Tradescantia

Tradescantia fluminensis

Also known as: tradescantia, wandering Jew, wandering willie

(Family: Commelinaceae)

Status in New Zealand

Tradescantia is listed as an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Tradescantia is a soft groundcover plant with succulent creeping stems that can form deep carpets. There are nodes along the stems that produce roots where they touch the ground. The oval leaves are dark-green, shiny, smooth and 3-6 cm long with pointed tips. It produces clusters of white flowers that are 2 cm in diameter and have three petals. It does not produce seeds in New Zealand.
Habitat	Tradescantia favours damp, shaded habitats, especially disturbed forest, forest edges,shrubland, streamsides, river systems, fernland, and wetlands.
Regional distribution	Tradescantia is widespread in Northland.
Competitive ability	Tradescantia is very tolerant of shade and poor drainage. It does not tolerate frost but can quickly recover or survive under trees (or other shelter) where frosts are lighter. It re-sprouts from shoot fragments after grazing or damage and grows rapidly.
Reproductive ability	Tradescantia does not produce seeds in New Zealand. Instead it reproduces from roots that grow from the spreading stems and from stem fragments. Vectors of spread: Fragments are dispersed by water, stock that trample plants and release fragments and humans (through dumping of garden rubbish, soil movement, pot plants and deliberate planting).
Resistance to control	Tradescantia is very difficult to control as it breaks into many pieces when pulled, with almost every piece of stem capable of resprouting. For this reason, extreme care needs to be taken when disposing of plant material. It can be controlled by the tradescantia leaf beetle or repeat applications of the herbicide triclopyr.
Benefits	Tradescantia was originally introduced to New Zealand as a garden plant.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	-	-
Horticulture	Low	Low
Native bush or forests	High	High
Urban	High	High
Coastal	Low	Low
Estuarine and marine	-	-
Freshwater/Wetland	Low	High

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	L	M	Mats of tradescantia growing on riverbanks can break away and contribute to flooding.	MPI
Species diversity	M	H	Tradescantia is an invasive, ground-mothering herb that is capable of preventing native forest regeneration by inhibiting	Standish, 2002

Category	Current	Potential	Comment	Source
			the growth of seedlings. It alters litter decomposition, nutrient cycling, the successional trajectory amongst plant species, and invertebrate biodiversity.	
Threatened species	L	M	Dense mats of tradescantia can inhibit the growth of seedlings and affect invertebrate diversity. This could include threatened species.	Standish, 2002
Social/cultural				
Human health	-	-		
Recreation	M	H	Tradescantia may reduce the aesthetic appeal of natural areas.	
Māori culture	M	H	Impacts upon native/taonga species.	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council in relation to this species.	Tradescantia is widespread in Northland but if no action is taken it may spread to new sites, with consequent environmental impacts and future control costs.	Moderate. If no action is taken, existing infestations of tradescantia may expand and it may spread to new sites.
Exclusion programme	Not applicable.	Not applicable.	Tradescantia is already present in Northland.
Eradication programme	Tradescantia is a serious environmental weed. If it could be eradicated, the adverse effects of this species would be prevented and the long-term costs of control would be avoided.	Eradication would require a large and sustained investment of resources.	High. Tradescantia is widespread in Northland and eradication is almost certainly unachievable.
Progressive containment programme	When compared to an eradication programme, a progressive containment programme would incur lower financial cost to NRC and landowners. It would aim to confine or reduce the	A Progressive containment programme would require an investment of time and resources from NRC and affected landowners. A Progressive containment programme would not aim to	High. Tradescantia is present throughout the region and a Progressive containment programme has a high chance of failing to reduce the impact of this species.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	distribution of tradescantia and reduce its adverse effects on the environment.	eradicate the species, so control costs would be on-going.	
Sustained control programme	When compared to an eradication programme, a sustained control programme (SCP) would incur lower short-term financial cost to NRC and landowners. A Sustained control programmewould aim to restrict the spread and impacts of tradescantia and prevent it from having increasingly severe impacts on the environment.	A Sustained control programme would require an investment of time and resources by NRC and affected landowners. A Sustained control programme would not aim to eradicate or contain the species, so control costs would be on-going. Tradescantia is already banned from sale and distribution in Northland and has been for a number of years so there would be no costs to plant retail outlets from a ban. These outlets are inspected regularly by council staff checking for many different plants.	Moderate. Tradescantia could still spread and become more common but, as a declared pest, it would be banned from sale under the Biosecurity Act. This could help reduce the risk of spread over time.
Site-led pest programme	A site-led programme, where control of tradescantia is required in defined parts of Northland could reduce the impacts of this species within the programme area(s).	A site-led programme would require an investment of time and resources by the council and affected landowners. It would not reduce or restrict the impacts of tradescantia in areas that are not identified as being of high priority.	Moderate. A site-led programme could effectively reduce or eliminate the adverse effects of tradescantia in some areas.
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that tradescantia does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be no regional intervention for tradescantia, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding. While tradescantia has not been afforded pest status in Northland, it may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes.		

Velvet groundsel

Roldana petasitis

Also known as: *Cineraia petasitis*, *Senecio petasitis,* Califonian geranium, roldana.

(Family: Asteraceae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Velvet groundsel is a large shrub or bush up to 2m tall. It has round, lobed, hairy leaves that are up to 20cm across and feel soft and velvety to the touch. Its stems are also hairy and are usually reddish in colour. During July to November it is covered in bunches of small, bright-yellow, daisy-like flowers. When flowering has finished there are numerous white fluffy seedheads.
Habitat	Velvet groundsel prefers disturbed, open sites such as forest margins, shrublands, roadsides, quarries, and wasteland. It can also be found in private gardens.
Regional distribution	Velvet groundsel is widespread in Northland.
Competitive ability	Velvet groundsel is fast growing and produces many seeds. Its fast growth rate means it can outcompete other plant species, smothering them and shading them out. It can also spread over the forest floor, preventing the regeneration of native seedlings. It prefers open sites but is semi-tolerant of shady conditions.
Reproductive ability	Velvet groundsel produces large numbers of seeds. It can also grow from stem fragments and where stems touch the soil they can take root. Vectors of spread: The seeds are spread by wind. Plant fragments can be spread in soil and dumped garden waste. Velvet groundsel may also be spread by gardeners, for ornamental purposes.
Resistance to control	Velvet groundsel can be controlled using a combination of physical methods (e.g. pulling plants out or felling them) and herbicide.
Benefits	Ornamental.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-

Land use type	Current land use infested	Potential land use
Sheep and beef	-	-
Forestry	-	-
Horticulture	-	-
Native bush or forests	Low	Low
Urban	Low	High
Coastal	Low	Low
Estuarine and marine	-	-
Freshwater/Wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	Low	Moderate	Velvet groundsel smothers and shades out smaller plants and can prevent the regeneration of native seedlings.	Weedbusters, 2008.
Threatened species	Low	Moderate	Velvet groundsel can outcompete other plants. This could include threatened species.	Weedbusters, 2008.
Social/cultural				
Human health	-	-		

Category	Current	Potential	Comment	Source
Recreation	Low	Moderate	Dense growth of velvet groundsel may impede access and reduce the aesthetic appeal of natural areas.	
Māori culture	Low	Moderate	Impacts upon native/taonga species.	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council under the RPMP in relation to this species. Rather than applying a programme under the Regional Pest Management Plan, the species could come under a 'Connecting Communities' programme outside the pest management plan, where advice and support are provided for specific sites. This will provide support to communities as and where the species is having impacts.	Velvet groundsel is already present in Northland but is not usually seen dominating large areas. If no action is taken it may spread, with consequent environmental impacts and future control costs.	Low. If no action is taken, existing infestations of velvet groundsel may expand and it may spread to new sites.
Exclusion programme	Not applicable.	Not applicable.	Velvet groundsel is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Velvet groundsel is present throughout the region so would not be suitable for an eradication programme.
Progressive containment programme	Not applicable.	Not applicable.	Velvet groundsel is present throughout the region so would not be suitable for an progressive containment programme.
Sustained control programme	Velvet groundsel could be included in a sustained control programme. As a declared pest it would be banned from sale under the Biosecurity Act.	Velvet groundsel is already banned from sale and distribution in Northland and has been for a number of years so there would be no	Moderate. Velvet groundsel could still spread and become more common.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	This could help reduce the risk of spread over time.	costs to plant retail outlets from a ban. Plant retail outlets are inspected regularly by council staff checking for many different plants.	
Site-led pest programme	A site-led programme, where control of velvet groundsel is required in defined parts of Northland could reduce the impacts of this species within the programme area(s).	A site-led programme would require an investment of time and resources by the council and affected landowners. It would not reduce or restrict the impacts of velvet groundsel in areas that are not identified as being of high priority.	Moderate. A site-led programme could effectively reduce or eliminate the adverse effects of velvet groundsel in local areas.
Summary of alternative assessments and preferred option:	Sustained control programme - Banned from Sale & Distribution With regard to section 6(1) of the NPD a low-level analysis was considered appropriate for velvet groundsel. In terms of alternative approaches assessed, under a do-nothing approach there would be no ability for Council to prevent the formal (nursery trade) or informal (fairs and on-line marketing) trade or circulation of this pest. Velvet groundsel is already naturalised in Northland and its distribution and assessment of effects mean that eradication and progressive containment programmes are not realistic or affordable. Site-led management would control some plants at some sites, but ultimately this approach would also be unsustainable. Sustained control is the preferred outcome and most viable option. Declaring velvet groundsel formally as a pest in the Plan automatically triggers sections 52 and 53 of the Biosecurity Act, banning the pest from sale, propagation and distribution in Northland. This plant is not covered in the current National Pest Plant Accord (NPPA) which has over 150 plants listed, banning them from sale, propagation and distribution nationally. However, the NPPA is nationally focused and doesn't necessarily account for regional differences. The risks of this plant have been evaluated specifically in terms of its effects in Northland. It is important to recognise the wide climate and temperature ranges in New Zealand and that some pests require regional based initiatives based on these factors. Accordingly, velvet groundsel is one of 32 pest plants banned from sale, propagation and distribution in the Northland region. This designation recognises that generally they are a lower risk to the regions' values compared with other more invasive species. Council wishes to take a more proactive stance over their management, as opposed to disregarding them under a do-nothing scenario, while acknowledging it must operate within a finite budget and limited resources. Nurseries in general support the concept of the NPPA and the outcomes being sought.		

Velvet leaf

Abutilon theophrasti

Also known as: butter print, China jute, Indian mallow

(Family: Malvaceae)

Status in New Zealand

Velvet leaf is listed as an unwanted organism under the Biosecurity Act 1993.

Relevant biology

Form	Velvet leaf is a summer-growing annual plant that can grow up to 1.5m tall or more. It has large, heart-shaped leaves, which are soft and velvety to the touch with a musky odour. It has small yellow to yellow-orange flowers that open for a few hours during the hottest part of the day. The distinctive black seed pods contain about 40 large, hard black seeds.
Habitat	Velvet leaf is native to India or China. In countries where it has been introduced it is found in wasteland, vacant lots, gardens and cultivated fields, especially maize and soyabean fields, and along fence rows. It is also reported as a weed of other row crops overseas, including asparagus, strawberries and orchards.
Regional distribution	Velvet leaf is not known to be present in Northland. However, there are infestations in the Waikato and North Auckland (Helensville).
Competitive ability	The spreading canopy of velvet leaf competes with other plants for sunlight, water and nutrients. It also produces chemicals that inhibit seed germination and seedling root elongation of other plants.
Reproductive ability	Velvet leaf reproduces from seeds, which are produced in large numbers and can survive for up to 50 years in soil. They germinate in large numbers in cultivated areas such as field crops. Vectors of spread: Velvet leaf has been accidentally imported into New Zealand with soya bean seed and in fodder beet and as a contaminant of other grains. The seed can also be spread on farm machinery, and as a contaminant in silage, straw and hay, or in effluent from animals that have been grazing infested land.
Resistance to control	Velvet leaf is much more susceptible to herbicides when it's very small (two to four leaves) and for effective control plants should be sprayed at this growth stage. The seeds can remain viable in the seedbank for up to 50 years.
Benefits	

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	Low
Sheep and beef	-	Low
Forestry	-	-
Horticulture	-	High
Native bush or forests	-	-
Urban	-	-
Coastal	-	-
Estuarine and marine	-	-
Freshwater/Wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	-		
Horticulture	-	M-H	Velvet leaf is one of the worst broadleaf weeds in maize and soya bean crops in USA. It affects many arable crops by competing for nutrients, space and water.	MPI;James & Cooper 2012
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	L	Velvet leaf produces chemicals that inhibit the germination and growth of other species.	James & Cooper 2012
Water quality	-	-		
Species diversity	-	L	Velvet leaf is not invasive to natural vegetation and the impact on biodiversity is small.	Invasive Species Compendium
Threatened species	-	-		
Social/cultural				
Human health	-	-		
Recreation	-	-		
Māori culture	-	-		

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	Velvet leaf is not known to be in Northland. If neighbouring regions were relied on to control	There would be limited public awareness of velvet leaf and a risk that it would	Medium. Without education and regulation there is a medium risk that velvet leaf

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	the species there would be no economic cost to the Northland region.	be accidentally introduced. If it is not in the pest management plan there would be no rules to manage the species in Northland.	could arrive and establish in Northland.
Exclusion programme	Public awareness and education about the risks and impacts of velvet leaf and a rule banning possession of the species in Northland could prevent it from establishing in the region. If it is included in the pest management plan there is the ability to respond immediately if an infestation is detected. This would include a rule requiring land owners or occupiers to destroy velvet leaf on land that they occupy.	Low. Velvetleaf is currently part of a MPI response. Excluding this species would prevent expenditure on its control if/when it invades Northland.	Low. People will be aware of the species and its potential impacts. There will be a rule banning possession of the species in Northland and allow immediate control should any be found.
Eradication programme	Public awareness and education about the risks and impacts of velvet leaf and a rule banning possession of the species in Northland could prevent it from establishing in the region. If it is included in the pest management plan there is the ability to respond immediately if an infestation is detected. This would include a rule requiring land owners or occupiers to destroy velvet leaf on land that they occupy.	Low. There is already educational material available for velvet leaf. Excluding this species would prevent expenditure on its control if/when it invades Northland.	Low. There are no currently known sites of velvet leaf in Northland, but it is possible that it is already here. People will be aware of the species and its potential impacts. There will be a rule banning possession of the species in Northland and allow immediate control should any be found.
Progressive containment programme	Not applicable	Not applicable	Velvet leaf is not known to be present in Northland.
Sustained control programme	Not applicable	Not applicable	Velvet leaf is not known to be present in Northland.
Site-led pest programme	Not applicable	Not applicable	Velvet leaf is not known to be present in Northland.
Summary of alternatives assessed and preferred option:	**Exclusion programme** In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for velvetleaf. In terms of alternative approaches assessed, under <u>no regional intervention</u> (or do nothing) there would be unacceptable loss of production values (as velvetleaf competes with crops for light, nutrients and water). There would also be significant political concerns and alarm from the farming/cropping sector given the high-profile nature		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	of this pest in relation to its post border spread throughout New Zealand in 2016 through contaminated seed. At the time of writing, there was still a level of uncertainty about the spread and impacts of velvetleaf from the initial incursions and the 2016/17 growing season will be a guide for any future responses required. Progressive containment or sustained control approaches would not be appropriate as the plant is thought to occupy only a fraction of the areas suitable in Northland. It would be risky relying on 'lesser' management options when eradication is deemed achievable, despite some lack of knowledge regarding its impacts among growers. Exclusion is the preferred outcome and a regulatory approach is proposed. Although velvetleaf is capable of late emergence, is shade tolerant and is capable of producing seed under the crop canopy, it is relatively easy to identify amongst low growing crops and is well controlled using herbicides. There has also been significant raising of awareness among farmers and the cropping industry and the Council is confident that velvetleaf will be relatively easy to destroy before it establishes. However, there may be some resistance to measures among growers if costs imposed become significant. As of late 2016, the anticipated council inspection and occupier control costs involved under an eradication programme are relatively minor and are not expected to affect the management outcomes sought.		

Wild ginger

Hedychium flavescens and Hedychium gardnerianum

(Family: Zingiberaceae)

Status in New Zealand

Wild ginger is listed as an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Both species are non-woody perennials, growing up to 2m tall from thick-branching rhizomes (swollen underground stems). Rhizomes form dense beds up to one metre deep excluding all other species. They produce shiny leaves 20-45cm long. Kahili ginger flowers January - March and produces scented, lemon-yellow flowers with conspicuous red stamens, followed by fruiting spikes with fleshy orange fruits. Yellow ginger produces scented, cream-coloured flowers in clusters, from May / June and does not produce fruit.
Habitat	Wild ginger is a forest invader, including regenerating forests, stream side and alluvial forest, light gaps and gullies. It cannot tolerate very dry or rocky areas, and prefers fertile soils.
Regional distribution	Found in many parts of Northland, particularly in and adjacent to coastal settlements. Major infestations are found in the Herekino, Whangaroa, Kohukohu, Rāwene, Waimamaku, Waipoua, Helena Bay, McLeods Bay and Whāngārei areas. Kahili ginger is the most common and invasive of the two species.

Competitive ability	Both species form dense colonies in native bush, on road sides and riverbanks, smothering and eventually replacing all other species. Extremely shade tolerant, somewhat tolerant of frost and drought, and can withstand immersion in sea water. Wild ginger can multiply when rhizomes are damaged. Young plants are palatable to livestock, and both species tend to invade all areas where stock are excluded.
Reproductive ability	Kahili ginger flowers and fruits in January - March, producing up to 100 seeds per flower head. These seeds are primarily dispersed by birds at distances of up to one kilometre, and secondarily by water for several kilometres. Seeds survive for 2-4 years. It can also reproduce from fragments of rhizomes. Yellow ginger does not produce seeds in New Zealand and reproduces solely by vegetative spread at distances of up to 5 metres. This spread can be influenced by human activity such as vegetation clearance and dumping, soil movement, and machinery. Fragments of rhizomes can also be dispersed in flood waters.
Resistance to control	Plants and cut stems can be treated with herbicide, or removed manually. If removed manually the plants must be disposed of correctly or dried and burned, as fragments can survive indefinitely.
Benefits	Not applicable.

Land uses occupied

Land use type	Current land use infested	Potential land use infested
Dairy	Low	Low
Sheep and beef	Low	Low
Forestry	High	High
Horticulture	Low	Low
Native	Low	High
Urban	Low	Low
Coastal	High	High
Estuarine and marine	-	-
Freshwater	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	L	L		
Sheep and beef	L	L		

Category	Current	Potential	Comment	Source
Forestry	L	H	Invades plantation forestry and forms dense swards that dramatically increase reestablishment costs after logging. Wild ginger can form dense growth in plantation forests, smothering young native seedlings and preventing them from establishing.	Global invasive species database; Invasive species compendium;
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	L	L	Contributes to erosion on steep land. In steep areas prolonged rainfall causes the rhizome beds to become heavy with absorbed water and the soil can become slip prone.	Invasive species compendium
Water quality	L	L	Erosion can also downgrade water quality, impede water flow and exacerbate flooding.	Invasive species compendium
Species diversity	M	H	Wild ginger can form dense growth in native forests, smothering young native seedlings and preventing them from establishing. Seedling density and species richness are lower in dense ginger stands, and seedling composition is dominated by species with larger seeds which may effect the forest canopy. This may result in the alteration on native forest habitats and ecosystems and in the degradation of native forest communities. It out-competes other species for light, space, nutrients and moisture and its shade tolerance makes it able to thrive in forests.	Global invasive species database; Invasive species compendium; Williams et al., 2003
Threatened species	L	M	As above. Dense clumps of wild ginger in areas where kiwi are present are likely to prevent them from foraging on the forest floor.	Waikato Regional Council
Social/cultural				
Human health	-	-		
Recreation	L	H	Can impede access, particularly around waterways.	
Māori culture	M	H	Prevents natural regeneration of native species that are potentially culturally important.	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no financial costs incurred by the council in relation to this species.	Wild ginger is a serious environmental weed with the ability to invade a range of habitat types. It is already common and widespread in Northland and if no action is taken, the population of this species will continue to increase and have adverse effects on the environment.	Wild ginger is highly invasive, spreads via bird-dispersed seeds and can establish in a range of habitats. If no action is taken it will continue to have high environmental and with it increased human health impacts.
Exclusion programme	Not applicable	Not applicable.	Wild ginger is already present within Northland
Eradication programme	Wild ginger is an agresive forest invader and an economic weed of production forests. Eradication, if possible would avoid long term costs of control	Eradication will require a very large and sustained investment of resources of both conventional and new technologies which would be unsustainable in the medium to long term.	High. Wild ginger is widespread and abundant. Eradication is unachievable given current technologies
Progressive containment programme	This would aim to reduce the distribution and adverse effects of wild ginger and result in less cost to ratepayers compared to eradication.	The approach would still incur a large cost as wild ginger is established throughout production and native forests. Control costs would be ongoing and significantly high.	High to moderate as wild ginger has already spread throughout northland. A Progressive containment programme would have to be sustained for the long term.
Sustained control programme	Predicted to incur lower short term costs to NRC and landowners than the above approaches. This approach would aim to restrict spread and impacts and could be included in a sustained control programme with a good neighbour rule with a specified boundary clearance	Would require an investment of time and financial resources and costs would be ongoing. Investment in biological control agents should also be regarded as a prudent control approach.	Moderate . Wild ginger has already spread throughout northland however the ongoing spread will mean a higher future cost to production forests and the environment. many landowners are undertaking control at their own cost and adjacent , unmanaged land can sometimes be a source of reinvestation. Therefore a level of intervention is warranted.
Site-led pest programme	A site led programme at a small scale would reduce the impacts of this species.	Much high value habitat of northland is in areas where access is difficult and control would be expensive and ongoing. In areas outside of the site led programmes	Moderate. Due to the abundance and wide spread distribution of wild ginger it is predicted this approach would only be successful at a small scale (up to a hundred

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
		spread of wild ginger would continue unchecked and provide an ongoing source of seed of reinvestation.	hectares) and fail at a regional scale.
Summary of alternative assessments and preferred option:	Sustained control programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for both ginger species. In terms of alternative approaches assessed, under no regional intervention (or do nothing) maintaining the gains of previous control programmes would be lost, including a recent council led revitalisation advocacy programme. Any control carried out would become voluntary and unenforceable, although many occupiers would continue ginger control in the absence of a Plan. Overall, the do-nothing approach would be unacceptable for many communities, particularly those in coastal areas where it is most prolific, who have been battling ginger for many years. There would be high political risk to council in not having wild ginger declared a pest and concerns would be voiced by the forestry industry, where ginger is also a considerable problem. Due to the widespread nature of wild ginger, eradication is not technically feasible or realistic and the direct control costs that would be imposed on both council and landowners (through monitoring and enforcement across entire properties and the region) would be inappropriate and unsustainable. Progressive containment and site led control may be achievable in some areas (with defensible boundaries from reinvasion and concerted control efforts) but on a region-wide scale these options would be costly and ineffective, particularly due to ginger's opportunistic ability to spread along riverbanks and roadsides and into coastal and waste areas. Sustained control, with a 10m boundary clearance 'good neighbour' rule (activated by a valid complaint from a directly affected nearby owner) is a pragmatic way to address most landowner concerns and is the preferred option. It recognises the widespread nature of wild ginger while ensuring that a robust process is available (via the Biosecurity Act) to reduce externality effects on landowners who want to actively control it. Further, mitigation is provided for in terms of a key pathway of ginger spread, with an additional clearance rule for quarries (the working face extraction areas) plus a 50m buffer around this area. Suggested reclassification Wild ginger is classified as a suppression plant in the current Regional Pest Management Plan. This category can be translated to a Sustained Control programme, which provides for sustainable control to a level where the cost imposed on persons are manageable. Proposed RPMP GNR: "Land occupiers within Northland shall destroy all Wild ginger within 10m of an adjacent property, where the adjacent or nearby land occupier is taking reasonable measures to manage Wild ginger or its impacts on pastoral production or environmental values. This good neighbour rule will be enforced on receipt of a complaint from a directly affected land occupier."		

Good neighbour rule tests

Before a rule can be identified as a good neighbour rule in a RPMP, the regional council must be satisfied of the matters in subclause (a), (c), and (d) and must comply with the requirements in subclause (b) and (e):	
Tests	

In the absence of the rule, the pest would: • spread to land that is adjacent or nearby within the life of the plan; and • cause unreasonable costs to an occupier of that land.	Wild ginger seeds can be spread up to 100 metres by bird and will also gradually spread vegetatively, or could be relocated some distance by human activity or flood. It is tolerant of most environmental conditions, and it is highly likely that it will spread to adjacent land if not controlled. Wild ginger can require ongoing management and appropriate disposal of removed plants. For some landowners there will be a considerable cost, particularly if re-infestation occurred from uncontrolled neighbouring land.
In determining whether the pest would spread as described in subclause (a) the regional council must consider: • the proximity and characteristics of the adjacent or nearby land; and • the biological characteristics and behaviour of the particular pest (the greater the distance between properties, the more difficult to satisfy the test in subclause (a).	With both seed and vegetative spread to consider, it is highly likely that Wild ginger would establish on adjacent land, including road and rail corridors, if not controlled in the boundary area.
The land that is adjacent or nearby, as described in subclause (a), must be clear from a pest or, if the pest is present on that land, the occupier of that land must be taking measures to manage the pest or its impacts	In order for the good neighbour rules in the proposed RPMP to apply, it is a requirement that the neighbouring property is clear of wild ginger, or neighbouring land is only sparsely infested.
The rule must not set a requirement on an occupier that is greater than that required to manage the spread of the pest.	The requirement of a ten metre control zone for boundaries adjoining properties where wild ginger is being controlled provides an adequate means of protecting adjacent properties free of wild ginger. Should Wild ginger re-infest these areas there is the potential for much further spread and significant ongoing management costs.
In determining the rules to be set to manage the costs to an occupier of land that is adjacent or nearby, of the pest spreading, the regional council must consider: • the biological characteristics and behaviour of the particular pest; and • whether the costs of compliance with the rule are reasonable relative to the costs that such an occupier would incur, from the pest spreading, in the absence of a rule.	Wild ginger plants have the ability to spread up to 100 metres from an original infestation, depending on the species, meaning there is a real risk of infestation should the plants not be controlled at the boundary. The costs of control imposed by wild ginger could be significant. Compliance costs are considered to be reasonable in comparison.
Proposed Good neighbour rules discussion: Rules in current RPMS: 1. Land occupiers must destroy all wild ginger within 10 metres of a property boundary where the boundary adjoins a road or rail reserve clear of wild ginger	

2. Every road or rail controlling authority shall implement a control programme aimed at progressively controlling wild ginger on road or rail reserves under their jurisdiction where adjoining land is clear or only sparsely infested with wild ginger, in accordance with a five year management plan which shall be negotiated with and agreed to by the Northland Regional Council

Proposed GNR rules for RPMP:

1.Land occupiers within Northland shall destroy all Wild ginger within 10m of an adjacent property, where the adjacent or nearby land occupier is taking reasonable measures to manage Wild ginger or its impacts on pastoral production or environmental values. This good neighbour rule will be enforced on receipt of a complaint from a directly affected land occupier.

Quantitative analysis

The medium level analysis for the proposed sustained control programme was undertaken using the GNR model for pest plants developed for regional councils (Harris et al., 2017) and adapted for the Northland situation. The model undertakes both the cost benefit and reasonableness assessments required under sections 6 and 8 respectively of the NPD. In terms of the cost benefit analysis, the model focuses on identifying the boundary distance between two properties that creates a net benefit, i.e. where the costs of introducing a GNR (the sum of the costs of control on the source property, the costs of inspection and the costs the receptor still bears due to seed bank net of any benefit the source property owner receives from controlling the plant pest) is less than the costs that the receptor bears in the absence of a GNR. For the reasonableness assessment, the model compares the costs of control imposed on the source property owner by the GNR with the additional costs of control that the receptor property faces in the absence of the GNR, and reports this as a ratio between the two.

The following two tables contain the specific pest, programme and monetary assumptions that were inputted for Wild ginger in Northland into the GNR model. The benefits from controlling the plant pest for each land use type was calculated based on the potential impact of the pest on the land use as described in the qualitative impact assessment above. As Wild ginger is not one of the pest plants included in the GNR model, gorse (without seedbank) was considered as the plant species most similar in terms of dispersal.

Pest and programme assumptions

Pest assumptions	Values	Programme assumption	Values
Seed bank included	Yes	Proposed boundary width	10 metres
Pest abundance	Locally common	Proposed inspection required	Once (over life of plan)
Density of source infestations	Dense	Cost of inspection	$500 per property

Land use specific assumptions ($/ha/annum)

Variable	Dairy	S&B intensive	Arable	Horticulture	Hill country	Hard hill country	Conservation	Forestry	Non-productive
Benefits from controlling the plant pest ($/ha/year)	$54	$14	$40	$228	$8	$6	$176	$183	$126
Land occupier costs of controlling dense	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000

Variable	Dairy	S&B intensive	Arable	Horticulture	Hill country	Hard hill country	Conservation	Forestry	Non-productive
infestations ($/ha/year)									

The following two tables present the results of the model. In terms of the cost benefit assessment, the results show that when the source infestation is dense plants, there is very likely to be a net benefit from introducing a 10m GNR for wild ginger when the receptor land use is hill country, hard hill country, conservation, forestry and non-productive. Further, the costs imposed by a GNR may possibly be be less than the costs of the situation without the GNR when the receptor land use is in dairy, sheep and beef intensive, arable or horticulture. A 10m GNR for wild ginger is not likely to create a net benefit when the source land use is hard hill country.

Cost benefit assessment: Length of boundary required for there to be a net benefit (metres)

		Receptor land use							
Source land use		Dairy	S&B intensive	Arable	Horticulture	Hill country	Hard hill country	Conservation	For
	Dairy	>2000m	>2000m	>2000m	>2000m	410	220	220	2
	Sheep and beef intensive	C > B	C > B	C > B	C > B	1370	350	350	3
	Arable	C > B	C > B	C > B	C > B	540	250	250	2
	Horticulture	130	130	130	130	100	80	80	
	Hill country	C > B	C > B	C > B	C > B	C > B	1980	1980	1
	Hard hill country	C > B	C > B	C > B	C > B	C > B	C > B	C > B	C
	Conservation	800	800	800	800	290	180	180	1
	Forestry	640	640	640	640	270	170	170	1
	Non-Productive	C > B	C > B	C > B	C > B	780	290	290	2

C > B = There is no net benefit. The costs imposed by the GNR are always greater than the costs without the GNR. Blank = no costs for receptor landholder

Plant pests

Reasonableness assessment: Ratio of costs for source landholder to the costs for the receptor landholder

		Receptor Land use								
Source Land use		Dairy	S&B intensive	Arable	Horticulture	Hill country	Hard hill country	Conservation	Forestry	Nor
	Dairy	1.18	1.18	1.18	1.18	0.94	0.79	0.79	0.79	
	Sheep and beef Intensive	1.18	1.18	1.18	1.18	0.94	0.79	0.79	0.79	

	Arable	1.18	1.18	1.18	1.18	0.94	0.79	0.79	0.79
	Horticulture	1.18	1.18	1.18	1.18	0.94	0.79	0.79	0.79
	Hill country	1.42	1.42	1.42	1.42	1.13	0.94	0.94	0.94
	High country	1.66	1.66	1.66	1.66	1.32	1.10	1.10	1.10
	Conservation	1.66	1.66	1.66	1.66	1.32	1.10	1.10	1.10
	Forestry	1.66	1.66	1.66	1.66	1.32	1.10	1.10	1.10
	Non Productive	1.66	1.66	1.66	1.66	1.32	1.10	1.10	1.10

In terms of reasonableness, when the source infestation is scattered plants the cost of compliance with the rule for the source landowner is between 0.79 and 1.66 times the cost for the occupier who would otherwise be affected.

Wild plum

Harpephyllum caffrum

Also known as: African plum

(Family: Anacardiaceae)

Status in New Zealand

Relevant biology

Form	The wild plum is a large, evergreen tree that grows up to 15 m tall. The main stem is clean and straight, the bark is smooth when young, becoming rough and a dark grey-brown as it grows older. Its branches are curved upwards, with leaves crowded towards the ends, forming a thick crown at the top of the tree. The leaves are sickle-shaped, shiny, glossy and are usually dark-green but sometimes interspersed with red leaves. The whitish-green flowers are borne near the ends of the branches and the tasty plum-like fruits first appear green and then turn red when they ripen in autumn.
Habitat	Wild plum is native to eastern parts of southern Africa, where it is usually found in riverine forests in frost-free areas.
Regional distribution	Wild plum has been recorded at one site in Northland, from where it has been eradicated. It spread from a garden to become naturalised in a dry, coastal site on sun-baked clay near Tutuakaka (L. Forester pers.comm.).
Competitive ability	Wild plum is present on Lord Howe Island (Lord Howe Island Board 2014) where it is regarded as an invasive plant that is targeted for eradication in the Lord Howe Island Biodiversity Plan (2014). It is also sparingly naturalised in Queensland (Chimera 2012) and has been recorded in New South Wales (AVH). There are cultivated specimens of wild plum in Auckland, at the University of Auckland and at Western Springs (Wilcox 1998).
Reproductive ability	Wild plum grows readily from seed.

	Vectors of spread: The fruits of wild plum are attractive to birds, which then distribute the seed. It may also be spread by humans, either inadvertently or deliberately for cultivation.
Resistance to control	
Benefits	Wild plum is an ornamental garden tree used for attracting birds and butterflies into gardens. The fruit is edible to humans and birds and the bark is a popular traditional medicine in South Africa.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	-	-
Horticulture	-	-
Native bush or forests	-	Low
Urban	-	High
Coastal	-	-
Estuarine and marine	-	-
Freshwater/Wetland	-	-

High = Preferred land use; Low = Less preferred land use

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-	There is no evidence that wild plum is an agricultural weed.	Chimera 2012
Sheep and beef	-	-	There is no evidence that wild plum is an agricultural weed.	Chimera 2012
Forestry	-	-		
Horticulture	-	-	There is no evidence that wild plum is a horticultural weed.	Chimera 2012
Other	-	-		
International trade	-	-		
Environment				

Category	Current	Potential	Comment	Source
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	M-H	Wild plum is native to eastern parts of southern Africa, where it is usually found in riverine forests. It has already been found growing wild in Northland on a dry, coastal site on sun-baked clay. Based upon these observations, it has the potential to spread into a range of habitats in Northland including gumland, coastal headlands, and native forest and scrub.	Cook 2014 L. Forester (NRC) pers. comm.
Threatened species	-	M-H	Wild plum has the potential to invade native vegetation such as gumlands which are habitat for threatened plant species.	L. Forester (NRC) pers. comm.
Social/cultural				
Human health	-	+	Wild plum produces edible fruits and the bark can be used for medicinal purposes.	PlantzAfrica
Recreation	-	-		
Māori culture	-	M	Impacts upon native/taonga species.	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Do nothing	Following the eradication of the only known infestation, wild plum is not known to be in Northland. If neighbouring regions were relied on to control the species there would be no economic cost to the Northland region.	There would be limited public awareness of wild plum and a risk that it would be intentionally introduced for ornamental purposes. If it is not in the pest management plan there would be no rules to prevent sale or possession of this species in Northland.	Medium-high. Without education and regulation there is a medium-high risk that wild plum could be brought to Northland and establish in the wild. It has already been cultivated here as an ornamental garden plant that was eradicated when it became invasive.
Exclusion programme	Public awareness and education about the risks and impacts this species could have in Northland, and a rule banning possession of the	Low-Medium. Educational material will need to be prepared. Excluding this species would prevent expenditure on its control	Low. People will be aware of the species and its potential impacts. There will be a rule banning possession of the species in Northland, which

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	species in Northland could prevent it from establishing in the region. If it is included in the pest management plan there is the ability to respond immediately if an infestation is detected in Northland.	if/when it invades Northland.	could help discourage people from bringing it to Northland and allow immediate control should any be found.
Eradication programme	Not applicable	Not applicable	Wild plum is not currently known to be present in Northland.
Progressive containment programme	Not applicable	Not applicable	Wild plum is not currently known to be present in Northland.
Sustained control programme	Not applicable	Not applicable	Wild plum is not currently known to be present in Northland.
Site-led pest programme	Not applicable	Not applicable	Wild plum is not currently known to be present in Northland.
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that wild plum does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be <u>no regional intervention</u> for wild plum, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding. While wild plum has not been afforded pest status in Northland, it may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes.		

Wilding kiwifruit

Actinidia spp.

Also known as: wilding kiwifruit, kiwifruit

(Family: Actinidiaceae)

Status in New Zealand

No legal status, however Kiwifruit Vine Health works collaboratively with Regional Councils and landowners to manage wild kiwifruit populations and abandoned orchards to reduce biosecurity risk to the kiwifruit industry. Kiwifruit Vine Health is a grower-driven, pan-industry organisation that was established in 2010 to respond to the Psa incursion.

Relevant biology

Form	Kiwifruit is a vigorous vine that is cultivated for its fruit. The entire plant is hairy. The leaves are oval, about 14cm across and have finely-toothed margins. The leaf stem is reddish in colour. During October-December kiwifruit produces white flowers that are up to about 6 cm across. They are followed by edible fruits that are brown, hairy, oval and up to 8cm long. They have green flesh and numerous black seeds. Wild kiwifruit vines can grow more than 20 m high into the forest canopy.
Habitat	Wilding kiwifruit are found in areas where kiwifruit is cultivated. They are a particular problem in the Bay of Plenty, where infestations are most often found in gullies and shelterbelts. It is able to grow in native forest and pine forest. Wilding kiwifruit is most commonly found near orchard areas but is also known from more isolated locations.
Regional distribution	There are very few wild kiwifruit in Northland but they have been found on roadsides and near orchards. It is not clear why kiwifruit has not readily established in the wild in Northland. It may be because the climate in Northland is too warm for good seed germination, but studies have shown that kiwi fruit seed can germinate without cold stratification (e.g. Lawes and Anderson 1980, Çelik *et al.* 2006).
Competitive ability	Wilding kiwifruit can grow in a wide variety of habitats including scrub, gullies, young and old stands of native bush and pine plantations. Seedlings appear to be moderately shade tolerant and can establish in tree fall gaps within mature forest. It is also tolerant of a reasonably wide temperature range, although young shoots are frost sensitive. Wilding kiwifruit grow rapidly so they can out-compete native seedlings and pine seedlings and form dense, heavy blankets of growth. The smothered plants beneath the kiwifruit vines are shaded and may break under the weight of the vines. Kiwifruit plants are also very long-lived.
Reproductive ability	Most wilding kiwifruit originate from orchard-grown plants but wild plants also produce seed. Each fruit contains about 300 seeds and hundreds to thousands of fruit can be produced in a season by a large female vine. Seed viability in the soil appears to be limited to about 3 years and plants do not begin producing fruit until they are about 5 years old. Vectors of spread: The seeds are spread by birds, especially silvereyes who eat fruit that is left on vines in orchards. They are also spread by humans dropping fruit remains, dumping reject fruit and using fruit as stock feed.
Resistance to control	Wilding kiwifruit can be sprayed or stump treated, but it can be difficult to trace plants back to their stumps.
Benefits	The fruit is edible and is cultivated for human consumption.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	-	High
Horticulture	Low	High
Native bush or forests	-	-
Urban	Low	High
Coastal	-	Low
Estuarine and marine	-	-
Freshwater/Wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	-	Wilding kiwifruit can outcompete pine seedlings and cause problems in commercial pine plantations.	Landcare Research 2002a
Horticulture	-	M	Wilding kiwifruit have the potential to impact upon kiwifruit orchards. Wild plants may harbour Psa (Pseudomonas syringae pv. actinidiae) which could then spread into orchards. Kiwifruit Vine Health is a grower-driven, pan-industry organisation that was established in 2010 to respond to the Psa incursion. It works collaboratively with Regional Councils and landowners to manage wild kiwifruit populations and abandoned orchards to reduce biosecurity risk to the kiwifruit industry.	Kiwifruit Vine Health (www.kvh.org.nz/wild_kiwifruit)
Other	-	-		

Category	Current	Potential	Comment	Source
International trade	-	M	Wilding kiwifruit have the potential to impact upon kiwifruit orchards. Wild plants may harbour Psa (Pseudomonas syringae pv. actinidiae) which could then spread into orchards, reducing the volume of kiwifruit available for export.	Kiwifruit Vine Health (www.kvh.org.nz/wild_kiwifruit)
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	M-H	Wilding kiwifruit can smother native plants and slow or prevent the regeneration of native forest and scrub.	Landcare Research 2002a
Threatened species	-	M	Wilding kiwifruit can smother native plants, potentially including threatened species.	Landcare Research 2002a
Social/cultural				
Human health	-	+	The fruits are edible and are cultivated, but it is not known if fruit are harvested from wilding plants.	
Recreation	L	L-M	Dense growth of vines may impede access to recreational areas.	
Māori culture	-	M-H	Impacts upon native/taonga species.	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council through the RPMP in relation to this species.	Kiwifruit is cultivated in Northland but wilding kiwifruit are very uncommon. If no action is taken it may spread, with consequent environmental impacts and future control costs.	High. Kiwifruit is cultivated in Northland and wilding vines could establish, with consequent adverse effects.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Exclusion programme	Not applicable	Not applicable	Kiwifruit are cultivated in the Region and wilding kiwifruit have been recorded.
Eradication programme	Wilding kiwifruit is uncommon in Northland but they have the potential to establish at more sites. Eradication would enable any infestations that are found to be destroyed, preventing long-term economic and environmental impacts and removing a potential "sink" for Psa.	Eradication of wilding kiwifruit would require an investment of resources to undertake surveys and control any plants that are found.	Low-Moderate. Wilding kiwifruit are only occasionally present in Northland and control methods are available. Kiwifruit Vine Health works collaboratively with Regional Councils and landowners to manage wild kiwifruit populations and abandoned orchards to reduce biosecurity risk to the kiwifruit industry.Therefore is only a low to moderate chance of eradication failing.
Progressive containment programme	Not applicable	Not applicable	A progressive containment programme would aim to confine the impacts of wilding kiwifruit to current infestation areas but all known infestations of wilding kiwifruit have been controlled.
Sustained control programme	When compared to an eradication programme, a sustained control programme would incur lower financial cost to the regional council in the short-term. It would aim to restrict the spread and impacts of wilding kiwifruit.	A sustained control programme would not aim to remove wilding kiwifruit from all the sites where it may be present. If/when it does become more widely established, eradication and containment may no longer be options and there will be long-term financial and environmental costs associated with the species.	Moderate-High. Kiwifruit produces large quantities of seeds and can establish in a range of habitats, so a sustained control programme may not be aggressive enough to prevent the spread of this species.
Site-led pest programme	Not applicable	Not applicable	There are currently no known infestations of wilding kiwifruit in Northland Region.
Summary of alternative assessments and preferred option:	Eradication programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for wilding kiwifruit. In terms of alternative approaches assessed, under no regional intervention (or do nothing), there would be unacceptable loss of biodiversity values if wilding kiwifruit was allowed to spread unimpeded from the current few known sites. There would also be moderate to high public or political concerns expressed by environmental and community groups, with the knowledge that eradication of the vine is feasible. Progressive containment or sustained control approaches would not be appropriate as the plant is very limited in distribution and occupies only one small area of all the suitable habitat in the region. Accordingly, it would be risky relying on 'lesser' management options when		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	eradication/zero density is readily achievable. Another compounding issue in relying on occupier or voluntary control is that, like most vigorous growing exotic vines, successful control may be problematic, requiring multiple visits to the treatment sites. Land occupier control would over time be costlier to oversee and inspect and is unlikely to be successful. These operational risks would compromise the outcomes that would be sought under these two lesser scenarios. Eradication is the preferred outcome, control effort while in low numbers is deemed to have a high net benefit and is realistic given the plants' limited distribution. NRC will undertake direct control of wilding kiwifruit wherever it occurs in the region (through its service delivery programme). The control costs involved under an eradication programme are relatively minor compared with the cost of doing nothing. Spinoff effects for PSA management might also accrue from the management of any wilding kiwifruit sources. Northland Regional Council would work closely with Kiwi Vine Health and the kiwifruit industry to manage wilding situations.		

Wilding conifers

Pinus spp. (including P. radiata, P. Pinaster, P. contorta) and Pseudotsuga menziesii

Also known as: wilding pines, including radiata pine, stone pine, contorta pine, Douglas fir

(Family: Pinaceae)

Status in New Zealand

Pinus contorta is listed as an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Wilding conifers can grow into tall, cylindrical trees up to approximately 70m tall and 2m in diameter. Their leaves are needle-like and have a resinous scent when crushed. They do not produce flowers but grow cones instead.
Habitat	Wilding conifers can grow in a range of habitats, including grasslands, shrublands, scrub riparian ecosystems and coastal dunes, from high altitudes to the near sea level. Low stature native vegetation /ecosystems are particularly vulnerable to wilding conifers.
Regional distribution	Wilding conifers are well established in Northland and their range is increasing. They are of particular concern in drier coastal areas and rare and vulnerable habitats such as gumlands and wetlands at Kaimaumau. *Pinus contorta* has successfully invaded a number of nutrient poor sites.
Competitive ability	Wilding conifers can establish in a range of habitats and grow faster and taller than low-stature indigenous vegetation. Indigenous ecosystems that are at particular risk from wilding conifer invasion include: tussock and other indigenous grasslands, alpine ecosystems, subalpine and dryland scrub and shrublands, frost-flats, wetlands, turf communities, geothermal areas, dunelands, riparian areas, coastal margins, bluffs and cliffs. Once wilding conifers invade low stature communities they shade out many of the native plant species and can form monocultures that exclude native species. Wetlands and riparian areas can become dry, especially in small catchments. Douglas fir has the greatest tolerance to shade and is capable of invading canopy gaps in native forests.

Reproductive ability	Wilding pines spread by seeds. They can start reproducing at 8 years of age, or even younger in some cases. Known seed viability ranges from 4 years (*P.contorta*) to 15 years (*Pseudotsuga menziesii*). Vectors of spread: Seeds are spread by wind and gravity. Wilding pines originate from intentional plantings for production forestry.
Resistance to control	Wilding conifers can be controlled by handpulling seedlings, grazing, ringbarking adults, frilling and stumptreating. Wilding conifers are particularly susceptible to metsulfuron methyl and other herbicides.
Benefits	Cultivated forests have high economic value but wilding conifers are not useful for timber.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	Low	Low
Horticulture	-	-
Native bush or forests	Low	High
Urban	Low	Low
Coastal	Low	High
Estuarine and marine	-	-
Freshwater/Wetland	Low	Low

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-	Wilding conifers are not typically a problem for intensive pastoral farming.	Froude 2011
Sheep and beef	-	-	Wilding conifers are not typically a problem for intensive pastoral farming.	Froude 2011
Forestry	-	-	Cultivated forests have high economic value but wilding conifers are not useful for timber.	

Category	Current	Potential	Comment	Source
Horticulture	-	-		
Other	M	H	Wilding conifers can adversely affect landscape values.	Froude 2011
International trade	-	-		
Environment				
Soil resources	+	+	In many catchments trees are helpful for reducing erosion.	Froude 2011
Water quality	-	-	In many catchments trees are helpful for reducing erosion and maintaining water quality. However, they may also cause drying of wetland and riparian habitats.	Froude 2011
Species diversity	M	H	Wilding conifers are are of particular concern in drier coastal areas and rare and vulnerable habitats such as gumlands and wetlands at Kaimaumau.	Froude 2011
Threatened species	M	H	Wilding conifers can adversely effect threatened species of plants, particularly those associated with relatively open or low stature ecosystems such as gumlands, dunes and wetlands.	Froude 2011
Social/cultural				
Human health	-	-		
Recreation	M	H	Wilding conifers can reduce the aesthetic values of natural areas.	
Māori culture	M	H	Impacts upon native/taonga species and blocking of access to cultural sites.	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs to the council under the pest management plan associated with wilding conifers.	Wilding conifers are invasive species that can invade natural areas. If no action is taken, the number and extent of infestations is likely to increase with consequent adverse effects on the environment. Future control costs would also increase.	High. Wilding conifers are invasive plants that spread easily and can invade a range of habitats. If no action is taken, the number and extent of infestations is likely to increase with consequent adverse effects on the environment, and increased control costs in future.
Exclusion programme	Not applicable	Not applicable	Wilding conifers are already present in Northland.
Eradication programme	Wilding conifers are present throughout Northland and have high impacts upon natural areas. If they could be eradicated before they spread further and/or become more abundant, it would prevent long-term impacts and financial costs.	Eradication of wilding conifers would require a large investment of resources to control the known infestations, undertake surveillance to ensure control has been successful, and carry out surveys to identify any additional infestations. If the species is not eradicated there will be on-going control costs.	High. Wilding conifers are abundant and widespread within Northland. At this time, eradication is not feasible.
Progressive containment programme	When compared to an eradication programme, a progressive containment programme would incur lower financial cost to council in the short-term. It would aim to confine or reduce the distribution of wilding pines.	A progressive containment programme would require a large investment of time and resources from council and affected landowners. It would not aim to eradicate the species, so control costs would be on-going.	High. Wilding conifers are present throughout Northland. Therefore, in the short- to medium-term a progressive containment programme has a high chance of failing to reduce the impact of these species.
Sustained control programme	Wilding conifers could be included in a sustained control programme, with a good neighbour rule with specified boundary clearances. This would aim to help reduce the impacts of wilding conifers on adjacent or nearby neighbour's assets and values.	Education, publicity, responding to reports and enforcement action.	Moderate - although these measures may help, wilding conifers are still widespread in Northland. However, these rules could help reduce the impacts on neighbours.
Site-led pest programme	A site-led programme, where control of wilding pines is required in	A site-led programme would require an investment of time and resources by council and	Low. Wilding conifers can be controlled and do not have a long-lived seedbank.

<table>
<tr><th>Option</th><th>Explanation of benefits</th><th>Explanation of costs</th><th>Level of risk that programme will not be successful</th></tr>
<tr><td></td><td>defined parts of Northland, would reduce the impact of this species in high priority areas.</td><td>affected landowners. It would not reduce or restrict the impacts of wilding conifers in areas that are not identified as being of high priority.</td><td>Site-led programmes that include follow-up control have a low chance of failing but will not address the impacts of wilding conifers outside of the site-led areas.</td></tr>
<tr><td>Summary of alternative assessments and preferred option:</td><td colspan="3">Sustained control programme
In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for the four wilding conifers of relevance in Northland. In terms of alternative approaches assessed, under <u>no regional intervention</u> (or do nothing) there would be further spread of wilding pines and impacts on landowners and communities. Any control carried out would be sporadic and uncoordinated and many occupiers would choose not to undertake control due to the effort involved. However, the do-nothing approach would be unacceptable and there would be moderate to high political risk to council in not having wilding conifers declared pests. A 'no intervention' stance would also run counter to the recent government focus on wilding conifer management under the MPI national wilding conifers strategy.
Due to the widespread nature of wilding conifers, <u>eradication</u> is not feasible or realistic and the direct control costs that would be imposed on both council and landowners would be inappropriate and unsustainable. <u>Progressive containment and site led</u> control may be achievable in some areas (with defensible boundaries from reinvasion and concerted control efforts) but on a region-wide scale these options would be costly and ineffective, particularly due to wilding conifers opportunistic abilities to spread by wind.
<u>Sustained control</u>, with a 10m boundary clearance 'good neighbour' rule (activated by a valid complaint from a directly affected nearby owner) is a pragmatic way to address most concerns and is the preferred option. It recognises the widespread and increasing range of wilding conifers while ensuring that a robust process is available (via the Biosecurity Act) to reduce externality effects on landowners who want to actively control them. Inclusion of wilding conifers in the Plan is more appropriate than relying on voluntary action because the effects of these plants are biodiversity related, that are in the public interest more than the private interest to manage, yet the conifers are prevalent on private land. The imposition of good neighbour rules may raise some interest or issues but these will largely be confined to a few individual property owners at a local scale.

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Proposed GNR

All land occupiers within Northland shall destroy all wilding conifers present on their land within 10m of

an adjacent or nearby property, prior to cone-bearing, where the affected adjacent or nearby land occupier is taking reasonable steps to control wilding conifers on their property to protect pastoral production and

biodiversity integrity. This rule will be enforced on receipt of a complaint from a directly affected land

occupier.</td></tr>
</table>

Good neighbour rule tests

Before a rule can be identified as a good neighbour rule in a RPMP, the regional council must be satisfied of the matters in subclause (a), (c), and (d) and must comply with the requirements in subclause (b) and (e):	
Tests	
In the absence of the rule, the pest would: • spread to land that is adjacent or nearby within the life of the plan; and • cause unreasonable costs to an occupier of that land.	Wilding conifers spread easily and have a long lived seed bank making them difficult to control. They spread via wind and gravity and require on-going management for landowners. For some landowners there will be a considerable cost, particularly if re-infestation occurred from uncontrolled neighbouring land.
In determining whether the pest would spread as described in subclause (a) the regional council must consider: • the proximity and characteristics of the adjacent or nearby land; and • the biological characteristics and behaviour of the particular pest (the greater the distance between properties, the more difficult to satisfy the test in subclause (a).	With both wind and gravity seed dispersal, it is highly likely that Wilding confiers would establish on adjacent land, including road and rail corridors, if not controlled in the boundary area.
The land that is adjacent or nearby, as described in subclause (a), must be clear from a pest or, if the pest is present on that land, the occupier of that land must be taking measures to manage the pest or its impacts	In order for the good neighbour rules in the proposed RPMP to apply, it is a requirement that the land occupier destroy all wilding conifers present within 10m of an adjacent or nearby by property, prior to cone-bearing.
The rule must not set a requirement on an occupier that is greater than that required to manage the spread of the pest.	The requirement of a ten metre control zone to boundaries provides an appropriate level of control. Should wilding conifers re-infest the neighbouring areas there is the potential for much further spread and significant ongoing management costs.
In determining the rules to be set to manage the costs to an occupier of land that is adjacent or nearby, of the pest spreading, the regional council must consider: • the biological characteristics and behaviour of the particular pest; and • whether the costs of compliance with the rule are reasonable relative to the costs that such an occupier would incur, from the pest spreading, in the absence of a rule.	Wilding conifers have the ability to spread quickly and out compete native species, reducing biodiversity. A good neighbour rule cannot be applied to manage spread from planted conifer plantations (including but not limited to shelter belts, plantation forestry, and amenity plantings), as the cost of control would exceed the benefits. Impacts deriving from commercial and other deliberate plantings of conifers are best managed through other avenues such as the Resource Management Act or through the New Zealand Wilding Conifer Management Strategy
Proposed Good neighbour rules discussion:	

All land occupiers within Northland shall destroy all wilding conifers present on their land within 10m of an adjacent or nearby property, prior to cone-bearing, where the affected adjacent or nearby land occupier is taking reasonable steps to control wilding conifers on their property to protect pastoral production and biodiversity integrity. This rule will be enforced on receipt of a complaint from a directly affected land occupier.

Quantitative analysis

The medium level analysis for the proposed sustained control programme was undertaken using the GNR model for pest plants developed for regional councils (Harris et al., 2017) and adapted for the Northland situation. The model undertakes both the cost benefit and reasonableness assessments required under sections 6 and 8 respectively of the NPD. In terms of the cost benefit analysis, the model focuses on identifying the boundary distance between two properties that creates a net benefit, i.e. where the costs of introducing a GNR (the sum of the costs of control on the source property, the costs of inspection and the costs the receptor still bears due to seed bank net of any benefit the source property owner receives from controlling the plant pest) is less than the costs that the receptor bears in the absence of a GNR. For the reasonableness assessment, the model compares the costs of control imposed on the source property owner by the GNR with the additional costs of control that the receptor property faces in the absence of the GNR, and reports this as a ratio between the two.

The following two tables contain the specific pest, programme and monetary assumptions that were inputted for wilding conifers in Northland into the GNR model. The benefits from controlling the plant pest for each land use type was calculated based on the potential impact of the pest on the land use as described in the qualitative impact assessment above. The GNR model for pest plants provides the possibility for undertaking separate calculations for a number of individual wilding pine species rather than wilding conifers in general. The *pinus radiata* option was used for this analysis.

Pest and programme assumptions

Pest assumptions	Values	Programme assumption	Values
Seed bank included	Yes	Proposed boundary width	10 metres
Pest abundance	Locally common	Proposed inspection required	Once (over life of plan)
Density of source infestations	Scattered	Cost of inspection	$500 per property

Land use specific assumptions ($/ha/annum)

Variable	Dairy	S&B intensive	Arable	Horticulture	Hill country	Hard hill country	Conservation	Forestry	Non-productive
Benefits from controlling the plant pest	$0	$0	$0	$0	$0	$0	$176	$15	$126
Land occupier costs of controlling scattered infestations	$200	$200	$200	$200	$250	$300	$300	$300	$300

The following two tables present the results of the model. In terms of the cost benefit assessment, the results show that when the source infestation is scattered plants, there is not likely to be a net benefit from introducing a 10m GNR for wilding pines when the source land use is hard hill country or forestry, nor when the land use being affected in in dairy, sheep and beef intensive, arable or horticulture. There may possibly or probably be a net benefit when the party being affected is in hill country, hard hill country, conservation, forestry and non-productive uses.

Cost benefit assessment: Length of boundary required for there to be a net benefit (metres)

		Receptor land use								
Source land use		Dairy	S&B intensive	Arable	Horticulture	Hill country	Hard hill country	Conservation	Forestry	Non-Produ
	Dairy	C > B	C > B	C > B	C > B	570	260	260	260	260
	Sheep and beef intensive	C > B	C > B	C > B	C > B	570	260	260	260	260
	Arable	C > B	C > B	C > B	C > B	570	260	260	260	260
	Horticulture	C > B	C > B	C > B	C > B	570	260	260	260	260
	Hill country	C > B	C > B	C > B	C > B	C > B	610	610	610	610
	Hard hill country	C > B	C > B	C > B	C > B	C > B	C > B	C > B	C > B	C > B
	Conservation	C > B	C > B	C > B	C > B	330	190	190	190	190
	Forestry	C > B	C > B	C > B	C > B	C > B	C > B	C > B	C > B	C > B
	Non-Productive	C > B	C > B	C > B	C > B	720	280	280	280	280

C > B = There is no net benefit. The costs imposed by the GNR are always greater than the costs without the GNR. Blank = no costs for receptor landholder

Reasonableness assessment: Ratio of costs for source landholder to the costs for the receptor landholder

		Receptor Land use								
Source land use		Dairy	S&B intensive	Arable	Horticulture	Hill country	Hard hill country	Conservation	Forestry	Non-Productive
	Dairy	1.00	1.00	1.00	1.00	0.80	0.67	0.67	0.67	0.67
	Sheep and beef Intensive	1.00	1.00	1.00	1.00	0.80	0.67	0.67	0.67	0.67
	Arable	1.00	1.00	1.00	1.00	0.80	0.67	0.67	0.67	0.67

	Horticulture	1.00	1.00	1.00	1.00	0.80	0.67	0.67	0.67	0.67
	Hill country	1.25	1.25	1.25	1.25	1.00	0.83	0.83	0.83	0.83
	High country	1.50	1.50	1.50	1.50	1.20	1.00	1.00	1.00	1.00
	Conservation	1.50	1.50	1.50	1.50	1.20	1.00	1.00	1.00	1.00
	Forestry	1.50	1.50	1.50	1.50	1.20	1.00	1.00	1.00	1.00
	Non Productive	1.50	1.50	1.50	1.50	1.20	1.00	1.00	1.00	1.00

In terms of reasonableness, when the source infestation is scattered plants the cost of compliance with the rule for the source landowner is between 0.67 and 1.5 times the cost for the occupier who would otherwise be affected.

Willow

Salix spp.

Also known as: crack willow, grey willow, pussy willow, grey sallow

(Family: Salicaceae)

Status in New Zealand

Unwanted organism

Relevant biology

Form	Willow trees are deciduous, growing to 25m, typically with long, weeping, lance shaped foliage. They produce catkins in spring.
Habitat	Willow trees originate from colder areas of the Northern Hemisphere and in New Zealand they prefer stream and lake edges, river systems, wetlands, and alluvial plains
Regional distribution	Willow trees occur widely across Northland as they were previously planted en masse to reinforce pastoral streambanks. They are now found in most wetlands, rivers and streams and cause many issues with damming, river blockages and structural changes to waterways
Competitive ability	Willow trees tolerate a wide range of conditions and their reproductive, fast growth and suckering capabilities prevent the regeneration of native species
Reproductive ability	Grey willow produces many short lived seeds annually and crack willow produces through suckering and stem fragments as only male plants are present in New Zealand
Resistance to control	Willow spp. are susceptible to a range of herbicides, crack willows must be poisoned standing and all remnants disposed of as they may resprout.
Benefits	Ornamental

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	-	-
Horticulture	-	-
Native bush or forests	-	-
Urban	-	-
Coastal	-	-
Estuarine and marine	-	-
Freshwater/wetland	Low	High

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy				
Sheep and beef				
Forestry				
Horticulture				
Other	Low	High	Widespread presence amongst wetlands and freshwater systems in Northland	Lawrence, pers. comm
International trade				
Environment				
Soil resources	-	-		
Water quality	L	M	Willow trees affect water flow and waterway structure, causing blockages and silt issues	Lawrence, pers.comm
Species diversity	L	M	Willow can reduce seedling regeneration due to their ability to create monocultures	Weedbusters

Category	Current	Potential	Comment	Source
Threatened species	L	M	Willows have serious impacts on wetlands and waterways which can effect native freshwater plant species and fish	Weedbusters, Lawrence, pers.comm
Social/cultural				
Human health	-	-		
Recreation	-	L	Willow spp. may reduce the aesthetic values of natural areas.	
Māori culture	-	M	Impacts upon native/taonga species.	

L = low; M= moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council under the RPMP in relation to this species. Rather than applying a programme under the Regional Pest Management Plan, the species could come under a 'Connecting Communities' programme outside the pest management plan, where advice and support are provided for specific sites. This will provide support to communities as and where the species is having impacts.	Willow is already present in Northland but is not usually seen dominating large areas. If no action is taken it may spread, with consequent environmental impacts and future control costs.	Low. If no action is taken, existing infestations of willow may expand and it may spread to new sites.
Exclusion programme	Not applicable.	Not applicable.	Willow is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Willow is present throughout the region so would not be suitable for an eradication programme.
Progressive containment programme	Not applicable.	Not applicable.	Willow is present throughout the region so would not be suitable for a progressive containment programme.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Sustained control programme	Willow could be included in a sustained control programme.	Willow species are currently banned from sale in Northland under the NPPA. Plant retail outlets are inspected regularly by council staff.	Moderate. Willows could still spread and become more common.
Site-led pest programme	A site-led programme, where control of willows is required in defined parts of Northland could reduce the impacts of this species within the programme area(s).	Site-led programme would require an investment of time and resources by the council and affected landowners. It would not reduce or restrict the impacts of willows in areas that are not identified as being of high priority.	Moderate. A site-led programme could effectively reduce or eliminate the adverse effects of willows in particular high value habitats.
Summary of alternative assessments and preferred option:	No regional intervention With regard to section 6(1) of the NPD a low-level analysis was considered appropriate for willow spp.. In terms of alternative approaches assessed, under a do-nothing approach the species is still listed under the NPPA and therefor is already nationally banned from sale and distribution. Willow spp. are already naturalised in Northland and its distribution and assessment of effects mean that eradication and progressive containment programmes are not realistic or affordable. Site-led management would control some plants at some sites, but ultimately this approach would also be unsustainable. A do nothing approach is the preferred outcome and most viable option as the species is listed a a NPPA species. Declaring willow spp. formally as a pest in the NPPA triggers sections 52 and 53 of the Biosecurity Act, banning the pest from sale, propagation and distribution in Northland. Nurseries in general support the concept of the NPPA and the outcomes being sought.		

Wonder tree

Idesia polycarpa

Also known as: wonder tree, igiri tree

(Family: Salicaceae)

Status in New Zealand

No legal status

Relevant biology

Form	Wonder tree is a deciduous tree that can grow to more than 20m tall with a trunk up to 50 cm in diameter. A distinctive feature of the wonder tree is the large bunches of red berries that hang from female trees during winter. Each berry is 5-10mm in diameter and contains several 2–3 mm brown seeds. The leaves of the wonder tree are large and heart-shaped with coarsely serrated margins. They are 8–20 cm long and 7–20 cm wide and grow from a red leaf stem. The flowers are small, yellow-green and fragrant.

Habitat	Wonder tree is cultivated in gardens. It prefers a sunny situation that is frost-free and grows best in moist soils.
Regional distribution	Wonder tree is cultivated in Northland as an ornamental tree. There are also wild plants, mainly close to towns and gardens.
Competitive ability	Wonder tree produces large numbers of berries that each contain 2-3 seeds. It is tolerant of light shade and drought. It is a relatively fast-growing tree that can reach heights of more than 20m. Its spreading canopy can shade out lower-growing plants.
Reproductive ability	Female trees produce large numbers of berries that hang on the tree all winter. Each berry contains several seeds. Vectors of spread: The seeds are eaten and spread by birds. Trees are grown and spread by gardeners, for ornamental purposes.
Resistance to control	
Benefits	Ornamental

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	-	-
Horticulture	-	-
Native bush or forests	-	Low
Urban	Low	High
Coastal	Low	High
Estuarine and marine	-	-
Freshwater/Wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	-		

Category	Current	Potential	Comment	Source
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	L-M	Wonder tree will invade bush areas and crowd out other species.	TERRAIN
Threatened species	-	-		
Social/cultural				
Human health	-	-	The fruit is edible, either raw or cooked.	Tanaka 1976
Recreation	-	-		
Māori culture	-	L	Impacts upon native/taonga species.	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council through the RPMP in relation to this species.	Wonder tree is already present in Northland, mainly in cultivation. If no action is taken it may spread, with consequent environmental impacts and future control costs.	High. Wonder tree is already present in Northland and there are areas of available habitat into which it could spread.
Exclusion programme	Not applicable	Not applicable	Wonder tree is already present in Northland.
Eradication programme	Wonder tree has the potential to spread from cultivation into more sites. Eradication would enable long-term economic and environmental impacts to be avoided. As a declared	Eradication of wonder tree would require a large investment of resources to control known plants and undertake on-going surveys to ensure all plants have	Moderate-High. There is a moderate to high risk of eradication being unsuccessful because wonder tree is widely cultivated.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	pest, wonder tree would be banned from sale under the Biosecurity Act.	been removed and there is no regrowth.	
Progressive containment programme	A progressive containment programme would incur lower financial cost to the regional council in the short-term and would aim to confine the impacts of wonder tree to current infestation areas, and gradually reduce the population. As a declared pest, it would be banned from sale under the Biosecurity Act.	Wonder tree is cultivated throughout Northland and large amounts of resources would be required to undertake surveys and control.	Moderate-High. There is a moderate to high risk of a progressive containment programme being unsuccessful because wonder tree is widely cultivated.
Sustained control programme	A sustained control programme would incur lower financial cost to the regional council in the short-term, and would aim to restrict the spread and impacts of wonder tree. Sites where it is growing in the wild could be targeted (as opposed to sites of cultivation). As a declared pest, wonder tree would be banned from sale under the Biosecurity Act.	A sustained control programme would not aim to remove wonder tree from all the sites where it is present. If/when it does become more widely established, eradication and containment may no longer be options and there will be long-term financial and environmental costs associated with the species.	Low-Moderate. Wonder tree produces bird-dispersed seed so a sustained control programme has a low to moderate chance of preventing this species from spreading to new sites. However, it would enable wonder tree to be banned from sale and would enable wild infestations to be controlled.
Site-led pest programme	A site-led programme, where control of wonder tree is required in defined parts of Northland could reduce the impacts of this species within the programme area(s).	A site-led programme would require an investment of time and resources by the council and affected landowners. It would not reduce or restrict the impacts of wonder tree in areas that are not identified as being of high priority.	High. A site-led programme could effectively reduce or eliminate specific infestations of wonder tree but the species is widely cultivated and the programme would not provide for the control of outlying infestations.
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that wonder tree does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be no regional intervention for wonder tree, the council has also had regard		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding. While wonder tree has not been afforded pest status in Northland, it may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes.		

Woolly nightshade

Solanum mauritianum

Also known as: tobacco weed, flannel weed, kerosene plant.

(Family: Solanaceae)

Status in New Zealand

Woolly nightshade is listed as an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Woolly nightshade is a shrub or small tree that can rapidly grow to 10m tall. It has large, grey-green leaves that are up to 25cm long and are covered in felt-like hairs. They have an unpleasant, pungent (kerosene like) smell when crushed or broken. It produces purple flowers with yellow centres and bunches of yellow berries when ripened.
Habitat	Woolly nightshade is adapted to a wide range of habitats. It can invade forest margins, disturbed forest, light gaps within forest, shrublands, riparian margins, estuarine margins, consolidated sand dunes, wetlands and urban areas. It rarely invades intact habitats. Can also be problematic along roadsides and exotic forest margins.
Regional distribution	Woolly nightshade is widespread throughout Northland region and occurs in almost every type of habitat.
Competitive ability	Woolly nightshade grows very rapidly and can crowd-out or shade-out native plants to form dense stands. It poisons the soil to inhibit or prevent the establishment of native plant seedlings and slows the regeneration of native forests. It is moderately shade tolerant, tolerant to frost and requires medium to high soil fertility. Dense stands can invade pasture on poor soils, especially in hill country areas and impede livestock movement. All parts of the plant are thought to be toxic to livestock.
Reproductive ability	Woolly nightshade can flower and fruit at any time of the year, producing large numbers of viable seeds. Even very young plants can produce seed, for example, seedlings established in summer can bear flowers by the autumn. It also spreads vegetatively when mechanically damaged by cutting or uprooting and pieces of root remaining in the soil will regrow.

	Vectors of spread: the fruit and seeds are dispersed by birds.
Resistance to control	Cut stems re-sprout quickly so must be treated with herbicide. At bare sites it can regenerate abundantly from seed left in the soil.
Benefits	Woolly nightshade is thought to have been introduced for ornamental purposes. The fruits are a food for native birds.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	High	High
Forestry	Low	Low
Horticulture	High	High
Native bush or forests	Low	Low
Urban	Low	Low
Coastal	Low	Low
Estuarine and marine	-	-
Freshwater/wetland	High	High

High = Preferred land use; Low = Less preferred land use

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	L	L	Woolly nightshade does not normally invade intensively grazed pasture. However, if pasture is left un-grazed it can establish.	ISC.
Sheep and beef	L	M	Woolly nightshade does not normally invade grazed pasture but in hill country areas on poor pasture it might. However if pasture is left un-grazed it can establish.	ISC.
Forestry	H	H	Woolly nightshade is a major problem in commercial forestry plantations where it competes with seedlings of pine trees.	ISC.

Category	Current	Potential	Comment	Source
Horticulture	L	L	Woolly nightshade does not normally invade mown grassland but if maintenance ceases it can establish.	
Other	-	-	Roadsides, disturbed places.	Popay et al. 2010
International trade	-	-		
Environment				
Soil resources	M	H	Woolly nightshade is allelopathic (that is, it produces toxins that poison the soil and inhibit seed germination).	Van den Bosch *et al.,* 2004.
Water quality	-	-		
Species diversity	H	H	Woolly nightshade is a serious environmental weed that can form dense stands that inhibit the growth of other species through overcrowding and shading.	ISSG; Williams and Champion, 2008.
Threatened species	M	H	Woolly nightshade is a serious environmental weed that can form dense stands that inhibit the growth of other species through overcrowding and shading. This could include threatened species.	ISSG; Williams and Champion, 2008.
Social/cultural				
Human health	L	L	All parts of the plant are poisonous to humans and livestock, especially the green berries. The hairy leaves can cause skin irritations.	ISSG; Williams and Champion, 2008.
Recreation	M	H	Woolly nightshade reduces the aesthetic values of natural areas and dense stands can impede access.	Williams and Champion, 2008.
Māori culture	M	H	Impacts on native/taonga species.	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful *
Do nothing	If no management action is undertaken there will be no financial costs incurred by the council in relation to this species.	Woolly nightshade is a serious environmental weed with the ability to invade a range of habitat types. It is already common and widespread in Northland and if no action is taken, the population of this species will continue to increase and have adverse effects on the environment.	High. Woolly nightshade is highly invasive, spreads via bird-dispersed seeds and can establish in a range of habitats. If no action is taken it will continue to have high environmental and with it increased human health impacts.
Exclusion programme	Not applicable.	Not applicable.	Woolly nightshade is already present within Northland.
Eradication programme	Woolly nightshade is a serious environmental weed and is also an economic weed of production forests. If it could be eradicated, the adverse effects of this species would be prevented and the long-term costs of control would be avoided.	Eradication would require a large and sustained investment of resources which is beyond the level of council to fund and would be unsustainable in both the short and long term.	High. Woolly nightshade is widespread and abundant within Northland and is found in almost all types of habitat. Given the abundance and widespread distribution of this species, eradication is unachievable.
Progressive containment programme	When compared to an eradication programme, a progressive containment programme would incur lower financial cost to NRC and landowners. It would aim to confine or reduce the distribution of this aggressive species and reduce its adverse effects on the environment.	A PCP would still require a large investment of time and resources from NRC and affected landowners. A PCP would not aim to eradicate the species, so control costs would be on-going and significant.	High/Moderate. Woolly nightshade has already spread throughout Northland and occupies much of the available habitat. Therefore, in the short- to medium-term a PCP has a moderate chance of failing to reduce the impact of this species. A PCP would be more successful if sustained for the long-term.
Sustained control programme	When compared to an eradication programme, a sustained control programme (SCP) would incur lower short-term financial cost to NRC and landowners. A SCP would aim to restrict the spread and impacts of woolly nightshade and prevent it from having increasingly severe impacts on the environment. Woolly nightshade could be included in a sustained control programme, with a good	A SCP would require an investment of time and resources by NRC and affected landowners. A SCP would not aim to eradicate or contain the species, so control costs would be on-going.	High. Woolly nightshade has already spread throughout Northland and occupies much of the available habitat. Any control undertaken under a SCP is unlikely to be aggressive enough to effectively reduce the adverse effects of this species. However, as the pest is poisonous to humans, some level of intervention is warranted. A rule based on complaints from directly affected people who can demosntrate effects via a

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful *
	neighbour rule with specified clearance requirements.		medical certificate could help reduce the impacts on neighbours.
Site-led pest programme	A site-led programme, where control of woolly nightshade is required in defined parts of Northland where there are high environmental values, would reduce the impact of this species in high priority areas.	A site-led programme would require an investment of time and resources by NRC and affected landowners. A site-led programme would not reduce or restrict the impacts of woolly nightshade in geographical areas that are not identified as being of high priority.	Moderate. There is a moderate risk that site-led programmes could fail due to the abundance of woolly nightshade, its prolific seeding, and its ability to establish in a range of habitats. High. There is a high risk that woolly nightsahde will continue to spread in areas that are not subject to a site-led programme.
Summary of alternatives assessed and preferred option:	Sustained control programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for woolly nightshade. In terms of alternative approaches assessed, under no regional intervention (or do nothing) land occupiers who have genuine health issues because of this pest would have no redress other than relying on voluntary control by the exacerbating land occupier. Due to its prolific distribution and growth in the region there would be a moderate level of risk around political or landowner concerns under a do-nothing scenario. Due to the widespread nature of woolly nightshade, eradication is not feasible or realistic and the control costs that would be imposed on landowners and council through a regulatory management approach would be inappropriate and unsustainable. Technically, woolly nightshade is a straight forward plant to destroy and progressive containment and site led control may potentially be achieved in some areas. However, on a region-wide scale these options too would be onerous, costly to maintain any gains made and ultimately would have a high likelihood and risk of failure. Sustained control, with a land occupier control rule which is activated by a valid health related complaint from a directly affected person, is a pragmatic way to address human health concerns around this pest plant and is the preferred option. A medical certificate/letter must be provided by the person affected. While woolly nightshade is both an economic and environmental pest in the region the favoured outcome, which aims to reduce demonstrated human health effects, is a pragmatic and cost effective solution for council to adopt. Overtime biological control may prove to be an effective tool in intractable situations.		

Yellow bristle grass

Setaria pumila

Also known as: yellow foxtail.

(Family: Poaceae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Yellow bristle grass is an upright grass that grows 25-45cm tall, although in open pasture its first leaves are typically parallel to the ground. The leaves are yellow-green to green in colour and usually red or purple at the base. They are flat, hairless, soft and twisted. The seed head is a cylindrical 'spike' that is 2.5–10cm long and consists of many densely-packed spikelets, with each spikelet bearing a single seed. At the base of each spikelet there are five to ten bristles, 5–8mm long. Initially the bristles are green, but they soon change to a golden-brown. It is the colour of these bristles that give the grass its name.
Habitat	Yellow bristle grass grows in areas where the soil has been disturbed, including cultivated areas, pastures, old gardens, waste places, footpaths and the side of roads, especially where water collects.
Regional distribution	Yellow bristle grass is widespread in Northland, occurring mainly in pasture and on roadsides.
Competitive ability	Yellow bristle grass is a fast-growing, invasive, annual grass weed in North America, Africa, Australia and New Zealand. It is tolerant to wide range of climatic conditions and habitat types and can adapt to a range of environmental conditions.
Reproductive ability	Yellow bristle grass reproduces only from seed. It grows rapidly and quickly produces seeds which can remain dormant in the soil for up to 10 years. Germination typically starts in mid-October and peaks from mid-November to mid-December. Early seed heads appear in late December but are most common in January and February. Vectors of spread: The seed is heavy but may be dispersed short distances by wind and gravity. Yellow bristle grass is dispersed mainly by human activities (mowing, farm machinery, hay, etc.) and stock (the seed survives passage through the rumen and is spread in dung).
Resistance to control	Mowing won't kill yellow bristle grass but seed will be produced very low down, lessening the risk of spread. It can be controlled with application of glyphosate just as the first seed head emerges. Residual herbicides have the potential to prevent germination.
Benefits	-

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	Low	High
Sheep and beef	Low	High
Forestry	-	-
Horticulture	-	-
Native bush or forests	-	-
Urban	Low	Low
Coastal	-	-
Estuarine and marine	-	-

Land use type	Current land use infested	Potential land use
Freshwater/Wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	L	H	Because of its poor nutritive value and avoidance by cows when seeding, losses in farm production can be substantial. It reduces pasture quality in late summer and autumn and reduce milk production in dairy pastures.	AgPest; Lamoureaux & Bourdôt 2014; James 2013
Sheep and beef	L	H	Because of its poor nutritive value and avoidance by cows when seeding, losses in farm production can be substantial. It reduces pasture quality in late summer and autumn. Death of yellow bristle plants can open pastures for establishment of winter weeds.	AgPest; Lamoureaux & Bourdôt 2014; James 2013
Forestry	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	L	L	Yellow bristle grass grows in areas where the soil has been disturbed, including cultivated areas, pastures, old gardens, waste places, footpaths and the side of roads, especially where water collects. Therefore, it is unlikely to invade native habitats.	Lamoureaux & Bourdôt 2014 James 2013
Threatened species	-	-		

Category	Current	Potential	Comment	Source
Social/cultural				
Human health	-	-		
Recreation	-	-		
Māori culture	-	-		

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council in relation to this species. Only where individual action or inaction in managing pests imposes undue effects on others is regional management needed. As this is primarily a pasture weed, the main benficiary of control is the land occupier.	Yellow bristle-grass is widespread in Northland and has the potential to become an increasingly serious pasture weed if no action is taken to prevent its spread and reduce its impacts.	Moderate. Yellow bristle-grass is a weed of pasture and, as such, there is an incentive for landowners to control it if they aware of its impacts. Therefore, uncontrolled spread is unlikely.
Exclusion programme	Not applicable.	Not applicable.	Yellow bristle-grass is already present in Northland.
Eradication programme	If yellow bristle-grass could be eradicated it would avoid future losses in pasture production and the long-term financial costs arising from control.	Eradication of yellow bristle-grass would require a considerable investment of resources to control the known infestations, identify and control additional infestations, and undertake on-going surveys to ensure all plants have been removed and there is no regrowth from seed. If the species is not eradicated there will be on-going control costs.	High. Yellow bristle-grass is widespread in Northland and there is a high chance that there are unrecorded infestations. It produces seeds which can be spread by wind, by farm management and by stock. Eradication of this species is not practicable at this time.
Progressive containment programme	When compared to an eradication programme, a progressive containment programme would incur lower financial cost to the council in the short-term. It would aim to confine or reduce the distribution of yellow bristle-grass.	A progressive containment programme would require an investment of time and resources from the council and affected landowners. It would not aim to eradicate the species, so control costs would be on-going.	High. Yellow bristle-grass is widespread and produces seeds that are readily spread by humans and animals (and, to a lesser extent, wind). Therefore, there is a high risk that a progressive containment programme will fail to confine the spread and

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
			the economic impacts of yellow bristle-grass.
Sustained control programme	When compared to an eradication programme, a sustained control programme would incur lower financial cost to the council in the short-term. It would aim to restrict the spread and impacts of yellow bristle-grass.	A sustained control programme would require an investment of time and resources by the council and affected landowners. It would not aim to eradicate the species, so control costs would be on-going and, in future, eradication or containment may no longer be options.	Moderate. There is a moderate risk that a sustained control programme will fail to manage the spread and the economic costs of this species.
Site-led pest programme	Not applicable	Not applicable	Site-led programmes can be used to manage species in high priority areas. Yellow-bristle grass is widespread in Northland and is not a suitable candidate for a site-led programme.
Summary of alternative assessments and preferred option:	No regional intervention. Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that yellow bristle grass does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be no regional intervention for yellow bristle grass, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding. While yellow bristle grass has not been afforded pest status in Northland, it may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes.		

Yellow flag iris

Iris pseudacorus

Also known as: yellow flag

(Family: Iridaceae)

Status in New Zealand

Yellow flag iris is listed as an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Yellow flag iris is an aquatic plant that grows as leafy clumps up to 2m tall. The sword-like leaves emerge in fans from a reddish-purplish base. From October to December it produces pale-yellow to golden-orange flowers that are up to 12cm in diameter and are followed by seed capsules containing many brown, flattened, three-sided, disc-like seeds.
Habitat	Yellow flag iris grows in still and slow-flowing water bodies and wetlands and it can invade flood-prone pasture. In other countries it has been recorded in salt marshes.
Regional distribution	Yellow flag iris is present in Northland. It is known at a limited number of sites between Kaiwaka and Kerikeri, including sites around Whangarei. The largest infestations are near Kaiwaka.
Competitive ability	Yellow flag iris is a fast-growing and fast-spreading invasive plant that can out compete other plants, forming almost impenetrable thickets as it over-tops and replaces native species. It can also grow out across the water, forming floating mats that are strong enough to support the weight of a person. It is poisonous to grazing animals and is tolerant of saline conditions, frost, flooding, drought, physical damage and many soil types.
Reproductive ability	Yellow flag iris reproduces from both rhizomes (roots) and seeds. Each seed capsule contains many viable seeds but the longevity of yellow flag iris seeds in the seed bank is unknown. It has been found to facilitate its own spread by contributing to soil compaction and hardpan development, which prevents other desired species from establishing on a site. Vectors of spread: Seeds and rhizome fragments may be spread by water, contaminated machinery and deliberate planting. The ability of yellow flag iris seeds to float for long periods of time contributes to long distance dispersal.
Resistance to control	Manual or mechanical methods that remove the entire rhizome (root) can successfully control small, isolated patches. However, caution should be used because it causes skin irritations and even small rhizome fragments can re-sprout. It is susceptible to many registered herbicides, but is resistant to terbutryne. Herbivores generally avoid yellow flag iris so stock grazing is not a control option.
Benefits	Yellow flag iris was introduced as an ornamental pond plant.

Water bodies occupied

Water body type	Current water body infested	Potential water body infested
Lakes	-	Low
Rivers and streams	-	Low
Wetlands	-	High
Ponds and dams	Low	High

Water body type	Current water body infested	Potential water body infested
Drains and canals	-	High
Troughs	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	M	Yellow flag Iris is poisonous, which makes the plant unpalatable to livestock. It can invade flood-prone pasture.	Jacobs et al. 2010
Sheep and beef	-	M	Yellow flag Iris is poisonous, which makes the plant unpalatable to livestock. It can invade flood-prone pasture.	Jacobs et al. 2010
Forestry	-	-	Yellow flag iris grows in still and slow-flowing water bodies and wetlands and it can invade flood-prone pasture. Therefore, it is unlikely to invade production forests.	New Zealand Plant Conservation Network
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	M	Yellow flag iris traps silt, raising the ground level and increasing flood potential.	West Coast Regional Council
Water quality	-	M	Clumps of yellow flag iris can restrict or eliminate water flow in irrigation and flood control ditches, and its seeds clog water control structures.	Jacobs et al. 2010
Species diversity	L	H	Yellow flag iris forms dense colonies that exclude native species, thus reducing plant community diversity. This may result in altered riparian area function and reduced habitat for a diversity of wildlife, bird, fish and pollinator species.	Jacobs et al. 2010
Threatened species	-	M	Yellow flag iris forms dense colonies that exclude native species.	Jacobs et al. 2010
Social/Cultural				

Category	Current	Potential	Comment	Source
Human health	-	H	Yellow flag iris is poisonous to humans.	Williams and Champion, 2008.
Recreation	-	M	Yellow flag Iris can block waterways, hindering boat access and recreational activities such as swimming and fishing.	Williams and Champion, 2008; WCRC
Maori culture	-	H	Impacts on native/taonga species and impeded access to waterways.	

L = low M= moderate H = high - = No impact + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred in relation to this species.	Yellow flag iris is a serious weed that has the potential to spread to riparian and wetland sites throughout Northland. If no action is taken, the population of this species will continue to increase, with consequent adverse effects on the environment.	High. Yellow flag iris is highly invasive. It spreads via water-dispersed seeds and root fragments and may be spread intentionally, for ornamental purposes. If no action is taken yellow flag iris will spread to more sites, its numbers will increase and its environmental impacts will become more severe.
Exclusion programme	Not applicable.	Not applicable.	Yellow flag iris is already present within Northland.
Eradication programme	Yellow flag iris currently occurs at scattered sites between Kaiwaka and Kerikeri but there are large areas of potential habitat for this species in Northland. If the species could be eradicated before it spreads elsewhere, it would prevent long-term impacts and financial costs.	A control programme has been underway since 2010. Eradication of yellow flag iris would require an ongoing investment of resources to control the known infestations, undertake surveillance to ensure control has been successful, and carry out surveys to identify any additional infestations. If the species is not eradicated there will be on-going control costs.	Low-medium. There is a low-medium risk that eradication will fail but yellow flag iris can be controlled by a combination of physical and chemical methods and is not yet abundant in Northland.
Progressive containment programme	A progressive containment programme would incur lower financial cost to NRC in the short-term than an	A progressive containment programme would require an investment of time and resources from the council and affected landowners.	High. Yellow flag iris is an aggressive weed that spreads by water-dispersed seeds and root fragments. Given this dispersal method, the amount of available

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	eradication programme. It would aim to confine the impacts of yellow flag iris to the locations where it is currently present and prevent it from having impacts elsewhere.	A progressive containment programme would not aim to eradicate the species, so control costs would be on-going. If the species were to spread, eradication may not be an option in future.	habitat and its perceived desirability as an ornamental plant, there is a high risk that a progressive containment programme will fail.
Sustained control programme	When compared to an eradication programme, a sustained control programme would incur lower short-term financial cost to the council and landowners. A sustained control programme would aim to restrict the spread and impacts of yellow flag iris and aim to prevent it from having increasingly severe impacts on the environment.	A sustained control programme would require an investment of time and resources from the council and affected landowners. A sustained control programme would not aim to eradicate or contain the species, so control costs would be on-going and eradication may not be an option in future if the population of this species increases.	High. Yellow flag iris is an aggressive weed that spreads by water-dispersed seeds and root fragments. Given this dispersal method, the amount of available habitat and its perceived desirability as an ornamental plant, there is a high risk that a sustained control programme will fail.
Site-led pest programme	Not applicable.	Not applicable.	Yellow flag iris is present in relatively low numbers at a number of sites within Northland, so it is not a suitable candidate for a site-led programme.
Summary of alternative assessments and preferred option:	Eradication Programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for yellow flag iris. In terms of alternative approaches assessed, under no regional intervention (or do nothing) there would potentially be unacceptable loss of biodiversity values (riparian plant communities) as there are many marginal wetland habitats for it to thrive in in Northland. Currently, yellow flag iris is reasonably limited in its regional distribution . Under a no intervention approach, NRC could rely on non-regulatory methods such as advocacy, education and site-led management, but loses the ability to undertake direct action (for current and any new infestations) and the tools to impose penalties for possession of or deliberate liberations of this pest. Progressive containment or sustained control approaches would not be appropriate as yellow flag iris is still not very common in Northland. It would be highly risky of Council to rely on 'lesser' control options when eradication or zero density is thought to be achievable. It would also be an unacceptable risk to bank on landowners to control infestations as control of any aquatic pests with herbicides is usually difficult and expensive. Additionally, as the sites involve treatment close to and at times over water, permissions to use herbicides are required through the Environmental Protection Agency (EPA). These situations require a high level of regional intervention (through professional surveillance and direct control approaches). These operational risks would compromise the outcomes sought if landowners were responsible for control work, therefore council service delivery is the most appropriate control measure. Eradication is the preferred outcome and is realistic given the current infestations and the technical challenges involved. There is some level of risk that yellow flag iris will be introduced to Northland or unknown infestations are found. NRC intends to undertake direct control of yellow flag iris wherever it occurs in the region. The costs involved under an eradication		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	programme are minor (compared with the risks of doing nothing and allowing it to spread) and provides Council with some regulatory tools to incentivise water users such as boaties, eel fishermen, anglers, and fowl shooters to stop the spread of wetland and semi-aquatic pests to new areas. The benefits of inclusion in the Plan are that significant wetlands and riparian areas around waterways would in the long-term remain free of this pest. The value is difficult to estimate but would be significant, given the high public interest in maintaining wetlands and aquatic ecosystems in a natural state.		

Animal pests

Argentine and Darwin's ants

Argentine ant (Linepithema humile) and Darwin's ant (Doleromyrma darwiniana)

(Family: Formicidae)

Status in New Zealand

Argentine ant is listed as an unwanted organism under the Biosecurity Act 1993.

Relevant biology

Form	Argentine ant: worker ants are only 2–3 mm long and are a uniform honey-brown colour. Foraging ants move steadily (not slowly) in defined continuous trails that can often be seen going up trees or shrubs, especially if these are flowering. The ants can't sting but some people react to their bite. They have a slight greasy odour when crushed, as opposed to the strong formic acid smell of some ant species. Darwin's ant: worker ants are about 2 mm long. They have a dark-brown head but the rest of the body and the legs are light brown. They look similar to Argentine ants but they give off a strong odour when crushed, which Argentine ants don't.
Habitat	Argentine ants are frequently associated with areas of human settlement but they are not entirely restricted to modified habitats. In New Zealand, Argentine ants have invaded native habitats including scrub, mangroves, coastal forest and the edges of native forest, but forest habitat appears unlikely to be utilised. Darwin's ants are native to Australia, where they are most commonly found in dry forested areas, including coastal scrub or heath, nesting in soil, under rocks or rotten logs, or occasionally in abandoned nests of other ants. Nests usually contain several hundred workers which disperse quickly when disturbed. In New Zealand, the species is associated with towns or cities with ports. It has been recorded in Whangarei, Mt Maunganui, Gisborne, Napier, Blenheim, Nelson and Lyttelton.
Regional distribution	Argentine Ants are widespread in the Northland Region They favour sandy coastal soils and volcanic soils but have also been found in other areas, particularly in association with human activity. They are being moved around the region by people (e.g. in potted plants, beehives, soil etc.). They are not currently known to be on any of Northland's offshore islands. Darwin's ants are confirmed at the Port of Whangarei and Whangarei Heads and are probably at other sites where they haven't been found/reported yet. It is suspected they are present at a hire centre in Whangarei, from where they could be transported around the region. They are not currently known to be on any of Northland's offshore islands.
Competitive ability	Several biological factors ensure the success of Argentine ants. These include: multi-queened colonies; large numbers of offspring and rapid recruitment; a very general diet and an ability to monopolise food sources; an ability to exploit a diversity of habitats; a propensity for forming super-colonies through successful mixing of individuals from separate nests that are linked by foraging trails and aggression to

	other ants. Their aggression and numerical dominance enables them to displace other ant species. The World Conservation Union lists the Argentine ant as one of the world´s worst invasive species. Darwin's ants can also build up large densities, often in urban gardens becoming a nuisance and displacing other invertebrates.
Reproductive ability	Nests of Argentine ants have multiple queens and are capable of multiplying into huge numbers in a very short time. Darwin's ants nest in soil or under stones and logs and usually maintain small colony sizes. Vectors of spread: Argentine ants and Darwin's ants can hitch rides in freight, potted plants, rubbish, vehicles, bee hives and bee-keeping equipment and other goods. Without human-mediated dispersal, spread is much slower through budding of colonies. Colonies of ants are able to relocate and survive in response to high levels of disturbance.
Resistance to control	The only effective method to control Argentine ants is to lay baits using Xstinguish™ ant bait. The toxic bait is carried back to the nest and fed to queen, young and other workers. Antstop G can be used to prevent re-infestation. Spraying other ant control products may make the problem worse by causing colonies of Argentine ants or Darwin's ant to split. The ants can detect the poisons and will move queens and eggs to new, uncontaminated areas.
Benefits	-

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	-	-
Horticulture	Low	High
Native	Low	Low
Urban	Low	High
Coastal	Low	High
Estuarine and marine	-	-
Freshwater	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				

Animal pests

Category	Current	Potential	Comment	Source
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	-		
Horticulture	L-M	H	Argentine ants "farm" sap-sucking insects, which reduces the quality and/or yield of crops such as grapes and citrus. They can transmit diseases from one plant to another and/or from one orchard to another. They also chew holes in plastic drip irrigation pipes in orchards.	Landcare Research; Lester et al., 2003
Other	M	H	Argentine ants rob bee hives and predate bees. They can disrupt the poultry industry by stressing chickens and killing hatchlings.	Landcare Research
International trade	-	M	Trade restrictions as a result of contamination of exports to countries that do not currently have Argentine ants, e.g. China, and Korea.	Landcare Research
Environment				
Soil resources	L	M	Argentine ants reduce the diversity of soil invertebrates and alter soil chemistry and the fibre content of litter. Their persistence in the ground litter layer may have long-term implications for soil and plant health in native ecosystems.	Harris, 2002; Stanley & Ward 2012
Water quality	-	-		
Species diversity	L	M	Argentine ants and Darwin's ants may exclude or act as predators towards other insects. They may also impact on vertebrates by attacking and killing nesting birds and competing for food. Overseas, Argentine ants are consistently better than native species at exploiting food resource in terms of speed of locating food, recruiting large numbers of workers to the food,	Human and Gorden, 1996); Landcare Research; Stringer et al. 2009; Lester et al. 2003.

Category	Current	Potential	Comment	Source
			and the length of foraging period,	
Threatened species	L	M	Argentine ants and Darwin's ant may impact upon threatened species, either directly or indirectly.	
Social/Cultural				
Human health	L	M	Argentine ants and Darwin's ants rank highly as a domestic nuisance species and can be a problem in commercial kitchens. They have been found in electrical junction boxes so may have the potential to cause fires.	Landcare Research S. Henderson (NRC) pers. comm.
Recreation	L	M	Their swarming and, in some cases, biting can result in people being unable to garden, hold social events, or let their children play outside in infested areas.	Landcare Research
Maori culture	L	M	Impacts upon native/taonga species and enjoyment of recreational areas.	

L = low M= moderate H = high - = No impact + = Benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred under the pest management plan in relation to these species.	If no action is taken, these ants have the potential to spread to new sites. This would have adverse effects on the environment, horticultural production and apiaries, and result in economic costs associated with control.	High. These species are capable of spreading over large distances (with the assistance of humans), breed rapidly and are difficult to control. If no action is taken, there is a high risk that the impacts of these species in Northland will increase.
Exclusion programme	Not applicable.	Not applicable.	Argentine ants and Darwin's ants are already present in Northland so an exclusion programme for the region is not an option.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Eradication programme	Argentine ants and Darwin's ants have serious impacts on horticulture, apiarists, and native ecosystems. If they could be eradicated, their adverse effects would be prevented and the long-term costs of control would be avoided.	Eradication would require a large and sustained investment of resources.	High. Argentine ants and Darwin's ants are highly mobile (with the unintentional assistance of humans), breed rapidly, and can occupy a range of habitats. Eradicating these species from Northland is unachievable at this time.
Progressive containment programme	When compared to an eradication programme, a progressive containment programme would incur lower financial cost to the council and landowners. It would aim to confine or reduce the distribution of Argentine ants and Darwin's ants and/or reduce their adverse effects.	A progressive containment programme would require a considerable investment of time and resources from the council and affected landowners. It would not aim to eradicate these species, so control costs would be on-going.	High. Argentine ants are widespread, breed rapidly and are frequently transported inadvertently by people. They can be controlled but reinvasions are likely. Therefore, during the lifetime of the RPMP a progressive control programme has a high chance of failing to confine or reduce the impacts of Argentine ants. Like Argentine ants, Darwin's ants can breed rapidly and are frequently transported inadvertently by people. However, unlike Argentine ants, they are not yet thought to be widespread in Northland. Therefore, there may be an opportunity to contain this species. However, as they look similar to Argentine ants, they be more widespread than currently thought.
Sustained control programme	When compared to an eradication programme, a sustained control programme would incur lower short-term financial costs to the council and landowners. It would aim to restrict the spread and impacts of Argentine ants and Darwin's ants and prevent them from having increasingly severe impacts on the environment. This may involve rules about movement of material or equipment that may contain these ants.	A sustained control programme would require an investment of time and resources by the council and affected landowners. It would not aim to eradicate or contain the species, so control costs and adverse effects on fauna would be on-going.	Moderate. These ants are already reasonably widespread in Northland. A sustained control programme would not reduce their distributions but their rate of spread may be slowed.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Site-led pest programme	Site-led programmes could be used to control Argentine ants and Darwin's ants in areas with high ecological values that are vulnerable to these species. This would reduce the impacts of the species in these high priority areas only.	Site-led programmes would require an investment of time and resources by the council and affected landowners. Argentine ants and Darwin's ants have severe impacts on ecosystems and site-led programmes could reduce these impacts in selected areas. However, a site-led approach would not reduce or restrict the impacts of these species in areas that are not identified as being of high priority.	Low-Moderate. This approach has a low to moderate risk of failing. Site-led programmes could be applied to high value ecosystems that are vulnerable to these species. There are methods available for controlling these ant species but populations would need to be maintained at low numbers in the long-term.
Summary of alternative assessments and preferred option:	Sustained control programme and Site-led programmes. In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for Argentine ants and Darwin's ants. In terms of alternative approaches assessed, under no regional intervention (or do nothing) council would not have any mandate to be involved in or fund Argentine ant and Darwin's ant control measures. There would be reliance on voluntary control by land occupiers (incentivised by the direct effects of the ants on human health or in specific ecosystems). A number of occupiers would continue to control these species in the absence of a Plan. Under 'do nothing' Argentine ant and Darwin's ant numbers would continue to increase and cause further impacts. Politically, a 'no regional intervention' attitude would be risky for council. Eradication and progressive containment programmes are altogether unrealistic due to the widespread distribution of Argentine ants in the region. Potentially, Darwin's ants may be more widespread than currently thought. Both scenarios would be beyond the ability of NRC to resource and implement, as the control costs that would be imposed on landowners (and council through an extensive advocacy and enforcement regime) would be inappropriate and unsustainable. A sustained control programme outcome (to reduce the impacts and slow the spread to other properties and places) is the preferred option and represents the most pragmatic and affordable management measure for NRC. The highest risk pathway for the further establishment of Argentine ants and Darwin's ants is via 'hitch-hiking' on goods and material moved by people. The intent of the Plan rule is to 'break the transport and movement cycle', requiring people with identified risk pathways to implement management programmes, thereby slowing the rate of spread. A site-led programme approach may be appropriate for some engaged community groups, focusing on the restoration of specific places, and NRC may support these groups. Many pest insect species are difficult to control due to their habitat and movement and difficulty in locating colonies and there are no guarantees with current control methods. However, information on the effectiveness of control measures is readily transferable and shared by the various organisations involved, therefore any operational or technical risks are low.		

Bearded dragon

Pogona barbata

(Family: Agamidae)

Status in New Zealand:

Sold in the pet trade.

Relevant biology

Form	Eastern bearded dragons are grey-brown reptiles native to Australia, which can grow to 55cm long. The throat is covered with distinctive spiny scales which can be raised to form a black "beard". The head is large, relatively long and triangular in shape, and the inside of the mouth is usually a bright yellow colour. Bearded dragons have a low wide body shape, and long spiny scales along the lower sides of the body. The tail is almost the same length as the head and body. Bearded dragons are active during the day and can move with considerable speed. Juveniles are insectivorous and adults are omnivorous, eating mainly insects and some vegetation. The lifespan in the wild is unknown but they are known to live for more than 10 years in captivity.
Habitat	In eastern Australia, they are common in open forests, particularly eucalypt forests, heathland and scrub and are also found in agricultural and urban areas. They prefer areas with trees (or fence posts) that they can climb to escape predators, sun-bake and survey the area. The main habitat areas generally have an annual rainfall of less than 381mm. They are able to withstand lower temperatures and higher humidity, making them more likely to be able to survive in the wild in some parts of New Zealand. Modelling indicates a moderate risk of establishing in the wild in parts of New Zealand.
Regional distribution	Bearded dragons do not appear to have established invasive populations in other countries but have established self-sustaining populations in other parts of Australia. None are known to be in the wild in Northland, or elsewhere in New Zealand. Climatic suitability modelling suggests the northern part of the North Island and coastal areas of the Bay of Plenty, Hawkes Bay and the Wanganui-Manawatu areas could provide suitable conditions for eastern bearded dragons.
Competitive ability	When threatened, eastern bearded dragons typically "freeze" in position and then retreat to their preferred perch. They will flee at imminent threat, and in response to a perceived threat of attack will open their mouth to display the bright yellow colour inside, and extend the "beard". In Australia, numbers are thought to be declining, but it is not considered to be threatened or at risk. It is a wide ranging species which also inhabits human-affected environments, with an opportunistic diet and is facing no major threats at this time. Road kill is recognised as a threat, as the dragons bask in the warmth of the road, but the risk has not been quantified. Other threats include hostile habitats and predation. Domestic pets such as cats and dogs, are known predators of bearded dragons.
Reproductive ability	Eastern bearded dragons mate in spring (September to December) in Australia, and females lay a clutch of approximately10-35 eggs about one month later. The eggs are laid in shallow holes dug into the soil in an open sunny spot, and incubate for 2-3 months, hatching in summer. Females may lay up to three clutches in one breeding season and first reproduce between 2-4 years old.

	The population in Western Sydney underwent a population crash in 2004. High rates of testis deformity were observed in males, which is likely to have contributed to the population decline. A possible cause of the deformity was thought to be atmospheric pollution. Initial modelling of temperature-dependent embryonic/egg development using degree-day modelling suggests that it would be difficult for eastern bearded dragons to successfully breed in current New Zealand climate conditions. In addition to soil temperature, soil moisture content is an important factor in egg development. Vectors of spread in New Zealand: Pet trade, accidental/intentional release, escape from captivity.
Resistance to control	Unknown
Benefits	Sold in pet trade for $400-600

Land uses occupied

Land use type	Current land use infested	Potential land use infested
Dairy	-	Low
Sheep and beef	-	Low
Forestry	-	High
Horticulture	-	Low
Native	-	High
Urban	-	Low
Coastal	-	-
Estuarine and marine	-	-
Freshwater	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-	Can occupy this land use type but unlikely to have impacts that affect production.	
Sheep and beef	-	-	Can occupy this land use type but unlikely to have impacts that affect production.	

Category	Current	Potential	Comment	Source
Forestry	-	-	Can occupy this land use type but unlikely to have impacts that affect production.	
Horticulture	-	-	Can occupy this land use type but unlikely to have impacts that affect production.	
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	M	Potential for predation on native invertebrates as they are opportunistic omnivores, also competition for food and resource with native species. Potential for disease transmission to other reptiles (for example, adenovirus infections, skin conditions, can transmit *Salmonella*).	Wotherspoon, 2007; Kikillus, 2010.
Threatened species	-	L	Potential for predation on native invertebrates as they are opportunistic omnivores, also competition for food and resource with native species.	Wotherspoon, 2007; Kikillus, 2010.
Social/cultural				
Human health	-	-		
Recreation	-	-		
Māori culture	-	L	Potential impacts on native/taonga species.	

L = Low; M= Moderate; H = High; - = No impact; + = Benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	This species is vulnerable to predation by domestic pets and other introduced predators and can be killed on the road. It has high resale value in the pet trade so is less likely to be released when no longer wanted. Current climatic and soil conditions indicate breeding	None (note: it is likely that we would consider investigating reports as general business).	Low – some risk that a wild population could establish in Northland.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	difficulty in the wild, and there are no known wild populations outside the natural range.		
Exclusion programme	To minimise the risks of pets escaping or being released and forming wild populations, we could include rules banning release within the Northland region and requiring sightings or pet escapes to be reported. This would help prevent establishment and greater future costs.	Publicity/education regarding dumping of pets. Follow-up on reports.	Low – could be included with other pets that we want to discourage from being dumped.
Exclusion programme	An exclusion programme with rules as above, and also including rules banning the sale and transportation of bearded dragon in Northland.	Inspection of pet shops; monitoring Trademe sales; enforcement action; follow-up on reports.	Medium – need to determine the resources the council would require to undertake an exclusion programme for this species.
Eradication programme	Not applicable.	Not applicable.	Bearded dragons are not known to be present in the wild in Northland.
Progressive containment programme	Not applicable.	Not applicable.	Bearded dragons are not known to be present in the wild in Northland.
Sustained control programme	Not applicable.	Not applicable.	Bearded dragons are not known to be present in the wild in Northland.
Site-led pest programme	Not applicable.	Not applicable.	Bearded dragons are not known to be present in the wild in Northland.
Summary of alternative assessments and preferred option:	**Exclusion programme** In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for bearded dragons. Regarding alternative approaches assessed, under no regional intervention (or do nothing) there would be some risk to Northland Regional Council in not being more proactive, in the knowledge that bearded dragons could do well under Northland conditions if allowed to establish. Biodiversity values would be impacted (direct and indirect competition with native species for food and other resources and through disease transmission) if bearded dragons were discovered in the wild and no intervention plans or measures were immediately available. New Zealand has very few reptiles and there is the potential for some exotic reptiles to impact on New Zealand ecology. However, there is little information on the likelihood of exotic reptiles establishing in the wild. As bearded dragons are not currently found in the wild in Northland, an exclusion programme listing is appropriate, and is a cautionary approach, until		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	research findings demonstrate otherwise. A small-scale management plan (SSMP) response under the Biosecurity Act to manage any incursion could be used in the event of a discovery. However, an SSMP draws on the same Biosecurity Act powers as a declared pest in an RPMP (and it would take time to implement a SSMP) so there is benefit in including bearded dragons in the region-wide plan at the outset. This would save time and money in the event they were to establish in the region, as the regulatory powers would already exist. The pet trade is potentially the highest risk pathway for the establishment of naturalised populations of bearded dragons. The council will engage further through the recent National Pest Pet Biosecurity Accord (NPPBA) to address the risks of these animals being released from captivity accidentally or on purpose. Reptiles are difficult to control due to their habitat and movement and difficulty in locating colonies and there are no guarantees with control methods. Therefore, an exclusion programme focusing on a comprehensive advocacy and surveillance programme, and dialogue with neighbouring Auckland region will help to mitigate any operational control risks by detecting any infestations very early on. In Auckland, bearded dragons are currently designated a 'research pest'. They can become a declared pest, with a rule applying, where they are not held in secure containment (although this status will change with their RPMP review).		

Big headed ant

Pheidole megacephala

(Family: Formicidae)

Status in New Zealand

Established.

Relevant biology

Form	Big-headed ants are a relatively small ant that are grey-yellow to dark brown in colour and covered in many sparse, long hairs. Big-headed ants have two main growth forms. Major workers are usually about 3.5mm long and have very large heart-shaped heads when compared to the minor workers, which are about 2mm long. Major workers mainly remain in the nest and minors do most of the foraging.
Habitat	Big-headed ants are known primarily from tropical lowland regions, but range into more temperate latitudes, including New Zealand. They tend to be more common in open,disturbed habitats with weedy vegetation but they are also found in coastal habitats, forests (both exotic and native), shrubland, grassland, wetlands and urban and agricultural areas. They are present in Auckland city and at the ports of Tauranga and Auckland and large populations have also been reported on the Kermadec Islands. Most of New Zealand is probably too cold for this species to realise its full pest potential, but the Far North could support populations if it is transported there.
Regional distribution	Big-headed ants are not known to be established in Northland although there have been incursions.
Competitive ability	Big-headed ants are omnivorous. They feed on invertebrates and small vertebrates (e.g. hatching birds) and also harvest seeds. This has direct and indirect effects on invertebrate communities, vegetation and ecosystem processes. They are aggressive to other ant species and can reach high densities due to a lack of intercolony aggression.
Reproductive ability	Little is known about many aspects of the biology of big-headed ants. In common with some other tramp species certain features have contributed to their reproductive success, e.g. Nests are multi-queened and the ants are able to spread by budding off groups of workers along with inseminated queens. They are also capable of forming interconnected super-colonies that cover tens of hectares. Vectors of spread: Big-headed ants can be inadvertently transported by humans hidden in plant products, packaging material, building supplies, vehicles and machinery.
Resistance to control	Big-headed ants have been effectively eradicated from some sites e.g. Kakadu National Park (Australia) in 2002.
Benefits	

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	Low
Sheep and beef	-	Low
Forestry	-	Low
Horticulture	-	Low
Native	-	High
Urban	-	High
Coastal	-	High
Estuarine and marine	-	-
Freshwater	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	-		
Horticulture	-	L	Big-headed ants can be an agricultural pest overseas on many crops, including pineapples, sugarcane, bananas, coffee, and coconuts, through enhancing populations of the plant-feeding insects. However, they do not appear to be threatening horticultural crops in New Zealand.	Wetterer 2012; Lester et al 2003
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		

Category	Current	Potential	Comment	Source
Species diversity	-	H	In areas where big-headed ants occur at high density, few native invertebrates persist. They are omnivorous and feed on invertebrates, small vertebrates and seeds. This has direct and indirect effects on invertebrate communities, vegetation and ecosystem processes.	Wetterer 2012
Threatened species	-	H	Big-headed ants have direct and indirect effects on invertebrate communities, vegetation and ecosystem processes.	Wetterer 2012
Social/Cultural				
Human health	-	M	As a household pest, big-headed ants commonly nest inside buildings and feed on human foodstuffs.	Wetterer 2012
Recreation	-	-		
Maori culture	-	M	Impacts upon native/taonga species and ecosystems.	

L = low M= moderate H = high - = No impact + = Benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial cost to council associated with the management of big-headed ants. MPI has run an invasive ant surveillance programme at high risk sites around New Zealand since 2003. This includes sites in Whangarei and at North Port.	Big-headed ants are not currently known to occur in Northland. However, they are present in Auckland and Tauranga and could be transported here with shipping cargo or in motor vehicles. If this happens and big-headed ants establish in the region, there will be serious environmental impacts and economic costs.	Moderate. Big-headed ants could inadvertently be introduced to Northland via a number of possible vectors. However, the high risk ant surveillance programme is likely to help detect incursions early. If an incursion was detected it could potentially be managed through a small scale management programm under section 100V of the Biosecurity Act.
Exclusion programme	An exclusion programme would raise public awareness and education about the risks and impacts of big-headed ants. If they are included in the RPMP there is the ability to respond immediately if an	There is already educational material available for big-headed ants. Excluding this species would prevent expenditure on its control if/when it invades Northland.	Low-Moderate. There is a low to moderate risk that an exclusion programme could fail because there is the potential for big-headed ants to be transported to the region in shipped goods, vehicles,

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	infestation is detected in Northland. MPI has run an invasive ant surveillance programme at high risk sites around New Zealand since 2003. This includes sites in Whangarei and at North Port.		building supplies, holiday-makers' luggage etc.
Eradication programme	Not applicable	Not applicable	Big-headed ant are not known to be present in Northland.
Progressive containment programme	Not applicable	Not applicable	Big-headed ants are not known to be present in Northland..
Sustained control programme	Not applicable	Not applicable	Big-headed ants are not known to be present in Northland.
Site-led pest programme	Not applicable	Not applicable	Big-headed ants are not known to be present in Northland.
Preferred option:	Exclusion programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for big headed ants. With regard to alternative approaches assessed, under no regional intervention (or do nothing) there would be a moderate to high risk to Northland Regional Council and criticism from environmental groups and probably the government (MPI) for not being more proactive, in the knowledge that big headed ants could thrive in Northland if allowed to establish. Biodiversity values would be impacted if big headed ants were discovered in the wild and no intervention plans or measures were available, especially since incursions have been recorded before. As big headed ants are not currently found in the wild in Northland, an exclusion programme outcome is the only appropriate option available. A small-scale management plan (SSMP) response under the Biosecurity Act to manage new incursions was considered. However, an SSMP needs to draw on the same Biosecurity Act powers as a declared pest in an RPMP, so there is benefit in including big headed ants in the region-wide plan at the outset and would save time and money in the event they were to establish in the region, as the regulatory powers would already exist. The highest risk pathway for the establishment of naturalised populations is via 'hitch-hiking' on goods and material moved by people. Many pest insect species are difficult to control due to their habitat and movement and difficulty in locating colonies and there are no guarantees with current methods. Therefore, an exclusion programme focusing on a comprehensive advocacy and surveillance programme, and dialogue with neighbouring regions and MPI (through the high-risk ant surveillance programme) will help to mitigate any operational control risks by detecting any infestations very early on.		

Blue-tongued skink

Common blue-tongue skink (Tiliqua scincoides) and Blotched blue-tongue skink (Tiliqua nigrolutea)

(Family: Scincidae)

Status in New Zealand:

Sold in the pet trade.

Relevant biology

Form	Common blue-tongue skinks are grey-pale brown reptiles native to Australia, which can grow to 60cm long. They have dark bands around the body and tail, the belly is cream-coloured, and they have a large triangular head with a distinctive bright blue tongue. Blotched blue-tongue skinks are mostly black with varying amounts of light brown or grey blotches or bands. These lighter markings may be pale yellow or even orange. They have a large triangular head, which is usually dark grey, as well as the distinctive blue tongue. Blue-tongue skinks are omnivorous, feeding during the day on berries, fruits, eggs, invertebrates and small vertebrates, as well as carrion. They can live for more than 30 years in captivity.
Habitat	Common blue-tongue skinks are found in eastern and northern Australia, they thrive in urban areas and are present in the suburbs of many cities. Common blue-tongue skinks prefer temperatures of 30-37°C, but have been recorded to be active at temperatures as low as 15°C. They use discrete home ranges and return to the same sleeping areas each night. Blotched blue-tongue skinks are naturally found in cooler areas of Australia than the common blue-tongue skinks, such as the Blue Mountains of New South Wales and in Tasmania. They are more active at cooler temperatures than common blue tongue skinks. Blotched blue-tongue skinks appear to be the most temperature sensitive species of blue-tongue skinks and require areas with higher rainfall and where summers and winters are cooler. Modelling indicates a high risk of the blue-tongue skink establishing in the wild, in parts of New Zealand.
Regional distribution	None are known to be in the wild in Northland, or elsewhere in New Zealand. Occasionally an escaped or released pet is found in the wild in New Zealand. Common blue-tongue skinks are kept as pets in New Zealand and juveniles are regularly sold on sites such as TradeMe. Botched blue-tongue skinks are only thought to be present in New Zealand in zoos, but would be well suited to Northland's climate. Climatic suitability modelling suggests suitable areas for common blue-tongue skinks occur throughout the country, with the exception of the central North Island and the western and southern coasts and interior of the South Island. Blotched blue-tongue skinks would be most suited to the eastern coast of the South Island, from Blenheim to Timaru.

Competitive ability	There is potential for predation of native wildlife, such as birds and their eggs, and smaller lizards. There is also the potential for disease transmission to native species. In urban areas, they would be susceptible to snail baits in gardens and predation by domestic animals. Common blue-tongue skinks are known to thrive in urban environments though, and show strong site fidelity, spending up to 70% of their time in "safe" locations, and they avoid roads.
Reproductive ability	Both species of blue-tongue skinks bear live young. Females usually select a safe site and remain there during the gestation period. Female blue-tongue skinks can have up to 25 young in one litter, and they grow rapidly, maturing in 2-3 years. Vectors of spread in New Zealand: Pet trade, release/escape from captivity.
Resistance to control	Unknown.
Benefits	Common blue-tongue skinks are sold in pet trade for approximately $170-400.

Land uses occupied

Land use type	Current land use infested	Potential land use infested
Dairy	-	Low
Sheep and beef	-	Low
Forestry	-	High
Horticulture	-	Low
Native	-	High
Urban	-	High
Coastal	-	-
Estuarine and marine	-	-
Freshwater	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-	Can occupy this land use type but unlikely to have impacts that affect production.	
Sheep and beef	-	-	Can occupy this land use type but unlikely to have impacts that affect production.	

Category	Current	Potential	Comment	Source
Forestry	-	-	Can occupy this land use type but unlikely to have impacts that affect production.	
Horticulture	-	-	Can occupy this land use type but unlikely to have impacts that affect production.	
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	M	Potential for predation on native invertebrates, smaller lizards and birds and their eggs as they are opportunistic omnivores. Also competition for food and resource with native species. Potential for disease transmission to other reptiles (for example, mites, endoparasites, skin conditions, and they can transmit *Salmonella*).	Koenig, et al. 2001. Kikilus, 2010. Society for General Microbiology, 2008.
Threatened species	-	M	Many of New Zealand's native lizards are threatened or critically endangered and could be further endangered through competition and disease transmission.	DOC website. Twentyman, C. 1999.
Social/cultural				
Human health	-			
Recreation	-			
Māori culture	-	M	Potential impacts on native/taonga species.	

L = low; M= moderate; H = high; - = No impact; + = Benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	Common blue-tongue skinks have high resale value in the pet trade so are less likely to be released when no longer wanted. However, if they are released, they could survive in Northland.	None	Low-medium – climate modelling indicates risk that a wild population of common blue-tongue skinks could establish in Northland, but it is less likely that the Northland climate would suit blotched blue-tongue skinks.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	The Northland climate is not thought to be particularly suitable for botched blue-tongue skinks, and they are not known to be in the pet trade in New Zealand.		
Exclusion programme	To minimise the risks of pets escaping or being released and forming wild populations, we could include rules banning release within the Northland region and requiring sightings or pet escapes to be reported, particularly for common blue-tongue skinks.	Publicity/education regarding dumping of pets. Follow-up on reports.	Low – could be included with other pets that we want to discourage from being dumped in the wild.
Exclusion programme	An exclusion programme with rules as above, and also including rules banning the sale and transportation of blue-tongue skinks in Northland.	Inspection of pet shops; monitoring Trademe sales; enforcement action; follow-up on reports.	Medium – need to determine the resources the council would require in order to undertake an exclusion programme for this species.
Eradication programme	Not applicable.	Not applicable.	Blue-tongue skinks are not known to be present in the wild in Northland.
Progressive containment programme	Not applicable.	Not applicable.	Blue-tongue skinks are not known to be present in the wild in Northland.
Sustained control programme	Not applicable.	Not applicable.	Blue-tongue skinks are not known to be present in the wild in Northland.
Site-led pest programme	Not applicable.	Not applicable.	Blue-tongue skinks are not known to be present in the wild in Northland.
Summary of alternative assessments and preferred option:	Exclsuon programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for blue-tongued skinks. Regarding alternative approaches assessed, under no regional intervention (or do nothing) there would be a moderate risk to Northland Regional Council and possible criticism from environmental groups for not being more proactive, in the knowledge that blue-tongued skinks are long lived and could thrive under Northland conditions if allowed to establish. Biodiversity values would be impacted (by predation on the eggs and chicks of ground nesting birds, other smaller, native lizards and through disease transmission) if blue-tongued skinks were discovered in the wild and no intervention plans or measures were immediately available.		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	As blue-tongued skinks are not currently found in the wild in Northland, an exclusion programme outcome is an appropriate option. A small-scale management plan (SSMP) response under the Biosecurity Act to manage any incursion could be used in the event of a discovery. However, an SSMP draws on the same Biosecurity Act powers as a declared pest in an RPMP (and it would take time to implement a SSMP) so there is benefit in including blue-tongued skinks in the region-wide plan at the outset. This would save time and money in the event they were to establish in the region, as the regulatory powers would already exist. The pet trade is potentially the highest risk pathway for the establishment of naturalised populations of blue-tongued skinks. The council will engage further through the recent National Pest Pet Biosecurity Accord (NPPBA) to address the risks of these animals being released from captivity accidentally or on purpose. Lizard species are difficult to control due to their habitat and movement and difficulty in locating colonies and there are no guarantees with control methods. Therefore, an exclusion programme focusing on a comprehensive advocacy and surveillance programme, and dialogue with neighbouring Auckland region (where they are currently designated a 'surveillance pest') will help to mitigate any operational control risks by detecting any infestations very early on.		

Canadian geese

Branta canadensis

(Family: Anatidae)

Status in New Zealand

Introduced. Legal protection removed in 2011.

Relevant biology

Form	Light brown goose with a black neck, head, bill, legs and feet and white chinstrap. The breast and abdomen are barred white and light brown. Length 85-95 cm, weight 4.5-5.5 kg, females are smaller than males. Flightless for a 3-4 week period in summer when all flight feathers moult simultaneously.
Habitat	Preferred habitat is pasture (especially irrigated pasture) adjoining a lake or large pond. They retreat to open water as a response to danger. Birds will utilise water reservoirs, golf courses, parks and other habitats where water bodies and suitable vegetation are present. Therefore even within a local area goose distribution can be highly clumped, with large numbers (hundreds) present on some farms and few if any on other nearby farms. This spatial clumping may be especially pronounced in dry years. Herbivorous, preferring high nitrogen content plants, including pasture grasses, clover, some grain and root crops, submerged aquatic plants and seed heads of sedges. Some birds remain in the same area year-round, while other flocks will move around the landscape on a seasonal basis.
Regional distribution	Present throughout Northland, but numbers are greatest in the far north and Pouto.
Competitive ability	Aggressively defend nests. Estimates of Canada geese at moult sites in Northland show an increasing population.
Reproductive ability	Breeding begins at 2-3 years old. They nest as monogamous pairs but often in close proximity to a flock and parental duties may be shared with other pairs. Nests are frequently hidden amongst rushes or other short vegetation. Females incubate eggs and males defend the nest territory. Typical clutch size is 4-5 eggs but sometimes up to 10. Usually one clutch per season, occasionally two.
Resistance to control	Wariness, acute senses and considerable capacity for learning and adapting behaviour making control difficult. Culls of moulting birds are the most common control method used.
Benefits	Valued game bird.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	Low	High (localised)
Sheep and beef	Low	High (localised)
Forestry	-	-

Land use type	Current land use infested	Potential land use
Horticulture	-	Low
Native	-	-
Urban	Low	Low
Coastal	Low	Low
Estuarine and marine	Low	Low
Freshwater	Low	High (localised)

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	L-M (low overall but spatially clumped, leading to localised M impacts)	M	Goose grazing on pastures can be at levels of appreciable economic impact. Quantitative NZ studies to date are largely based on South Island High Country farming, which limits the inferences which can be drawn with respect to northern NZ pastures. However in the High Country goose abundance is positively correlated with loss of pasture production. Farmers have estimated economic losses can be in the order of \$1500-\$10,000 per annum. Impacts tend to be concentrated heavily on a few farms with the most suitable habitat. Inefficient digestive system leads to high faecal output compared to sheep for the same food intake. Flocks of birds can foul pasture with droppings sufficiently that stock will avoid the pasture for several days.	nzbirdsonline.org.nz, 2015; Department of Conservation, 2006; 2011; Coleman, 2008; Win, 2001.
Sheep and beef	L-M (low overall but spatially clumped, leading to localised M impacts)	M	As above.	

Category	Current	Potential	Comment	Source
Forestry	-	-		
Horticulture	L	L-M	Geese will graze crops such as turnips, peas and grains, although quantification of impact is not available.	Coleman, 2008; Conover, 1988.
Other	L	M	Waterfowl can act as a disease reservoir for nearby poultry farms. Management to prevent bird strike can be costly for airports (further details under 'Human health').	Zheng et al., 2010; Department of Conservation, 2011.
International trade	-	-		
Environment				
Soil resources	L	L	Goose feeding is associated with reduced leaf litter accumulation. Trampling can accelerate litter incorporation into the soil, thereby increasing nitrogen mineralisation rates. Goose feeding removes plant material and disturbs the ground, leading to erosion in some circumstances.	Best and Arcese, 2009; Zacheis et al., 2001; Zacheis et al., 2002; 2001; Dawe et al., 2011.
Water quality	L	L-M	Capable of contributing substantial amounts of nitrogen and phosphorous to water bodies by feeding outside of the water body and defecating within it. However nutrients from waterfowl may predominantly settle to lakebed sediments (thereby enhancing macrophyte growth), rather than becoming available within the water column. Furthermore, the proportion of nutrient loading contributed by geese will depend on both the goose population size at the site and other sources of nutrient loading; a study at the Waitaki Lakes (Canterbury) found that	Chaichana et al 2010 Clarke and Meredith 2014 Hahn et al. 2008 Manny et al. 1994 Unckless and Makarewicz 2007 Dawe et al. 2011

Category	Current	Potential	Comment	Source
			Canada geese contributed a very small proportion of nutrient loading to the water bodies. Erosion caused by goose feeding activity can cause sedimentation and infilling of stream channels.	
Species diversity	L	M	Geese alter the composition of plant communities through selective grazing, by seed dispersal, and by modifying the abiotic environment (e.g. trampling, increasing light penetration to the soil surface, increased erosion/sedimentation, altered nutrient cycling patterns). In some cases overseas this has been shown to favour disturbance specialists including exotic grasses. In New Zealand the browsing behaviour of geese can serve to maintain diverse native lake margin turf communities (exotic geese may be functional substitutes for extinct native avifauna). Geese likely also act as seed dispersers for some of these plant species, such as *Alternanthera nahui*. Overseas some instances documented of large flocks feeding heavily within a short time period damaging plant communities to a point which impairs mid-term recovery. Aggressive towards other wildlife, with potential impacts on co-occurring bird species including displacement from territory and mortality. However, co-occurring bird species may also benefit from Canadian goose aggression through enhanced protection from predators.	Best and Arcese 2009 Dawe et al. 2011 Isaac-Renton and Bennett 2010 Krafft et al 2013 Zacheis et al. 2001 Korsten et al. 2013 Heenan et al. 2009 Rivers and Short 2007 Banks et al. 2008 Green and Elmberg 2014 Giroux 1981
Threatened species	L	M	As above	

Category	Current	Potential	Comment	Source
Social/Cultural				
Human health	L	M	Concerns raised regarding bird strike risk. Because of their substantial body size the magnitude of risk is greater than for smaller birds. Potential vectors of human disease through contamination of water bodies, pasture and crops with pathogens such as Camphylobacter, Salmonella, Cryptosporidium and *Escherichia coli*, including antibiotic-resistant strains.	Department of Conservation 2011 Cole et al. 2005 Feare et al. 1999 Graczyk et al. 1997; 1998; 2008 Kullas et al. 2002 Middleton and Ambrose 2005 Moriarty et al. 2011; 2012 Rutledge et al. 2013
Recreation	L	L	Benefits to recreational hunters. Potential negative impacts to other users of freshwater ecosystems through fouling.	
Maori culture	L	M	Possible impacts on the mauri of wai māori through nutrification and species diversity impacts.	

L = low M= moderate H = high - = No impact + = Benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	There would be no costs to council if there was no programme under the RPMP. Rather than applying a programme under the pest management plan, the species could come under a 'council supported management' programme, where advice and support are provided for specific species. This will provide support to communities as and where the species is having local impacts.	Canadian geese may continue to spread and establish in the wild throughout Northland, including in the vicinity of high value lakes where they may impact native species and water quality.	Low. Canadian geese are already widespread throughout Northland water ways.
Exclusion programme	Not applicable.	Not applicable.	Canadian geese are already present in Northland.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Eradication programme	Not applicable.	Not applicable.	Canadian geese are present throughout the region so would not be suitable for an eradication programme.
Progressive containment programme	Not applicable.	Not applicable.	Canadian geese are present throughout the region so would not be suitable for a progressive containment programme.
Sustained control programme	Canadian geese could be included in a sustained control programme. This could include rules requiring land occupiers to control geese below threshold levels. However, as geese flocks move readily from one place to another, rather than developing a large population in one place, this is not reasonable and unlikely to be effective.	Responding to reports, inspections and surveys, enforcement action.	High. Resource intensive, and impractical. Also wariness, acute senses and considerable capacity for learning and adapting behaviour make control difficult without appropriate knowledge and training.
Site-led pest programme	The council could specify high value lakes as site-led programmes, as an incursion at these sites could have significant impacts. Canadian geese could be listed as a pest in these lakes, and controlled if numbers of geese of likely to cause impacts.	Rules would only be applicable in the areas defined as site led programmes and could not be enforced elsewhere.	Low - as action would take place in specific high value places making better use of limited resources.
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that Canadian geese do not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be no regional intervention for Canadian geese, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding. While Canadian geese have not been afforded pest status in Northland, they may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes.		

Cats - feral and stray

Felis catus

(Family: Felidae)

Status in New Zealand

Established.

Relevant biology

Form	Feral and stray cats originate from domesticated cats. They are usually short-haired and slightly built, with a large head and sharp features. They can be found in varying degrees of physical condition. Feral cats have none of their needs provided by humans and their population size fluctuates largely independently of humans. They do not need to live around centres of human habitation and their population is self-sustaining, requiring no input from the domestic cat population. Stray cats have been lost or abandoned by humans but may still have many of their needs indirectly supplied by humans and live around centres of human habitation. Stray cats may rely on humans for food but they are usually wary of humans and may be aggressive when cornered or captured. Bengal cats are a cross between a wild Asian leopard cat and a domestic moggy. They have a long and lean, substantial body size, with males weighing between 4-9 kg, and females about 4-5 kg. Bengal cats like water and are excellent climbers and are considered every bit as predatory for native wildlife as other cat breeds.
Habitat	Cats can be found in most terrestrial habitats, including urban areas, production landscapes (e.g. farms, orchards) and natural areas (e.g. forests, dunes, wetlands).
Regional distribution	Feral and stray cats are widespread throughout Northland. The status of Bengal cats is unknown but they are likely to be held as pets and bred and sold in the region.
Competitive ability	Cats are generalist predators and can have large home ranges. It is estimated that feral, stray and pet cats kill up to 100 million birds in New Zealand each year. They are a major predator of kiwi chicks and also eat eggs, lizards, invertebrates and frogs. Bengal cats have the potential to hybridise with existing feral cat populations. Because of their larger size these feral hybrids may be capable of predating on native species too large for a normal feral cat. For example, adult kiwi could be at risk from a cat of this size.
Reproductive ability	Cats are prolific breeders. Females usually take 6 - 9 months to reach sexual maturity but kittens as young as 4 months can become pregnant. Pregnancy lasts about 68 days and litters are most commonly of 3-6 kittens. A female can have more than one litter each year. Stray cats have higher survival rates than feral cats and faster reproduction rates. Vectors of spread: Cats are mobile animals that can travel large distances on foot. They are also spread by people (e.g. through dumping of unwanted pets).

Resistance to control	Cats can be controlled by hunting, trapping and poisoning. The trap-neuter-release approach advocated by some people is not an effective control method because studies have shown that these cats are out-competed and displaced by sexually entire stray or feral cats.
Benefits	Domestic cats are valued as pets. Stray and feral cats have no, or very little, interaction with humans.

Bengal cats are declared an 'exclusion pest' in the Southland region (domestic and feral), with several rules around their management (e.g. permits required). Refer to the following link.
http://www.es.govt.nz/Document%20Library/Plans%20policies%20and%20strategies/Strategies/Regional%20Pest%20Management%20Strategy/rpms_2013_web.pdf

Land uses occupied

Land use type	Current land use infested	Potential land use infested
Dairy	Low	Low
Sheep and beef	Low	Low
Forestry	Low	High
Horticulture	Low	Low
Native	Low	High
Urban	Low	High
Coastal	Low	High
Estuarine and marine	-	-
Freshwater	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	L	H	Feral cats can carry bovine tuberculosis with the potential to infect cattle.	De Lisle et al., 1990
Sheep and beef	L	H	Feral cats can carry bovine tuberculosis with the potential to infect cattle.	De Lisle et al., 1990
Forestry	-	-		
Horticulture	-	-		
Other	M	H	Stray and feral cats can carry many diseases which can be transmitted to pet cats.	Thompson, 1999
International trade	-	-		

Category	Current	Potential	Comment	Source
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	H	H	Stray and feral cats (including Bengal and domestic cats) present a significant risk to wildlife. It is estimated that feral, stray and pet cats kill up to 100 million birds in New Zealand each year, many of which are native. They are a major predator of kiwi chicks and also eat eggs, lizards, invertebrates and frogs.	Farnworth et al., 2013
Threatened species	H	H	Cats are predators of threatened species such as young kiwi, dotterel, seabirds and reptiles.	Farnworth et al., 2013
Social/cultural				
Human health	M	H	Cats that are not given regular preventative treatments can spread diseases. For example, toxoplasmosis can be caught from direct contact with cats or from eating contaminated meat or vegetables. It is a common affliction and can cause symptoms that range from mild to severe, including miscarriage. It has also been linked to schizophrenia.	Auckland District Health Board, 2011; Torrey and Yolken, 2003
Recreation	-	-		
Māori culture	H	H	Impacts upon native/taonga species.	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	Rather than applying a programme under the pest management plan, the species could come under a 'council supported management' programme, where advice and support are provided for specific species. This will provide support to communities as and where the species appears. This could include education and	Cats have serious impacts on native wildlife and can spread diseases to humans, farm animals, and pet cats. If no action is taken, feral and stray cats will continue to increase in number and distribution and have increasingly severe effects. By not applying a programme and rules to the species, there would be no provisions under the pest	Moderate. Cats breed prolifically and can spread over large distances. If no action is taken, populations of feral and stray cats will increase and they will continue to have high environmental impacts.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	advocacy work with other agencies promoting responsible cat ownership.	management plan to manage inappropriate practises that are exacerbating the spread.	
Exclusion programme	Not applicable.	Not applicable.	Cats are already present in Northland. It is important that they do not establish on Northland's pest-free islands.
Eradication programme	Cats hunt native wildlife, particularly birds, reptiles and invertebrates. If stray and feral cats could be eradicated, their adverse effects would be prevented and the long-term costs of control would be avoided.	Eradication would require a large and sustained investment of resources.	High. Cats are widespread, highly mobile, breed rapidly, can disperse over large distances and can occupy many types of habitats. Eradicating stray and feral cats from Northland is not achievable at this time.
Progressive containment programme	When compared to an eradication programme, a progressive containment programme would incur lower financial cost to NRC and landowners. It would aim to confine or reduce the distribution of stray and feral cats and reduce their adverse effects.	A progressive containment programme would require a considerable investment of time and resources from the council and affected landowners. It would not aim to eradicate stray and feral cats, so control costs would be on-going.	High. There are effective control methods available to manage stray and feral cats. However, they are present throughout Northland in a variety of habitat types, breed rapidly and are highly mobile. Therefore, a progressive containment programme has a high chance of failing.
Sustained control programme	When compared to an eradication programme, a sustained control programme would incur lower short-term financial cost to NRC and landowners. It would aim to reduce the impacts of stray and feral cats on the environment, human health and animal health, through rules banning dumping and releasing cats.	A sustained control programme would require an investment of time and resources by council. It would not aim to eradicate or contain stray and feral cats, so control costs and adverse effects would be on-going.	Moderate-High. Stray and feral cats are having severe impacts on native wildlife in Northland and a sustained control programme aiming to reduce impacts through rules that can be difficult to enforce has a moderate-high risk of failure..
Site-led pest programme	Site-led programme(s) could be used to control stray and feral cats in defined areas. This would reduce their impacts in these area(s) only.	Stray and feral cats can be found in a wide range of habitats and are generalist predators. Therefore, a site-led approach would only be able to address their impacts on vulnerable native species at a limited number of locations. A site-led approach would not reduce or restrict the impacts of stray	Low-Moderate. Stray and feral cats are widespread in Northland and can occupy a range of habitats. A site-led approach could be used to reduce their impacts in high priority areas (e.g. kiwi habitats, weka habitats and shorebird nesting sites).

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
		and feral cats in areas that are not part of the programme(s).	
Summary of alternative assessments and preferred option:	**Sustained control and 'council supported management programme'** In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for feral/stray cats (including feral Bengal cats). In terms of alternative approaches assessed, under no regional intervention (or do nothing) council would not have any mandate to be involved in or fund feral/stray cat management. There would be reliance on voluntary control, principally by community ecological restoration groups, therefore some level of control would continue in the absence of a Plan. However, under 'do nothing' feral/stray cat numbers would likely increase and cause further biodiversity and potentially human health impacts. Whether cats are viewed as 'friend or foe' varies as widely for Northland residents as it does for all New Zealanders. Politically, a no regional intervention position would be high risk for council, while there is also some political risk to council from the 'pro-cat' lobby. The Draft National Cat Management Strategy (NZNCMS) may assist NRC in making future determinations around feral/stray cats – refer below. Eradication and progressive containment programmes would be unrealistic due to the widespread distribution of feral/stray cats in the region. Overall, these scenarios would be well beyond the ability of NRC to resource and implement, as the costs of control that would be imposed on landowners and council would more than likely exceed the benefits and be unsustainable. A sustained control programme outcome (to reduce the impacts and possibly the spread of feral/stray cats into other properties/areas of the region) is the preferred option and is a pragmatic and affordable management intervention measure for council to adopt. There are no specific rules for occupiers to adhere to (other than it being an offence to knowingly dump unwanted cats - through Biosecurity Act s.52 and 53 provisions) so the focus is on fostering awareness around managing ferals and strays (including the role feral Bengal cats might play in the demise of native wildlife) and providing advice and information on the various intervention and control methods. A watching brief will be maintained over Bengal cats. Because of their larger size feral hybrids may be capable of predating on native species too large for a normal feral cat (e.g. adult kiwi could be at risk). Operational risks for dealing with feral cats in general is considered low. Because of the low costs involved with the preferred programme the benefits of occupier incentivised cat control will likely outweigh the costs, especially if the loss of biodiversity values could be quantified under a CBA model. A site-led approach to feral/stray cats (including Bengal cats and feral hybrids) may also be appropriate and there are many existing community groups engaged in the restoration of specific places, along with other pests. NRC supports these groups under the Community Pest Control Areas (CPCA) programme. A potential 'game changing' approach for managing cats can be found in the Draft NZNCMS. The first National Cat Management Strategy (NZNCMS) was published in September 2016. Its purpose is to develop a humane management strategy that recognises both the positive benefits of cat ownership and negative concerns regarding the impacts cats have on wildlife. By 2025 it is hoped that cats are responsibly owned and valued and humanely managed in a way that protects their welfare and New Zealand's unique environment. To achieve this vision, the national working group, which comprises animal welfare, local government and conservation groups, proposes a mix of national legislation, ongoing educational programmes and local Council bylaws (e.g. powers for mandatory micro-chipping and desexing of cats, imposing cat curfews in ecologically sensitive areas, restricting cat ownership and infringement systems for nuisance cat issues). Under the final NZNCMS there will be roles (yet undetermined) for NRC and district/city councils. Refer to link below for more details: http://www.rnzspca.org.nz/images/Documents/ NCMSG-Strategy-Implementation-Background-Document-Sept-2016.pdf		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful

Cockatoo

No regional intervention

see sulphur crested cockatoo

Eastern rosella

Platycercus eximius

(Family: Psittacidae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Eastern rosellas are brightly coloured parakeets, with a red head, white cheeks, yellow/green upper body with black markings, blue shoulders, and yellow/green underside. They are approximately 30cm long and weigh 90-120g. Foraging is either on their own or in small flocks (approximately 2-20+ individuals). They forage mainly on the ground but to some extent in trees. The diet is primarily herbivorous on a wide range of plant material including seeds (especially those of grasses), fruits, nectar, shoots, buds, leaves, but they also eat some invertebrates.
Habitat	Preferred habitats include open, wooded areas including gardens, parklands, wetlands, gumlands, farmland, orchards, plantation forests and native forests. They will utilise native forest but mainly the edges and remnant fragments rather than core. Nest in cavities in tree trunks. In native forest in Auckland most nest cavities are in puriri, tree ferns and pohutukawa, although tree ferns appear to be sub-optimal habitat. Large potential home ranges, probably in excess in 78 ha.
Regional distribution	Naturalised in suitable habitat across the region.
Competitive ability	Eastern rosellas aggressively defend the nest cavity and surrounding area. They appear to be an inferior aggressor compared with tui, kingfisher and kukupa as well as some exotic birds such as myna and starling. There is some behavioural flexibility in nest site requirements.
Reproductive ability	Secondary cavity-nester, utilising existing cavities mainly in trees especially puriri, but able to use sub-optimal nest sites such as tree ferns in less mature forest (e.g. urban forest fragments) where mature, cavity-bearing trees are lacking. Monogamous. Clutch size 4-7 eggs. Normally one clutch per season but they can produce two. Young fledge at approximately 31 days old.
Resistance to control	Lack of adequate control tools available for pest birds.
Benefits	Valued by some as a colourful and attractive addition to the avifauna.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	Low
Sheep and beef	-	Low
Forestry	Low	Low

Land use type	Current land use infested	Potential land use
Horticulture	Low	Low
Native	Low	Low
Urban	Low	Low
Coastal	Low	Low
Estuarine and marine	-	-
Freshwater	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	Nil-L	L	Will utilise pine plantations. Potential impacts on production data deficient.	Woon et al., 2002.
Horticulture	L	L-M	Will utilise orchards causing damage to a variety of fruit (including vineyards), grain and nut crops.	NSW DPI n.d.
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	L-M	M	Implicated as a reservoir for transmission of Beak and Feather Disease Virus to native parrot species. This is likely to be the most important ecological impact, and is likely to pose a higher risk as rosellas increase in range and population density.	Galbraith, 2010; Galbraith et al., 2014; Ha et al., 2007; Innes et al., 2010; Jackson et al., 2014; 2015; Massaro et al., 2012.

Category	Current	Potential	Comment	Source
			Eastern rosellas are an inferior aggressor compared with, and pose little threat to, several native species such as tūī. Data deficient with respect to aggressive interactions with several other native species including kākāriki and hihi. Suitable nesting cavities appear to be uncommon in the region, with the potential for cavities to be a limited resource. Species most likely to be impacted are those with most niche overlap, particularly red-crowned kākāriki. However, at present in much of the region native parrots are suppressed by predation to levels at which nest sites are not likely to be limiting. Population-level impacts of this potential competition are data deficient. Seed predators, consuming seeds from a range of native plants including harakeke, totara and pohutukawa, and nectar from puriri and other native plants. Data deficient on ecological implications of seed predation and other feeding.	
Threatened species	L-M	M-H	Kākā, red-crowned and yellow-crowned kākāriki at risk of acquiring Beak and Feather Disease Virus from eastern rosellas. While overall risk to native parrots from this disease is now considered lower than previously, small populations of threatened species can still be significantly impacted by such diseases. Range/population expansion on off-shore islands would likely result in increased risk of vectoring Beak and Feather Disease Virus to threatened native parrot species, and increase competition for nesting cavities with native birds such as kākāriki and tieke.	Galbraith, 2010; Galbraith et al., 2014; Jackson et al., 2015.
Social/Cultural				

Category	Current	Potential	Comment	Source
Human health	-	-		
Recreation	-	-		
Maori culture	L	M-H	See 'Species diversity' and 'Threatened species'.	

L = low M= moderate H = high - = No impact + = Benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention			
Exclusion programme	Not applicable		
Eradication programme			
Progressive containment programme			
Sustained control programme			
Site-led pest programme			
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that eastern rosellas do not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be no regional intervention for eastern rosellas, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding. While eastern rosellas have not been afforded pest status in Northland, they may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	experiencing localised effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes.		

Feral deer

All Cervus, Odocoileus and Dama species and hybrids

Includes but is not limited to: red deer (*Cervus elaphus scoticus*), fallow deer (*Dama dama*) and sika deer (*Cervus nippon*).

(Family: Cervidae)

Status in New Zealand

Deer are considered feral wherever they are not:

a. held behind fencing that meets the requirements of the Deer Farming Regulations; and

b. identified as required by those Regulations.

The Department of Conservation is responsible for regulating deer farming under the Wild Animal Control Act 1977. This includes specifying the areas deer farming is allowed, the fencing requirements and other requirements.

Relevant biology

Form	Deer are ruminant mammals. Males grow antlers in spring and shed them in winter. There are three species of deer present in Northland: red deer, sika deer and fallow deer. Red deer and fallow deer are farmed but sika deer is present only as a result of illegal releases. Red deer are the largest of the three species and tend to be reddish-brown, occasionally with white spots around the spine. Sika deer is one of the few deer species that does not lose its spots upon reaching maturity. Fallow deer are the most variable of any deer species in New Zealand with four quite distinctive colour phases. The most common colour is brown-black back with paler grey-brown underside and neck, and no spots.
Habitat	Feral deer can live in forest from high mountain areas and steep hill country to river flats and coastal lowlands.
Regional distribution	Feral deer were not present in Northland prior to 1990. However, by 1997 increasing wild deer populations and related research findings prompted a range of agencies and farmer representatives to collaborate in a ten year multi-stakeholder campaign to remove all wild deer populations and halt their establishment and dispersal through reducing the risk of farm escapes and illegal liberations. Currently, deer are potentially living in the wild in at least eight separate locations in Northland (three sourced from illegal liberations and five from farm escapes), with numbers estimated to be just a few tens of animals. The programme has faced significant challenges, including many deer farm escapes and a clear desire by some landowners/hunters to illegally release deer.
Competitive ability	Deer are selective browsers and target particular forest species over others. This can result in significant changes to forest composition and has effects on the fauna that rely on those plants. Deer can destroy the understorey of native forest by browsing, grazing, bark stripping and trampling, which in turn may increase soil erosion. Feral deer can reduce production by damaging crops and exotic forests. They have also been implicated in the transmission of bovine Tb. To date there has been no positive identification of Tb in feral deer within the Northland Region.
Reproductive ability	The hinds are capable of producing a single calf (rarely twins) annually. Deer mate in autumn and the fawns are born in spring.

	Vectors of spread. The areas where wild deer have been found in Northland are where they have been illegally released or have escaped from nearby farms.
Resistance to control	Deer are controlled primarily through shooting/hunting.
Benefits	Deer are valued as a recreational resource by hunters.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	Low
Sheep and beef	-	Low
Forestry	Low	High
Horticulture	-	-
Native	Low	High
Urban	-	-
Coastal	-	-
Estuarine and marine	-	-
Freshwater	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	L	In the absence of hunting pressure, deer roam onto grassland resulting in loses in pasture production. They are potential carriers of bovine tuberculosis (Tb).	Sweetapple, 2006
Sheep and beef	-	L	In the absence of hunting pressure, deer roam onto grassland resulting in loses in pasture production. They are potential carriers of bovine tuberculosis (Tb).	Sweetapple, 2006
Forestry	-	M	Economic losses can be caused by deer stripping bark from production stands in the 3 to 12-year-old age classes.	New Zealand Forestry Owners Forum, 2005

Category	Current	Potential	Comment	Source
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	L	Heavy browsing by deer may make some contribution to soil erosion on steep country.	Sweetapple, 2006
Water quality	-	L	Deer can carry giardia.	Ministry of Health, NZ
Species diversity	L	H	Deer are able to consume virtually all of the foliage of preferred native plants that is available to them, strongly modifying forest composition. This can have long-term effects even after deer have been eradicated from an area. Deer-induced changes in litter composition can also effect invertebrate fauna and the birds that feed on them. The impact of deer is also related to the density of goats. For example, in an area where goats are at low densities, deer will have higher impacts than in an area where there is already a high population of goats.	Nugent et al., 2001 Sweetapple, 2006
Threatened species	L	H	There is a large number of threatened species of plants in Northland, many of which have the potential to be adversely effected by deer browsing and trampling.	Sweetapple, 2006
Social/Cultural				
Human health	-	L	Deer can carry giardia.	Ministry of Health, NZ
Recreation	L	M	Deer are valued as a recreational resource by hunters.	Sweetapple, 2006
Maori culture	L	H	Impacts upon native/taonga species.	

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no regional intervention is undertaken there will be no short-term financial costs incurred by the council under the pest management plan in relation to this species.	Feral deer impact upon native vegetation and wildlife, pasture production, and animal welfare. If no action is taken, the existing population is likely to expand and new populations could establish, with severe environmental and economic consequences.	High. Given the frequency of farm escapes, illegal liberation and the extent of available habitat in Northland, there is considerable scope for deer populations to expand.
Exclusion programme	Not applicable.	Not applicable.	Feral deer are already present in Northland.
Eradication programme	If deer could be eradicated, their impacts upon the environment would be prevented in the future and the long-term costs of control would be avoided.	Eradication would require an ongoing concentrated investment of resources at the site(s) where there are known population(s) of feral deer. A jointly funded multi agency eradication programme started in Northland in 1996/1997 and continued until June 2015. The council contributed approximately 16% of the programme costs annually to the programme, which had a total cost of approximately $125 000 per year. This funding model expired in June 2015, and the programme is currently under review. Some of the objectives of the programme were not entirely achieved due to ongoing farm escapes and illegal deer liberations. However, the impacts of feral deer in Northland are currently minimal due to this programme.	Moderate-High. A number of small populations of feral deer have already been successfully eradicated from Northland as part of a joint agency funded project. However, complete and permanent eradication of deer from Northland is not currently a realistic strategic option. It is likely that deer will continue to escape from the (currently 28) existing deer farms; that the risk for further illegal liberations by some landowners and/or hunters will remain (at least in the short to medium term); and that there is a small risk that some deer may disperse northward from the Auckland Region.
Progressive containment programme	A progressive containment programme implemented through a joint agency funded project would aim to confine or reduce the distribution of feral deer and reduce their adverse effects. This would include monitoring of deer farms to detect any escapes and responding to reported escapes or illegal releases	A progressive containment programme would require an investment of time and resources from council and affected landowners. This would not aim to eradicate feral deer during the next 10 years, so control costs would be on-going.	Moderate. Feral deer have a limited distribution in Northland and they can be effectively controlled. However, there are 8 potential populations currently known, and ongoing farm escapes and illegal liberations make it difficult to map containment zones.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	(either by recovering the deer and returning them to the farm or eradicating them). .		
Sustained control programme	When compared to an eradication programme, a sustained control programme would incur lower financial cost to the council in the short-term. A sustained control programme would aim to restrict the spread and impacts of feral deer and prevent them from having increasingly severe impacts on the environment.	Feral deer are invasive with the potential to spread rapidly. A sustained control programme would aim to maintain zero density of feral deer through a variety of deer farmer liaison, fence inspections, surveillance, wild deer response activities, and statutory management, to prevent the successful establishment of wild deer populations.	Low-Moderate. This programme would continue the successful joint agency control programme that has been in place for a number of years, while recognising that complete and permanent eradication of deer from Northland is not currently a realistic strategic option.
Site-led pest programme	Not applicable.	Not applicable.	Feral deer are not abundant or widespread. Therefore, a site-led pest programme would be equivalent to an eradication programme, but with more limitations should any new populations be discovered.
Summary of alternative assessments and preferred option:	Eradication programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for feral deer. In terms of alternatives assessed, under no regional intervention (or a do-nothing scenario) council would have no mandate to be involved in or fund feral deer management, including advocacy or direct control measures. Sporadic deer control might be carried out in the absence of a plan, generally by DOC (where appropriate) and by keen hunters. However, under 'do nothing' feral deer numbers would likely increase and could start to cause biodiversity and production impacts. In the absence of a RPMP it is envisaged that there will continued risk of feral deer populations establishing in the region from deliberate releases and escapes. There are plenty of areas they could thrive in. Feral deer browsing removes palatable plant species. A loss of biodiversity over time would result if there was no intervention and would be a moderate to high political risks to NRC of doing nothing, with potential lobbying by environmental groups. Irreversible changes could eventually occur if deer were left to establish in all parts of the region. Without a plan and support for a multi-agency deer programme there would be fragmentation of effort and a lack of co-ordination between agencies. This could result in the failure of the programme which overall would see feral deer numbers increase. Because of their potential to adversely impact sensitive environments if left uncontrolled and unmonitored, Northland Regional Council considers that feral deer meet the criteria for management as pests under the Biosecurity Act. However, progressive containment or sustained control approaches are not appealing or very appropriate, as ongoing efforts and funding would be required under these scenarios, but feral deer would remain in the region. Feral deer are known to exist in the wild in Northland, where their distribution is very limited and the key control agencies (NRC and DOC) are best placed to respond to any sightings and take direct control action. Technically, it is thought possible to eradicate feral populations		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	from known areas with current methods, and council agrees that attempting eradication is potentially a better outcome, although it is costlier. It would be an unacceptable ecological risk to rely on landowners/hunters to locate and destroy individual animals or to only confine or reduce numbers when other options are thought realistic. <u>Eradication</u> of feral deer is the preferred outcome and working in partnership with DOC is a pragmatic and affordable management intervention measure for council and DOC to adopt. There may be some potential for operational risk – overlap with, or confusion, because of Wild Animal Control Act provisions. A good working relationship is required with DOC to ensure this scenario is robust and overall the costs of deer management in the region are small, including any regulatory measures because of a plan rule. It is very difficult to determine if the benefits of this approach outweigh the costs, especially as the loss of biodiversity values cannot be quantified under a CBA model. The propensity for deer to be either intentionally released or escape accidentally, creates a moderate risk for achievement of an eradication outcome. Overall, the costs involved under an eradication programme are higher than for any other management options but with DOC as a key partner and taking the lead on control, costs are not expected to be excessive or adversely affect achievement of eradication objectives.		

Feral goat

Capra hircus

(Family: Bovidae)

Status in New Zealand

Naturalised.

Under the Wild Animal Control Act 1977, any goat that is not suitably identified and effectively contained is recognised as a "wild" or feral goat.

Relevant biology

Form	Feral goats vary in size and colour, and have a 'blocky' appearance, with stout strong legs designed for climbing. Adult male goats stand 76-91cm at the shoulder, with a body length of 116-152 cm, and weigh 45 - 55kg. Females look similar to males but are considerably smaller, weighing 25-35kg. They are social, preferring to travel in small groups.
Habitat	Generalist herbivore that browses a wide variety of plant species but often concentrates the majority of feeding on a small number of favoured species. They are able to stand on two legs to reach higher vegetation, and will eat fresh leaf litter as well as live vegetation. Feral goats are able to occupy a wide variety of climates and habitat types, and are able to survive in the absence of a permanent water source.
Regional distribution	Feral goats are widespread throughout Northland. Populations are generally dense in areas of exotic and indigenous forest vegetation, as well as in areas of poor pasture/scrub land. The largest numbers of feral goats are on private properties bordering the Department of Conservation estate, and in Department of Conservation land not under goat management programmes.
Competitive ability	Four-compartment fore-stomach and regurgitation-re ingestion strategy enables efficient digestion of leaf material, facilitating use of a wide variety of plant species. Goats destroy the under storey of vegetation and, when combined with possum damage to the upper canopy, severe deterioration of native forest occurs. Pest plant invasion can occur under these circumstances. Goats also damage vegetation planted on land retired for soil conservation purposes and newly planted or young trees in exotic forests. Goats are one of the most destructive animals found in forests. They have the ability to live in a healthy state where other animals would die out.
Reproductive ability	Polygynous mating system (one male with a group of females) with high reproductive success. Females can become pregnant from 6 months old, but first year breeders contribute little to population growth. Feral goats are able to conceive year round but mating activity tends to peak December/January and June/July. One or two (occasionally three) offspring are produced per year. Gestation takes approximately150 days. Juveniles stay with the mother for about 6 months.
Resistance to control	
Benefits	Domestic goats farmed for milk and meat.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	Low
Sheep and beef	Low	Low
Forestry	Low	Low
Horticulture	Low	Low
Native bush or forests	High	High
Urban	-	-
Coastal	-	-
Estuarine and marine	-	-
Freshwater/Wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	L	Feral populations can act as disease reservoirs for farmed goats.	Chynoweth et al., 2013.
Forestry	L	M	Damage exotic forests by browsing and trampling young trees, and by stripping bark from older trees.	Bay of Plenty Regional Council. Waikato Regional Council.
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	L	M	Reduction in vegetation through browsing and trampling can lead to reductions in leaf litter, erosion, soil loss, reduced soil fertility and moisture retention, and altered patterns of soil carbon and nitrogen storage.	Coblent, 1978; Parkes, 1990; Wardel et al., 2001; Chynoweth et al., 2013.

Category	Current	Potential	Comment	Source
Water quality	L	L-M	Soil erosion may lead to sedimentation of freshwater and marine ecosystems. Can inhibit revegetation in erosion prone sites.	Chynoweth et al., 2013.
Species diversity	M	M-H	Prevents seedling regeneration. Browsing causes reductions in vegetation cover and density, loss of plant species richness and altered community composition in favour of unpalatable species. In the long term this can result in catastrophic structural changes to the plant community, including transition between grassland and forest communities. In some situations goat grazing may suppress unwanted pest plants, whereas in others it may open communities up to increased invasion by exotic plants. Indirect impacts on native birds and reptiles through competition and/or habitat modification. Can reduce abundance and diversity of ground-dwelling invertebrates through reductions in litter quality.	Coblentz, 1978; Zavaleta et al., 2001; Parkes, 1990; Chimera et al., 1995; Chynoweth et al., 2013; Wardle et al., 2001.
Threatened species	M	M-H	Although palatable species will be consumed first, a wide variety of species are browsed. Thus less palatable species can be consumed when required which may enable sustained populations and browsing pressure on favoured species even when these species are at low density. Thus threatened plant populations can be exterminated by goat browsing. Goats can compete for food with native species such as kokako. Habitat alteration by goats can affect native frogs and other species.	Parkes, 1990; Chynoweth et al., 2013; Leathwick et al., 1983.
Social/cultural				
Human health	-	-		
Recreation	+	+	Minor game resource for recreational hunters.	

Category	Current	Potential	Comment	Source
Māori culture	M	M-H	See 'Environment section'. May also be used as hunting resource.	

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council under the RPMP in relation to this species.	Feral goats impact upon native vegetation and wildlife, pasture production, and animal welfare. If no action is taken, the existing populations may expand, with severe environmental and economic consequences.	High. Feral goats can breed rapidly and can occupy a wide range of habitats. If no action is taken their economic and environmental impacts will increase.
Exclusion programme	Not applicable	Not applicable	Feral goats are already present in Northland.
Eradication programme	If feral goats could be eradicated, their impacts upon the environment would be prevented in the future and the long-term costs of control would be avoided.	Eradication would require a large investment across the region in control, surveys, responding to reports, and enforcement action.	High. Feral goats are widespread and common in Northland. Eradication is not a feasible approach.
Progressive containment programme	A progressive containment programme would incur lower financial cost to the council and landowners. It would aim to confine or reduce the distribution of feral goats and reduce their adverse effects on native flora, fauna and habitats.	A progressive containment programme would require a considerable investment of time and resources from the council and affected landowners. It would not aim to eradicate feral pigs, so control costs would be on-going.	High. Feral goats are present throughout Northland. They are widespread, fast-breeding, and mobile. Therefore, during the lifetime of the RPMP a progressive control programme has a high chance of failing to reduce the impact of feral goats.
Sustained control programme	A sustained control programme would incur lower short-term financial cost to the council and landowners. It would aim to restrict the spread and impacts of feral goats through deliberate actions of people.	A sustained control programme would require an investment of time and resources by the council and affected landowners. It would not aim to eradicate or contain the species, so control costs and the adverse effects of feral goats on the environment would be on-going.	Moderate. A sustained control programme to prevent feral goats from having "increasingly severe impacts on the environment" has a moderate chance of failing. It will fail to address the existing impacts that feral goats are having on native habitats, but will aim to deter people from illegally releasing pigs into new places.
Site-led pest programme	Site-led programmes could be used to control feral	Site-led programmes would require an investment of time	Low-Moderate. Depending on the size(s) of the area(s)

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	goats in areas of high ecological value. This would reduce the impacts of feral pigs in these high priority areas only.	and resources by the council and affected landowners. Feral goats are widespread in Northland and adversely effect various components of the ecosystem, including soil, plants, invertebrates and some birds. A site-led approach would not reduce or restrict the impacts of feral goats in areas that are not identified as being of high priority.	identified for site-led programmes, this approach has a low-moderate risk of failing. Feral goats have serious adverse effects on the environment and are mobile species, so any site-led approach is unlikely to be comprehensive enough to effectively manage the impacts of these species unless the sites are large. In many sites, success or failure will partly depend upon the level of support in local communities.
Summary of alternative assessments and preferred option:	Sustained control programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for feral goats. In terms of alternative approaches assessed, under no regional intervention (or do nothing) council would have no mandate to be involved in or fund feral goat management, including regulatory measures. Some undetermined and sporadic goat control would continue in the absence of a Plan. Further, under 'do nothing' feral goat numbers would increase and cause further biodiversity and production impacts. Eradication and progressive containment programmes are unrealistic due to the widespread distribution of feral goats in the region and their mobility and fecundity. Both scenarios would be well beyond the ability of NRC to resource and implement, as the costs of control that would be imposed on landowners and council would more than likely exceed the benefits and be unsustainable. Even a site-led approach would have a moderate to high risk of failure due to the widespread nature of feral goats and the unpredictable responses (support or opposition) of land occupiers surrounding identified sites to protect. A sustained control programme outcome (to reduce the impacts and possibly the spread of feral goats into mapped indigenous areas of the region) is the preferred option and is a pragmatic and affordable management intervention measure for council to adopt. The success of this scenario depends on the degree to which the regulatory approach is engaged with by 'potential goat farmers' and the effort required by council. There is some operational risk associated with a goat farming rule – potential overlap with, or confusion, because of Wild Animal Control Act provisions (which also have criteria stated around farmed v feral goats). A good working relationship is required with DOC to ensure this scenario is robust. It is very difficult to determine if the benefits of this approach outweigh the costs, especially as the loss of biodiversity values cannot be quantified under a CBA model.		

Feral pig

Sus scrofa

Also known as: feral pig

(Family: Suidae)

Status in New Zealand

Relevant biology

Form	Feral pigs are smaller and more muscular than domestic pigs. They are usually black but they can be ginger, sandy brown, white, grey or combinations of these colours. Their tusks are triangular in cross-section, approximately 150mm long and extend out from the lower jaw and curve upwards, outward and backwards.
Habitat	Feral pigs occur in both native forest and in exotic plantations, and are well established throughout New Zealand.
Regional distribution	Feral pigs are widespread throughout Northland and are common in some areas.
Competitive ability	Feral pigs eat a wide variety of food including grasses, roots, seeds and other plant material as well as carrion, invertebrates (e.g. snails) and ground-nesting birds. They damage forests by uprooting trees and saplings and eating native plants and invertebrates. They also eat pasture and crops and are known to be carriers of bovine tuberculosis and leptospirosis.
Reproductive ability	Feral pigs breed throughout the year. Each litter comprises 6-10 piglets but only 3-6 are likely to survive. Newborn piglets stay within or near the nest for first 2-3 weeks, wean at 2-4 months and stay with the sow until the next litter is due. Vectors of spread: Feral pigs are mobile animals and may also be intentionally released into new areas by recreational hunters.
Resistance to control	Remote country occupied can make hunting difficult, resistant generally to toxins such as 1080.
Benefits	Feral pigs are considered by pig hunters to be a recreational resource, and there have been many releases of pigs into forested areas.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	Low
Sheep and beef	Low	Low
Forestry	Low	Low
Horticulture	Low	Low
Native	High	High

Land use type	Current land use infested	Potential land use
Urban	-	-
Coastal	-	-
Estuarine and marine	-	-
Freshwater	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	L	M	Feral pigs are known to be carriers of bovine Tuberculosis. They can affect pastures and compete with domestic stock directly by eating grass and rooting up the soil.	Nuttall 1986 McIroy 2001
Sheep and beef	L	M	Feral pigs are known to be carriers of bovine Tuberculosis. They can affect pastures and compete with domestic stock directly by eating grass and rooting up the soil. Also can predate on new born lambs.	Nuttall 1986 McIroy 2001
Forestry	L	M	Damage to young plantation trees has been noted.	Parkes 2006
Horticulture	L	M	Damage to crops has been noted.	Parkes 2006
Other	-	-		
International trade	-	-		
Environment				
Soil resources	L	M	Feral pigs contribute to erosion through rooting, trampling, compaction and wallowing.	GWC
Water quality	L	M	Feral pigs contribute to erosion through rooting, trampling, compaction and wallowing.	GWC
Species diversity	M	H	Feral pigs have a significant effect on natural values. Their disturbance and their predation on plants, invertebrates and	McIroy 2001 GWC

Category	Current	Potential	Comment	Source
			ground-nesting birds can affect long-term ecosystem processes such as nutrient cycling and alter vegetation composition.	
Threatened species	M	H	Pigs rooting up the forest floor could disturb kiwi and they disturb and predate threatened invertebrates.	McIroy 2001
Social/Cultural				
Human health	-	-		
Recreation	+	+	Pigs are regarded as a resource by recreational hunters.	
Maori culture	-	-	Pigs adversely effect native/taonga species but are also regarded as an important food resource by some communities.	

L = low M= moderate H = high - = No impact + = Benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council under the RPMP in relation to this species.	Feral pigs impact upon native vegetation and wildlife, pasture production, and animal welfare. If no action is taken, the existing populations may expand, with severe environmental and economic consequences.	High. Feral pigs can breed rapidly and can occupy a wide range of habitats. If no action is taken their economic and environmental impacts will increase.
Exclusion programme	Not applicable	Not applicable	Feral pigs are already present in Northland.
Eradication programme	If feral pigs could be eradicated, their impacts upon the environment would be prevented in the future and the long-term costs of control would be avoided.	Eradication would require a large investment across the region in control, surveys, responding to reports, and enforcement action.	High. Feral pigs are widespread and common in Northland. They are also valued as a recreational resource by some and illegal releases do occur. Eradication is not a feasible approach.
Progressive containment programme	A progressive containment programme would incur lower financial cost to the council and landowners. It would aim to confine or reduce the distribution of	A progressive containment programme would require a considerable investment of time and resources from the council and affected landowners. It would not aim	High. Feral pigs are present throughout Northland. They are widespread, fast-breeding, and mobile. In addition, their dispersal may be aided by hunters releasing pigs to create

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	feral pigs and reduce their adverse effects on native flora, fauna and habitats.	to eradicate feral pigs, so control costs would be on-going.	a recreational resource. Therefore, during the lifetime of the RPMP a progressive control programme has a high chance of failing to reduce the impact of feral pigs.
Sustained control programme	A sustained control programme would incur lower short-term financial cost to the council and landowners. It would aim to restrict the spread and impacts of feral pigs through deliberate actions of people.	A sustained control programme would require an investment of time and resources by the council and affected landowners. It would not aim to eradicate or contain the species, so control costs and the adverse effects of feral pigs on the environment would be on-going.	Moderate. A sustained control programme to prevent feral pigs from having "increasingly severe impacts on the environment" has a moderate chance of failing. It will fail to address the existing impacts that feral pigs are having on native habitats, but will aim to deter people from illegally releasing pigs into new places.
Site-led pest programme	Site-led programmes could be used to control feral pigs in areas of high ecological value. This would reduce the impacts of feral pigs in these high priority areas only.	Site-led programmes would require an investment of time and resources by the council and affected landowners. Feral pigs are widespread in Northland and adversely effect various components of the ecosystem, including soil, plants, invertebrates and some birds. A site-led approach would not reduce or restrict the impacts of feral pigs in areas that are not identified as being of high priority.	Low-Moderate. Depending on the size(s) of the area(s) identified for site-led programmes, this approach has a low-moderate risk of failing. Feral pigs have serious adverse effects on the environment and are mobile species, so any site-led approach is unlikely to be comprehensive enough to effectively manage the impacts of these species unless the sites are large. In many sites, success or failure will partly depend upon the level of support in local communities.
Summary of alternative assessments and preferred option:	Sustained control programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for feral pigs. In terms of alternative approaches assessed, under no regional intervention (or do nothing) council would have no mandate to be involved in or fund feral pig management, including using any regulatory measures. Sporadic, but in some places quite intense, pig control would continue in the absence of a Plan, although any benefits would be very localized. Overall, under 'do nothing', feral pig numbers would continue to increase and cause further biodiversity and production impacts than currently experienced. Eradication and progressive containment programmes are wholly unrealistic due to the widespread distribution of feral pigs in the region and their mobility and fecundity. Both scenarios would be well beyond the ability of NRC to resource and implement, as the costs of control that would be imposed on landowners and council would exceed the benefits and be unsustainable. Even a site-led approach would have a moderate to high risk of failure due to the widespread nature of feral pigs and the unpredictable responses (support or opposition) of land occupiers surrounding identified sites to protect. At some sites however, feral pig control might help to stem the spread of kauri dieback disease.		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	A sustained control programme outcome (to reduce the impacts and aid as a deterrent to the deliberate spread of feral pigs in the region) is the preferred option and is a pragmatic and affordable management intervention measure for council to adopt. The success of this scenario depends on building strong relationships with pig hunting groups, awareness initiatives around the problem of feral pigs and the degree to which the regulatory approach is implemented and the effort required by council. It is very difficult to determine if the benefits of this approach outweigh the costs, especially as the loss of biodiversity values cannot be quantified under a CBA model. There is some operational risk associated with feral pig management in Northland, in that pig hunting is embedded in the culture of many Northland communities and changing attitudes in some 'high-risk' areas may be challenging.		

Galah

Cacatua roseicapilla Syn. Eolophus roseicapillus

(Family: Cacatuidae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Galahs have a white crown and rump, grey wings and the neck, abdomen and underwing coverts are pink. Male and female plumage is indistinguishable. They are approximately 325g in weight, and 36cm long. Galahs are ground feeding grain eaters, but will also eat buds, flowers, berries and insect larvae. They are gregarious, forming variably sized semi-nomadic flocks. Courtship and mating occurs in August in New Zealand.
Habitat	Preferred habitats include agricultural landscapes with forest fragments or hedgerows, urban parks and gardens. Tree cavities are required for nesting. Galahs do not usually colonise dense forest.
Regional distribution	There are no known established populations of galahs in Northland. Galahs are established in Auckland at Ponui and Pakihi Islands, South Auckland including Hunua, Clevedon, Kawakawa Bay, and Pukekohe. It appears to be the same population moving between these areas, and has been established for well over a decade.
Competitive ability	Galahs defend up to 3m surrounding their nest site, and may retain the nest site year round.
Reproductive ability	Little is known regarding breeding biology in naturalised New Zealand populations. In the native range, galahs produce 1-5 eggs per nesting attempt, with different hatching times leading to age and size differences among nest mates. Young fledge at approximately 7 weeks old. Fledglings may congregate in inter-familial crèches.
Resistance to control	Parrots are smart and difficult to control.
Benefits	May be perceived by some as a colourful and valuable addition to local avifauna.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	Low
Forestry	-	Low
Horticulture	-	Low
Native	-	Low
Urban	-	High

Land use type	Current land use infested	Potential land use
Coastal	-	Low
Estuarine and marine	-	-
Freshwater	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	L	See 'Horticulture' section re: impact on maize.	
Forestry	-	L	Can damage forestry seedlings.	Bomford and Sinclair, 2002.
Horticulture	-	L-M	Feed on grain crops including maize. Major pest of grain crops in Australia, impact in NZ likely to worsen if population increased.	Bomford and Sinclair, 2002; Heather and Robertson, 2005.
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	L-M	May compete with native hole nesting birds for nest cavities. May act as reservoir and vector of wildlife disease.	Bomford and Sinclair, 2002; Menchetti and Mori, 2014.
Threatened species	-	L	Potential impacts on native parrots through competition and disease.	
Social/Cultural				
Human health	-	L	May act as reservoir and vector of human pathogens.	Menchetti and Mori, 2014.
Recreation	-	-		

Category	Current	Potential	Comment	Source
Maori culture	-	L	See 'Species diversity'.	

L = low M= moderate H = high - = No impact + = Benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. The Galah did not meet the requirements for this programme.		
Exclusion programme	Not applicable	Not applicable	-
Eradication programme	Not applicable	Not applicable	-
Progressive containment programme	Not applicable	Not applicable	-
Sustained control programme	Not applicable	Not applicable	-
Site-led pest programme	Not applicable	Not applicable	-
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that the galah does not meet the 'tests' under the Act, even though it could be present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be no regional intervention for galahs, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding.		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	While galahs have not been afforded pest status in Northland, they may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes.		

Hare

Lepus europaeus occidentalis

Also known as: European hare, brown hare

(Family: Leporidae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Hares are easily distinguished from rabbits. They are much larger, with long, black-tipped ears and large muscular hindquarters. Hares are mostly brown in colour, with a lighter brown belly. The tail is black on top with a white underside and while the hare runs the tail faces down as apposed to rabbits which face up. The front legs are about half the size of the hind legs and appear undeveloped in comparison. Hares tend to be solitary animals and live above ground, whereas rabbits live in large groups and usually nest underground.
Habitat	Hares are found in most pastoral and grassland areas of New Zealand and feed on numerous plant species. Hares are primarily nocturnal. During daylight hours they crouch in a "form", an oval shaped depression in vegetation or soft ground.
Regional distribution	Hares are widespread throughout Northland, but population densities are generally low.
Competitive ability	Hares cause damage to new tree plantings and horticultural crops, amenity plantings and shelter belts by eating tree bark and young shoots. Hare population densities appear to be self-regulated so they do not undergo the kinds of irruptions seen in rabbits. There is no evidence that they are limited by food, they are not territorial, and direct aggressive interactions seem to be rare. Adult hares are remarkably free from predation in New Zealand and are also relatively free of parasites and disease.
Reproductive ability	In New Zealand, hares start breeding in early July and continue until mid-March. The average litter size in one New Zealand study was 2.14 and the average number of successful litters per year was 4.59. This gave an annual production of 9.8 young per female. Vectors of spread: Hares are territorial but young males disperse over distances of several hundred metres to several kilometres. Rates of dispersal in new suitable areas in South America were calculated at between 10 and 37km per year.
Resistance to control	Hares can be controlled by shooting, but other control tools are limited.
Benefits	-

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	Low	Low
Sheep and beef	Low	Low
Forestry	Low	Low
Horticulture	Low	Low
Native	-	-
Urban	-	-
Coastal	Low	Low
Estuarine and marine	-	-
Freshwater	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	L	L	Hares can damage newly pine young trees.	Bay of Plenty Regional Council.
Horticulture	L	L	Hares can damage newly-planted shelter belts, young trees, cuttings, crops and plants in nurseries.	Bay of Plenty Regional Council.
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	L	L	Hares have generally been perceived to have minimal impact on the environment because they live at relatively low densities, eat palatable	Wong and Hickling, 1999.

Category	Current	Potential	Comment	Source
			plants without killing them, graze only a few leaves from many plants over a wide area, and do not dig burrows. However, they can affect the recovery of native sedges, exotic grasses and native herbs in wetlands.	
Threatened species	-	L	Hares have generally been perceived to have minimal impact on the environment but they can affect the recovery of native sedges and native herbs in wetlands.	Wong and Hickling, 1999.
Social/Cultural				
Human health	-	-		
Recreation	+	+	Recreational shooting.	
Maori culture	-	-		

L = low M= moderate H = high - = No impact + = Benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by council in relation to this species.	Land owners/occupiers of horticultural or forestry land are likely to continue undertaking control to protect their crops.	Low. Hares are capable of spreading over large distances and breed rapidly, but densities are low in Northland. As affected land occupiers are the main beneficiaries of control, it is likely that they will continue with this.
Exclusion programme	Not applicable.	Not applicable.	Hares are already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Hares are widespread and relatively common in Northland. Eradication is not a feasible approach and the level of resources required would be disproportionate to their impacts.
Progressive containment programme	Not applicable.	Not applicable.	Hares are present throughout Northland. They are widespread, fast-breeding, and mobile, so it would not be

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
			possible to define a progressive containment area.
Sustained control programme	A sustained control programme would incur lower short-term financial cost to the council and landowners. It would aim to restrict the spread and impacts of hares and prevent them from having increasingly severe impacts on the environment.	A sustained control programme would require an investment of time and resources by the council and affected landowners. It would not aim to eradicate or contain the species, so control costs and the adverse effects of hares on forestry and horticulture would be on-going.	Low-Moderate. Hares can be controlled by shooting to prevent them from having "increasingly severe impacts" in horticultural areas and production forests.
Site-led pest programme	Site-led programmes could be used to control hares in areas of high ecological value. This would reduce the impacts of hares in these high priority areas only.	Site-led programmes would require an investment of time and resources by the council and affected landowners. Hares are widespread in Northland but their impacts are greatest in horticultural areas and production forests, not in areas with high ecological values.	Not applicable. Hares are not suitable for a site-led programmes because these programmes aim to control species in areas of high ecological value but hares' impacts are greatest in horticultural areas and production forests.
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that hare do not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be <u>no regional intervention</u> for hare, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding. While hare have not been afforded pest status in Northland, they may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes.			

Hedgehogs

Lepus europaeus occidentalis

Also known as: European hare, brown hare

(Family: Leporidae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Hares are easily distinguished from rabbits. They are much larger, with long, black-tipped ears and large muscular hindquarters. Hares are mostly brown in colour, with a lighter brown belly. The tail is black on top with a white underside and while the hare runs the tail faces down as apposed to rabbits which face up. The front legs are about half the size of the hind legs and appear undeveloped in comparison. Hares tend to be solitary animals and live above ground, whereas rabbits live in large groups and usually nest underground.
Habitat	Hares are found in most pastoral and grassland areas of New Zealand and feed on numerous plant species. Hares are primarily nocturnal. During daylight hours they crouch in a "form", an oval shaped depression in vegetation or soft ground.
Regional distribution	Hares are widespread throughout Northland, but population densities are generally low.
Competitive ability	Hares cause damage to new tree plantings and horticultural crops, amenity plantings and shelter belts by eating tree bark and young shoots. Hare population densities appear to be self-regulated so they do not undergo the kinds of irruptions seen in rabbits. There is no evidence that they are limited by food, they are not territorial, and direct aggressive interactions seem to be rare. Adult hares are remarkably free from predation in New Zealand and are also relatively free of parasites and disease.
Reproductive ability	In New Zealand, hares start breeding in early July and continue until mid-March. The average litter size in one New Zealand study was 2.14 and the average number of successful litters per year was 4.59. This gave an annual production of 9.8 young per female. Vectors of spread: Hares are territorial but young males disperse over distances of several hundred metres to several kilometres. Rates of dispersal in new suitable areas in South America were calculated at between 10 and 37km per year.
Resistance to control	Hares can be controlled by shooting, but other control tools are limited.
Benefits	-

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	Low	Low
Sheep and beef	Low	Low
Forestry	Low	Low
Horticulture	Low	Low
Native	-	-
Urban	-	-
Coastal	Low	Low
Estuarine and marine	-	-
Freshwater	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	L	L	Hares can damage newly pine young trees.	Bay of Plenty Regional Council.
Horticulture	L	L	Hares can damage newly-planted shelter belts, young trees, cuttings, crops and plants in nurseries.	Bay of Plenty Regional Council.
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	L	L	Hares have generally been perceived to have minimal impact on the environment because they live at relatively low densities, eat palatable	Wong and Hickling, 1999.

Category	Current	Potential	Comment	Source
			plants without killing them, graze only a few leaves from many plants over a wide area, and do not dig burrows. However, they can affect the recovery of native sedges, exotic grasses and native herbs in wetlands.	
Threatened species	-	L	Hares have generally been perceived to have minimal impact on the environment but they can affect the recovery of native sedges and native herbs in wetlands.	Wong and Hickling, 1999.
Social/Cultural				
Human health	-	-		
Recreation	+	+	Recreational shooting.	
Maori culture	-	-		

L = low M= moderate H = high - = No impact + = Benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by council in relation to this species.	Land owners/occupiers of horticultural or forestry land are likely to continue undertaking control to protect their crops.	Low. Hares are capable of spreading over large distances and breed rapidly, but densities are low in Northland. As affected land occupiers are the main beneficiaries of control, it is likely that they will continue with this.
Exclusion programme	Not applicable.	Not applicable.	Hares are already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Hares are widespread and relatively common in Northland. Eradication is not a feasible approach and the level of resources required would be disproportionate to their impacts.
Progressive containment programme	Not applicable.	Not applicable.	Hares are present throughout Northland. They are widespread, fast-breeding, and mobile, so it would not be

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
			possible to define a progressive containment area.
Sustained control programme	A sustained control programme would incur lower short-term financial cost to the council and landowners. It would aim to restrict the spread and impacts of hares and prevent them from having increasingly severe impacts on the environment.	A sustained control programme would require an investment of time and resources by the council and affected landowners. It would not aim to eradicate or contain the species, so control costs and the adverse effects of hares on forestry and horticulture would be on-going.	Low-Moderate. Hares can be controlled by shooting to prevent them from having "increasingly severe impacts" in horticultural areas and production forests.
Site-led pest programme	Site-led programmes could be used to control hares in areas of high ecological value. This would reduce the impacts of hares in these high priority areas only.	Site-led programmes would require an investment of time and resources by the council and affected landowners. Hares are widespread in Northland but their impacts are greatest in horticultural areas and production forests, not in areas with high ecological values.	Not applicable. Hares are not suitable for a site-led programmes because these programmes aim to control species in areas of high ecological value but hares' impacts are greatest in horticultural areas and production forests.
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that hare do not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be no regional intervention for hare, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding. While hare have not been afforded pest status in Northland, they may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes.		

Indian ring-neck parrot

Psittacula krameri

(Family: Psittacidae)

Status in New Zealand

Available for sale.

Relevant biology

Form	Indian ring-neck parrots are 38-42cm, typically with a green body. Colour variations are available due to selective breeding/mutation. Colours other than green usually cost more to buy. The neck is encircled by a red band (males) or indistinct emerald band (females). Males also have a black bib from underside of the beak down to the neck band, and may have a bluish tinge on the back of the head. Sub-adult males are difficult to distinguish from females. Males become sexually mature and develop the neck ring at 2-3 years old. Life-span in captivity is approximately 20 years (in some cases up to 34 years). It is gregarious and feeds and breeds in groups.
Habitat	Broad climatic tolerance from cool and wet to hot and dry. Naturalised in at least 35 countries. Probability of occurrence declines with increasing number of frost days per annum, and reproductive success is greater in warmer climates (for example, Mediterranean) than in cooler climates (for example, United Kingdom). However, these birds are well established in London and elsewhere in the Southern UK, therefore are unlikely to be limited by cold in Auckland. They are typically most abundant in urban areas and parks near human populations. Rural forest fragments are also recorded as occupied overseas but extensive areas of forest appear to be less favoured than orchards, urban parks and gardens. Cavity nesting, in pre-existing natural cavities and nest boxes (minimum hole entrance diameter 40 mm). They can undertake some weak excavation to augment small holes. Known to nest in rock crevices and buildings in their native range but not in the UK. Parakeet abundance overseas is positively correlated with cavity abundance (that is, availability of nesting habitat). They favour cavities with substantial tree/shrub cover around them, and cavities in trees with a larger diameter at breast height (mean 73.7cm in UK). The parrots consume a wide range of grains (for example, maize), flowers, buds and fruit (for example, guava, apples, pears, plums). They will return repeatedly to the same food tree until the resource is exhausted, and will take a broad range of supplementary foods when offered (including bread and meat). Supplementary feeding by humans may play an important role in supporting elevated populations in urban environments.
Regional distribution	Available for sale in one pet shop within the region and across Auckland. No known naturalised populations.
Competitive ability	Gregarious foraging, enabling domination of food sources. High levels of inter-specific aggression. Relatively early breeding season overseas resulting in pre-emptive cavity occupancy, followed by aggressive and often successful defence of cavities against

	other species, and some reports of eviction of other species from cavities. Therefore, potential to competitively exclude other cavity nesting species from the nest habitat. Appear to defend only the nest cavity rather than the entire tree, therefore may have lesser impact on non-cavity nesting species. More likely to be aggressive with smaller body-mass bird species. Aggressively attack potential nest predators such as rats, often successful, sometimes resulting in death of the predator.
Reproductive ability	Clutch size ranges from 1-7 eggs. Number of eggs per clutch may be influenced by cavity type. Populations in some regions produce two clutches per year, others only one. New Zealand breeders indicate two broods per year are unlikely here. Nestlings fledge at around 7 weeks of age. Rapid rate of population increase documented in overseas invasions (for example, average annual population increases of around 15-30% in the UK, 22% in Netherlands). Although abundance may increase rapidly, geographic range expansion may be slower (0.4 km/y in UK). Establishment of breeding populations overseas is positively correlated with human populations, that is, there are greater numbers where people live.
Resistance to control	Lack of effective control tools available.
Benefits	Attractive and hardy pet bird.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	-	Low
Horticulture	-	High
Native	-	Low
Urban	-	High
Coastal	-	Low
Estuarine and marine	-	-
Freshwater	-	-

High = Preferred land use; Low = Less preferred land use

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		

Category	Current	Potential	Comment	Source
Forestry	-	L	Some potential for damage to tree crops through bark stripping and bud consumption.	
Horticulture	-	M	Causes economically significant damage to grain crops such as maize overseas. May also attack fruit such as citrus, guava, grapes.	Ahmad et al., 2012; Butler, 2003; Khan et al., 2011.
Other	-	L	Potential vector of poultry diseases. Accounted for 4.5% of bird strike incidents at Heathrow airport in 2006 at a cost of £20,000 per strike.	Butler, 2003; Tayleur, 2010.
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	M	Highly aggressive to other species, including birds and small mammals such as bats. Potential to competitively exclude other cavity-nesting species through eviction or early occupancy and successful defence of cavities. Potential for complex nest competition interactions among parakeets, other exotic cavity nesting species such as mynas, and native avifauna. Potential for interference competition resulting in increased vigilance and reduction in time spent foraging by other bird species. Potential source of disease and parasite transmission to native species, especially native parrots (for example, beak and feather disease virus). High density roost sites may lead to deposition of large quantities of guano, which could locally alter plant and invertebrate communities. Feeding includes stripping tree bark, which can kill	Butler, 2003; de Sa et al., 2014; Hernandez-Brito et al., 2014; Mechetti et al., 2014; Mori et al., 2015; Orchan et al., 2013; Peck et al., 2014; Strubbe and Matthysen, 2009b; Tayleur, 2010.

Category	Current	Potential	Comment	Source
			trees. Impacts most likely to affect populations near human populations. However, most bush fragments within the Northland and Auckland region are likely to contain sufficient 'edge' habitat to support populations.	
Threatened species	-	M	Potentially serious impacts on populations of native parrots via transmission of beak and feather disease virus and also through inter-specific competition.	Massaro et al., 2012; de Sa et al., 2014.
Social/cultural				
Human health	-	L	Potential disease vector.	
Recreation	-	L	Colourful, therefore may be perceived as visually pleasing addition to urban fauna, but aggregations of birds may cause a noise nuisance. Produce loud alarm call when threatened.	Hart and Downs, 2014; Hernandez-Brito et al., 2014.
Māori culture	-	M	Any serious impacts on native parrot populations would have significant implications for Māori.	

L = low M= moderate H = high - = No impact + = Benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Do nothing			
Exclusion programme	Indian ringneck parakeets are a strong competitor, excluding this species from northland protects native bird species.	There is a low cost to council in providing funds for surveillance of the species, this is far outweighed by the benefits of the programme.	Medium- there is a risk that in the lifetime of the plan a population is able to establish in Northland.
Eradication programme	Not applicable	Not applicable	Indian ringneck parakeets are not thought to exist in the wild in Northland.
Progressive containment programme	Not applicable	Not applicable	Indian ringneck parakeets are not thought to exist in the wild in Northland.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Sustained control programme	Not applicable	Not applicable	Indian ringneck parakeets are not thought to exist in the wild in Northland.
Site-led pest programme	Not applicable	Not applicable	Indian ringneck parakeets are not thought to exist in the wild in Northland.
Summary of alternative assessments and preferred option:	**Exclusion programme** Summary of alternative assessments and preferred option: In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for ringneck parakeets. With regard to alternative approaches assessed, under no regional intervention (or do nothing) there would be some criticism of Northland Regional Council from government (MPI) and environmental preservation groups, for not being more proactive while knowing that naturalised populations of these parakeets exist in neighbouring regions. Biodiversity values (e.g. displacement of native cavity nesting birds) would be impacted if ringneck parakeets were discovered and no intervention plans or measures were available. As ringneck parakeets are not currently found in Northland, an exclusion programme outcome is the only appropriate option available. Like rainbow lorikeet, these parakeets may be kept in captivity but if or when released (accidentally or deliberately) they are deemed unwanted organisms. Accordingly, and although their pest status has been elevated recently, there is a moderate to high risk (involving bird fanciers) around the extent to which an exclusion programme will be successful. The current legislation contains an anomaly which allows for their movement through the pet trade. This is potentially the highest risk pathway for the establishment of naturalised populations, as evidenced with the Paeroa and Havelock North discoveries. Most bird species are difficult to control and there are no guarantees with current methods. Therefore, an exclusion programme focusing on a comprehensive advocacy and surveillance programme, and dialogue with neighbouring regions where they are found, will help to mitigate any operational control risks by detecting any infestations very early on.		

Magpie

White-backed magpie *(Gymnorhina tibicen hypoleuca)* and black-backed magpie *(Gymnorhina tibicen tibicen)*

(Family: Artamidae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Magpies were brought to New Zealand from Australia in the 1860s to control insect pests. They are approx 36-44cm in length, weighing 280-340 gms. Two sub-species were introduced, the white-backed *(Gymnorhina tibicen hypoleuca)* and black-backed *(Gymnorhina tibicen tibicen)* magpie. Both subspecies are black and white in colour. The white-backed form *tyrannica* is the largest of the sub-species. The male has a white hind-neck, mantle, rump and shoulder patches. The upper two-thirds of the tail and under-tail coverts are also white. The rest of the plumage is black, with a blue iridescence. The female is similar, but the mantle is grey, and the black parts of the plumage are less iridescent. Both sexes have a blue-grey bill with a dark tip, and red eyes. The male takes several years to attain full adult plumage; after the second moult it resembles an adult female. Some white appears on the mantle after the third moult, and the remainder after the fourth moult. The juvenile is mottled grey on the under-surface. The black-backed magpie is similar to the white-backed forms, but with a black mantle. The female can be identified by the presence of some grey on the lower hind-neck. The two subspecies interbreed, resulting in offspring with a varying amount of black on the mantle, ranging from a few feathers to a narrow band. Both sexes have a distinctive carolling song; "quardle oodle ardle wardle doodle". With its large size and strikingly pied plumage, the Australian magpie is not readily confused with any other species.
Habitat	Magpies are most abundant on farmland with shelterbelts of pines, macrocarpas and gums and the edges of native bush areas. They inhabit both lowland and hill-country farming districts, and are frequently found in urban habitats such as parks and golf-courses.
Regional distribution	Widely found but in varying densities (generally unknown and unsurveyed). Naturalised in most suitable habitat across the region.
Competitive ability	Magpies are extremely territorial birds and show aggression to anything that may pose a threat to their territory. They can be a considerable nuisance during the breeding season, swooping on and occasionally attacking humans. Council receives occasional complaints during the nesting season regarding harm caused by 'dive-bombing' magpies. Most complaints are in relation to urban and public parks, reserves and fields, and occasionally on private properties. Magpies can affect native birds by excluding them from breeding territories but are not known to attack and kill adult native birds. They on occasion may prey on chicks and eggs to feed to their own young.

	A study by several regional councils and Landcare Research (1999 - 2002) found little evidence that magpies affected the populations of other species of birds. Magpies were removed from a number of blocks of land, and other blocks were left untouched as controls. The bird species were surveyed before commencement of control in the "kill" blocks, and then again after the operations had been completed. Little change in numbers of other species was found afterwards, or in comparison with the populations in the control blocks. However the visibility of other species was affected; without magpies some were more frequently seen.
Reproductive ability	Magpies breed early in the season, commencing nest-building in late July, and are normally single brooded. The bulky nest is built of twigs, roots, and man-made materials including wire, and lined with hair and wool. It is usually located in the crown or side-branches of tall trees, especially pines, macrocarpas and gums. Native trees such as tawa and beech are also frequently used. The usual clutch consists of 3-4 eggs, and the resulting chicks are fed by both parents for 4-5 weeks until fledging. They rely on their parents for a further 2 months or so afterwards. Usually only one or two chicks survive, as in most cases it takes one parent per chick to provide sufficient food.
Resistance to control	Magpies are very wary birds which makes shooting difficult. They can be lured into traps containing other magpies, as 'live bait', especially magpies from outside their territory. Poisoning and trapping are effective if good techniques are used.
Benefits	None known. Insects pests may be eaten along with desirable native invertebrates. Some people are engaged by the flute like call of magpie, the subject of early New Zealand writers/poets.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	Low	Low
Sheep and beef	Low	Low
Forestry	Low	Low/medium
Horticulture	Low	Low
Native	Low (edges)	Low
Urban	Low- scattered	Low
Coastal	-	-
Estuarine and marine	-	-
Freshwater	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-	Nuisance impacts only	

Category	Current	Potential	Comment	Source
Sheep and beef	-	L	Nuisance impacts only	
Forestry	-	L	Offers more prefered habitat - edges of forestry block - gum and pines	
Horticulture	-	L	Unlikely to have significant impacts, seeds and grain may be taken occasionally.	
Other	-	-	-	
International trade	-	-	Nil	
Environment				
Soil resources	Nil	Nil	-	
Water quality	Nil	Nil	-	
Species diversity	-Nil to low	L	Low level impacts on native birds (chicks and eggs) - due to omnivorous diet preferences.	http://www.nzbirdsonline.org.nz
Threatened species	-	L	Known to chase and harass native sepcies and may displace them, usually occupy different habitats from endangered or threatened species.	http://www.nzbirdsonline.org.nz
Social/Cultural				
Human health	M	M-H	Magpies may harm human health but over short time periods only during nesting season where they are very territorial (September)	http://www.nzbirdsonline.org.nz
Recreation	-	-	Some visual and aesthetic impacts for people recreating. People may be affected in different ways on hearing their calls and observing them	Anecdotal
Maori culture	-	L	Not anticipated to have any quantifiable impacts	

L = low M= moderate H = high - = No impact + = Benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. The magpie did not meet the requirements for this programme.	None	-
Exclusion programme	Not applicable	Not applicable - magpies are already in the region	-
Eradication programme	Not applicable	Not applicable - magpies are widely found in the region	-
Progressive containment programme	Not applicable	Not applicable - magpies are widely found in the region.	-
Sustained control programme	Not applicable	Not applicable	-
Site-led pest programme	Not applicable. Research showed that controlling magpies at sites resulted in population voids being created, which over a short period of time were infilled rapidly again by birds moving in from other territories.	Not applicable	-
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that magpies do not meet the 'tests' under the Act, even though they are present in the region and possibly causing seasonal impacts (anecdotal and unmeasured, low level human health impacts). Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be no regional intervention for magpies, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding.		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	While magpies have not been afforded pest status in Northland, they may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised effects (e.g. dive bombing birds during nesting times around schools). The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes.		

Monk parakeet

Myiopsitta monachus

Also known as Quaker parrots.

(Family: Psittacidae)

Status in New Zealand

Available for sale as pets.

Relevant biology

Form	This is a medium-sized parrot (around 90-120g). It is greenish-grey above with a yellower underside, and blue secondary and flight feathers on the wings. The face and throat are grey. There is slight sexual dimorphism; males tend to be slightly heavier than females except during breeding, but colouration is similar between sexes.
Habitat	Urban and rural ecosystems. They benefit from human modification of the environment and in New Zealand would likely occupy similar habitats to those already occupied by other exotic birds such as sparrows and mynas. Monk parakeets feed on the ground and arboreally - in trees - including fruit (preferred when available) and grain crops, flower and leaf buds and seedlings, as well as grass and forb seeds in short-stature grasslands, and insects. They will use supplementary feeding stations, and supplementary feeding appears to support larger populations overseas. Nesting occurs in the tallest available structures (trees or artificial structures). The preferred roost tree species varies according to availability, but Eucalyptus and palms are preferred when available. They roost in nests year-round, not just in the breeding season. Dense forest with under-storey tends not to be invaded, as they prefer tall trees or other structures located within a more open landscape. Broad temperature tolerances; with colonisation in areas with mean winter minimum temperatures around -11°C. However, occurrence at broad spatial scales is negatively related to the number of frost days and they may be more restricted to urban ecosystems under extreme cold conditions.
Regional distribution	No pet shops currently sell this species in Northland. No known naturalised populations.
Competitive ability	Complex social groups (flock size up to around 60 individuals, but generally less than 15), long development period and high intelligence levels. Opportunistic omnivores capable of exploiting a range of ephemeral food sources. Monk parakeet nests are sometimes shared by other bird species, and house sparrows have been seen apparently displacing monk parakeets from their nests.
Reproductive ability	Moderately high propagule pressure from escapes from captivity. Build large nests out of sticks, either as single nests or complex multi-chambered communal nests, which can exceed 1000kg. They can build nests so are not limited by the availability of tree cavities. Birds begin breeding in the second or third year, and live to six years or more in the wild. Monogamous, females incubate the eggs. Clutch size is variable but there are usually around 4-6 eggs per nest. Natal dispersal estimated at <2 km in native range and up to c.100 km (though usually much shorter distances) in introduced range. Exotic range expansion documented at 2.1-7.6 km/year in Argentinian Pampas. Population growth is exponential in many parts of the introduced range.

Resistance to control	Lack of effective control tools available. These parrots are clever, mobile and difficult to control. Overseas studies suggest control to levels that would adequately minimise impacts on crops may require a massive, impractical and unsustainable control effort.
Benefits	Valued pet species and may be valued by some people as a brightly coloured interesting addition to wild bird communities. Control programmes in urban areas overseas have met with widespread public opposition for these reasons.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	
Sheep and beef	-	
Forestry	-	
Horticulture	-	
Native	-	
Urban	-	
Coastal	-	
Estuarine and marine	-	
Freshwater	-	

1 = Preferred land use; 2 = Less preferred land use

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	L	Consume maize and short stature grassland species.	Canavelli et al., 2013.
Sheep and beef	-	L	Consume maize and short stature grassland species.	Canavelli et al., 2013.
Forestry	-	L	Eucalyptus and Pinus plantation trees favoured as nest sites overseas.	Bucher and Aramburu, 2014.
Horticulture	-	L	Feed on leaf buds, vegetables (for example, tomatoes), orchard fruits, and grain crops such as maize and sunflower seeds. Crop losses overseas estimated at between 5-25%, though there may be an over-estimation bias associated with some of these estimates.	Bucher and Aramburu, 2014; Canavelli et al., 2013; Conroy and Senar, 2008; Mott, 1973.

Category	Current	Potential	Comment	Source
Other	-	M-H	Widely naturalised overseas. Tendency to nest on power line poles, cell phone towers, satellite dishes and other utility structures is associated with power outages, fires, and considerable time and money spent removing nests and repairing damage. Documented using short-stature grasslands at airports overseas, though relatively low use of air space and associated risk.	Marateo et al., 2015.
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	L	Potential impacts on native birds through competition for food and through disease transmission, but risk likely relatively low in intact forest ecosystems, higher in urban areas and fragmented/open/low stature native ecosystems. Potential minor impacts on native vegetation from feeding damage. Seed dispersers; potentially positive and/or negative impacts depending on whether native or invasive plant species are consumed and dispersed. Show a preference for nesting in exotic palms, and may exacerbate spread of these species.	Rodriguez-Pastor et al., 2012; Bucher and Aramburu, 2014; Davis et al., 2014.
Threatened species	-	L	Most probable impacts on threatened species would be through disease transmission to native birds.	
Social/cultural				

Category	Current	Potential	Comment	Source
Human health	-	L-M	Risk of human injury and property damage when large nests are dislodged during storms. Risk of human injury from electrical fires and electrocution due to damage to electrical utilities and trespassing at power plants in order to capture birds from sale.	Conroy and Senar, 2008; Davis, 1974; Newman et al., 2008; Pruett-Jones et al., 2005.
Recreation	-	L	Noise disturbance, especially from large colonies. A group of 8-10 birds reported to be heard squawking up to five blocks away. Damage to garden ornamental plants, fruit trees and vegetables. Positive impacts due to enjoyment derived from colourful, charismatic urban species.	Conroy and Senar, 2008; Davis, 1974. Di Santo et al., 2013; Hyman and Pruett-Jones, 1995; South and Pruett-Jones, 2000.
Māori culture	-	L	See 'Species diversity' and 'Threatened species'.	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Do nothing	In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. The Monk parakeet did not meet the requirements for this programme.		
Exclusion programme	Not applicable	Not applicable	
Eradication programme	Not applicable	Not applicable	

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Progressive containment programme	Not applicable	Not applicable	
Sustained control programme	Not applicable	Not applicable	
Site-led pest programme	Not applicable	Not applicable	
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that monk parakeets do not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be <u>no regional intervention</u> for monk parakeets, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding.		

Mustelids

Mustelids includingferrets (Mustela furo), stoats (Mustela erminea) and weasels (Mustela nivalis vulgari)

(Family: Mustelidae)

Status in New Zealand

Ferrets are listed as unwanted organisms under the Biosecurity Act 1993. It is illegal to farm and/or sell any ferret, stoat or weasel unless authorised by the Chief Technical Officer of the Ministry for Primary Industries.

Relevant biology

Form	Ferrets, stoats and weasels belong to a group of animals known as mustelids. **Ferrets** are the largest of the three species and are about 48-56cm long, including the tail. Their colours vary but they are usually dark brown or blackish with a creamy under fur, but they can appear almost white. The tail is uniformly dark. The face is pale with a dark mask over the eyes. Adult males are generally larger than the females. **Stoats** are the most common of the three mustelids and grow to 34-40cm long, including the tail. Stoats are very thin and about half the size of a rabbit. They have a chestnut-brown coat, which turns white in winter, a light-coloured belly, and a bushy, black-tipped tail. **Weasels** are the smallest and least common of the three mustelids in New Zealand. They have a thin, muscular body and a small head. Their colouring is very like the stoat, but with a more red-brown coat, and a shorter tail. They grow to 20-25cm long and will attack prey that is much larger than themselves.
Habitat	**Ferrets** are generally absent or in low numbers in areas of high rainfall, where there are few rabbits, or deep within forested areas. It was originally thought that ferrets were limited to open country like pasture, scrubland, coastal areas, and in the fringes of forests. However, recent research has found ferrets within some Northland forests, placing added pressure on already threatened kiwi populations. **Stoats** will live in any habitat where they can find prey. In New Zealand they can be found at any altitude, in any kind of forest - exotic or native - in scrub, dunes, and pasture. They are even known to occur near human settlements. In open country they are less common than ferrets, but in the forest they are much more common. **Weasels** are usually found where there are plenty of mice, in gardens and near buildings, rather than in open paddocks.
Regional distribution	Mustelids are widespread throughout Northland but are absent from a number of offshore islands.
Competitive ability	Mustelids can be devastating to native bird life and other fauna. They have very good hearing and a strong sense of smell. **Ferrets** hunt mainly at night. Their main prey are rabbits and hares but they also feed on native birds, especially ground-nesting birds, and lizards, frogs and large native invertebrates (for example, weta). They are good climbers and can steal eggs and

	chicks from nests in trees. Ferrets are one of the few predators able to kill an adult kiwi. They will also kill little blue penguins, possums, lizards, eels, hedgehogs and other small mammals. **Stoats** are extremely fierce and will kill more prey than they need for food if they have the opportunity. They will also attack prey much larger than themselves. It is estimated that 60% of North Island brown kiwi chicks born each year are killed by stoats. Stoats hunt during the day or at night and can cover large distances. The main prey of stoats are rodents, birds, rabbits, hares, possums and invertebrates (particularly weta). Lizards, freshwater crayfish, carrion, birds, eggs, hedgehogs and fish are also taken. **Weasels** are not as common in New Zealand as other mustelids, but they also have an impact on native birds and lizards, especially skinks. They kill most of their prey underground, and are usually found where there are plenty of mice, in gardens and near buildings.
Reproductive ability	**Ferrets** are successful breeders, producing between four and eight kittens per litter and one or two litters each year. Within three months of being born, the young ferret is capable of moving out into its own territory. There is high mortality in the first year, and an average lifespan in the wild may be 4-5 years. **Stoats** produce a single litter of up to 12 kits each year. Female stoats have the unusual ability to carry fertilised eggs inside their bodies from mating in summer until the following spring. Young stoats are adults at two months, and female kittens can be mated while still in the nest. They can travel large distances, even crossing water. Most stoats live less than one year but adult mortality is lower and they may reach 6-8 years of age. **Weasels** produce 1-2 litters each year, each containing 4-6 young. The young of the first litter grow very fast and are weaned at four weeks, at which time their eyes open. They are able to hunt and kill at 5-8 weeks.
Resistance to control	To be effective any control must be carried out intensively and be sustained. Trapping is the most effective control method and the best time to catch mustelids is from mid-summer to autumn when they are most active. They are difficult to catch and precision is required in the siting, setting and baiting of traps. They can also be controlled with toxin as a secondary kill, for example, when they eat poisoned rats. A new generation of toxin called Predastop (PAPP) is now available and does not pose a threat of secondary poisoning.
Benefits	Ferrets have been used in the (distant) past for rabbit control (ferreting) but this practice is generally unknown in Northland today.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	High	High
Sheep and beef	High	High
Forestry	High	High
Horticulture	Low	Low
Native	High	High

Land use type	Current land use infested	Potential land use
Urban	Low	Low
Coastal	High	High
Estuarine and marine	-	-
Freshwater	Low	Low

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	L	M	Ferrets and stoats are vector of bovine tuberculosis. Ferrets also carry parasites.	Ragg et al., 1995
Sheep and beef	L	M	Ferrets and stoats are carriers of bovine tuberculosis. Ferrets also carry parasites and toxoplasmosis that can cause abortions in sheep.	Ragg et al., 1995
Forestry	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	H	H	Mustelids can be devastating to native bird life and other fauna. They are fierce predators, can cover large distances, occupy a wide range of habitats, and kill more prey than they need for food.	Invasive Species Compendium Department of Conservation
Threatened species	H	H	Sixty percent of North Island brown kiwi chicks born each year are killed by stoats. Ferrets are one of the few predators able to kill an adult kiwi. They are also predators of other bird species (for example, fernbirds,	Invasive Species Compendium; Department of Conservation.

Category	Current	Potential	Comment	Source
			weka), native lizards and invertebrates.	
Social/cultural				
Human health	L	M	Ferrets carry parasites and toxoplasmosis that can cause abortions in sheep and illness in humans.	Ragg et al., 1995
Recreation	-	-		
Māori culture	H	H	Impacts upon native/taonga species.	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	Rather than applying a programme under the Regional Pest Management Plan, the species could come under a 'Connecting Communities' programme outside of the pest management plan, where advice and support are provided for specific sites. This will provide support to communities as and where the species is having impacts.	Support for community led programmes. Staff time and advice. By not applying a programme and rules to the species, there would be no provisions under the pest management plan to manage inappropriate practises that are exacerbating the spread.	Moderate. Mustelids reproduce rapidly, can disperse over large distances and are effective predators of native fauna. Community led programmes have been very successful in local areas but mustelid populations will increase outside of these areas, and they will continue to have high environmental impacts.
Exclusion programme	Not applicable.	Not applicable.	Mustelids are already present in Northland.
Eradication programme	Not applicable.	Not applicable.	High. Mustelids are widespread, highly mobile, breed rapidly, can disperse over large distances (including across water) and can occupy almost any type of habitat. Eradicating these species from Northland is unachievable at this time.
Progressive containment programme	Not applicable.	Not applicable.	High. Mustelids are widespread, highly mobile, breed rapidly, can disperse over large distances (including across water) and can occupy almost any type of habitat. Progressive containment of these species in

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
			Northland is unachievable at this time.
Sustained control programme	Mustelids could be included in a sustained control programme. The council could include a rule banning possession of live mustelids in the Northland region.	A sustained control programme would require an investment of time and resources by the council and affected landowners. It would not aim to eradicate or contain the species, so control costs and adverse effects on fauna would be on-going.	Moderate - if the objective is to discourage people from holding or moving mustelids around.
Site-led pest programme	The council could specify areas of high biodiversity value as site-led programmes. This would reduce the impacts of mustelids in these high priority areas only.	Site-led programmes would require an investment of time and resources by the council and affected landowners. Mustelids are serious predators of native wildlife, are widespread in Northland and can occupy a range of habitats. A site-led approach would not reduce or restrict the impacts of mustelids in areas that are not identified as being of high priority.	Moderate. Depending on the sizes of the areas identified for site-led programmes, this approach has a moderate risk of failing. Mustelids are serious predators of native wildlife, are widespread in Northland and can occupy a range of habitats so a site-led approach is unlikely to be comprehensive enough to effectively manage the impacts of these species unless the sites are large.
Summary of alternative assessments and preferred option:	Sustained control (and site-led programmes). Also connecting 'communities programme' outside the pest management plan. In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for mustelid species. In terms of alternative approaches assessed, under no regional intervention (or do nothing) council would not have any mandate to be involved in or fund mustelid control or any other management measures. There would be reliance on voluntary control by community groups (incentivised by localised biodiversity outcomes) and some land occupiers would continue to control mustelids in the absence of a Plan. Under a 'do nothing' scenario mustelid numbers would likely increase and cause further environmental (and potentially production) impacts. Politically, a no regional intervention policy or attitude would be high risk for council, due to the widespread destruction they cause to endemic fauna, in particular. Eradication and progressive containment programmes are altogether unrealistic due to mustelids' widespread distribution in the region. Overall, these scenarios would be well beyond the ability of NRC to resource and implement, as the control costs that would be imposed on landowners (and council through an extensive advocacy and enforcement regime) would be wholly inappropriate and unsustainable. A sustained control programme outcome (to raise awareness and to restrict their ability to be kept in captivity) is the preferred option and represents the most pragmatic and affordable management measure for the Northland region. The focus is on promoting land occupier control and providing advice and information on the various methods, including wider advocacy (such as future Predator Free NZ programmes) and land occupier training initiatives. A site-led approach will be appropriate for some engaged community groups, focusing on the enhancement of native fauna at specific places, and NRC may support these groups. On a region-wide scale this approach too might prove to be unaffordable. Mustelids have a		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	higher than ever regional profile and are well accepted as pests in New Zealand. Except for a few remaining ferret owners (who might view these animals as pets) there is unlikely to be any significant concern raised or controversy over their control, provided animal welfare provisions are met. There is extensive operational and research data available, under New Zealand conditions, regarding mustelid biology, behaviours and control. New technologies are constantly being worked on in an effort to develop cost effective tools for region-wide management of mustelids.		

Myna

Lepus europaeus occidentalis

Also known as: European hare, brown hare

(Family: Leporidae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Hares are easily distinguished from rabbits. They are much larger, with long, black-tipped ears and large muscular hindquarters. Hares are mostly brown in colour, with a lighter brown belly. The tail is black on top with a white underside and while the hare runs the tail faces down as apposed to rabbits which face up. The front legs are about half the size of the hind legs and appear undeveloped in comparison. Hares tend to be solitary animals and live above ground, whereas rabbits live in large groups and usually nest underground.
Habitat	Hares are found in most pastoral and grassland areas of New Zealand and feed on numerous plant species. Hares are primarily nocturnal. During daylight hours they crouch in a "form", an oval shaped depression in vegetation or soft ground.
Regional distribution	Hares are widespread throughout Northland, but population densities are generally low.
Competitive ability	Hares cause damage to new tree plantings and horticultural crops, amenity plantings and shelter belts by eating tree bark and young shoots. Hare population densities appear to be self-regulated so they do not undergo the kinds of irruptions seen in rabbits. There is no evidence that they are limited by food, they are not territorial, and direct aggressive interactions seem to be rare. Adult hares are remarkably free from predation in New Zealand and are also relatively free of parasites and disease.
Reproductive ability	In New Zealand, hares start breeding in early July and continue until mid-March. The average litter size in one New Zealand study was 2.14 and the average number of successful litters per year was 4.59. This gave an annual production of 9.8 young per female. Vectors of spread: Hares are territorial but young males disperse over distances of several hundred metres to several kilometres. Rates of dispersal in new suitable areas in South America were calculated at between 10 and 37km per year.
Resistance to control	Hares can be controlled by shooting, but other control tools are limited.
Benefits	-

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	Low	Low
Sheep and beef	Low	Low
Forestry	Low	Low
Horticulture	Low	Low
Native	-	-
Urban	-	-
Coastal	Low	Low
Estuarine and marine	-	-
Freshwater	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	L	L	Hares can damage newly pine young trees.	Bay of Plenty Regional Council.
Horticulture	L	L	Hares can damage newly-planted shelter belts, young trees, cuttings, crops and plants in nurseries.	Bay of Plenty Regional Council.
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	L	L	Hares have generally been perceived to have minimal impact on the environment because they live at relatively low densities, eat palatable	Wong and Hickling, 1999.

Category	Current	Potential	Comment	Source
			plants without killing them, graze only a few leaves from many plants over a wide area, and do not dig burrows. However, they can affect the recovery of native sedges, exotic grasses and native herbs in wetlands.	
Threatened species	-	L	Hares have generally been perceived to have minimal impact on the environment but they can affect the recovery of native sedges and native herbs in wetlands.	Wong and Hickling, 1999.
Social/Cultural				
Human health	-	-		
Recreation	+	+	Recreational shooting.	
Maori culture	-	-		

L = low M= moderate H = high - = No impact + = Benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by council in relation to this species.	Land owners/occupiers of horticultural or forestry land are likely to continue undertaking control to protect their crops.	Low. Hares are capable of spreading over large distances and breed rapidly, but densities are low in Northland. As affected land occupiers are the main beneficiaries of control, it is likely that they will continue with this.
Exclusion programme	Not applicable.	Not applicable.	Hares are already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Hares are widespread and relatively common in Northland. Eradication is not a feasible approach and the level of resources required would be disproportionate to their impacts.
Progressive containment programme	Not applicable.	Not applicable.	Hares are present throughout Northland. They are widespread, fast-breeding, and mobile, so it would not be

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
			possible to define a progressive containment area.
Sustained control programme	A sustained control programme would incur lower short-term financial cost to the council and landowners. It would aim to restrict the spread and impacts of hares and prevent them from having increasingly severe impacts on the environment.	A sustained control programme would require an investment of time and resources by the council and affected landowners. It would not aim to eradicate or contain the species, so control costs and the adverse effects of hares on forestry and horticulture would be on-going.	Low-Moderate. Hares can be controlled by shooting to prevent them from having "increasingly severe impacts" in horticultural areas and production forests.
Site-led pest programme	Site-led programmes could be used to control hares in areas of high ecological value. This would reduce the impacts of hares in these high priority areas only.	Site-led programmes would require an investment of time and resources by the council and affected landowners. Hares are widespread in Northland but their impacts are greatest in horticultural areas and production forests, not in areas with high ecological values.	Not applicable. Hares are not suitable for a site-led programmes because these programmes aim to control species in areas of high ecological value but hares' impacts are greatest in horticultural areas and production forests.
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that hare do not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be no regional intervention for hare, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding. While hare have not been afforded pest status in Northland, they may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes.		

Possum

Trichosurus vulpecula

Also known as: brushtail possum

(Family: Phalangeridae)

Status in New Zealand

Relevant biology

Form	Possums are furry animals of medium to stout build with thick, bushy tails. Their bodies are 38-45cm long (65-95cm long including the tail) and their weight varies greatly but averages 2-3kg. There are two main colour forms, grey and black. Possums have large eyes and catlike whiskers, which are characteristic of nocturnal animals.
Habitat	Possums can live anywhere that has shelter and a varied food supply. Forests are their favoured habitat but forest/pasture margins can also support very dense populations of possums. Possums feed mainly on leaves but also take buds and flowers, fruits, ferns, bark, fungi, invertebrates (including land snails and weta), native birds and their eggs, and carrion. They are nocturnal, but in winter starving or sick animals may emerge to feed in the afternoon.
Regional distribution	Possums are found throughout Northland, although their density varies from area to area. They are absent from a number of offshore islands.
Competitive ability	Possums are able to occupy a range of habitats and can survive on poor or irregular food supplies. By eating plant foliage they damage and destroy forests, and affect pasture, vegetable and horticultural crops. Possums can be a vector in the spread of diseases that affect domestic animals and humans, such as tuberculosis (Tb). In Northland, possums are currently free of Tb. However, there is a high possum population in some areas and long bush boundaries on many farms, so stock are in close contact with possums. These factors may facilitate the spread of Tb. Possum populations expand their range by the gradual spread of female offspring on the edge of occupied home ranges. Their ability to produce more than one offspring per year and the enhanced survival of juvenile females when conditions are good, allows possum populations to increase rapidly in newly invaded areas or after populations have been reduced by control pressure. Northland provides a graphic example of how fast possums can spread because they were virtually unheard of here in the 1960s.
Reproductive ability	The average life span of a possum is 7 to10 years. Most female possums breed from one year of age and can produce one or, less commonly, two young in a season if food supplies are adequate. Young possums spend the first part of their life in their mother's pouch, feeding on rich milk. After weaning at 5-8 months, young females tend to remain close to their mother's home range. Young males disperse randomly in search of receptive females and have been recorded migrating between 0.5 to 20 kilometres.
Resistance to control	Possums can be controlled using traps and/or toxins. Following control, reinvasion can be minimised with pest-proof fencing, or ongoing control operations.
Benefits	Possum fur and skins are an economic resource.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	Low	Low
Sheep and beef	Low	Low
Forestry	High	High
Horticulture	Low	Low
Native	High	High
Urban	Low	Low
Coastal	Low	Low
Estuarine and marine	-	-
Freshwater	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	L	M	Possums eat pasture plants and carry and spread Tb. Forest-pasture margins can support dense populations of possums.	Ritchie 2000
Sheep and beef	L	M	Possums eat pasture plants and carry and spread Tb. Forest-pasture margins can support dense populations of possums	Ritchie 2000
Forestry	M	H	Possums are a significant pest in production forests, predominantly young pine plantations. They browse the main shoots and strip bark, killing up to half the trees at some sites.	Ritchie 2000
Horticulture	M	H	Possum damage to horticulture is widespread and numerous types of fruits and vegetables are affected. Shelterbelts may also be severely damaged.	Ritchie 2000
Other	-	-		

Category	Current	Potential	Comment	Source
International trade	+	+	There is an international trade in possum fur and skins.	
Environment				
Soil resources	-	-		
Water quality	L	M	Possums can carry and spread giardia, a food- and water-borne disease.	Ministry of Health, NZ
Species diversity	M	H	Possums reduce plant species diversity by causing catastrophic dieback of forest, depletion of palatable species, and inhibition of regeneration. Possums reduce fauna species diversity by competing with them for habitat and food, and eating birds, eggs and invertebrates.	Landcare Research
Threatened species	M	H	Possums impact upon native fauna and flora, including threatened species.	Landcare Research
Social/Cultural				
Human health	L	L	Possums carry bovine tuberculosis which can infect humans. This occurs only rarely, due to pasteurisation of milk.	Landcare Research
Recreation	L	M	Possums can reduce the recreational and aesthetic values of natural areas by impacting upon flora and fauna.	
Maori culture	M	H	Impacts upon native/taonga species.	

L = low M= moderate H = high - = No impact + = Benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful *
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the NRC in relation to this species.	Possums impact upon native vegetation and wildlife, pasture production, animal welfare, horticultural production and forestry yields. If no action is taken, possums will continue to increase in number and	High. Possums can spread and increase their populations rapidly. If no action is taken, possum populations will increase and they will continue to have high economic and environmental impacts.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful *
		distribution and have increasingly severe effects on the environment and economy of Northland.	
Exclusion programme	Not applicable.	Not applicable.	Possums are already present in Northland.
Eradication programme	Possums can cause forest dieback, depletion of palatable species, and inhibition of regeneration. They compete with native fauna for habitat and food, and eat birds, eggs and invertebrates. They reduce pastoral, horticultural and forestry production. If possums could be eradicated, the adverse effects of possums would be prevented and the long-term costs of control would be avoided.	Eradication would require a large and sustained investment of resources.	High. Possums are widespread, highly mobile, breed rapidly, can disperse over large distances and can occupy many types of habitats. Eradicating possums from Northland is not achievable at this time.
Progressive containment programme	When compared to an eradication programme, a progressive containment programme (PCP) would incur lower financial cost to NRC and landowners. It would aim to confine or reduce the distribution of possums and reduce their adverse effects.	A PCP would require a considerable investment of time and resources from NRC and affected landowners. A PCP would not aim to eradicate possums, so control costs would be on-going.	Moderate. Possums are present throughout Northland in a variety of habitat types. They are widespread, mobile, and breed and spread rapidly. However, they can be effectively controlled using trapping, toxins or a combination of methods. Therefore, in the short- to medium-term a PCP has a moderate chance of failing to reduce the impact of possums. A PCP would be more successful if sustained for the long-term.
Sustained control programme	When compared to an eradication programme, a sustained control programme (SCP) would incur lower short-term financial cost to NRC and landowners. A SCP would aim to restrict the spread and impacts of possums and prevent them from having increasingly severe impacts on the environment.	A SCP would require an investment of time and resources by NRC and affected landowners. A SCP would not aim to eradicate or contain possums, so control costs and adverse effects on the environment and economy would be on-going.	High. The impacts of possums on the environment and economy of Northland are severe. A SCP that aims to prevent "increasingly severe impacts" will fail to address the existing impacts.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful *
Site-led pest programme	Site-led programme(s) could be used to control possums in defined areas. This would reduce the impact of possums in these area(s) only.	Given the wide distribution of possums and their ability to exploit a range of habitats, it would be difficult to define meaningful priority areas for site-led programmes. A site-led approach would not reduce or restrict the impacts of possums in areas that are not part of the programme(s).	Moderate-High. Possums are widespread in Northland and can occupy a range of habitats so a site-led approach is unlikely to be comprehensive enough to effectively manage both the economic and environmental impacts of this species.
Summary of alternative assessments and preferred option:	Sustained control (and 'connecting communities' programme) In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for possums. In terms of alternative approaches assessed, under no regional intervention (or do nothing) council would not have any mandate to be involved in or fund possum management. There would be complete reliance on voluntary and therefore random control by land occupiers, although many in the community would continue to control possums in the absence of a Plan. Under 'do nothing' possum numbers may increase and cause further environmental and production impacts. Politically, a no regional intervention position would be high risk for council. Eradication and progressive containment programmes are entirely unrealistic due to the very widespread distribution of possums in the region. Overall, these scenarios would be well beyond the ability of NRC to resource and implement, as the costs of control that would be imposed on landowners and council would exceed the benefits and be unsustainable. A sustained control programme outcome (to reduce the impacts and possibly the spread of possums to other properties/areas of the region) is the preferred option and is a pragmatic and affordable management intervention measure for council to adopt. There are no land occupier control rules to adhere to (other than being an offence to keep possums in captivity or to transport them) so the focus is on fostering land occupier control (with a regional overview) and providing advice and information on the various methods, including wider advocacy and training around different control initiatives. A site-led approach to possums is appropriate and there are many existing community groups engaged in the restoration of specific places, along with other pests. NRC supports these groups under the Community Pest Control Areas (CPCA) programme. The impacts and behavioural characteristics of brush-tailed possums have seen the longest and most intense level of pest control research carried out of any introduced pest to New Zealand. This is due to their great adaptability to New Zealand conditions and huge impacts on biodiversity (forest health and species predation) and agricultural impacts (spread of bovine TB and competition with stock for grass). Many millions of dollars have been spent on determining the most effective control measures and there are many tools available, except yet biological control. Many residents of Northland would regard possums as the number one pest in the region and other than a minority who are opposed to poisoning, possum control overall is not considered contentious. Accordingly, any operational risk is deemed to be low. Because of the ubiquitous nature of possum impacts the benefits of occupier incentivised possum control will likely outweigh the costs, especially if the loss of biodiversity values could be quantified under a CBA model.		

Rabbit

Oryctolaques cuniculus cuniculus

Also known as: European rabbit

(Family: Leporidae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Rabbits are usually grey-brown in colour, with other colour varieties occasionally occurring in the wild. They may live in communal warrens (underground tunnels with multiple entrances) or above-ground where sufficient cover exists. They move by hopping, using their long and powerful hind legs. To facilitate quick movement, a rabbit's hind feet have a thick padding of fur to dampen the shock of rapid hopping. Their toes are long, and are webbed to keep from spreading apart as the animal jumps.
Habitat	Rabbits prefer habitats with free draining soils and open grassland.
Regional distribution	Rabbits are widespread throughout Northland. Soil type and land management have a significant influence on population levels, with the greatest densities on hard-grazed, lighter, and drier, sandy and volcanic soils.
Competitive ability	Rabbits breed rapidly and populations can recover quickly after being reduced by disease, control pressures or environmental changes. They eat a variety of plant matter including grasses (they compete directly with stock for grazing and can sour pasture by eating out the most palatable species of grass), seedlings of trees and crops.
Reproductive ability	Rabbits can breed rapidly. Females may be pregnant for 70% of a year and can produce a total of 20 – 50 young each. They are also capable of adjusting litter-sizes to food supply so rabbit populations are capable of rebounding quickly from natural disasters or control pressures. Some wild rabbits may live up to seven years but life spans are generally much shorter. Vectors of spread: Rabbits are a mobile species that can spread over wide areas. They are already present throughout Northland.
Resistance to control	Rabbits can be controlled by shooting, poisoning, and pathogens.
Benefits	Recreational shooting. Pet food market.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	Low	Low
Sheep and beef	Low	Low

Land use type	Current land use infested	Potential land use
Forestry	Low	Low
Horticulture	Low	Low
Native	Low	Low
Urban	Low	Low
Coastal	High	High
Estuarine and marine	-	-
Freshwater	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	L	L	Rabbits can compete with livestock for grazing. The costs incurred in their control can be very high in semi-arid areas of the South Island, but elsewhere populations are generally low and stable.	Lough, 2009.
Sheep and beef	L	L	Rabbits can compete with livestock for grazing. The costs incurred in their control can be very high in semi-arid areas of the South Island, but elsewhere populations are generally low and stable.	Lough, 2009.
Forestry	L	L	Rabbits can browse seedlings and foliage, and ring-bark some species.	Norbury, 1996.
Horticulture	L	L	Rabbits can browse seedlings and foliage, and ring-bark some species.	Norbury, 1996.
Other	-	-		
International trade	-	-		
Environment				
Soil resources	L	M	At high densities, rabbits can cause significant soil damage and soil erosion.	Lough, 2009.

Category	Current	Potential	Comment	Source
Water quality	L	M	At high densities, rabbits can cause significant soil damage and soil erosion, with subsequent effects on water quality.	Lough, 2009.
Species diversity	L	M	Rabbits can pose a threat to ecosystems and habitats within semi-arid lands such as sand dunes. These areas are prone to erosion resulting from their burrowing and rabbits also graze many native sand dune plants. They may alter the composition of plant communities by selectively browsing palatable species, including orchids. High rabbit populations assist in maintaining high predator numbers e.g. stoats and cats.	Lough, 2009; Norbury, 1996.
Threatened species	L	M	High rabbit populations assist in maintaining high predator numbers e.g. stoats and cats (which are a serious predators of kiwi in Northland). They impact upon other threatened species by browsing, altering vegetation composition and causing erosion (e.g. on sand dunes).	Lough, 2009; Norbury, 1996.
Social/Cultural				
Human health	-	-		
Recreation	L	L	They can damage golf courses, gardens and grassed recreational areas. Rabbit shooting is a recreational activity.	
Maori culture	M	M	Impacts upon native/taonga species.	

L = low M= moderate H = high - = No impact + = Benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by council under the RPMP in relation to this species.	If no action is taken, the rabbit population in parts of Northland may increase. This would have adverse effects on the environment and the economy (due to lost production and costs associated with control).	Moderate. Rabbits are capable of spreading over large distances and breed rapidly. They are already present throughout Northland but if no action is taken, there is a moderate risk that the impacts of rabbits in some parts of Northland will increase.
Exclusion programme	Not applicable.	Not applicable.	Rabbits are already widespread throughout Northland.
Eradication programme	Not applicable.	Not applicable.	Rabbits are already widespread throughout Northland.
Progressive containment programme	Not applicable.	Not applicable.	Rabbits are already widespread throughout Northland.
Sustained control programme	A sustained control programme would incur lower short-term financial cost to the council and landowners. It would aim to restrict the spread and impacts of rabbits and prevent them from having increasingly severe impacts on the environment.	A sustained control programme would require an investment of time and resources by the council and affected landowners. It would not aim to eradicate or contain the species, so control costs and the adverse effects of rabbits would be on-going.	Low-Moderate. Rabbits can be controlled by shooting and other methods to prevent them from having "increasingly severe impacts".
Site-led pest programme	Site-led programmes could be used to control rabbits in areas of high ecological value. This would reduce the impacts of rabbits in these high priority areas only. Alternatively, this could be managed through a council supported management programme outside the RPMP in areas where local communities are concerned about impacts.	Site-led programmes would require an investment of time and resources by the council and affected landowners. In Northland, the environmental impacts of rabbits are highest in sand dune ecosystems.	Low. Site-led programmes could used to reduce or prevent the adverse impacts of rabbits in dune ecosystems.
Summary of alternatives assessed and	Sustained control programme (and council supported management programmes outside the RPMP) In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for rabbits. In terms of alternative approaches assessed, under <u>no</u>		

<table>
<tr><th>Option</th><th>Explanation of benefits</th><th>Explanation of costs</th><th>Level of risk that programme will not be successful</th></tr>
<tr><td>preferred option:</td><td colspan="3">regional intervention (or do nothing) council would not have any mandate to be involved in or fund rabbit management measures. There would be total reliance on voluntary control by land occupiers (incentivised by farm economics) although many occupiers would continue to control rabbits in the absence of a Plan. Under 'do nothing' rabbit numbers may increase and cause further environmental and production impacts, depending on the geographic location in the region (based on soil and land management types). Politically, a no regional intervention attitude would be risky for council.

Eradication and progressive containment programmes are altogether unrealistic due to rabbits' widespread distribution in the region. Overall, these scenarios would be well beyond the ability of NRC to resource and implement, as the control costs that would be imposed on landowners (and council through an extensive advocacy and enforcement regime) would be wholly inappropriate and unsustainable.
A sustained control programme outcome (to reduce the impacts and spread to other properties) is the preferred option and represents the most pragmatic and affordable management measure for the Northland region. There are no rules to adhere to, the focus is purely on promoting land occupier control (under a watchful 'regional eye') and providing advice and information on the various methods, including wider advocacy and land occupier training initiatives.
A site-led approach may be appropriate for some engaged community groups, focusing on the restoration of specific places, and NRC may support these groups. Rabbits are one of the universally accepted pests in New Zealand and there is unlikely to be any concern raised or controversy over their control, provided animal welfare provisions are met. There is extensive operational and research data available, under New Zealand conditions, regarding rabbit biology, behaviours and control. The effectiveness of control measures available are long standing and well understood and a new RHD strain to be introduced further strengthens the number of wide-ranging, effective tools available to control rabbits. This information is readily transferable and shared by the various organisations involved, therefore any operational risk is low.</td></tr>
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Rainbow lorikeet

Trichoglossus haematodus

(Family: Psittacidae)

Status in New Zealand

The rainbow lorikeet is listed as an Unwanted Organism under the Biosecurity Act 1993 with an exemption for people to hold and sell birds.

Relevant biology

Form	Rainbow lorikeets are long-tailed, brightly-coloured parrots that are about 30cm long. They have a bright-red beak and eyes, a blue head and belly, green wings, tail and back and an orange/yellow breast. They make distinctive screeching and chattering calls and are almost always seen in pairs or in flocks. Rainbow lorikeets look very similar to the more common eastern rosella, but rosellas have a red head (the lorikeets' is blue).
Habitat	Rainbow lorikeets were introduced to New Zealand from Australia as cage birds and were illegally and deliberately released in the Auckland area in the 1990s. Rainbow lorikeets feed mainly on nectar and pollen in the outer canopy of trees. They also take fruit, seeds, and occasionally insects. Rainbow lorikeets are acrobatic feeders, often hanging head down to access flowers and fruit. In New Zealand, rainbow lorikeets are mostly likely to occur in suburban parks and gardens, horticultural blocks, and forest edges.
Regional distribution	No viable wild populations are known in New Zealand. There was one reported escape event in Northland during 2015, near Mangawhai, and the birds were recaptured by their owner.
Competitive ability	Rainbow lorikeets are prolific breeders and they compete with native birds for food and nesting sites. Native honey eaters, like the tūī, bellbird, and hihi (stitchbird), are at risk of competition from rainbow lorikeets as they utilise the same food sources. Native cavity nesters, such as kākā, kākāriki, and short-tailed and long-tailed bats, may be at risk from rainbow lorikeets competing for their nest and roost sites. Rainbow lorikeets can carry diseases that can threaten the health of native bird species.
Reproductive ability	Rainbow lorikeets nest in the hollow limbs or trunks of dead or living trees. They are prolific breeders, with pairs known to rear as many as three successive broods (6 chicks) in a single season. Vectors of spread: Rainbow lorikeets are strong fliers, travelling up to 30km between feeding and roosting sites. They may also be spread by people illegally releasing caged birds.
Resistance to control	Birds can be trapped or netted.
Benefits	Rainbow lorikeets are kept as pets in cages and aviaries throughout the country.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	-	Low
Horticulture	-	High
Native	-	High
Urban	-	High
Coastal	-	Low
Estuarine and marine	-	-
Freshwater	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	-		
Horticulture	-	H	Rainbow lorikeets can damage apples, grapes and other soft fruit. They pose a threat to the commercial fruit growing industry, with the potential to significantly impact orchards and vineyards.	Polkanov & Keeling 2000; Department of Conservation; New Zealand Birds Online; MPI.
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		

Category	Current	Potential	Comment	Source
Species diversity	-	H	Rainbow lorikeets compete with native birds by dominating their food sources and nesting sites. They may also carry avian diseases which can threaten the health of native bird species.	Polkanov & Keeling 2000; Department of Conservation; New Zealand Birds Online; MPI
Threatened species	-	H	Rainbow lorikeets compete with native birds by dominating their food sources and nesting sites. They may also carry avian diseases which can threaten the health of native bird species.	Polkanov & Keeling 2000; Department of Conservation; New Zealand Birds Online; MPI
Social/Cultural				
Human health	-	-		
Recreation	-	-		
Maori culture	-	M	Impacts on native/taonga species.	

L = low M= moderate H = high - = No impact + = Benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial cost to council associated with the management of rainbow lorikeets.	Rainbow lorikeets are not currently known to occur in the wild in Northland. However, they are held as caged birds and could escape from these aviaries or be illegally released. If this was to occur and rainbow lorikeets established in the region, there would be be serious environmental impacts and economic costs, particularly to the horticulture industry.	High. Rainbow lorikeets could escape into the wild or be illegally released.
Exclusion programme	An exclusion programme would raise public awareness and education about the risks and impacts of rainbow lorikeets. If they are included in the RPMP there is the ability to respond immediately if an escape or	There is already educational material available for rainbow lorikeets. Excluding this species would prevent expenditure on its control if/when wild populations establish in Northland.	Low-Moderate. There is a low to moderate risk that an exclusion programme could fail.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	release is detected in Northland.		
Eradication programme	Not applicable.	Not applicable.	Rainbow lorikeets are not known to be present in the wild in Northland.
Progressive containment programme	Not applicable.	Not applicable.	Rainbow lorikeets are not known to be present in the wild in Northland.
Sustained control programme	Not applicable.	Not applicable.	Rainbow lorikeets are not known to be present in the wild in Northland.
Site-led pest programme	Not applicable.	Not applicable.	Rainbow lorikeets are not known to be present in the wild in Northland.
Summary of alternative assessments and preferred option:	Exclusion programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for rainbow lorikeets. Regarding alternative approaches assessed, under no regional intervention (or do nothing) there would be significant disapproval of and risk to Northland Regional Council by environmental and local community restoration groups and the government (MPI) for not being more proactive, in the knowledge that naturalised populations of rainbow lorikeets could thrive in the region if allowed to establish. Biodiversity values (e.g. displacement of native cavity nesting birds and feeding sources for pollen and nectar feeders) would be impacted if rainbow lorikeets were discovered in the wild and no intervention plans or measures were available. As rainbow lorikeets are not currently found in the wild in Northland, an exclusion programme outcome is the only appropriate option available. As with Indian ring-necked parakeets, rainbow lorikeets may be kept in captivity but if or when released (accidentally or deliberately) they are deemed unwanted organisms. Accordingly, and although their pest status has been nationally elevated for some years, there is a relatively high risk (regarding the actions of bird breeders and fanciers) whether an exclusion programme will be successful. The current legislation contains a potential anomaly which allows for their movement through the pet trade. This is potentially the highest risk pathway for the establishment of naturalised populations. Most bird species are difficult to control due to their habitat and movement and there are no guarantees with current methods. Therefore, an exclusion programme focusing on a comprehensive advocacy and surveillance programme, and dialogue with neighbouring Auckland region where they been previously deliberately released, will help to mitigate any operational control risks by detecting any infestations very early on.		

Rainbow skink

Lampropholis delicata

Also known as: plague skink.

(Family: Scinidae)

Status in New Zealand

Rainbow skinks are listed as unwanted organisms under the Biosecurity Act 1993.

Relevant biology

Form	Rainbow skinks are 3-4cm long from the tip of the nose to hind legs, excluding the long thin tail. They are brown or grey-brown with a dark brown stripe down each side, and an iridescent rainbow, or metallic sheen, when seen in bright light. They look very similar to native skinks but rainbow skinks have one large scale on the top of their head, and native skinks have two smaller scales.
Habitat	Rainbow skinks prefer moist areas and are commonly found under vegetation, litter, rocks and logs. They also thrive in urban areas, gardens, commercial areas, industrial sites, garden centres, and waste ground. They will frequently enter freight and shipping containers. They are known to be well established in the greater Auckland area, Coromandel Peninsula, Tauranga, and Te Puke. Populations are also present in the Waikato region and in Northland.
Regional distribution	In Northland, rainbow skinks were first recorded around Whangarei but they have now been recorded as far north as Kaitaia. They are widespread in Northland, and still spreading.
Competitive ability	Rainbow skinks can reach high population densities in a relatively short time, competing with native lizards and other native fauna for food and habitat, and increasing predation pressure on native invertebrates. Rainbow skinks breed rapidly but most native skinks are long-lived and only breed once per year. Some don't even start breeding until they are around five years old.
Reproductive ability	Rainbow skinks reproduce rapidly – laying up to eight eggs three times per year (more than five times as fast as most native lizards). They also mature in less than half the time of native lizards. Vectors of spread: Rainbow skinks are mobile animals and are also transported by human activity. For example, in household items, mail, personal effects and shipping containers. Plants and potting mix from nurseries have also been found harbouring skinks and eggs.
Resistance to control	Control tactics are extremely limited and any control efforts would need to be careful to avoid harming native skinks. Additionally, some native skinks are difficult to distinguish from rainbow skinks.
Benefits	

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	Low	High
Horticulture	Low	High
Native	Low	High
Urban	Low	High
Coastal	Low	High
Estuarine and marine	-	-
Freshwater	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	L	M	Rainbow skinks compete with native lizards and prey on native invertebrates. Captive rainbow skinks have been observed to successfully compete for food with native copper skinks.	Ministry for Primary Industries; Peace, 2004.
Threatened species	L	M	Rainbow skinks compete with native lizards (many of which are	Ministry for Primary Industries.

Category	Current	Potential	Comment	Source
			threatened species), and prey on native invertebrates.	
Social/Cultural				
Human health	-	L	Rainbow skinks are a hygiene risk as they can spread germs in kitchen facilities.	Ministry for Primary Industries.
Recreation	-	-		
Maori culture	-	M	Impacts upon native/taonga species.	

L = low M= moderate H = high - = No impact + = Benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	Rather than applying a programme under the pest management plan, the species could come under a 'council supported management' programme, where advice and support are provided for specific species. This could provide support to communities where the species is having local impacts.	By not applying a programme and rules to the species, there would be no provisions under the pest management plan to manage inappropriate practises that are exacerbating the spread.	Low - impacts are likely to be localised and populations may be short lived.
Exclusion programme	Not applicable.	Not applicable.	Rainbow skinks are already present within Northland.
Eradication programme	Not applicable.	Not applicable.	Resources and control tools to eradicate rainbow skink are currently limited, so an eradication programme is not an appropriate option.
Progressive containment programme	Not applicable.	Not applicable.	Resources and control tools to contain rainbow skink are currently limited, so a progressive containment programme is not an appropriate option.
Sustained control programme	Rainbow skink could be included in a sustained control programme. The council could include rules aimed at reducing the spread within the Northland region.	Education and publicity. Enforcement of rules; responding to reports.	High -Resources and control tools to contain rainbow skink are currently limited.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Site-led pest programme	Not applicable.	Not applicable.	Resources and control tools to contain rainbow are currently limited, so a site-led programme is not an appropriate option.
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that rainbow/plague skinks do not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be no regional intervention for rainbow/plague skinks, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding. While rainbow/plague skinks have not been afforded pest status in Northland, they may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes.		

Rats

Norway rat(Rattus norvegicus) and ship rat(Rattus rattus)

(Family: Muridae)

Status in New Zealand

Naturalised.

Domestic caged rats are not considered pests for the purposes of the RPMP.

Relevant biology

Form	Norway rats are the larger of the two European rats found in New Zealand. Their coats are grey-brown and shaggy with a pale underside. They are distinguished from the ship rat in that the tail, which is about 180 mm in length, is thick and shorter than the body, which is about 200 mm in length. Ship rats are smaller than Norway rats but their tails are larger and thicker and longer than their bodies.
Habitat	Rats are mainly nocturnal. They have a varied diet that includes native birds, eggs and chicks, invertebrates, frogs, and lizards. They eat large quantities of native seeds, either from the ground or straight from the tree (in the case of ship rats, which can climb high into the canopy). Norway rats are common in wet habitats and urban areas. Ship rats are found in most habitats and they are the most abundant and widespread rat on mainland New Zealand.
Regional distribution	Rats are widespread throughout Northland but are absent from a number of offshore islands.
Competitive ability	Since their arrival in New Zealand, Norway rats and ship rats have had significant impacts on native flora and fauna. They have been implicated in the decline of many native species including the bellbird (korimako), robin (toutouwai), stitchbird (hihi), saddleback (tiekie), native thrush, parakeets (kakariki), flightless weevil, and giant weta.
Reproductive ability	Rodents are prolific breeders. Rats can breed throughout the year if conditions are suitable, with a female producing up to five litters a year. They can live for 3 years but wild animals probably live for less than a year. Vectors of spread: Rats are mobile species. They may also be transported inadvertently by people in cargo, vehicles and boats.
Resistance to control	Various methods can be used to control rats including trapping, 1080 and other poisons.
Benefits	-

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	Low	Low
Sheep and beef	Low	Low
Forestry	Low	Low
Horticulture	High	High
Native	High	High
Urban	High	High
Coastal	Low	Low
Estuarine and marine	-	-
Freshwater	Low	Low

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-	Rodents inhabit dairy farms but do not impact upon production.	
Sheep and beef	-	-	Rodents inhabit dairy farms but do not impact upon production.	
Forestry	-	-	Rodents inhabit pine plantations. They predate fauna in these habitats but their impacts are on native fauna and flora not on forest production.	Clout, 1980.
Horticulture	M	M	Rodents eat and contaminate grain and food stores and some nut crops.	Invasive Species Compendium.
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		

Category	Current	Potential	Comment	Source
Species diversity	H	H	Rats have major impacts on New Zealand's wildlife because they eat native fruit and plants, birds and their eggs, lizards, and invertebrates such as weta and kauri snails. They also compete with native wildlife for food. Norway rats are large enough to kill nesting adult seabirds and prey on animals that live, roost or nest close to the ground. Ship rats are good climbers, so they are able to access even birds' nests high in trees.	Department of Conservation; Harper and Rutherford, 2016; Dowding and Murphy, 1994.
Threatened species	H	H	Rodents have been implicated in the decline of many threatened species including the stitchbird (hihi), saddleback (tiekie), native thrush, parakeets (kakariki), flightless weevil, and giant weta. In addition to predation, they also effect threatened species indirectly, through competition for food.	Department of Conservation; Harper and Rutherford, 2016; Dowding and Murphy, 1994.
Social/Cultural				
Human health	L	L	Rodents nest in and around human dwellings and can carry diseases such as the bubonic plague and leptospirosis, and nematodes. These diseases are typically transferred to humans via urine and droppings, or through hosts that interact with both rats and humans.	Invasive Species Compendium.
Recreation	M	M	High numbers of rats may reduce the recreational values of natural areas.	
Maori culture	H	H	Impacts upon native/taonga species.	

L = low M= moderate H = high - = No impact + = Benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council to administer the RPMP for rats.	Rats have major impacts on New Zealand's wildlife, reproduce rapidly, are highly mobile, and can disperse over large distances. If no action is taken, their impacts on wildlife and long-term effects on ecosystems will intensify.	High. Rats reproduce rapidly, can disperse over large distances, are predators of native fauna and consumers of seeds and fruits. If no action is taken, rodent populations will increase and they will continue to have high environmental impacts.
Exclusion programme	Not applicable.	Not applicable.	Rats are already present in Northland so an exclusion programme for the region is not an option.
Eradication programme	Rats have serious impacts on native flora and fauna, including threatened species. If they could be eradicated, their adverse effects would be prevented and the long-term costs of control would be avoided.	Eradication would require a large and sustained investment of resources.	High. Rodents are widespread, mobile, breed rapidly, and can occupy almost any type of habitat. Eradicating rodents from Northland is unachievable at this time.
Progressive containment programme	A progressive containment programme would incur significant financial cost to the council and landowners. It would aim to confine or reduce the distribution of rats and reduce their adverse effects.	A progressive containment programme would require a significant investment of time and resources from the council and affected landowners. It would not aim to eradicate rats, so control costs would be on-going.	High. Rats are present throughout Northland. They are widespread, fast-breeding, and mobile. Progressive containment is not a feasible approach at this time.
Sustained control programme	When compared to an eradication programme, a sustained control programme would incur lower short-term financial cost to the council and landowners. It would aim to restrict the spread and impacts of rodents and prevent them from having increasingly severe impacts on the environment.	A sustained control programme would require an investment of time and resources by the council and affected landowners. It would not aim to eradicate or contain the species, so control costs and adverse effects on fauna would be on-going.	Moderate. Rats are already present throughout most of Northland and a sustained control programme would not reduce their distribution. However, their populations could be reduced using trapping and/or poisoning.
Site-led pest programme	Site-led programmes could be used to control rats in areas with high ecological values. This would reduce the impacts of rodents in	Site-led programmes would require a significant investment of time and resources by the council and affected landowners. rats	Moderate. This approach has a moderate risk of failing. There are proven methods for controlling rats but populations would need to be

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	these high priority areas only.	have severe impacts on native flora and fauna, are widespread in Northland and can occupy a range of habitats. A site-led approach would not reduce or restrict the impacts of rodents in areas that are not identified as being of high priority.	maintained at low numbers in the long-term if native flora and fauna are to recover, requiring ongoing resources.
Summary of alternative assessments and preferred option:	**Sustained control programme** (and council supported management programmes outside the RPMP). In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for ship and Norway rats. In terms of alternative approaches assessed, under <u>no regional intervention</u> (or do nothing) council would not have any mandate to be involved in or fund rat management measures. There would be reliance on voluntary control by community groups (incentivised by localised wildlife/biodiversity preservation) although many occupiers would continue to control rats in the absence of a Plan. Under 'do nothing' rat numbers may increase and cause further environmental impacts, including possible expansion to offshore islands currently designated as 'rat-free'. Politically, a no regional intervention policy or attitude would be high risk for council, due to the widespread destruction they cause to endemic fauna in particular. <u>Eradication and progressive containment programmes</u> are altogether unrealistic, due to the ubiquitous nature of rat distribution in the region. These two scenarios are well beyond the ability of NRC to resource and implement, as the control costs that would be imposed on landowners (and council through an extensive advocacy and enforcement regime) would be wholly inappropriate and unsustainable. There are currently no means to eradicate rats other than on offshore islands or in fenced terrestrial sanctuaries. A <u>sustained control programme</u> outcome (to reduce the impacts and spread to other properties) is the preferred option and represents the most pragmatic and affordable management measure for the Northland region. There are no rules to adhere to, the focus being supporting community programmes outside of the Plan (including future Predator Free NZ initiatives), promoting general land occupier control and providing advice and information on the various control methods. A <u>site-led approach</u> may be appropriate for some engaged community groups, focusing on the restoration of specific places and NRC may support these groups, as outlined above. Rats are one of the universally accepted pests in New Zealand and there is unlikely to be any concern raised or controversy over their control, provided animal welfare provisions are met. There is extensive operational and research data available, under New Zealand conditions, regarding rat biology, behaviours and control. The effectiveness of the different control measures available are well understood. This information is readily transferable and shared by the various organisations involved, therefore any operational risk of designating rats is considered to be very low.		

Rook

Corvus frugilegus

Also known as: rook

(Family: Corvidae)

Status in New Zealand

Rooks are listed as an unwanted organism under the Biosecurity Act 1993.

Relevant biology

Form	Rooks are black birds that are approximately the same size as magpies. Adults are totally black except for their face, which has light-grey skin bare of feathers. Juvenile birds have a black-feathered face. Rooks have long, pointed black beaks and dark-brown eyes. They fly with steady wing beats.
Habitat	Rooks nest in colonies, usually in eucalyptus, pine or macrocarpa trees, and they have been recorded in Norfolk pines and acacia trees. They usually travel up to 10km from their night-time roost to feeding sites, but in the breeding season they forage within a few kilometres of the rookery.
Regional distribution	There are no known populations of rooks in Northland. In the North Island, rook populations are known exist or have existed in Miranda (Firth of Thames), Tolaga (north of Gisborne), Waitotara (Taranaki), southern Waikato, Manawatu (from Palmerston North to Cheltenham), and Taihape as well as their strong hold of Hawke's Bay and northern Wairarapa. Historical rates of spread suggest it would take many decades for rooks to occupy all suitable habitats in New Zealand.
Competitive ability	Rooks can cause serious damage to farms and market gardens as they feed on most types of crops, either the seed heads or pulling out young plants. They occasionally pierce fruit such as apples and pears with their bills. The main foods of rooks are invertebrates, especially fly larvae and adult beetles and larvae (grass grub) during warmer months. Rooks can also tear up large areas of pasture looking for invertebrates.
Reproductive ability	Rooks lay up to 7 eggs between August and October and the females incubate the eggs for 15-19 days. The male feeds the female and nestlings, which fledge at between 26 and 38 days. Generally, rooks start to breed at between 2-3 years of age. The longest living banded rook in Hawke's Bay was about 15 years old. Vectors of spread: Rooks are mobile animals that disperse aerially. Although long-distance dispersal events can occur (up to 500km), these seem to be rare and involve very small numbers of birds.
Resistance to control	Disturbance of rookeries, for example by poisoning or shooting, may result in the wide dispersal of surviving birds.
Benefits	A beneficial effect of rooks, through feeding on soil and crop invertebrate pests, has been suggested, but remains contentious.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	High
Sheep and beef	-	High
Forestry	-	Low
Horticulture	-	High
Native	-	Low
Urban	-	Low
Coastal	-	Low
Estuarine and marine	-	-
Freshwater	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	L	Rooks can damage pasture by opening it up to thistles and other weeds while looking for grass grub. On the positive side they do remove a number of pest insects and break up stock dung looking for fly larvae.	New Zealand Birds Online
Sheep and beef	-	L	Rooks can damage pasture by opening it up to thistles and other weeds while looking for grass grub. On the positive side they do remove a number of pest insects and break up stock dung looking for fly larvae.	New Zealand Birds Online
Forestry	-	-		
Horticulture	-	M	Rooks have been recorded damaging a wide range of crops in New Zealand, including cereals, maize, corn, peas, broad beans, pumpkins, potatoes, nuts (walnuts, acorns), and fruit such as apples.	Cowan et al., 2010
Other	-	-		

Category	Current	Potential	Comment	Source
International trade	-	-		
Environment				
Soil resources	-	L	Damage to pasture caused by rooks can expose the soil to erosion.	Cowan et al., 2010
Water quality	-	-		
Species diversity	-	-	Rooks feed mainly on pastoral and cultivated land.	Cowan et al., 2010
Threatened species	-	-		
Social/Cultural				
Human health	-	-		
Recreation	-	-		
Maori culture	-	-		

L = low M= moderate H = high - = No impact + = Benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred in relation to this species.	Rooks are not currently known to occur in Northland. If they were to establish there would be economic costs associated with lost pastoral and horticultural production.	Low-Moderate. The closest known populations of rooks are in the Waikato but most of Northland is suitable habitat for this species. Long-distance dispersal can occur (up to 500km) but is rare and historical rates of spread suggest it would take many decades for rooks to occupy all suitable habitats in New Zealand.
Exclusion programme	An exclusion programme would raise public awareness and education about the risks and impacts of rooks. If they are included in the RPMP there is the ability to respond immediately if the species is detected in Northland.	There is already educational material available for rooks. Excluding this species would prevent expenditure on its control if/when it invades Northland and avoid the losses in pastoral and horticultural production that rooks can cause.	Low. Long-distance dispersal events can occur (up to 500km), but are rare. With an exclusion programme, if such an event did occur there would be public awareness about the species and an ability to respond.
Eradication programme	Not applicable	Not applicable	Rooks are not present in Northland.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Progressive containment programme	Not applicable	Not applicable	Rooks are not present in Northland.
Sustained control programme	Not applicable	Not applicable	Rooks are not present in Northland.
Site-led pest programme	Not applicable	Not applicable	Rooks are not present in Northland.
Summary of alternative assessments and preferred option:	Exclusion Programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for rooks. The impacts of rooks are well known and documented in New Zealand and there has been significant collaboration between North Island regions over the years to substantiate these effects. Consequently, and in terms of alternative approaches assessed, under no regional intervention (or do nothing) there would be significant risk of criticism of Northland Regional Council from cropping farmers and within farming political circles, for not being more proactive while knowing rooks were established in southern regions. Economic (cropping) production values would be impacted if rooks were discovered and no intervention was forthcoming. As rooks are not currently found in Northland an exclusion programme outcome is the only appropriate option available. If discovered, there is unlikely to be any concern or controversy over their control, including poisoning of birds in their nests, which is undertaken with full Medical Officer Health approvals in place. While technically very challenging, rook control if required to be carried out follows well established and successful procedures. In regions where rooks are present, the benefits of control far outweigh the production related costs, particularly as rooks have not invaded all the potential available habitat. Control while in relative low numbers is substantially more beneficial than doing nothing, then undertaking control only when they are established throughout the region. A wide-ranging surveillance programme and dialogue with neighbouring councils and land occupiers that have rooks will assist in achieving the exclusion outcome.		

Shingleback lizard

Tiliqua rugosa

(Family: Scincidae)

Status in New Zealand:

Not applicable

Relevant biology

Form	Shingleback lizards are usually dark brown all over, with or without yellow spots. The underside is usually pale with darker patches. They have small, reddish-brown to grey eyes, a dark blue tongue and the lining of the mouth is bright pink. Shingleback lizards have very large heads, a very short blunt tail and large rough scales. They grow up to 410mm long, most of which is the head and body length. Shingleback lizards eat a wide variety of plants and animals. More plants are eaten than animals, and they are not very agile so mostly eat slow-moving animals. They have large teeth and strong jaw muscles so they can crush snail shells and beetles.
Habitat	Shingleback lizards are common and widespread in New South Wales, Australia from approximately Bathurst all the way to the coast of Western Australia. They inhabit semi-arid plains and woodlands that typically have a harsh, dry summer and fall, followed by a cool winter and spring with increased precipitation and resources. These lizards usually live in open country with lots of ground cover such as tussock type grasses or leaf litter. At night, they shelter among leaf litter or under large objects on the ground, such as rocks and logs. They remain inactive, buried deep in their shelter sites during cold weather, emerging to bask on sunny days.
Regional distribution	There are none known to be in the wild in Northland, or elsewhere in New Zealand. They are rarely seen offered for sale in New Zealand. Climatic suitability modelling suggests that there are very few suitable areas for shingleback lizards – only a few small pockets in coastal areas of Northland, Hawkes Bay, Blenheim and Christchurch. Shingleback lizards are thought to pose a low establishment risk and they are not common in the pet trade in New Zealand.
Competitive ability	There is potential for predation on native invertebrates and there is also the potential for disease transmission to native species. In Australia, the major predators of shinglebacks are large predatory birds and large snakes. They are also eaten by feral cats and dogs. Young lizards are easy prey for suburban dogs and cats.
Reproductive ability	Shingleback lizards live alone for most of the year, but reunite between September and November to form monogamous pairs. Female shinglebacks give birth to 2-3 young during summer, 3-5 months after mating. The young are ready to look after themselves straight after birth and usually disperse within a few days.

Resistance to control	Unknown
Benefits	Shingleback lizards are known to be in the New Zealand pet trade, but are not often seen for sale.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	High
Forestry	-	High
Horticulture	-	-
Native	-	High
Urban	-	Low
Coastal	-	High
Estuarine and marine	-	-
Freshwater	-	-

High = Preferred land use; 2 = Less preferred land use

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-	Can occupy this land use type but unlikely to have impacts that affect production.	
Forestry	-	-	Can occupy this land use type but unlikely to have impacts that affect production.	
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		

Category	Current	Potential	Comment	Source
Species diversity	-	L	Potential for predation on slow moving native invertebrates, also competition for food and resource with native species. Potential for disease transmission to other reptiles (for example, they can transmit *Salmonella*).	Kikilus, 2010. Twentyman, 1999.
Threatened species	-	L	Potential for predation on slow-moving native invertebrates as they are opportunistic omnivores and also competition for food and resources with native species.	Kikilus, 2010. Twentyman, 1999.
Social/cultural				
Human health	-	-		
Recreation	-	-		
Māori culture	-	L	Potential impacts on native/taonga species.	

L = low; M= moderate; H = high; - = No impact; + = Benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful *
Do nothing	This species is vulnerable to predation by domestic pets and other introduced predators and to becoming road kill. It is not common in the New Zealand pet trade, and would have high resale value so is less likely to be released when no longer wanted. The majority of Northland's climate is not suitable and the establishment risk is considered low.	None (note: it is likely that we would consider investigating reports as general business).	Low – low risk that a wild population could establish in Northland.
Exclusion programme	To minimise the risks of pets escaping or being released and forming wild populations, we could include rules banning the release within the Northland region and requiring sightings or pet escapes to be reported.	Publicity/education regarding dumping of pets. Follow-up on reports.	Low – could be included with other pets that we want to discourage from being dumped.
Exclusion programme	An exclusion programme with rules as above, and also including rules	Inspection of pet shops; monitoring Trademe sales;	Medium – need to determine the resources

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful *
	banning the sale and transportation of the shingleback lizard in Northland.	enforcement action; follow-up on reports.	the council would require to undertake an exclusion programme for this species.
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that the shingleback lizard does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be no regional intervention for shingleback lizards, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding.		

Spur-winged plover

Vanellus miles novaehollandiae

(Family: Charadriidae)

Status in New Zealand

Self-introduced naturalised, classified as native because its arrival pre-dates the Wildlife Act 1953. Legal protection removed in 2010.

Relevant biology

Form	Large (around 350-370g) stocky wading bird with a pronounced yellow bill, wattles and an eye ring. Black crown, hand neck, collar and tail. The remainder of the head and underside are white and the back is light grey-brown. The legs are long, reddish-brown. A long yellow spur protrudes from carpal area of each wing. The birds are diurnal and eat grass grubs, earthworms and other invertebrates in grassland ecosystems, molluscs and crustaceans in coastal habitats.
Habitat	Coastal and open habitats, including wetlands, beaches, estuaries, riverbeds, farmland, golf courses, sports grounds, parks and airfields. They may remain at inland habitats year round rather than moving to the coast outside of the breeding season. Nesting is on open ground.
Regional distribution	Occurs throughout Northland.
Competitive ability	Aggressively defend nesting sites. Known to attack eggs of other shorebirds, including dotterels.
Reproductive ability	High reproductive rate. Isolated monogamous pairs share incubation and chick care. One-four eggs per clutch, capable of producing multiple clutches per breeding season.
Resistance to control	Lack of effective control tools available.
Benefits	

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	Low	Low
Sheep and beef	Low	Low
Forestry	-	-
Horticulture	Low	Low
Native	-	-
Urban	Low	Low
Coastal	High	High

Land use type	Current land use infested	Potential land use
Estuarine and marine	High	High
Freshwater	Low	Low

High = Preferred land use; Low = Less preferred land use

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	L	Some potential benefits to farming via consumption of grass grubs and other invertebrate pests, and some potential negative impacts due to consumption of valued invertebrates such as earthworms.	Dann, 1981.
Sheep and beef	-	L	As above.	
Forestry	-	-		
Horticulture	L	L	Cause damage to market gardens, especially leafy vegetables.	Department of Conservation, 2006.
Other	L	M-H	Most common species involved in bird strikes in New Zealand. Grasslands around airports are favoured habitats, and in the breeding season birds will aggressively defend nests even against on-coming aeroplanes, leading to relatively high rates of bird strikes. Large body size (compared to smaller passerines) causes more damage than strikes by smaller birds. An average of 281 spur-winged plover strikes per year were reported to the Civil Aviation Authority 1999-2004 nationally. These figures are conservative estimates given that in 24% of bird strikes the species cannot be identified.	Department of Conservation, 2006; Shaw and McKee, 2008. Chilvers et al., 1997; Steele and Renner, 2010; Steele, 2001.
International trade	-	-		

Category	Current	Potential	Comment	Source
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	L	L	In coastal habitats molluscs and crustaceans form basis of diet. Potential competition with native shore birds for food and nesting sites (the latter being aggressively defended).	Coleman, 2010.
Threatened species	L	L-M	Known predator of New Zealand dotterel eggs. Non-lethal nest visits associated with behavioural responses by dotterels (for example, temporarily leaving nest). Therefore, potential for population impacts through sub-lethal mechanisms such as altered activities patterns.	Wills et al., 2003; Sanders and Moloney, 2002; Ray, 2013.
Social/cultural				
Human health	L	L	Bird strikes usually result only in damage to aircraft, but in worst case scenarios can cause planes to crash with potential loss of life.	Department of Conservation, 2006.
Recreation	-	-		
Māori culture	L	L-M	Possible impacts of the māori of wai māori. See also 'Species diversity' and 'Threatened species'	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Do nothing	Based on the qualitative impact assesment Spur-winged plovers do not meet the requeirments for this programme.		
Exclusion programme	In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	nominated to determine what (if any) regional intervention would be appropriate. The Spur-winged plover did not meet the requeirments for this programme.		
Eradication programme	Not applicable	Not applicable	
Progressive containment programme	Not applicable	Not applicable	
Sustained control programme	Not applicable	Not applicable	
Site-led pest programme	Not applicable	Not applicable	
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that spur-winged plovers do not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be <u>no regional intervention</u> for spur-winged plovers, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding. While spur-winged plovers have not been afforded pest status in Northland, they may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes.		

Sulphur crested cockatoo

Cacatua galerita

Also known as: sulphur-crested cockatoo

(Family: Cacatuidae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Sulphur-crested cockatoos are large, white birds that have prominent yellow crests on the tops of their heads. The crest usually lies flat, but fans out and forwards when aroused. There is also pale yellow on the underside of the tail and wing. Their beaks are black and their eyes are a dark red-brown. Females are slightly larger than males and juveniles have a paler eye, and may have some grey in their plumage. Their most common call is a harsh screech but they also make softer cries, and guttural croaks or barks. Sulphur-crested cockatoos usually occur as pairs or small groups in spring and summer and may form large flocks in autumn and winter.
Habitat	Sulphur-crested cockatoos are native to woodland habitats in northern and eastern Australia. In New Zealand they are mainly found in farmland close to native forest or exotic tree plantations. The largest populations are associated with arable land, especially where maize is grown near to woodland habitat. There are populations in the Bay of Plenty, Hawke's Bay, Wairarapa, Manawatu and Waikato and small populations in the Waitakere ranges, Wellington, Banks Peninsula and the Catlins. The largest populations, Port Waikato, and Turakina and Pohangina Valleys, contain several hundred birds. Remaining New Zealand populations each contain fewer than 100 birds.
Regional distribution	There are no known wild populations of sulphur-crested cockatoos in Northland. However, individual birds have been observed at times. These may be pets that are free-flying or which have escaped from cages.
Competitive ability	Sulphur-crested cockatoos forage on the ground and in trees. Their diet consists predominantly of seeds, but they may take invertebrates. Important foods are seeds of grass, thistles, maize, macrocarpa and pines. In autumn they spend a lot of time feeding on the fruit of native trees, particularly podocarps, such as kahikatea.
Reproductive ability	Sulphur-crested cockatoos form long-lasting pair bonds. They lay1-2 eggs in nest cavities in trees. The nest is lined with wood chips chiselled from the walls of the nest cavity. Most chicks fledge in late December. Only part of the population breeds in any one year and the rest of the population forms small nomadic flocks that range over a large area. They are very long-lived, and can live for more than 70 years in captivity (or probably 20-40 years in the wild). Vectors of spread: Sulphur-crested cockatoos are very mobile birds that can fly and range over long distances (tens of kilometres per day). They are not migratory, but there is seasonal variation in use of their home range and in spring and summer they disperse over a large area. They can also be spread by the pet trade, from escaped caged birds and, possibly, illegal releases.

Resistance to control	Sulphur-crested cockatoos can be trapped.
Benefits	Sulphur-crested cockatoos are kept as caged birds and are captured from the wild for this purpose.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	Low
Sheep and beef	-	Low
Forestry	-	High
Horticulture	-	High
Native	-	Low
Urban	-	High
Coastal	-	Low
Estuarine and marine	-	-
Freshwater	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	M	Sulphur-crested cockatoos mainly eat the seeds of introduced conifer trees and pasture and crop species. They may cause damage to pine plantations by stripping branches when feeding.	Styche 2000 NZ Birds Online
Horticulture	-	M	Sulphur-crested cockatoos mainly eat the seeds of introduced conifer trees and pasture and crop species, such as grasses and maize. Their impact on horticulture is generally localised, with flocks	Styche 2000 NZ Birds Online

Category	Current	Potential	Comment	Source
			targeting specific fields of maize. Otherwise they are more of a nuisance value for rural communities, feeding on walnuts and damaging ornamental conifers.	
Other	-	-		
International trade	-	-		
		Environment		
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	M	Sulphur-crested cockatoos rely on native podocarp forest remnants for day-time refuges, nests and nocturnal roost sites. However, most of their food is obtained from introduced vegetation. They can have a massive impact on individual trees, at times stripping large numbers of branches. Defoliation of native trees and epiphytes may have potential consequences for forest dynamics,such as increase in understorey vegetation and reductions in populations of some species. They may compete for nest sites with kaka and native bats.	Styche 2000 NZ Birds Online
Threatened species	-	L-M	Sulphur-crested cockatoos may effect threatened species either directly (by defoliating plants) or indirectly (through competition for nest sites or by changing vegetation composition or structure).	Styche 2000
Social/Cultural				
Human health	-	-		
Recreation	-	-		
Maori culture	-	L	Impacts upon native/taonga species.	

L = low M= moderate H = high - = No impact + = Benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred in relation to these species.	If no action is taken, the sulphur-crested cockatoo could become established in the wild in Northland. This would have adverse effects upon the environment and forest and horticultural production. It could also result in economic costs associated with control.	Moderate-High. Sulphur-crested cockatoos are held as caged birds in Northland and there are small wild populations in the Auckland region. They sometimes escape from captivity and are capable of spreading over large distances. If no action is taken, there is a moderate to high risk that these birds could establish wild populations in Northland.
Exclusion programme	An exclusion programme would raise public awareness and education about the risks and impacts of sulphur-crested cockatoos. If they are included in the pest management plan there is the ability to respond immediately if a wild population is detected.	There is already some educational material available for sulphur-crested cockatoos. Excluding this species would prevent expenditure on its control if/when it invades Northland.	Low. There is a low risk that an exclusion programme could fail because sulphur-crested cockatoos could escape from captivity.
Eradication programme	Not applicable	Not applicable	A wild population of sulphur-crested cockatoos is not currently known to be present in Northland.
Progressive containment programme	Not applicable	Not applicable	A wild population of sulphur-crested cockatoos is not currently known to be present in Northland.
Sustained control programme	Not applicable	Not applicable	A wild population of sulphur-crested cockatoos is not currently known to be present in Northland.
Site-led pest programme	Not applicable	Not applicable	A wild population of sulphur-crested cockatoos is not currently known to be present in Northland.
Summary of alternative assessments and preferred option:	Exclusion programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for sulphur crested cockatoo. Regarding alternative approaches assessed, under <u>no regional intervention</u> (or do nothing) there would be some risk to NRC from environmental lobby groups and possibly affected land occupiers for not being more		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	proactive, in the knowledge that populations of sulphur crested cockatoocould potentially thrive in the region if allowed to establish. Biodiversity values (e.g. displacement of native cavity nesting birds and direct competition for food through consumption of native invertebrates and native fruits) would be impacted if sulphur crested cockatoos were discovered in the wild and no intervention plans or measures were available. As sulphur crested cockatoos are not currently found in the wild in Northland, but are known in neighbouring Auckland region, an <u>exclusion programme</u> outcome is the most appropriate management option available. Unlike Indian ring-necked parakeets and rainbow lorikeets they are not deemed unwanted organisms but can be held in captivity as pets. The costs for council of an advocacy and awareness programme are minimal until such time a response is required. There is some risk that by naming them as a pest, when they can be kept as pets (by bird breeders and fanciers), is sending mixed messages to Northland people. Consequently, the actions of people who hold sulphur crested cockatoos will determine whether an exclusion programme will ultimately be successful. The pet trade is potentially the highest risk pathway for the establishment of naturalised populations and council will engage further through the recent National Pest Pet Biosecurity Accord (NPPBA) to address the risks of these birds going wild. Most bird species are difficult to control due to their habitat and highly mobile nature and there are no guarantees with current management methods. Therefore, an exclusion programme focusing on a comprehensive advocacy and surveillance programme, and dialogue with neighbouring Auckland region will help to mitigate any operational control risks by detecting any infestations very early on.		

Wallaby

Macropus, Petrogale and Wallabia species

(Family: Macropodidae)

Status in New Zealand

Wallabies are listed as an unwanted organisms under the Biosecurity Act 1993. This status will expire on 19 September 2016.

Relevant biology

Form	Wallabies are small marsupial animals that look like miniature kangaroos. They are silver-grey to dark brown in colour.
Habitat	Wallabies live in scrub, native forest and production forests. They prefer the edges of these habitats, where there is dense vegetation and easy access to grassy areas (e.g. paddocks) where they can feed at night.
Regional distribution	There are no known wallaby populations in Northland. They are found on Kawau Island, just south of the boundary with the Auckland region, and there are large numbers present in the Rotorua Lakes area and in North Otago.
Competitive ability	Wallabies are nocturnal and start feeding during early to late evening. They eat grasses, native shrubs and trees. Their browsing of native plants changes vegetation composition with subsequent negative impacts on the indigenous flora and fauna.
Reproductive ability	Depending on the species, female wallabies become sexually mature at 12-24 months of age and produce one young each year. Most births occur during January-March and the young stay in the pouch for 250-275 days. Vectors of spread: Wallabies are mobile animals and have also been illegally transported and released elsewhere.
Resistance to control	Wallabies can be controlled by trapping, shooting (either aerially or ground-based) and 1080 is registered for use against wallabies.
Benefits	Some hunters regard wallabies as a recreational resource.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	Low
Sheep and beef	-	Low
Forestry	-	High
Horticulture	-	Low
Native	-	High
Urban	-	-

Land use type	Current land use infested	Potential land use
Coastal	-	Low
Estuarine and marine	-	-
Freshwater	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	M	Wallabies compete with stock in a similar way to rabbits, maintaining pasture to a short sward.	National Possum Control Agencies, 2007.
Sheep and beef	-	M	Wallabies compete with stock in a similar way to rabbits, maintaining pasture to a short sward.	National Possum Control Agencies, 2007.
Forestry	-	M	Wallabies have been blamed for damage to newly planted pines on Kawau Island.	Wodzicki and Flux, 1967.
Horticulture	-	L	Wallabies may browse upon young crops.	
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	M	Wallabies are likely to be responsible for inhibiting the regeneration of palatable species such as hangehange, fuschia, raurekau, karamu, pate and fivefinger. The long term consequence is a substantial structural change to the forest.	National Possum Control Agencies, 2007.
Threatened species	-	M	Wallabies feed on native plants and cause structural change to	National Possum Control Agencies, 2007.

Category	Current	Potential	Comment	Source
			the forest. This may have adverse effects on threatened species.	
Social/Cultural				
Human health	-	-		
Recreation	-	+	Wallabies are regarded as a resource by some recreational hunters.	
Maori culture	-	M	Impacts upon native/taonga species.	

L = low M= moderate H = high - = No impact + = Benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred in relation to this species.	Wallabies are not currently known to occur in Northland. However, they are present in Auckland and the Bay of Plenty. If they were to establish in Northland there will be serious environmental impacts and economic costs.	Moderate. There is a moderate risk that wallabies could establish in Northland following illegal releases.
Exclusion programme	An exclusion programme would raise public awareness and education about the risks and impacts of wallabies. If they are included in the RPMP there is the ability to respond immediately if they are detected in Northland. Wallabies will be removed from the unwanted organism list in 2016. This means section 52 and 53 of the Biosecurity Act will not apply unless they are included in the RPMP as a pest. These sections prevent the sale, breeding and distribution of wallabies currently. An exclusion programme would also include a rule banning possession of wallabies.	There is already educational material available for wallabies. Excluding these species would prevent expenditure on control if/when they invade Northland.	Low. There is a low risk that an exclusion programme could fail.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Eradication programme	Not applicable	Not applicable	Wallabies are not currently present in Northland.
Progressive containment programme	Not applicable	Not applicable	Wallabies are not currently present in Northland.
Sustained control programme	Not applicable	Not applicable	Wallabies are not currently present in Northland.
Site-led pest programme	Not applicable	Not applicable	Wallabies are not currently present in Northland.
Summary of alternative assessments and preferred option:	Exclusion programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for wallabies. In terms of alternative approaches assessed, under a no regional intervention (or do nothing) approach to wallabies becoming established in Northland, there would be no attempt made to control them, including no ability to ban them from being possessed by any person. There would be risks and significant public and political criticism of Northland Regional Council for not being more proactive while knowing wallabies were already in neighbouring regions. Biodiversity and production values would be at high potential risk and impacted significantly if wallabies were discovered and no intervention was imminent. As wallabies are not currently found in Northland an exclusion programme outcome is the only appropriate option available. There is a low operational/outcome risk that wallabies will be spread intentionally by disaffected people, however this remains the most likely pathway of introduction. Northland Regional Council's ability to control this pathway risk is minimal, even with undertaking or increasing awareness campaigns. The technical ability to control wallabies is, operationally, low risk. However, detection and control while at very low numbers (and potentially across a wide area) presents a low-medium logistical challenge (and associated risk) with the current technology used. An exclusion programme focusing on a comprehensive awareness programme and increased surveillance will help to mitigate these risks by detecting any infestations very early on. Any operational risks overall, are relatively minor and would not adversely affect control efforts if wallabies became established.		

Wasp sp.

Wasp sp.

Australian paper wasp (Polistes humilis), Asian paper wasp (Polistes chinensis), Common wasp (Vespula vulgaris) and German wasp (Vespula germanica)

(Family: Vespidae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Paper wasps are distinguished by their body shape, which is slender and 13-25mm long. They have reddish-brown to black bodies with yellow rings and reddish areas on the abdomen. The wings are reddish or amber brown and they have long legs that hang down during flight. The Asian paper wasp is larger than the Australian paper wasp. It arrived in New Zealand in the late 1970s and by 1995 was widespread throughout the upper North Island. The Australian paper wasp has been in New Zealand for more than a century. Common wasps are generally 12-17mm long, although queens are larger. Workers can be identified by a black mark behind the eye on the side of the head and an anchorshaped or dagger-shaped mark on the 'face', parallel yellow pronotal bands, and black dots and rings on the abdomen which are usually fused. The black dots and yellow rings on German wasps are separate and the pronatal band is just behind the head, but to the untrained eye German wasps are almost indistinguishable from common wasps.
Habitat	The paper wasps frequently construct their nests above ground on houses or other buildings and will also nest in trees or bushes. Large populations of Asian paper wasps occur in lowland open habitats such as shrublands, swamps and salt marshes. Both German and common wasps are social insects that inhabit agricultural areas, natural forests, planted forests, scrub/shrublands and urban areas (along stream banks in sunny locations) where they nest underground and in cavities in trees and buildings.
Regional distribution	Wasps have already reached the extent of their habitat inNorthland, but their densities will fluctuate from season to season largely based on weather conditions at the time of queen emergence in November.
Competitive ability	Asian paper wasps can occur at high densities of more than 200 nests per hectare and 6300 wasps per hectare. The potential impact of such high densities of these wasps on native ecosystems is a concern, although the full extent of this impact requires further research. Asian paper wasps prey mainly on invertebrates, especially caterpillars, and are capable of consuming 957g per hectare per season of invertebrate biomass. They also compete with other insects for nectar and honeydew resources. As well as inflicting a painful sting, and in some cases allergic reactions, wasps frighten people, cause schools to close, forestry operations to stop, and anecdotaly force campers and tourists to leave some of Northland's most visited conservation areas. Beekeepers class wasps as a serious threat to their industry and orchardists and viticulturists suffer the destruction of fruit. The German wasp is a successful invader of disturbed environments and natural ecosystems. It establishes large nests and the workers efficiently exploit food resources such as nectar and insects, which native fauna depend on. This species is difficult to

	control as a new colony can be established from a single inseminated female. The common wasp has been nominated as one of the world's worst invaders. This species impacts on conservation, forestry, beekeeping, horticulture and human activities. In addition to stinging humans, they compete with birds and other insects for insect prey and sugar sources. They will also eat fruit crops and scavenge around rubbish bins and picnic sites.
Reproductive ability	Wasps have few natural enemies and in mild winters wasp numbers are not greatly reduced, allowing workers to survive and expand the followin gspring, where they can quickly increase their numbers.
Resistance to control	Chemical and phyiscal control methods are available but require experience and good planning. Vespula species have a new wasp toxin available (Vespex) but require prefeeding and baiting when temperatures are high enough and protein levels are right. Large nests require significant experience to handle.
Benefits	None known

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	Low	Low
Forestry	Low	Low
Horticulture	Low	Medium
Native	Low	Medium
Urban	Low	Low
Coastal	Low	Low
Estuarine and marine	-	-
Freshwater	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-	Unlikely to impact farming	
Sheep and beef	-	L	Unlikely to impact farming	
Forestry	L	L-M	Nuisance factor but at sites with high numbers could impact on operations.	
Horticulture	L-M	M	Impacts on horticulture	

Category	Current	Potential	Comment	Source
Other	-	-		
International trade	-	-	Nil	
Environment				
Soil resources	-	-	Nil	
Water quality	-	-	Nil	
Species diversity	-	L-M	Competition with nectar feeders.	Global Invasive Species Database: www.issg.org/database/species/ecology.asp?si=67&fr=1&sts Toft RJ, Harris R J 2004. Can trapping control Asian paper wasp (Polistes chinensis antennalis) populations? New Zealand Journal of Ecology 28, pp 279-282. Clapperton BK 1999. Abundance of wasps and prey consumption of paper wasps (Hymenoptera, Vespidae: Polistinae) in Northland, New Zealand. New Zealand Journal of Ecology 23, pp 11-19.
Threatened species	L	L-M	In high numbers at key areas where there are threatened species, they could impact survival of some species.	
Social/Cultural				
Human health	L-M	M-H	Although they have seasonal impacts, increasing wasp numbers will likely see increased impacts on humans.	Anecdotal
Recreation	-	-	Wasps could have significant impacts on enjoyment of recreation, especially as visitor numbers increase.	Anecdotal
Maori culture	L	L-M	Overtime impacts could increase	

L = low M= moderate H = high - = No impact + = Benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. The wasp species did not meet the requirements for this programme.	None	-
Exclusion programme	Not applicable	Not applicable	-
Eradication programme	Not applicable	Not applicable	-
Progressive containment programme	Not applicable	Not applicable	-
Sustained control programme	Not applicable	Not applicable	-
Site-led pest programme	Not applicable	Not applicable	-
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that the named wasp species do not meet the 'tests' under the Act, even though they are present in the region and are causing impacts (anecdotal and unmeasured) on regional values (biodiversity and human health). Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgements are necessarily used. In determining that there will be <u>no regional intervention</u> for the wasp species, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgements on what it can most effectively and efficiently achieve given finite resources and limited funding. While Australian paper wasp, Asian paper wasp, common wasp and German wasp have not been afforded pest status in Northland, they may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	advice and information to support communities experiencing localised effects of these species. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes. Biological control of some wasp species is current research being carried out by Landcare Research and probably offers the best long-term management solutions.		

Diseases and pathogens

Kauri dieback

Phytophthora agathidicida

(Family: Peronosporaceae)

Status in New Zealand

Management of kauri dieback is being addressed by the Kauri Dieback Programme, which is a collaborative effort between the Ministry for Primary Industries, the Department of Conservation, Auckland Council, Northland Regional Council, Waikato Regional Council, Bay of Plenty Regional Council and Tāngata Whenua.

Relevant biology

Form	Kauri dieback is a deadly, fungus-like disease that can kill kauri trees of any age. Spores in the soil infect kauri roots and damage the tissues that carry nutrients within the tree. Infected trees show a range of symptoms including yellowing of foliage, loss of leaves, canopy thinning, dead branches and lesions that bleed gum at the base of the trunk. However, some trees can show symptoms of dieback and even be killed without any gum showing on the trunks. Nearly all infected kauri die and in the past 10 years, it has killed thousands of kauri in New Zealand.
Habitat	Kauri dieback disease can infect any kauri tree. Kauri forest grows only in northern New Zealand north of 38°S, which is roughly from Kawhia Harbour in the west (Waikato Region) to the Kaimai Range in the east (Bay of plenty Region). Kauri forests are scattered throughout Northland with the most well-known locations including Puketi, Waipoua, Trounson, Whangarei Heads and Russell Forest.
Regional distribution	Kauri dieback disease is present in Northland. It has been found in samples collected at Waipoua Forest, Trounson Kauri Park, Russell Forest, Omahuta, Raetea and Glenbervie. The source of infection at the latter three sites may have been seedlings from a plant nursery at Waipoua.
Competitive ability	Nearly all trees that are infected with kauri dieback disease will die. In a laboratory study on two-year-old seedlings the disease spread through the plants quickly and they all died within about 6 weeks (Horner and Hough 2014). It produces millions of spores that can be spread in soil or water.
Reproductive ability	Kauri dieback disease produces millions of spores. Resting spores (oospores) can be found in soil around infected trees and can survive for at least three years, and possibly much longer. Waterborne spores (zoospores) are produced in wet conditions and can move through water films in soil, freshwater streams and ponds. They do not survive in seawater and have a short life span. Vectors of spread: Kauri dieback disease is spread in contaminated soil and water and in the timber and roots of infected trees. Human activity is thought to be the main way that contaminated soil is spread e.g. on footwear, tyres, machinery. It can also be spread by animals such as feral pigs and dogs. The spores are unlikely to be transported in the air, by wind.
Resistance to control	There is currently no know control method (or "cure") for kauri dieback disease. However, there are ways to prevent the chances of spreading the disease. Soil and plant material should be cleaned from shoes, vehicles, machinery and other equipment both before and after visiting kauri forest. People visiting and working in kauri areas need to clean their shoes, and equipment with soapy water and a scrubbing brush

	before and after entering each area. Machinery should be steam cleaned or water blasted to remove all soil before and after entering kauri areas. The Kauri Dieback Management Programme recommends the use of disinfectants (such as Trigene) as an extra precaution especially for people who cannot clean their shoes between visiting different kauri areas. In addition, animals should be kept away from kauri trees to prevent them from spreading the spores. This can be achieved by fencing stock out of kauri forest, keeping dogs on a lead and controlling mammalian pests.
Benefits	None

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	-	-
Horticulture	Low	Low
Native bush or forests	Low	High
Urban	Low	High
Coastal	-	-
Estuarine and marine	-	-
Freshwater/Wetland	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	-		
Horticulture	Low	Low	Kauri dieback disease has been found in nursery-grown kauri plants.	Beauchamp, 2013.
Other	Low	Moderate	Kauri trees and kauri forests are important to tourism in Northland: State Highway 12 is known as the "Kauri Coast Highway", tourism operators provide guided walks in kauri forests and there are museums	Kauri Coast website; Mana magazine; Northland Inc. Website;

Category	Current	Potential	Comment	Source
			and shops dedicated to kauri. Tāne Māhuta, the largest Kauri tree on earth, is a must-see for thousands of tourists annually.	
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	Low	High	Kauri dieback disease can rapidly kill kauri seedlings and kauri trees of all ages. This changes the structure and functioning of forests because kauri influence habitat characteristics and overall forest diversity.	Van der Westhuizen et al., 2013; Waipara et al., 2013; Wyse et al., 2014.
Threatened species	Low	High	Kauri dieback disease can alter the structure, functioning and diversity of forests. This may have consequences for threatened species of flora and fauna in these habitats.	Van der Westhuizen et al., 2013; Waipara et al., 2013; Wyse et al., 2014.
Social/cultural				
Human health	-	-		
Recreation	Low	High	Kauri forests are important sites for recreation, particularly tramping and sight-seeeing. Kauri dieback reduces the aesthetic appeal of natural areas and measures to prevent the spread of the disease may affect recreational activities.	
Māori culture	Moderate	High	Kauri is considered a taonga species by many Māori. It is valued as a connection to the spiritual beliefs and way of life of the ancestors.	Kauri Dieback Management Team.

L = low; M= moderate; H = high; - = No impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred under the pest management plan in relation to these species.	Should the species remain unmanaged, it may be spread by human activities beyond the scope of normal species spread, and have a significant impact on species diversity and economic, social and cultural values in Northland.	High. Existing populations would not be subject to management measures. If no action is taken, there is a high risk that the impacts of kauri dieback in Northland will increase.
Exclusion programme	Not applicable.	Not applicable.	Kauri dieback is already present in Northland so an exclusion programme for the region is not an option.
Eradication programme	Not applicable.	Not applicable.	Resources and control tools to eradicate kauri dieback (reduce the infestation to zero density) are not currently available, so an eradication programme is not a feasible option.
Progressive containment programme	Not applicable.	Not applicable.	Resources and control tools to control kauri dieback are not currently available, so a progressive containment programme is not a feasible option.
Sustained control programme	A sustained control programme would aim to slow the spread and reduce the impacts of kauri dieback and prevent increasingly severe impacts on the environment. This will involve rules about movement of material or equipment that may contain kauri dieback.	A sustained control programme would require an investment of time and resources by the council and affected landowners. It would not aim to eradicate or contain the species, so management costs and adverse effects would be on-going.	Moderate. A sustained control programme would not reduce the distribution of kauri dieback in Northland but the rate of spread may be slowed.
Site-led pest programme	Not applicable.	Not applicable.	Resources and control tools to control kauri dieback are not currently available, so a site-led programme is not a feasible option.
Preferred option:	Sustained control programme In relation to NPD considerations (section 6(1) outlines four criteria) a **medium-level analysis** was deemed appropriate for Kauri dieback disease.		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	In terms of alternative approaches assessedunder no regional intervention (or do nothing), there would be no control or management of existing sites and no intervention for any new sites, this would have a high environmental, cultural, economic and social risk to Northland. As Kauri dieback is already present in Northland and control tools are not currently available an eradication programme would not be viable. A Progressive containment approach would also not be viable because of the lack of control tools and resources for managing Kauri dieback. A sustained control approach is the preferred outcome and aims to slow the spread and reduce the impacts of Kauri dieback. Slowing the rate of spread allows for increased time and resources for research funding to understand and develop control methods for the disease. The costs to council of a sustained control programme for Kauri dieback are acceptable given the environmental, social, cultural and economic risk of the disease spreading.		

Quantitative analysis

The high level analysis for Kauri dieback was undertaken using a benefit-cost model. The model was developed using a logistic model for spread, per hectare benefit estimates as used in the inter-agency Kauri Dieback Programme, Northland specific data and NRC staff expertise. The benefit of the alternative programmes assessed are determined, in dollar terms, as the difference between unmanaged and managed risk.

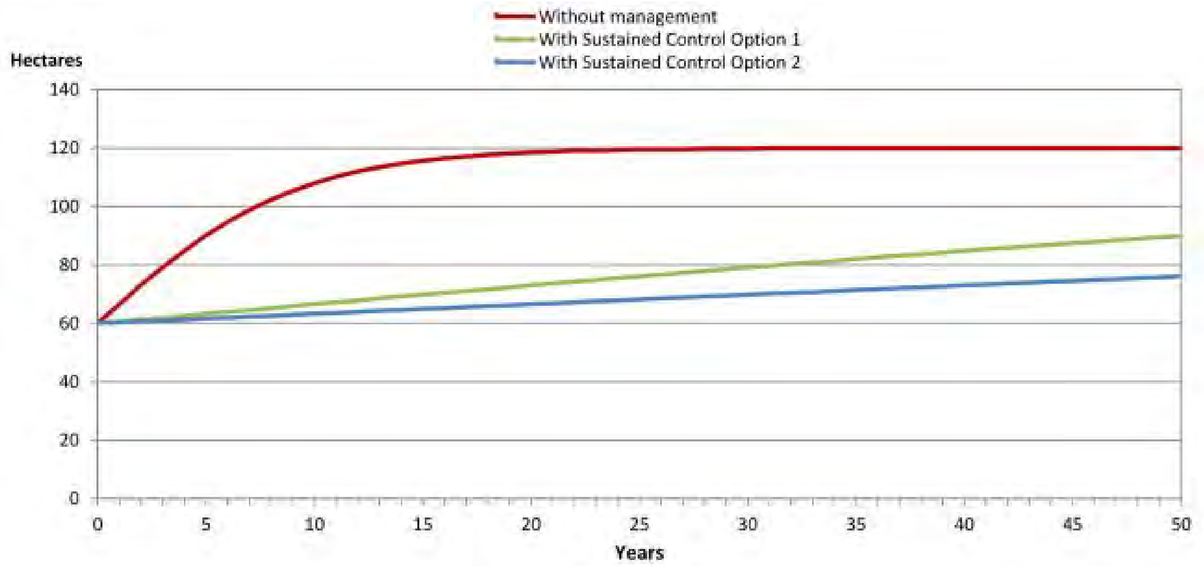
Impact evaluation

The following table outlines the specific programme assumptions that have been used in the benefit cost analysis for Kauri dieback. The council costs are based on the annual cost of inspection for Kauri dieback sites. The occupier compliance cost for Sustained Control Option 1 is NRC's estimate of the average cost of a basic management plan. Sustained Control Option 2 imposes an additional one-off cost of $5,000 to fence off the infected area. The likelihood of programme failure has been rated as low (1-9% chance of failure). There is a large degree of uncertainty regarding the spread rate for kauri dieback. Over the past ten years or so, 60ha of kauri on private land have been infected. The analysis assumes that a similar rate of spread will occur with no regional intervention in place. The analysis focuses on the benefit of reducing spread on private land only as this is the objective of the council programme. Any benefit acheived in lowering the spread of kauri dieback disease to public land through the programme is additional to the benefits calculated in this assessment.

Programme specific assumptions

Variables for analysis	Sustained Control Option 1	Sustained Control Option 2	
Council costs ($/pa)	$160,000	$240,000	
Occupier compliance costs ($/pa/ha)	$500	$5,000 one-off plus $500 pa/ha	
Reduction in spread rate	90%	95%	
Likelihood of programme failure	Low	Low	Low (1-9%), Moderate (10-50%), High (>50%) chance of failure
Likelihood of programme failure	5%	5%	

The graph below projects the invasion trajectory of Kauri dieback without any regional intervention and with the implementation of Sustained Control Option 1 and Sustained Control

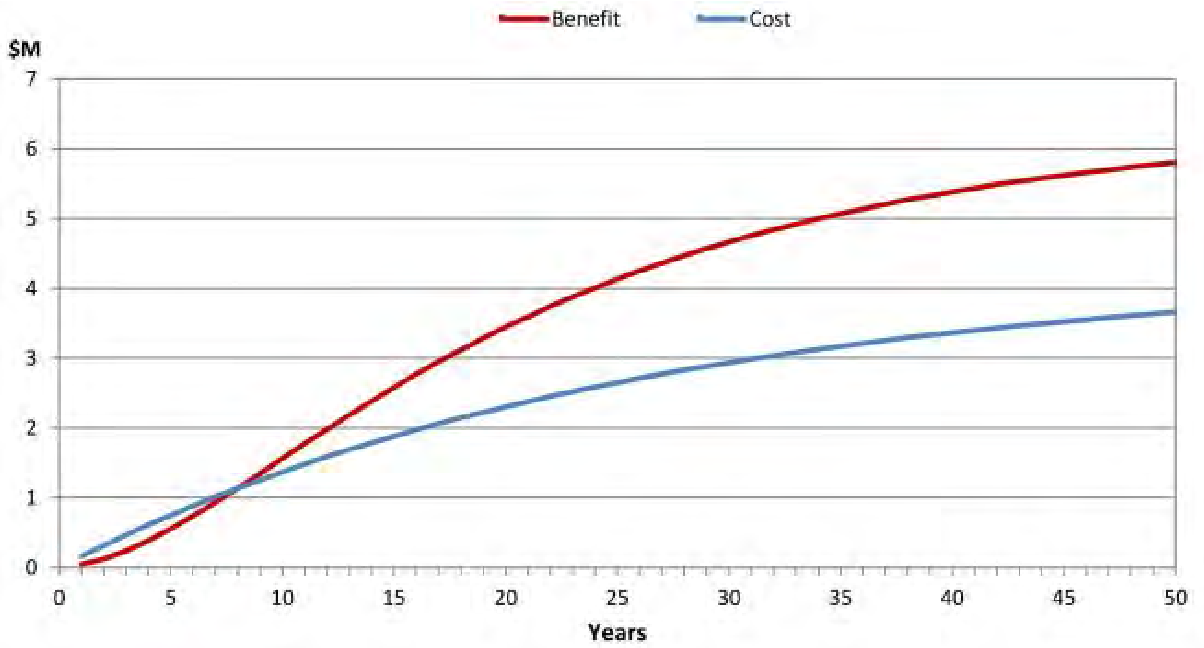


The following table summarises the benefits and costs of the two sustained control options over ten year and fifty year time frames. Over a 10 year period Sustained Control Option 1 returns a positive net benefit of $0.19M compared to a net loss of $-0.37M for Sustained Control Option 2. Over a 50 year time period both management options return positive net results, however Sustained Control Option 1 yields a more significant net benefit of $2.14M compared to $1.45M for Sustained Control Option 2.

Summary table

Cumulative present value of additional benefits and costs for kauri dieback programmes				
	Ten years		Fifty years	
	Sustained Control Option 1	Sustained Control Option 2	Sustained Control Option 1	Sustained Control Option 2
Benefit ($M)	$1.56	$1.67	$5.80	$6.70
Cost ($M)	$1.37	$2.04	$3.66	$5.25
Net benefit (B-C) ($M)	$0.19	-$0.37	$2.14	$1.45

The following figure shows the cumulative value of benefits and costs for Sustained Control Option 1 over time. It shows that benefits will be greater than costs from year eight onwards.



Assumptions and sensitivity of the model

Standard assumptions of the model

Data to input into benefit cost analysis	
Invasion Trajectory Without Management	
Initial area infested (ha):	60
Maximum area that could become infested (ha):	120
Time for infestation to reach 90% of maximum:	10
Spread rate	22%
Benefits	
Discount rate:	4%
Value of land ($ per ha):	$8,000
Reduction in value caused by the weed / pest:	100%

Pest specific assumptions

	Land use type								Total
Variables for analysis	Dairy	Sheep and beef	Horticulture	Plantation forest	Indigenous Forest	Scrub	Urban	Sand, gravel & rock	Total
Total Northland area (ha)	123,167	482,683	9,322	188,209	269,926	133,989	9,790	14,577	
Estimated value per ha	$2,154	$338	$9,100	$609	$8,000	$485	$100	$100	

	Land use type								
Current infestation by water body type (ha)	0	0	0	0	60	0	0	0	60
Suitability of land use type for pest (to determine potential area occupied)	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Primary	Unsuitable	Unsuitable	Unsuitable	
Maximum area of infestation (ha)	0	0	0	0	40,489	0	0	0	40,489
Share of maximum infested area by land use / water body type (%)	0%	0%	0%	0%	100%	0%	0%	0%	100%
Weighted value of land at risk	$0	$0	$0	$0	$8,000	$0	$0	$0	$8,000
Impact of pest on land use type values	Not applicable	Not applicable	Not applicable	Not applicable	High	Not applicable	Not applicable	Not applicable	
Weighted impact of potential impact	$0	$0	$0	$0	$8,000	$0	$0	$0	$8,000

Sensitivity analysis

Fifty year cumulative net present value of kauri dieback programmes		
Change in assumption (all other variables remain constant)	$M	
	Sustained Control Option 1	Sustained Control Option 2
Baseline	$2.14	$1.45
Discount rate doubled to 8%	$0.96	$0.38
Years to reach 90% of maximum area 50% longer	$1.86	$0.88
Reduction in spread rate achieved by programme halved	-$2.36	-$3.79
Dollar value of benefit halved	-$0.76	-$1.90
Private cost double	$1.92	$1.45

Freshwater pests

Leuciscus idus

Also known as: Orfe, golden orfe, ide

(Family: Cyprinidae)

Status in New Zealand

Orfe have no legal status in New Zealand.

Relevant biology

Form	Similiar to rudd but with smaller scales and lacking the small projection at the base of the pelvic and pectoral fins. Orfe have no teeth. They often have a bright colour and the variant introduced to New Zealand is a more golden hue. In Europe the average length is about 40cm, although orfe can reach 80cm and 4kg in weight.
Habitat	Orfe reportedly inhabit slow flowing or still rivers and lakes and are migratory. In widny conditions they retreat to deeper waters, but otherwise feed in shoals.
Regional distribution	Orfe were illegally introduced to New Zealand in the 1980's, the only reported population in a pond north of Auckland was eradicated. However, some sources report orfe releases in ponds in Northland and it is entirely possible that these fish persist in small populations.
Competitive ability	Orfe are opportunistic feeders that are capable of switching to a vegetation-based diet when invertebrates or other, smaller fish and prey are scarce. It tolerates a wide variety of conditions, with a high tolerance of saline waters. They can also survive very low temperatures.
Reproductive ability	Spawning occurs in spring at depths of 0.5-1.5m. Eggs are laid over gravel, weed beds or mud substrate where they adhere to debris, stones or vegetation. Egg development is dependent on temperature, with 23 days at 9°C and 5 days at 14°C. Fish live up to 15 years and maturation is dependent on growth, with maturation achieved at 2 years if growth is quick, of 6 years with slow growth. Vectors of spread: Orfe will be spread through human activity, through intentional introductions or accidental, by transfer of eggs on machinery or gear.
Resistance to control	Orfe, like any other fish species are very susceptible to standard methods of eradication, via netting or piscicide.
Benefits	Orfe are a popular coarse fish for anglers overseas.

Land uses occupied

Land use type	Current land use infested	Potential land use
Dairy	-	-
Sheep and beef	-	-
Forestry	-	-
Horticulture	-	-
Native	-	-
Urban	-	-

Land use type	Current land use infested	Potential land use
Coastal	-	-
Estuarine and marine	-	-
Freshwater/wetland	Low	High

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	M	Orfe are likely to have an impact on native species where it occupies the same habitats. The ability of orfe to feed throughout the water column means it will compete for food with inanga, smelt, bullies, eels and invertebrates,	Collier & Grainger, 2015
Threatened species	-	M	Orfe could particularly compete with inanga due to its ability to tolerate brackish water. It could colonise the lower reaches of tidal rivers, reducing their overall habitat.	Collier & Grainger, 2015
Social/cultural				
Human health	-	-		
Recreation	-	L	Orfe are likely to compromise water quality through their benthic feeding habits and the	Collier & Grainger, 2015

Category	Current	Potential	Comment	Source
			addition of nutrients into the water.	
Māori culture	-	L	Impacts upon native/taonga species.	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If orfe are found to be present in Northland and no management action is undertaken, there would be no financial impact on council through staffing requirements	Orfe are a species believed to be eradicated but possibly still persist in Northland, as such their current range is unknown. If no action is taken and orfe are present, they mayspread, with consequent adverse effects on the environment and economic costs associated with control.	High. If orfe are present in Northland, then the risk of the population expanding into new sites increases with no regional intervention.
Exclusion programme	Exclusion programme would allow for rules around the prevention of the spread of orfe, without placing undue costs onto Council if orfe are discovered to have been eradicated from New Zealand	Costs are unlikely to be incurred, unless orfe are discovered in the region, in which case they will most likely be placed in the Eradication category.	Low, orfe are not known to be present in Northland at this current point in time.
Eradication programme	N/a	N/a	N/a.
Progressive containment programme	N/a	N/a	N/a
Sustained control programme	N/a	N/a	N/a
Site-led pest programme	N/a	N/a	N/a
Summary of alternative assessments and preferred option:	Exclusion programme Because orfe are not known to be present in Northland but recovered records from a MAF investigation indicate that some small populations may persist, orfe should not be removed from the RPMP until it can be conclusively proved that they have been eradicated from New Zealand. Placing the orfe as an Exclusion programme species would not place any undue costs onto Council and it is anticipated that if orfe were discovered, it would be a joint operation between council, DOC and MPI to contain the population.		

Alligator weed

Alternanthera philoxeroides

Also known as: alligator weed

(Family: Amaranthaceae)

Status in New Zealand

Naturalised, unwanted organism under the Biosecurity Act 1993 and listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Alligator weed is a perennial emergent aquatic plant that can also grow in terrestrial areas. Its leaves are green, hairless, waxy, have a conspicuous midrib and are up to 4 x 10cm long. The flowers resemble those of white clover but are smaller and each cluster is produced on a long stalk. Stems are hollow and buoyant. Amphibious; in aquatic situations it is typically bottom-rooted at the margins but forms floating mats which spread across the water surface. It has short, filamentous roots from floating stem nodes, capable of becoming bottom-rooting if mats break up. Terrestrial roots are thicker and capable of extending approximately 50cm deep through soil.
Habitat	Still and slow-moving water bodies, including lakes, streams, drainage channels. It will tolerate brackish water. Terrestrial habitats including pasture, cropland and gardens. Prefers temperate climates.
Regional distribution	Alligator weed is widely distributed in rivers, streams, lakes and ponds throughout the region. It also occurs in terrestrial areas, especially low lying areas with clay soils. It is currently only known to be present at two of Northland's highest value lakes.
Competitive ability	Alligator weed has a history of invasiveness overseas and is a strong competitor. It is very hardy and displays phenotypic plasticity, tolerating wide range of environmental conditions and disturbance regimes. In terrestrial situations it is most competitive with high soil moisture. It prefers full sun but is more shade tolerant than typical pasture grasses, therefore may be advantaged by slight shading. It can spread easily from plant fragments. Tolerant of total submergence during flood events. May have allelopathic properties, inhibiting growth of other species.
Reproductive ability	Alligator weed doesn't set viable seed in New Zealand. It reproduces vegetatively from stem nodes and root fragments. Vectors of spread: Dispersed naturally by water movement, plus human-mediated dispersal via movement of contaminated soil and machinery as well as cultivation by some ethnic communities as a vegetable.
Resistance to control	Very herbicide tolerant, re-sprouting following control and requiring repeat applications over long time frames. Selective herbicides can result in release from competition from surrounding susceptible species, thus exacerbating alligator weed dominance. Mechanical control can exacerbate spread from stem and/or root fragments.

	The alligator weed beetle biocontrol agent provides some control of floating mats but is less effective against plants rooted on the margins of water bodies and provides no control in terrestrial habitats. The stem boring moth provides very little control in any habitat.
Benefits	None

Water bodies occupied

Water body type	Current water body infested	Potential water body infested
Lakes	Low	High
Rivers and streams	Low	High
Wetlands	Low	High
Ponds and dams	High	High
Drains and canals	High	High
Troughs	-	Low

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	L	M	Displaces valuable pasture species. Associated with photosensitisation and liver damage when eaten by cattle, although this effect appears to be inconsistent and the cause is unknown.	Julien et al. 1992 Bourke and Rayward 2003
Sheep and beef	L	M	As above.	
Forestry	-	-		
Horticulture	L	L-M	Known to substantially reduce crop yield in rice crops overseas. Also capable of invading drier cropping systems such as kumara.	Yu et al. 2007 Graham 1976 Vogt et al. 1992
Other	L	L	Blocks drainage channels, exacerbating flooding. Can damage fences when large mats wash up against them during floods.	Schooler et al. 2008 Julien 1995
International trade	-	-		

Category	Current	Potential	Comment	Source
Environment				
Soil resources	-	L	May be impacted by drainage issue described above.	
Water quality	L	L	Alters decomposition rates and nutrient cycling in invaded water bodies via rapid growth, rapidly decomposing leaf litter and boom-bust biomass cycles (the latter component primarily when biocontrol agent also present). Mass decomposition can also lead to depleted dissolved oxygen levels.	Bassett et al. 2010 Hockley 1974 Coffey 1981
Species diversity	L-M	H	Capable of forming extensive, dense mats which cover the water's surface, profoundly altering aquatic habitat structure (e.g. water flow, light penetration). Displaces native plant species in wetlands and margins of water bodies. Alters invertebrate community composition, including changes in functional group composition. Probably alters fungal community composition and/or biomass. Possible impacts on inanga and other native fish spawning sites via habitat modification.	Bassett et al. 2011; 2012a; 2012b Pan et al. 2010 Clements et al. 2011 Chatterjee and Dewanji 2014 Timmins and Mackenzie 1995
Threatened species			As above.	
Social/Cultural				
Human health			Accumulates metals from soil, therefore may be unsafe to eat when growing in contaminated soils.	Chao et al. 2004
Recreation and aesthetics			Dense mats can impede boat access and other recreational water uses.	Bassett 2008
Maori culture			Multiple impacts on wai māori (see 'Water quality', 'Species diversity' and 'Recreation').	

L = low M= moderate H = high - = no impact + = benefit

Proposed management

Option	Explanation of Benefits	Explanation of Costs	Level of risk that programme will not be successful
No regional intervention	Rather than applying a programme under the Regional Pest Management Plan, the species could come under a	There would be no immediate costs to council. However, costs in future could be	High. By not applying a programme and rules to the species, there would be no provisions under the pest management plan to manage

Option	Explanation of Benefits	Explanation of Costs	Level of risk that programme will not be successful
	council supported management programme outside of the pest management plan, where advice and support are provided for sites of interest to communities. This will provide support to communities as and where the species is having impacts. People would still be encouraged to be careful not to move aquatic pests around through the 'Check Clean Dry' programme.	greater if the species continues to spread.	inappropriate practises that are exacerbating the spread.
Exclusion programme	Not applicable.	Not applicable.	Exclusion is not an option because alligator weed is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Alligator weed is present in ponds, dams and drains throughout the region, as well as some lakes and rivers so would not be suitable for an eradication programme.
Progressive containment programme	Not applicable.	Not applicable.	Already present in some high value lakes in Northland, as well as in rivers, ponds and drains throughout the region so would not be suitable for a progressive containment programme.
Sustained control programme	Alligator weed could be included in a sustained control programme. The council could include a rule banning dumping/deliberate spread within the Northland region which may help reduce the spread of alligator weed.	Education, publicity, responding to reports, enforcement action.	Moderate - although these measures may help, alligator weed could still spread in Northland and infest high value water ways.
Site-led pest programme	The council could specify high value lakes as site-led programmes, as an incursion at these sites could have significant impacts. Alligator weed could be listed as a progressive containment or eradication species in these lakes, so that if an incursion is detected through regular surveillance we are ready to act.	Rules would only be applicable in the areas defined as site led programmes and could not be enforced elsewhere. Education, publicity, responding to reports, response to new incursions, enforcing rules.	Low - efforts could be targeted to protecting and responding to incursions in the highest value sites in Northland.

Option	Explanation of Benefits	Explanation of Costs	Level of risk that programme will not be successful
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that alligator weed does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be <u>no regional intervention</u> for alligator weed, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding. While alligator weed has not been afforded pest status in Northland, it may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes.		

Alpine newt

Ichthyosaura alpestris apuana

(Family: Salamandridae)

Status in New Zealand:

Unwanted organism.

Relevant biology

Form	Alpine newts are small reptiles approximately 5-11cm long. They are dark grey or dark brown on the back – males are grey and females brown. The skin surface on the back appears rough-textured. The underside is bright orange from the chin to belly. More mature individuals may have a band of blue or cream with black spots down their sides (between the dark back and orange underside). Mature males have a spotted crest or ridge down their back. The larvae eat a large number of planktonic organisms, while the adults focus on insect larvae and amphibian eggs. The species life-expectancy may be more than 20 years, but is usually around seven years.
Habitat	Alpine newts usually hibernate in small burrows during winter. In spring and summer they are found in wetlands, ponds and streams where they lay their eggs among aquatic plants. In their natural range they are widespread in both alpine and lowland habitats including wet, shaded coniferous, mixed and deciduous forests, sub-alpine meadows and pasture land.
Regional distribution	Alpine newts were deliberately smuggled into New Zealand. A population has been established near Waihi, Waikato for 10-15 years. The New Zealand population may result from a one-off introduction directly from Europe as genetic data provided a full match with populations from Tuscany, Italy.
Competitive ability	The illegal importation, release and spread of exotic amphibians are a threat to New Zealand's rare and endemic native frogs. The aquatic diet of adult alpine newts is known to include amphibian eggs and larvae. If alpine newts were to establish, it would add a significant threat to the already endangered native frog populations. There is also a pathogen and parasite risk from the newt to native species as this population has tested positive for *Batrachochytrium dendrobatidis* (chytrid fungus). This is the same fungi is thought to be responsible for a major decline in our native frogs in 2001. They are also possibly vectors for other infections our native amphibians may be susceptible to, such as Ranavirus.
Reproductive ability	Alpine newts breed, and larval development takes place, in stagnant waters including shallow ponds, temporary pools, lakes, and ditches, drinking troughs, ruts and sometimes slow-moving streams. The generation time is between two and 10 years depending on the locality. Several dozens to hundreds of eggs are deposited per female each year. Vectors of spread: alpine newt have a terrestrial phase and are able to move between waterways. However, all newts captured in New Zealand to date have been less than 400m from the initial incursion site, indicating some site fidelity. The most likely means of dispersal from this site is by human spread.

Resistance to control	The current eradication programme is the first such attempt in New Zealand, so has been a learning process for the agencies involved. Methods being used include netting, box-traps, drift-fencing, pitfall traps, sniffer dogs, and pond-emptying. More than 3000 newts have already been removed over a two-year operational period.
Benefits	Not applicable.

Water bodies occupied

Water body type	Current water body infested	Potential water body infested
Lakes	-	High
Rivers and streams	-	-
Wetlands	-	High
Ponds and dams	-	High
Drains and canals	-	Low
Troughs	-	Low

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Farming (toxic to stock, and affects drainage)	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	M	The larvae eat a large number of planktonic organisms, while the adults focus on insect larvae and amphibian eggs.	Denoel and Andreone, 2003.
Threatened species	-	M	The aquatic diet of adult alpine newts is known to include amphibian eggs and larvae. If alpine	Ministry Primary Industries, pers.

Category	Current	Potential	Comment	Source
			newts were to establish, it would add a significant threat to the already endangered native frog populations. There is also a pathogen and parasite risk from the newt to native species as this population has tested positive for *Batrachochytrium dendrobatidis* (chytrid fungus). Only one known native frog population in Northland.	com.; Arntzen et al., in press.
Social/cultural				
Human health	-	-		
Recreation and aesthetics	-	-		
Māori culture	-	M	Potential impacts on native/taonga species, which are already endangered.	

L = low; M= moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	There is only one known population in New Zealand, likely to have resulted from a one-off illegal introduction. There is currently an eradication programme underway. Alpine newt have never been available through the pet trade in New Zealand. The chances of alpine newt spreading to Northland are minimal, but if it did arrive a council could declare a small-scale management programme under s100V of the Biosecurity Act to respond.	None	Low – an extremely low level of risk that a wild population could establish in Northland.
Exclusion programme	To minimise the risks of anyone moving alpine newts to Northland, we could include rules banning transport and release into or within the Northland region and requiring sightings (or pet escapes) to be reported.	Publicity/education; follow-up on reports.	Low – it is unlikely that alpine newts will be spread from the known incursion site to Northland.
Eradication programme	Not applicable.	Not applicable.	Alpine newt is not known to be present in Northland.

Progressive containment programme	Not applicable.	Not applicable.	Alpine newt is not known to be present in Northland.
Sustained control programme	Not applicable.	Not applicable.	Alpine newt is not known to be present in Northland.
Site-led pest programme	Not applicable.	Not applicable.	Alpine newt is not known to be present in Northland.
Summary of alternative assessments and preferred option	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that alpine newts do not meet the 'tests' under the Act. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be no regional intervention for alpine newts, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding.		

Bladderwort

Utricularia gibba

(Family: Lentibulariaceae)

Status in New Zealand

Bladderwort is listed as an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Bladderwort is a perennial aquatic herb, which forms dense sprawling mats of long branched filamentous stolons, with no roots. The mats float at or just below the water's surface with the aid of tiny round bladders. Carnivorous; small spherical traps suck prey inwards when triggered by external hairs. Zooplankton and small insects may be caught as prey, and other organisms such as phytoplankton may live within traps. Submerged stems bear underwater flowers that self-fertilise without opening. Bladderwort has small yellow flowers, borne above the water December - February. Seeds are very small and ripen summer-autumn.
Habitat	Still and slow-moving water bodies including lakes, wetlands, farm and garden dams, ponds, drains. Often in shallow water, but sometimes also deep water. In larger water bodies bladderwort mats are often confined to a narrow marginal band and/or the downwind end of the water body. Prefers acid, high nutrient waters but can grow aggressively in lower nutrient habitats.
Regional distribution	Bladderwort is widespread in waterways throughout Northland.
Competitive ability	Bladderworts can form dense mats of 75-95% cover, and are habitat generalists. Prey captured by traps can be translated into growth responses, but its importance in New Zealand situations is unknown. Bladderwort may struggle to establish in exposed sites subject to wind or wave action.
Reproductive ability	Some populations display limited seed-set, while others readily produce viable seed (possibly reflecting separate introductions). Able to spread very rapidly to new water bodies, as evidenced by exponential rate of increase in infested water bodies in Northland in the last 15 years. Vectors of spread: Dispersed primarily via seeds or vegetative fragments attached to waterfowl. Also spread via human movement of boats, fishing equipment and as a contaminant with other aquarium/ornamental pond plants.
Resistance to control	No known control tools. Primarily spread by natural means (waterfowl) therefore difficult to prevent spread to new water bodies, including isolated sites.
Benefits	Can be grown as pond ornamental or by carnivorous plant enthusiasts.

Water bodies occupied

Water body type	Current water body infested	Potential water body infested
Lakes	High	High
Rivers and streams	Low	Low
Wetlands	High	High
Ponds and dams	High	High
Drains and canals	High	High
Troughs	Low	Low

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	L	L	Can impede drainage and irrigation.	National Plant Pest Accord assessment 2006
Sheep and beef	L	L	As above	
Forestry	L	L	As above	
Horticulture	L	L	As above	
Other	-	-		
International trade	-	-		
Environment				
Soil resources	L	L	Can suppress native rooted macrophytes through shading, and this may result in reduced oxygen levels within sediment, and consequent changes in sediment chemistry.	Urban et al. 2006; 2009
Water quality	-	-		
Species diversity	L	L-M	Spreading aggressively. Potentially serious threat to small turf-forming species. Possible impacts on submerged vegetation through shading, but no evidence of substantial collapse or displacement of	Heenan et al. 2004a Champion and Wells 2014 NPPA assessment 2006 Titus and Grisé 2009

Category	Current	Potential	Comment	Source
			submerged vegetation beneath floating bladderwortmats in New Zealand to date.	Urban et al. 2006; 2009
Threatened species	M	M	Native species *Utricularia australis* has a conservation status of nationally critical and occupies similar habitat to bladderwort and may be displaced by it.	NZPCN
Social/Cultural				
Human health	-	-		
Recreation and aesthetics	L	L	Interferes with recreational activities such as boating and swimming.	Williams 2008
Maori culture	L	L-M	Impacts on the wairua of wai māori. See 'Soil resources', 'Species diversity', 'Threatened species' and 'Recreation'.	

L = low M= moderate H = high - = no impact + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial cost to council associated with the control of this species.	There will be no costs to council if this species is not included in a management programme.	Low - Bladderwort is already widespread in Northland and is in many high value lakes. It is spreading through natural means as well as through human activities. There are no effective control methods currently available.
Exclusion programme	Not applicable.	Not applicable.	Exclusion is not an option because bladderwort is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Bladderwort is present in lakes, ponds, streams and drains throughout the region. It is spreading through natural means and there are no control methods currently available. It would not be suitable for an eradication programme.
Progressive containment programme	Not applicable.	Not applicable.	Bladderwort is present in lakes, ponds, streams and drains throughout the region. It is spreading through natural means

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
			and there are no control methods currently available. It would not be suitable for a progressive containment programme.
Sustained control programme	Bladderwort could be included in a sustained control programme. The council could include a rule banning dumping/deliberate spread within the Northland region however, this is unlikely to help reduce the spread of bladderwort.	Education, publicity, responding to reports, enforcement action.	High - although these measures may help, bladderwort is still likely to spread in Northland and has already infested high value water ways.
Site-led pest programme	Not applicable.	Not applicable.	Bladderwort is present in lakes, ponds, streams and drains throughout the region. It is spreading through natural means and there are no control methods currently available. It would not be suitable for a site-led programme.
Summary of alternative assessments and preferred option	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that bladderwort does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be no regional intervention for bladderwort, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding. While bladderwort has not been afforded pest status in Northland, it may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes.		

Brown bullhead catfish

Ameiurus nebulosus

(Family: Italuridae)

Status in New Zealand

Naturalised.

Under the Fisheries (Amateur Fishing) Regulations 2013 catfish must be killed on capture, and under the Fisheries (Commercial Fishing) Regulations 2001 live sale is prohibited.

Relevant biology

Form	Brown bullhead catfish are a dark brown to olive green colour with paler sides and bellies. They have eight distinctive barbels around the mouth, small eyes and smooth, scaleless skin. The leading edge on their dorsal and pectoral fins has a sharp toxic spine. Catfish are an extremely robust fish and can survive for very long periods out of water. They commonly grow to 250-500mm long, and live for 5-8 years. They are opportunistic, generalist feeders. Juveniles predominantly eat zooplankton and invertebrates. The adult diet broadens to include a wider range of macroinvertebrates as well as molluscs, vegetation and fish. Catfish are predominantly nocturnal, but there is some diurnal activity as well.
Habitat	Lakes and slow-moving water bodies including streams and drainage channels. They favour areas with submerged vegetation. Spatial use of habitats within an invaded water body can vary seasonally to meet changing spawning and/or food requirements. They have broad environmental tolerances including very low dissolved oxygen levels.
Regional distribution	Catfish are now well established in the Wairoa River catchment (Figure 3-3C) but they appear to be relatively scarce elsewhere in Northland (only 10 known sites). Isolated populations have been found in a small stream draining into the Hokianga Harbour, in a tributary of the Kawakawa River, and in Lake Ora near Whāngārei. Catfish were also historically reported from Lake Ōmāpere, but more recent and comprehensive eel surveys have found none there (Williams et al., 2009). Catfish could be readily spread from the Wairoa River catchment to a range of other waters, including lakes, in Northland.
Competitive ability	Tolerance of poor water quality enables them to cope with habitats that many other species are unable to tolerate. Tolerance of low oxygen levels may also increase risk of surviving human-mediated dispersal between water bodies. Invasive overseas.
Reproductive ability	Catfish form pair-bonds are territorial during the preparation of the spawning site and during spawning. They usually spawn between September and December. Spawning occurs in shallow depressions in bottom mud or sand. In New Zealand catfish mature at two years old and are able to spawn for the next 4-5 years. They are one of the few freshwater fish species that provide parental care of their broods, significantly increasing offspring survival. Vectors of spread: human-mediated dispersal by coarse anglers stocking new water bodies and accidental transfers via boats and trailers.

Resistance to control	Chemical control (for example, rotenone) is non-selective, therefore has potential non-target impacts on native fish. Chemical control is also less effective when submerged macrophytes are present. Some sites may have a strong probability of re-invasion due to connections with other water bodies and/or human-mediated dispersal.
Benefits	Caught for sport by coarse fishing anglers.

Water bodies occupied

Water body type	Current water body infested	Potential water body infested
Lakes	Low	High
Rivers and streams	Low	High
Wetlands	-	Low
Ponds and dams	Low	High
Drains and canals	Low	Low
Troughs	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Farming	-	-		
	-	-		
	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	L	M	Can contribute to poor water clarity by eating zooplankton, thereby exacerbating algal blooms. Bottom feeding also causes re-suspension of sediment and up-rooting of submerged plants and macro-algae. Excretion of nutrients in faeces exacerbates nutrient re-suspension. Combined effects of planktivory and benthic	Rowe, 2007; Schallenberg and Sorrell, 2009; Rowe and Verburg, 2015.

Category	Current	Potential	Comment	Source
			feeding can contribute to lakes 'flipping' to alternative stable state devoid of vegetation, with turbid water dominated by phytoplankton. Impacts on water quality appear to be greater when multiple species of exotic fish are present, and catfish presence is significantly correlated with the incidence of New Zealand lakes 'flipping'.	
Species diversity	L	H	Rated highly for impact and management priority in New Zealand and some overseas jurisdictions. Opportunistic, generalist feeders, therefore wide range of taxa potentially impacted by predation. Documented eating common bullies as well as a wide range of invertebrates including koura (native crayfish - preferred food source where available), caddis fly, snails and midges. May affect establishment and persistence of submerged vegetation.	Rowe and Wilding, 2012; Chadderton et al., 2003; Verbrugge et al., 2012; Barnes and Hicks, 2003; de Winton et al., 2002; Dugdale et al., 2006.
Threatened species	L	M	Implicated in local extinctions of freshwater species overseas, and is the invasive species most frequently cited as threatening at risk freshwater species in Canada.	Dextrase and Mandrak, 2006.
Social/cultural				
Human health	-	-		
Recreation and aesthetics	L	M	Impacts on water clarity (see 'Water quality'), reducing the aesthetic appeal of water bodies for swimming and other recreational uses. May contribute to cyanophycean (toxic algal) blooms. Can be a contributing factor to public complaints regarding lake water quality (for example, Lake Wainamu, Auckland).	Rowe and Verburg, 2015.
Māori culture	L	M	Numerous impacts on mauri of wai Māori (see 'Water quality', 'Species diversity' and 'Threatened species').	Rowe and Verburg, 2015.

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	Rather than applying a programme under the Regional Pest Management Plan, the species could come under a 'Connecting Communities' programme outside of the pest management plan, where advice and support are provided for specific sites. This will provide support to communities as and where the species is having impacts.	By not applying a programme and rules to the species, there would be no provisions under the pest management plan to manage inappropriate practises that are exacerbating the spread.	High. By not applying a programme and rules to the species, there would be no provisions under the pest management plan to manage inappropriate practises that are exacerbating the spread.
Exclusion programme	Not applicable.	Not applicable.	Brown bullhead catfish are already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Brown bullhead catfish are present throughout the region so would not be suitable for an eradication programme.
Progressive containment programme	Not applicable.	Not applicable.	Brown bullhead catfish are present throughout the region so are unlikely to be suitable for a progressive containment programme.
Sustained control programme	Brown bullhead catfish could be included in a sustained control programme. The council could include a rule banning dumping/deliberate spread within the Northland region. However, fishing regulations already require that catfish are killed on capture and may not be sold alive.	Education and publicity. Enforcement of rules; responding to reports.	Moderate - resources required.
Site-led pest programme	The council could specify high value lakes as site-led programmes, as an incursion at these sites could have significant impacts. Brown bullhead catfish could be listed as a progressive containment or eradication species in these lakes, so that if a new incursion is detected through regular surveillance the council is ready to act. The council could also introduce rules about the species people were allowed to keep in outdoor ponds/dams close to a high value lake.	Enforcement of rules (rules would only be applicable in the areas defined as site led programmes and could not be enforced elsewhere); response costs should an incursion occur	Low - as action would take place in specific high value places making better use of limited resources.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Summary of alternative assessments and preferred option:	Sustained control programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for brown bullheaded catfish. In terms of alternative approaches assessed, under no regional intervention (or do nothing) there could be unacceptable loss of biodiversity values in the regions' waterways if brown bullheaded catfish were to spread uncontrollably. There would be significant public and political concerns and consequences if brown bullheaded catfish were known to be present and no action was taken to control or limit distribution. Eradication of brown bullheaded catfish is not technically feasible, due to the habitats in which they live and lack of effective, wide-scale control techniques, for example in long river systems. However, much of the region is free of the pest and some currently infested sites would be contained in the long-term. There would be political risks associated with seeking region-wide eradication and then being unable to achieve that goal. Due to the extent of populations in the Wairoa River system and catchment, progressive containment is not considered achievable and a site led approach would be seen as a lesser management option and one which would allow brown bullheaded catfish to slowly spread into new areas. A sustained control programme outcome (to reduce the impacts and spread to other places) is the preferred option and represents the most pragmatic and affordable management measure for the Northland region. There are rules to adhere to around not keeping fish live, not transporting them and killing them when caught. NRC intends to undertake direct control of this fish pest in any new sites through its service delivery programme and will work with others on control strategies. Any operational risks are deemed low to moderate and depend very much on the individual sites where brown bullheaded catfish are found. The biggest risk to achieving a sustained control outcome is through sports fishers not adhering to the proposed rules and intentionally catching and releasing brown bullheaded catfish to new waterways or others not being motivated to adhere to the rules.		

Californian bulrush

Schoenoplectus californicus

(Family: Cyperaceae)

Status in New Zealand

Californian bulrush is listed as an unwanted organism under the Biosecurity Act 1993, and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Californian bulrush is a tall (up to 4 m) dense, clump-forming rush that has no apparent leaves. The dark-green, rounded stems are triangular near the base. Rusty-brown, scaly, drooping flower heads form near the tip of each stem. Californian sedge can be confused with the native sedges *Schoenoplectus tabernaemontani* and *S. pungens*. However, *S. tabernaemontani* does not have drooping flower heads and *S. pungens* is consistently triangular in cross section and is a smaller plant.
Habitat	Within its native range in North America and South America, Californian bulrush is restricted to almost permanently flooded areas. In New Zealand it favours brackish waters along coastal river banks and estuaries and also grows in drains and poorly drained pasture that is prone to seasonal flooding.
Regional distribution	Californian bulrush is abundant on riverbanks near Dargaville (e.g. Kaihu River, Northern Wairoa River, Manganui River). It is stabilising some the banks of these rivers but is also growing in small waterways, where it is blocking water flows.
Competitive ability	Californian bulrush can form dense, tall stands that exclude other species. It prefers brackish water and is cold tolerant.
Reproductive ability	In New Zealand, Californian bulrush grows and spreads from fragments of rhizomes (roots). It produces viable seeds in New Zealand, but seedlings have not been observed in the field. The seed is long-lived. Vectors of spread: The usual method of spread is from rhizome (root) fragments that are transported by water or machinery. It may be spread deliberately by humans, to protect riverbanks from erosion. The seeds can attach themselves to feathers, fur and clothing.
Resistance to control	Californian bulrush may be controlled manually, mechanically or with herbicide, depending on the situation. If manual or mechanical methods are used, care must be taken to ensure that fragments of rhizome (roots) are disposed of appropriately so that they do not re-grow. Herbicide application can present challenges because the species grows in or adjacent to waterways. Removing this species from riverbanks can cause erosion.
Benefits	Californian bulrush has been planted for wetland restoration and was used in constructed wetlands (e.g. for effluent treatment). It may be being spread by farmers in the Dargaville area, who use it to stabilise riverbanks.

Water bodies occupied

Water body type	Current water body infested	Potential water body infested
Lakes	-	Low
Rivers and streams	Low	High
Wetlands	Low	High
Ponds and dams	-	High
Drains and canals	Low	High
Troughs	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	L	M	Californian bulrush is unpalatable to cattle and can block drains.	de Lange *et al.* 2010
Sheep and beef	L	M	Californian bulrush is unpalatable to cattle and can block drains.	de Lange *et al.* 2010
Forestry	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	L	H	Californian bulrush can block drains and cause siltation.	Williams & Champion 2008; de Lange *et al.* 2010
Species diversity	L	M	Californian bulrush can form tall, almost pure stands that may exclude native species.	de Lange *et al.* 2010
Threatened species	L	M	Californian bulrush can form tall, almost pure stands that may exclude native species.	de Lange *et al.* 2010
Social/Cultural				

Category	Current	Potential	Comment	Source
Human health	-	-		
Recreation and aesthetics	L	M	Californian bulrush can form dense, tall stands which may impede access to estuaries and waterways.	
Maori culture	L	M	Impacts upon native/taonga species and impeding access to estuaries and waterways.	

L = low M= moderate H = high - = no impact + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs incurred by the council in relation to this species.	Californian bulrush is already established in and beside waterways near Dargaville. If no action is taken it is likely to spread, with consequent environmental and economic impacts.	Medium-High. If no action is taken, Californian bulrush is likely to be spread to other parts of Northland by people (either accidentally or deliberately, for streambank stabilisation). There are large areas of available habitat in the upper reaches of harbours and on the margins of water bodies.
Exclusion programme	Not applicable.	Not applicable.	Californian bulrush is already present in Northland.
Eradication programme	Californian bulrush is an invasive weed that impacts on waterways and native species. If it could be eradicated, the adverse effects of this species would be prevented and the long-term costs of control would be avoided.	Eradication of Californian bulrush would require a large investment of resources to control the known infestations, undertake surveillance to ensure control has been successful, and carry out surveys to identify any additional infestations. If the species is not eradicated there will be on-going control costs.	High. Infestations of Californian bulrush are concentrated near Dargaville. This species is difficult to eradicate and the population of Californian bulrush is too large for eradication to be an option in the short to medium term. In addition, eradication of this species would expose riverbanks to erosion.
Progressive containment programme	When compared to an eradication programme, a progressive containment programme would incur lower financial cost to the council in the short-term. It would aim to confine or reduce the distribution of Californian bulrush.	A progressive containment programme would require an investment of time and resources from the council and affected landowners. It would not aim to eradicate Californian bulrush in the short to medium term, so	Medium. Californian bulrush is an invasive species with the potential to be spread by water and machinery. Therefore, there is some risk that a progressive containment programme will fail to confine the spread and the economic impacts of this species. A progressive

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
		control costs would be on-going.	containment programme would probably need to include plans for remedial planting and catchment management to prevent erosion of riverbanks following the removal of Californian bulrush.
Sustained control programme	When compared to an eradication programme, a sustained control programme would incur lower financial cost in the short-term. It would aim to restrict the spread and impacts of Californian bulrush.	This type of programme would require an investment of time and resources and would not aim to eradicate or contain the species, so control costs would be on-going. If the species was to spread, the opportunity to eradicate or contain it may be lost.	High. There is a risk that a sustained control programme will fail to manage the spread and the economic costs of this species.
Site-led pest programme	Not applicable	Not applicable	Californian bulrush has a very limited distribution in Northland (i.e. the area around Dargaville) so it is not a suitable candidate for a site-led programme.
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that Californian bulrush does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be no regional intervention for Californian bulrush, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding. While Californian bulrush has not been afforded pest status in Northland, it may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes.		

Canadian pondweed (elodea)

Elodea canadensis

(Family: Hydrocharitaceae)

Also known as elodea.

Status in New Zealand

Naturalised..

Relevant biology

Form	Canadian pondweed, also known as elodea, is a submerged, bottom-rooting freshwater plant which can grow up to 5m tall. It has pale, brittle stems and translucent, linear, dark green leaves 6-12mm long, in whorls of three. Elodea produces small white and purple, five-petalled flowers that sit on the surface of the water on long thread-like stalks between November and January. It looks quite similar to the other oxygen weeds, egeria and lagarosiphon.
Habitat	Canadian pondweed can grow in a variety of habitats, including both still and slow flowing waters, but prefers fertile, silty sediments in clear water, as it requires moderate to high light levels. It is tolerant of water temperatures up to 28ºC, and grows best in water deeper than 0.9m. In very clear water, elodea can grow to 10m deep.
Regional distribution	Canadian pondweed is widely naturalised throughout New Zealand, but is not common in Northland, only known to be present in one high value dune lake.
Competitive ability	Canadian pondweed is known as a pioneering species as it is quick to establish in new sites, however, it is also quickly replaced by the taller species, egeria and lagarosiphon, if they arrive. Elodea does not usually grow as densely as other submerged weeds such as hornwort, egeria and lagarosiphon and because of this it has a lower nuisance value in New Zealand water bodies compared with other oxygen weeds. Impacts are usually relatively minor, and Canadian pondweed often co-exists with indigenous plants. People should still be discouraged from deliberately dumping this species into waterways though as it could still have significant impacts in some high value water bodies. Canadian pondweed is well known as an invasive species in Europe and Australia, where new invasions and explosive growth still occur.
Reproductive ability	No seed is known to set in New Zealand. It reproduces by vegetative fragmentation from stem material and is dispersed through water flow. New areas are invaded by spread from contaminated boats and trailers (occasionally motor-cooling water), eel nets, diggers, people liberating fish, and floods from ornamental ponds. Vectors of spread: grows from small fragments.
Resistance to control	Susceptible to the aquatic herbicide diquat, but is not affected by the aquatic herbicide aquathol. The only other control tools currently available are hand weeding or mechanical removal.
Benefits	Sold in the aquarium trade.

Water bodies occupied

Water body type	Current water body infested	Potential water body infested
Lakes	Low	High
Rivers and streams	Low	High
Wetlands	-	Low
Ponds and dams	Low	High
Drains and canals	Low	Low
Troughs	Low	Low

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Farming	-	L	Canadian pondweed is commonly found in drains throughout New Zealand. Aquatic weeds in drains can reduce the ability of the drain to remove excess water, which can then cause flooding, affect soils, crops and grazing. High levels of nutrients are often present allowing dense growths of aquatic weeds to build up, and ongoing drain maintenance is usually required.	Hudson and Hayward, 2004.
Horticulture	-	L	Canadian pondweed is commonly found in drains throughout New Zealand. Aquatic weeds in drains can reduce the ability of the drain to remove excess water, which can then cause flooding, affect soils, crops and grazing. High levels of nutrients are often present allowing dense growths of aquatic weeds to build up, and ongoing drain maintenance is usually required.	Hudson and Hayward, 2004.
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	L	Can be affected through drainage issues described above.	
Water quality	-	L	Overgrowth of aquatic weeds can have an impact on slowing stream velocities, which can lead to increased sedimentation.	Champion and Tanner, 2000; Hudson and Hayward, 2004.

Category	Current	Potential	Comment	Source
Species diversity	-	L-M	Usually relatively minor impacts as it can co-exist with indigenous species and doesn't usually grow as densely as other submerged weeds in Northland.	Champion and Clayton, 2000; Champion et al., 2013.
Threatened species	-	L	Usually relatively minor impacts as it can co-exist with indigenous species and doesn't usually grow as densely as other submerged weeds in Northland.	Champion and Clayton, 2000;Champion et al., 2013.
Social/cultural				
Human health	-	-		
Recreation and aesthetics	-	L	Potential impacts on recreational use of waterways.	
Māori culture	-	L	Potential impacts on native/taonga species.	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	Rather than applying a programme under the Regional Pest Management Plan, the species could come under a 'Connecting Communities' programme outside of the pest management plan, where advice and support are provided for specific sites. This will provide support to communities as and where the species is having impacts. This 'do nothing' option is considered because Canadian pondweed is the least invasive of the oxygen weeds. People would still be encouraged not to dump aquarium contents and to be careful not to move aquatic pests around through the 'Check Clean Dry' programme.	By not applying a programme and rules to the species, there would be no provisions under the pest management plan to manage inappropriate practises that are exacerbating the spread.	Low
Exclusion programme	Not applicable.	Not applicable.	Exclusion is not an option because Canadian pondweed is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Although only known to be present in one high value lake in Northland,

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
			Canadian pondweed is present in ponds and drains throughout the region so would not be suitable for an eradication programme.
Progressive containment programme	Not applicable.	Not applicable.	Although only known to be present in one high value lake in Northland, Canadian pondweed is present in ponds and drains throughout the region so would not be suitable for an progressive containment programme.
Sustained control programme	Canadian pondweed could be included in the pest management plan as an organism not declared a pest. It could still be sold by the aquarium industry, and poses a lower risk to waterbodies than the other oxygen weed species. To reduce the risk of spread through the deliberate actions of people, the council could include a rule banning dumping/deliberate spread within the Northland region.	Although allowable it could be confusing for people to have a species included in the RPMP that is not a pest. It could be difficult to enforce a rule banning deliberate spread.	Moderate.
Sustained control programme	Canadian pondweed could be included in a sustained control programme. As a declared pest it would be banned from sale under the Biosecurity Act. This could help reduce the risk of spread as over time less people would have Canadian pondweed in aquariums. The council could include a rule banning dumping/deliberate spread within the Northland region.	This plant could no longer be sold in the aquarium trade. Inspection of pet shops; monitoring Trademe sales; enforcement action.	Moderate. Resource intensive. Lack of alternatives in aquarium industry at present.
Site-led pest programme	The council could specify high value lakes as site-led programmes, as an incursion at these sites could have significant impacts. Canadian pondweed could be listed as a progressive containment or eradication species in these lakes, so that if a new incursion is detected through regular surveillance we are	Rules would only be applicable in the areas defined as site led programmes and could not be enforced elsewhere.	Low

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	ready to act. We could also introduce rules about the species people were allowed to keep in outdoor ponds/dams close to a high value lake.		
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that Canadian pondweed does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be <u>no regional intervention</u> for Canadian pondweed, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding. While Canadian pondweed has not been afforded pest status in Northland, it may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes.		

Caudo

Phalloceras caudimaculatus

Also known as: leopardfish, speckled mosquitofish. One-spot live bearer

(Family: Poeciliidae)

Status in New Zealand

Unknown.

Relevant biology

Form	Caudo are brightly coloured, hardy and relatively easy to breed. They are a popular aquarium fish and have been transported around the world by the aquarium trade. Caudo are native to eastern South America between Brazil and Uruguay. They are similar in size and shape to the related gambusia (mosquitofish), although they are more yellowish in colour. The males are distinctively speckled with irregular black spots and blotches. Females can grow to 6cm and males to 2.5 cm in length.
Habitat	Caudo prefer still or gentle-flowing fresh or brackish water with dense aquatic vegetation. They are hardy and tolerate a wide range of environmental conditions. In Australia, where it has been introduced, it thrives in urban, aquatic habitats such as degraded creeks and storm water drains.
Regional distribution	Only known outside aquaria from several water troughs near Kamo, Whangarei. They were eradicated from the troughs in 1999 and were not found during a survey of the nearby stream. A repeat survey of the water troughs and stream in June 2016 did not find any caudo. However, the original source of the caudo was never able to be confirmed.
Competitive ability	Caudo have dominated habitats in southwestern and eastern Australia that previously contained high densities of a highly invasive species of gambusia with documented impacts on aquatic ecosystems and endemic fish species.
Reproductive ability	Caudo give birth to live young rather than laying eggs as most fish do, and produce broods of up to 80-100 offspring. Vectors of spread: deliberately spread by people.
Resistance to control	Chemical control (for example, rotenone) is non-selective, therefore has potential non-target impacts on native fish. Chemical control may also be less effective when submerged macrophytes are present. Some sites may have strong probability of re-invasion due to connections with other water bodies and/or human-mediated dispersal.
Benefits	Sometimes valued for mosquito control overseas, although there is no evidence that they are effective. Not commonly kept as an ornamental fish.

Water bodies occupied

Water body type	Current water body infested	Potential water body infested
Lakes	-	High
Rivers and streams	-	Low
Wetlands	-	High
Ponds and dams	-	High
Drains and canals	-	High
Troughs	-	Low

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	L-M	M	Similar species to gamusia, which can contribute to poor water clarity, altered patterns of nutrient cycling and water temperature by consumption of zooplankton, thereby exacerbating algal blooms.	Hurlbert et al., 1972; Hurlbert and Mulla, 1981; Capps et al., 2009.
Species diversity	M	M	Limited data on impacts available. Displacement of native fish through competition is the main potential impact. Caudo have dominated habitats in southwestern and eastern Australia that previously contained high densities of a highly invasive species of	Maddern, 2008; Morgan et al., 2004; Corfield et al., 2008.

Category	Current	Potential	Comment	Source
			gambusia with documented impacts on aquatic ecosystems and endemic fish species.	
Threatened species	M	M	Limited data on impacts available. Displacement of native fish through competition is the main potential impact. Caudo have dominated habitats in southwestern and eastern Australia that previously contained high densities of a highly invasive species of gambusia with documented impacts on aquatic ecosystems and endemic fish species.	Maddern, 2008; Morgan et al., 2004; Corfield et al., 2008.
Social/Cultural				
Human health	-	-		
Recreation and aesthetics	-	-		
Maori culture	M	M	Potential impacts on mauri of wai Māori, (see 'Water quality', 'Species diversity' and 'Threatened species').	

L = low M= moderate H = high - = no impact + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial cost to council under the RPMP associated with the control of this species.	There are currently no known active sites of caudo in Northland However, it has previously been eradicated from water troughs near Kamo. If there are undiscovered infestations elsewhere and no action is taken, caudo could spread and there would be serious environmental impacts and economic costs. If caudo is not present in Northland and no action (for example, advocacy) is undertaken, it may be deliberately introduced for ornamental purposes.	Low. Caudo may be present in Northland or be intentionally introduced. If no action is taken this species could establish and/or spread. However, this species is not commonly kept as an ornamental which reduces the risk.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Exclusion programme	Caudo is not currently known to occur in Northland. The species has some ornamental value and an exclusion programme could raise public awareness and education about the risks and impacts of this species. A rule banning possession of the species in Northland could prevent it from establishing in the region. If it is included in the Regional Pest Management Plan there is the ability to respond immediately if an infestation is detected in Northland.	Excluding this species would prevent expenditure on its control if/when it invades Northland. Costs include pet shop inspections, following up reports and attempting control if any populations are found.	Moderate. People will be aware of the species and its potential impacts. There will be a rule banning possession of the species in Northland, which could help discourage people from bringing it to the region and allow immediate control to be attempted should any be found. However, there is a moderate risk that an exclusion programme could fail because there may already be undiscovered infestations. Therefore, surveys of likely infestation sites will be required and any potential sightings will require follow-up.
Eradication programme	Not applicable.	Not applicable.	There are no known active sites of caudo in Northland, so an eradication programme is not appropriate.
Progressive containment programme	Not applicable.	Not applicable.	There are no known active sites of caudo in Northland, so a progressive containment programme is not appropriate.
Sustained control programme	Not applicable.	Not applicable.	There are no known active sites of caudo in Northland, so a sustained control programme is not appropriate.
Site-led pest programme	Not applicable.	Not applicable.	There are no known active sites of caudo in Northland, so a site-led programme is not appropriate.
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that caudo do not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	will be no regional intervention for caudo, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding.		

Eastern water dragon

Intellagama lesueurii lesueurii

(Family: Agamidae)

Previously known as *Physignathus lesueurii lesueurii*

Status in New Zealand:

Sold in the pet trade.

Relevant biology

Form	Eastern water dragons are a grey to brownish-grey colour above with patterns of black stripes along the ridge of the back as well as down the tail. They also have a dark stripe horizontally from the eye extending down the neck. The limbs are mostly black with spots and stripes of grey and the tail is patterned with grey and black stripes. They are coloured yellowish-brown underneath, with the chest and upper belly becoming bright red in mature males. Eastern water dragons are the largest species of exotic lizard available in the New Zealand pet trade and can grow to 80 to 90cm long. Water dragons are completely insectivorous as juveniles, and as they grow they become omnivorous with vegetable matter gradually making up almost half of the diet. In the wild, water dragons have been observed ground feeding on insects such as ants as well as foraging amongst the branches of trees for insects like cicadas. They may also eat molluscs and crustaceans from freshwater, as well as algae and crabs in intertidal zones, and are strong swimmers. Hatchlings and young dragons may also be eaten by adult water dragons.
Habitat	In their native range, eastern water dragons are found along the east coast of Australia from Cooktown in the north down to the New South Wales south coast. They have broad environmental tolerances and are found in a variety of habitats from tropical rainforest in the north of Australia to alpine streams in the south. Their key habitat preference is flowing water with ample tree cover and basking sites. Water dragons are also found in built-up urban areas as long as these conditions can be found and water quality is reasonable. They are often found in tree branches overhanging water, and will drop into the water when disturbed. Modelling indicates a very high risk of establishing in the wild in parts of New Zealand.
Regional distribution	Eastern water dragons do not appear to have established invasive populations in other countries but have established self-sustaining populations in other parts of Australia. There are no known populations established in the wild in Northland, or elsewhere in New Zealand.
Competitive ability	There is potential for water dragons to dive into the water when disturbed; they are strong swimmers and can remain submerged for up to 60 minutes. Large adult water dragons have very sharp claws and can deliver a serious bite. They are capable of thriving in urban environments.

	Dogs and cats can cause injury and death to eastern water dragons, and predatory birds may prey on young hatchlings and small juveniles. They are often seen basking on roads and concrete in Australia and many are accidentally killed by vehicles.
Reproductive ability	Breeding occurs with the onset of warmer weather in spring. Males become sexually mature at about five years old (snout-vent length 210mm and weight 400g) and females from four years. Males are highly territorial during the breeding season. In their native range, females can lay up to three clutches per year. Sperm storage has not been documented in this species, but is known to occur in a closely related species which has the ability to store sperm for up to 580 days after mating. Eggs are laid in sandy soil in clutches of six to 18 eggs, and hatch within 60-120 days. Incubation length depends on temperature, with eggs incubated at warmer temperatures hatching earlier. **Vectors of spread in New Zealand:** Pet trade, accidental/intentional release, escape from captivity.
Resistance to control	Unknown
Benefits	Sold in the New Zealand pet trade for $400-1000

Water bodies occupied

Water body type	Current water body infested	Potential water body infested
Lakes	-	Low
Rivers and streams	-	High
Wetlands	-	Low
Ponds and dams	-	Low
Drains and canals	-	Low
Troughs	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Farming (toxic to stock, and affects drainage)	-	-		
Horticulture	-	-		
Other	-	-		

Category	Current	Potential	Comment	Source
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	M	Predation of native species most likely threat posed. Potential for disease transmission to other reptiles (for example, parasites, can transmit *Salmonella*).	Kikilus, 2010.
Threatened species	-	L	Potential for predation on native invertebrates as they are opportunistic omnivores.	
Social/cultural				
Human health	-	-		
Recreation and aesthetics	-	-		
Māori culture	-	L	Potential impacts on native/taonga species.	

L = low; M= moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful *
No regional intervention	Eastern water dragons have high resale value in the pet trade so are less likely to be released when no longer wanted. However, if they are released, they could survive in Northland.	None	Low-medium – risk that a wild population could establish in Northland.
Exclusion programme	To minimise the risks of pets escaping or being released and forming wild populations, we could include rules banning release within the Northland region and requiring sightings or pet escapes to be reported.	Publicity/education regarding dumping of pets. Follow up on reports	Low – could be included with other pets that we want to discourage from being dumped.
Exclusion programme	An exclusion programme with rules as above, and also including rules banning the sale and transportation of	Inspection of pet shops; monitoring Trademe sales; enforcement action; follow-up on reports.	Medium – need to determine the resources the council would require to undertake an

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful *
	eastern water dragons in Northland.		exclusion programme for this species.
Eradication programme	Not applicable.	Not applicable.	Eastern water dragons are not known to be present in the wild in Northland.
Progressive containment programme	Not applicable.	Not applicable.	Eastern water dragons are not known to be present in the wild in Northland.
Sustained control programme	Not applicable.	Not applicable.	Eastern water dragons are not known to be present in the wild in Northland.
Site-led pest programme	Not applicable.	Not applicable.	Eastern water dragons are not known to be present in the wild in Northland.
Summary of alternative assessments and preferred option:	Eradication programme Summary of alternative assessments and preferred option: In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for eastern water dragons. In terms of alternative approaches assessed, under no regional intervention (or do nothing) there could be potential loss of biodiversity values in the long-term if wild eastern water dragons populations were 'allowed' to establish. There is an increasing general awareness about the impacts of these animals if released into the wild. These continued acts will over time raise the level of public concern and there is some political risk in NRC not responding now to the various signals around this animal. No intervention may appeal to some in the community that view eastern water dragons as pets, although the majority of responsible owners would probably agree that releasing them into the wild in Northland could lead to long term ecological issues. Progressive containment or sustained control approaches, with corresponding land occupier control rules, (or fewer Council resources being deployed) would not be appropriate. Although they are not known to exist in the wild in Northland, the key stakeholders are better placed to respond to any sightings and take direct control action. It would be risky relying on 'lesser' management options when eradicating eastern water dragons from the wild would be achievable and realistic with current tools available (e.g. catch and euthanize). It would be an unacceptable risk to rely on directing landowners to locate and then destroy individual animals. Eradication of wild eastern water dragons is the preferred outcome within the region but relies heavily on members of the public firstly encountering an animal in the wild then secondly, being motivated to report it. Awareness around the need to control wild populations of eastern water dragons will be stepped up over time. Pet trade issues and the propensity for these animals to be either intentionally released or escape accidentally, creates a moderate risk for achievement of an eradication outcome. Overall, the costs involved under an eradication programme are relatively minor (although potentially greater than for progressive containment of sustained control) but are not expected to adversely affect control outcomes.		

Eelgrass

Vallisneria australis

Also known as: ribbongrass, eel weed

(Family: Hydrocharitaceae)

Status in New Zealand

Eelgrass is listed as an unwanted organism under the Biosecurity Act 1993, and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Eelgrass is a submerged, bottom-rooted freshwater plant. It produces long, thick, strap-like leaves that are up to 3m long and 0.5-5cm wide. The leaves never extend above the surface of the water. Both male and female plants are known from Lake Pupuke (Auckland) but other known infestations comprise only female plants. Male flowers consist of large pollen-filled sacs produced at the base of mature plants. Female flowers are small and green and produced on the end of a very long, spirally coiled stalk that can extend to the water's surface.
Habitat	Eelgrass can be found in moderately-fast flowing water and still water bodies. It forms dense beds that displace native plants, may affect recreational activities, impede navigation and obstruct water out-takes.
Regional distribution	Eelgrass occurs at one known site in Northland, but there is the possibility that is has been introduced to other unknown sites.
Competitive ability	Eelgrass forms dense beds that out-compete and displace native plants. In New Zealand, it is generally spread through intentional planting.
Reproductive ability	There is no evidence of viable seed production occurring in New Zealand, although both male and female plants exist in Lake Pupuke (Auckland). It spreads from root fragments. Vectors of spread: fragments of eelgrass are spread by humans, usually intentionally (rather than accidentally).
Resistance to control	Controlling eelgrass with herbicide can be difficult because it grows submerged beneath the surface of water bodies. Diquat can be effective.
Benefits	Eelgrass is valued as an aquarium plant.

Water bodies occupied

Water body type	Current water body infested	Potential water body infested
Lakes	-	High
Rivers and streams	-	High

Water body type	Current water body infested	Potential water body infested
Wetlands	-	Low
Ponds and dams	-	High
Drains and canals	-	High
Troughs	-	Low
Aquaria	Low	High

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Farming	-	M	Eelgrass can block dams and waterways, impeding drainage and obstructing water out-takes.	MPI; Williams and Champion, 2008.
Horticulture	-	M	Eelgrass can block dams and waterways, impeding drainage and obstructing water out-takes.	MPI; Williams and Champion, 2008.
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	H	Eelgrass forms dense beds of vegetation that displace native plants. It can completely dominate some sites.	MPI; Williams and Champion, 2008.
Threatened species	-	H	Eelgrass forms dense beds of vegetation that displace native plants. It can completely dominate some sites.	MPI; Williams and Champion, 2008.
Social/cultural				
Human health	-	-		
Recreation and aesthetics	-	H	Eelgrass impacts upon recreation in Lake Pupuke and reduces aesthetic values	Coffey & Clayton, 1988;

Category	Current	Potential	Comment	Source
			because it becomes uprooted and washes up on the shore. It obstructs water-flow, impacting upon recreation.	Williams and Champion, 2008.
Māori culture	-	H	Impacts upon native/taonga species.	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial cost to the council associated with control of this species.	Eelgrass is currently known from only one location in Northland. If it spread from this site to infest lakes, ponds, dams and waterways, there would be serious environmental impacts. The economic cost of delaying control until there are larger/more infestations is potentially considerable.	High. Without education and regulation there is a high risk that eelgrass could be spread by, for example, aquarium enthusiasts.
Exclusion programme	Not applicable.	Not applicable.	Eelgrass is already present in Northland.
Eradication programme	Eelgrass is currently present at only one known site in Northland. If the species could be eradicated before it spreads elsewhere, it would prevent long-term impacts and financial costs.	Eradication of eelgrass would not require a large investment of resources because the species is known from only one site.	Low-moderate. There is a low risk that eradication of the known infestation would fail. However, there is a moderate risk that the species at other unknown locations.
Progressive containment programme	Not applicable.	Not applicable.	There is only one known site in Northland and it is very small.
Sustained control programme	Not applicable.	Not applicable.	There is only one known site in Northland and it is very small.
Site-led pest programme	Not applicable.	Not applicable.	There is only one known site in Northland and it is very small.
Summary of alternative assessments and preferred option:	Eradication programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for eelgrass. In terms of alternative approaches assessed, under <u>no regional intervention</u> (or do nothing), there would potentially be unacceptable loss of biodiversity values as there are many suitable habitats for it to thrive in in Northland. Currently, eelgrass is very limited in distribution. However, there is less likelihood of significant public		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	or political concerns as this pest plant is not widely known, although it is included in neighbouring regions RPMPs. Under a no intervention approach, NRC could rely on non-regulatory methods such as advocacy, education and site-led management, but loses the tools, regionally to impose penalties for possession of or deliberate liberations of this pest. Progressive containment or sustained control approaches would not be appropriate as eelgrass is very rare in Northland. It would be highly risky of Council relying on 'lesser' control options when eradication or zero density is achievable. It would be an unacceptable risk to rely only on landowners to control infestations – for example, it is not readily identified and control of any aquatic pests with herbicides is usually difficult and expensive. Additionally, as the sites involve treatment over water, permissions to use herbicides are required through the Environmental Protection Agency (EPA). These situations require a high level of regional intervention (through professional surveillance and direct control approaches). These operational risks would compromise the outcomes sought if landowners were responsible for control work, therefore council service delivery is the most appropriate control measure. Eradication is the preferred outcome and is realistic given the current infestations and the technical challenges involved. There is some level of risk that eelgrass will be introduced to Northland or unknown infestations are found. NRC intends to undertake direct control of eelgrass wherever it occurs in the region. The costs involved under an eradication programme are minor (compared with the risks of doing nothing and allowing it to spread) and provides Council with some regulatory tools to incentivise water users such as boaties, eel fishermen, anglers, and fowl hunters (particularly those outside the region) to stop the spread of wetland and semi-aquatic pests to new areas. The benefits of inclusion in the Plan are that significant wetlands and margins of waterways would in the long-term remain free of this pest. The value is difficult to estimate but would be significant, given the high public interest in maintaining wetlands and aquatic ecosystems in a natural state.		

Egeria (oxygen weed)

Egeria densa

(Family: Hydrocharitaceae)

Status in New Zealand

Egeria is listed as an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Bottom-rooted submerged perennial aquatic herb. Stems can be more than 3m in length. Leaves are up to 5 x 30mm, in whorls of four to five. Flowers are white, approximately 20mm in diameter, borne at the water's surface from November-January. All New Zealand plants are male, so no seed is set.
Habitat	Still to moderately flowing water bodies to a depth of about 7-8m. It prefers high nutrient water bodies and silty or sandy substrates. Optimum water temperatures, 10-25°C.
Regional distribution	Scattered widely across region but still absent from numerous high value water bodies. Recorded from Lakes Heather, Mini, Ngakeketa N (Te Paki), Carrot, Rotoroa, Te Werahi Lagoon, Waiparera, Ōmāpere, Owhareiti, Stanner's Road Dam, Waro, Rotokawau, Roto-otuauru (Swan), Awanui River, and Wairua Falls. Weed eradication projects are underway and nearly complete in Lake Rotootuaruru and Lake Heather.
Competitive ability	History of invasiveness overseas. History of displacing native species as well as the oxygen weeds Canadian pondweed and lagarosiphon (especially in warmer waters). Tolerates low light levels associated with turbidity. Less competitive in low nutrient water bodies.
Reproductive ability	No sexual reproduction in New Zealand. Grows from stem fragments. Vectors of spread: moved between water bodies by humans through deliberate releases as well as accidentally on machinery and fishing equipment. Public accessibility of site strongly predicts invasion likelihood. Spreads within catchments via natural water movement.
Resistance to control	Mechanical control can contribute to further spread of stem fragments. Limited range of herbicides acceptable for use in water, and adequate uptake can be difficult to achieve in water. Rapid recovery especially in warm regions.
Benefits	Grown as an ornamental pond and aquarium plant.

Water bodies occupied

Water body type	Current water body infested	Potential water body infested
Lakes	Low	High
Rivers and streams	Low	Low

Water body type	Current water body infested	Potential water body infested
Wetlands	Low	Low
Ponds and dams	High	High
Drains and canals	High	High
Troughs	Low	Low

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	L	L	Can impede water flow in drains, exacerbating flooding.	Hudson and Harding, 2004.
Sheep and beef	L	L	As above.	
Forestry	-	-		
Horticulture	-	-		
Other	-	L	Can clog reservoirs.	Yarrow et al., 2009.
International trade	-	-		
Environment				
Soil resources	L	L	May be impacted by drainage issue described above.	
Water quality	L	M	May be associated with regime shifts to a turbid state; development of large-standing biomass can cause self-shading and sudden stand collapse. Large standing biomass can also reduce flow velocity and impede gas exchange. Resultant impacts can include lowered dissolved oxygen levels, increased sedimentation, changes to primary production and nutrient cycling capacity of the invaded water body.	de Castro et al., 2013. Champion and Tanner, 2000. Schallenberg and Sorrell, 2009. Suzuki et al., 2014.
Species diversity	L-M	M-H	Forms dense stands displacing native macrophytes. Altered habitat structure likely to influence community composition and/or abundance	Freshwater Biodiversity Information System records Champion and Wells, 2014.

Category	Current	Potential	Comment	Source
			of macroinvertebrates and fish; empirical New Zealand data lacking. May be advantaged by climate change.	de Winton and Clayton, 1996. Riis et al., 2012. Schultz and Dibble, 2012. Tanner et al., 1990. Wells and Clayton, 1991. Yarrow et al., 2009.
Threatened species			As above.	
Social/cultural				
Human health	L	L	Drowning risk via entanglement. Implicated in regime change resulting in toxic cyanobacterial blooms.	Williams and Champion, 2008.
Recreation and aesthetics	L-M	M	Impedes recreational water use and reduces aesthetic appeal.	Williams and Champion, 2008.
Māori culture	L	M	Impacts on mauri of wai Māori (see 'Water quality', 'Species diversity' and 'Recreation'). Impacts on customary harvest species such as eel data deficient.	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional invervention	Rather than applying a programme under the Regional Pest Management Plan, the species could come under a 'Connecting Communities' programme outside of the pest management plan, where advice and support are provided for sites of interest to communities. This will provide support to communities as and where the species is having impacts. People would still be encouraged not to	There would be no immediate costs to council. However, costs in future could be greater if the species continues to spread.	High. By not applying a programme and rules to the species, there would be no provisions under the pest management plan to manage inappropriate practises that are exacerbating the spread.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	dump aquarium contents and to be careful not to move aquatic pests around through the 'Check Clean Dry' programme.		
Exclusion programme	Not applicable.	Not applicable.	Exclusion is not an option because egeria is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Egeria is present in ponds and drains throughout the region so would not be suitable for an eradication programme.
Progressive containment programme	Not applicable.	Not applicable.	Already present in some high value lakes in Northland, as well as in rivers, ponds and drains throughout the region so would not be suitable for a progressive containment programme.
Sustained control programme	Egeria could be included in a sustained control programme. The council could include a rule banning dumping/deliberate spread within the Northland region which could help reduce the spread of egeria.	Education, publicity, responding to reports, enforcement action.	Moderate - although these measures may help, egeria could still spread in Northland and infest high value water ways.
Site-led pest programme	The council could specify high value lakes as site-led programmes, as an incursion at these sites could have significant impacts. Egeria could be listed as a progressive containment or eradication species in these lakes, so that if a new incursion is detected through regular surveillance we are ready to act. We could also introduce rules about the species people were allowed to keep in outdoor ponds/dams close to a high value lake.	Rules would only be applicable in the areas defined as site led programmes and could not be enforced elsewhere. Education, publicity, responding to reports, response to new incursions, enforcing rules.	Low - efforts could be targeted to protecting and responding to incursions in the highest value sites in Northland.
Preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate.		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	Resulting from this process, the council is of the opinion that egeria does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be no regional intervention for egeria, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding. While egeria has not been afforded pest status in Northland, it may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes.		

Gambusia

Gambusia affinis

Also known as: mosquitofish.

(Family: Poeciliidae)

Status in New Zealand

Naturalised. Gambusia is listed as an unwanted organism under the Biosecurity Act 1993.

Relevant biology

Form	Gambusia have been introduced into many countries due to the misconception that they could help control mosquitoes by eating the larvae. Gambusia are small, nondescript silver fish. Females are slightly larger than males (up to approximately 6cm and 3.5cm respectively). The scales are darker coloured on the edges, giving them a crosshatch pattern. They have rounded caudal fins and a single, high, rounded dorsal fin. Gambusia are generalist predators, foraging predominantly in surface waters and consuming zooplankton, larval and adult macroinvertebrates, eggs and larvae of fish and amphibians. Diet varies depending on the prey available.
Habitat	Shallow margins of still or slow moving water bodies including lakes, wetlands, ponds, streams. Wide environmental tolerances, including brackish conditions and low dissolved oxygen levels. Prefers warm water temperatures.
Regional distribution	Gambusia are widespread throughout Northland, and are common in many areas.
Competitive ability	History of invasiveness overseas. Very aggressive, including intra-specific aggression, although will also school together. High feeding rates. Capable of rapid evolution to adapt to local conditions. Parasite release; New Zealand populations have few of the native range parasites, and fewer parasites than co-occurring native fish.
Reproductive ability	Give birth to live young rather than eggs. Clutch size is highly variable (reported range internationally 1-375). Gambusia are capable of multiple broods (and even multiple generations) per breeding season. Growth and maturation rate are influenced by environment and diet. Effective dispersers within water body. Vectors of spread: deliberately spread by people for mosquito control and/or to act as a prey source for coarse fish, which is likely the main source of jump dispersal.
Resistance to control	Chemical control (for example, rotenone) is non-selective, therefore has potential non-target impacts on native fish. Chemical control may also be less effective when submerged macrophytes are present. Some sites may have strong probability of re-invasion due to connections with other water bodies and/or human-mediated dispersal.

Benefits	Sometimes valued for mosquito control, though their efficacy is context-specific and in some ecosystems mosquitoes may instead benefit through removal of competitors and/or other predators. May also be seen as valuable prey species for coarse fish.

Water bodies occupied

Water body type	Current water body infested	Potential water body infested
Lakes	High	High
Rivers and streams	Low	Low
Wetlands	High	High
Ponds and dams	High	High
Drains and canals	High	High
Troughs	Low	Low

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-			
Water quality	L-M	M	Can contribute to poor water clarity, altered patterns of nutrient cycling and water temperature by consumption of zooplankton, thereby exacerbating algal blooms.	Hurlbert et al., 1972; Hurlbert and Mulla, 1981; Capps et al., 2009.
Species diversity	M	M	Prey on zooplankton, eggs and larvae of fish, and a diverse range of aquatic and terrestrial macroinvertebrates, including crustacea,	Barrier and Hicks, 1994;

Category	Current	Potential	Comment	Source
			odonata, chironomidae and other diptera, spiders. Can induce avoidance behaviours such as changes in habitat use in a range of fish and crustacean taxa. Population or community-level impacts are unclear in New Zealand, but based on overseas evidence direct predation along with trophic effects of removal of competitors or lower-order predators may result in altered plankton and invertebrate community composition. Implicated in population declines of native fish species such as common bullies. Climate change may exacerbate impacts.	Capps et al., 2009; Galat and Robertson, 1992; Hayes and Rutledge, 1991; Keskin, 2014; Leyse et al., 2003; Ling, 2004; Lydeard and Belk, 1993; Mansfield and Mcardle, 1998; McDowell, 1999; Nagdali and Gupta, 2002; Peck and Walton, 2008; Pyke, 2005; Rowe and Smith, 2002.
Threatened species	M	M	May impact mudfish and inanga through multiple mechanisms, including predation of eggs and juveniles, reduced prey foraging effectiveness and altered habitat use by native fish due to gambusia aggression. However, population-level impacts are uncertain; black mud fish and inanga may be able to co-exist with gambusia due to habitat use differences in some ecosystems, possibly caused by habitat-specific characteristics such as refuges. Aggressive biting of native species including Galaxias and tuna (eel) results in visible mutilation of fins, lips and other body parts. Population-level impacts are unclear, although mortality is known to sometimes occur, and survivors may be displaced into deeper-water habitats. Impacts are likely to be exacerbated by climate change. Known to impact freshwater Crustacea overseas; impacts on koura unclear.	Barrier and Hicks, 1994; Leyse et al., 2003; Ling, 2004; Tame te Rangi pers.comm.; McDowall, 1999; Rowe et al., 2007; Rowe and Wilding, 2012.

Category	Current	Potential	Comment	Source
Social/cultural				
Human health	-	-		
Recreation and aesthetics	L	L	Impacts on water clarity (see 'Water quality') may reduce aesthetic appeal of water bodies for swimming and other recreational uses.	
Māori culture	H	H	Numerous impacts on mauri of wai Māori, including on cultural harvest of species such as tuna (see 'Water quality', 'Species diversity' and 'Threatened species').	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	There are no known control tools for gambusia apart from chemical control such as rotenone, and they are widespread throughout Northland water ways. Gambusia are listed as an unwanted organism under the Biosecurity Act which means that they cannot be sold or distributed. People would still be encouraged not to dump aquarium contents and to be careful not to move aquatic pests around through the 'Check Clean Dry' programme.	There would be no costs to council if there was no programme.	Low. Gambusia are already widespread throughout Northland water ways.
Exclusion programme	Not applicable.	Not applicable.	Gambusia are already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Gambusia are present throughout the region so would not be suitable for an eradication programme.
Progressive containment programme	Not applicable.	Not applicable.	Gambusia are present throughout the region so would not be suitable for a progressive containment programme.
Sustained control programme	Gambusia could be included in a sustained control programme. The council could include a rule	Enforcement of rules; responding to reports.	High - it is unclear what meaningful objectives could be defined for gambusia.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	banning dumping/deliberate spread within the Northland region. However, gambusia are listed as an unwanted organism under the Biosecurity Act which means that they cannot be sold or distributed.		
Site-led pest programme	Not applicable.	Not applicable.	High - there are no known control techniques and gambusia are already widespread throughout Northland.
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that gambusia do not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be no regional intervention for gambusia, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding. While gambusia has not been afforded pest status in Northland, it may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes.		

Goldfish

Carassius auratus

(Family: Cyprinidae)

Status in New Zealand

Naturalised. Sold in the aquarium trade.

Relevant biology

Form	Colour varies from red/gold, bronze/black through to olive green – brightly coloured goldfish may be more likely to be preyed upon in wild populations. Goldfish are distinguished from closely related species such as carp by the lack of barbels, the presence of a stiff serrated spine at the origin of dorsal and anal fins. Their lifespan is usually 6-7 years. Goldfish are typically 150-220mm in length, though some individuals may reach larger sizes (occasionally up to around 400mm), and weigh around 100-400g.
Habitat	Lakes, ponds, streams and creeks. Spawning and larval stages do well in terrestrial floodplain habitats. Goldfish are more abundant in water ways with high amounts of chlorophyll a and zooplankton. Goldfish tolerate disturbed, high-nutrient, slow moving waterbodies and low oxygen conditions, especially at cooler temperatures.
Regional distribution	Widespread in water bodies throughout the region, including some lakes, rivers, ponds and wetlands.
Competitive ability	May be among the most numerous fish in some water bodies. Tolerate degraded environmental conditions.
Reproductive ability	Reproduce in large numbers. Vectors of spread: ongoing spread by people, and risk of introduction to new water bodies via release of unwanted pets.
Resistance to control	Chemical control (for example, rotenone) is non-selective, therefore has potential non-target impacts on native fish. Chemical control may also be less effective when submerged macrophytes are present. Some sites may have a strong probability of re-invasion due to connections with other water bodies and/or through people.
Benefits	Widely kept pets. Feral goldfish are reportedly used as live bait by fishers overseas – it's unconfirmed whether this occurs in New Zealand as well.

Water bodies occupied

Water body type	Current water body infested	Potential water body infested
Lakes	Low	High
Rivers and streams	Low	Low
Wetlands	Low	High

Water body type	Current water body infested	Potential water body infested
Ponds and dams	High	High
Drains and canals	High	High
Troughs	Low	Low

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	L-M	L-M	Impacts on water quality appear to be additive/synergistic when multiple species of exotic fish are present. Bottom feeding results in sediment re-suspension and increased turbidity. Uprooting of vegetation may further exacerbate this. Bottom feeding may also reduce substrate temperature and dissolved oxygen levels. Phytoplankton growth may be enhanced following passage through the gut of fish, exacerbating algal blooms. Goldfish predation on zooplankton may also exacerbate algal blooms due to an imbalance between	Rowe, 2007; Schallenberg and Sorrell, 2009; Richardson et al., 1995; Richardson and Whoriskey, 1992; Rowe and Smith, 2002. Kolmakov and Gladyshev, 2003; Richardson et al., 1995; Schallenburg and Sorrell, 2009.

Category	Current	Potential	Comment	Source
			phytoplankton and zooplankton levels, and by re-suspension of nutrients into the water column.	
Species diversity	L-M	M	There is limited data about impacts in New Zealand. Able to breed with koi carp; risk of advantageous traits being passed to koi carp populations (including disease resistance – goldfish are resistant to some diseases to which koi carp are susceptible). Koi carp and goldfish commonly co-occur in New Zealand. Potential hosts of parasites and diseases, increasing the risk of parasite loading on native fish; feral goldfish are known hosts of a range of parasites in Australia, Turkey and South Africa, although New Zealand populations may have few parasites present. Potential competition with native fish for food and habitat. Generalist feeders consuming macrophytes, algae, diatoms, insects (especially larvae), crustaceans, small fish (especially eggs/larvae) and detritus. Circumstantial evidence suggests population-level impacts of goldfish on co-occurring fish species. Possible explanations for this include direct predation or competition or indirect impacts via increased turbidity. Goldfish commonly co-occur with other exotic fish, and therefore it can be difficult to attribute impacts directly to a single species. Bottom feeding uproots aquatic vegetation (both emergent and submerged). Root disturbance plus reduced light can lead to decreases in plant size.	Haynes et al., 2012; Smith and McVeagh, 2005. Rowe, 2007. Fletcher and Whittington, 1998; Mouton et al., 2001; Innal, 2011. Zhang, 2012. Khan et al., 2011; Morgan and Beatty, 2004; Richardson et al., 1995. Deacon et al., 1964; Richardson and Whoriskey, 1992. Richardson et al., 1995.

Category	Current	Potential	Comment	Source
			Risk of invasive weeds spread with with releases of pet goldfish into the wild.	
Threatened species	L	M	As above	
Social/cultural				
Human health	-	-		
Recreation and aesthetics	L	M	Impacts on water clarity (see 'Water quality') reducing the aesthetic appeal of water bodies for swimming and other recreational uses. May contribute to cyanophycean (toxic algal) blooms. Contributing factor to public complaints regarding lake water quality (for example, Wainamu).	Rowe, 2007.
Māori culture	L	M	Numerous impacts on mauri of wai Māori (see 'Water quality', 'Species diversity' and 'Threatened species').	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	There would be no costs to council if there was no programme under the RPMP. They are commonly sold in the aquarium trade, and this could continue if there was no programme. People would still be encouraged not to dump aquarium contents and to be careful not to move aquatic pests around through the 'Check Clean Dry' programme. Rather than applying a programme under the pest management plan, the species could come under a 'council supported management' programme, where advice and support are provided for specific species. This will provide support to communities as and where the species is having local impacts.	Goldfish may continue to spread and establish in the wild throughout Northland, including in high value lakes where they may impact native species and water quality.	Low. Goldfish are already widespread throughout Northland water ways.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Exclusion programme	Not applicable.	Not applicable.	Goldfish are already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Goldfish are present throughout the region so would not be suitable for an eradication programme.
Progressive containment programme	Not applicable.	Not applicable.	Goldfish are present throughout the region so would not be suitable for a progressive containment programme.
Sustained control programme	Goldfish could be included in the pest management plan as an organism not declared a pest. They could still be sold by the aquarium industry. To reduce the risk of spread through the deliberate actions of people, the council could include a rule banning dumping/deliberate spread within the Northland region.	Education and publicity; responding to reports and enforcement.	Moderate. Although allowable it could be confusing for people to have species included in the RPMP that is not a pest. It could be difficult to enforce a rule banning deliberate spread, and would require resources for surveys and following up on reports.
Sustained control programme	Goldfish could be included in a sustained control programme. As a declared pest they would be banned from sale under the Biosecurity Act. This could help reduce the risk of spread as over time less people would have goldfish in aquariums or ponds in Northland. The council could include a rule banning dumping/deliberate spread within the Northland region.	This species could no longer be sold in the aquarium trade. Would have to make allowances for goldfish already held as pets - which is very common. Inspection of pet shops; monitoring Trademe sales; enforcement action.	Moderate. Resource intensive.
Site-led pest programme	The council could specify high value lakes as site-led programmes, as an incursion at these sites could have significant impacts. Goldfish could be listed as a progressive containment or eradication species in these lakes, so that if a new incursion is detected through regular surveillance we are ready to act. We could also introduce rules about the species people were allowed to keep	Rules would only be applicable in the areas defined as site led programmes and could not be enforced elsewhere.	Low - as action would take place in specific high value places making better use of limited resources.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	in outdoor ponds/dams close to a high value lake.		
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that goldfish do not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be no regional intervention for goldfish, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding. While goldfish have not been afforded pest status in Northland, it may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes.		

Green and golden bell frog

Litoria aurea

(Family: Hylidae)

Status in New Zealand

Introduced and naturalised

Relevant biology

Form	Adults are bright to dark green, or golden to dark brown, or both, with a cream stripe from eye to groin. Inner thighs are blue (but are hidden when at rest). The under-surface is creamy white or the throat olive. They are capable of considerable colour change (lighten/darken) within the space of a few minutes. They produce a free-floating egg mass, which then sinks. Tadpoles are black to greenish above, whitish below, typically growing up to 70-100mm in total length. Males grow to between 50-60mm from snout tip to vent, females about 70-80mm snout-vent length (occasionally individuals of both sexes may grow up to 10-15mm larger than this). The diet varies with age. Young tadpoles may be herbivorous, including rasping of algal films from rocks and other surfaces. Older tadpoles and adults are primarily carnivorous. Adults eat a wide variety of invertebrate prey species, and will also eat other frogs (including cannibalising conspecifics, that is, members of the same species) and small lizards.
Habitat	Farmed and urban areas and bush edges. Usually in or near swamps, lakes, large ponds, farm dams, slow-moving streams. They are diurno-noctural: most foraging occurs at night with sun basking during the day.
Regional distribution	Widespread but population fluctuates due to Chytrid fungus.
Competitive ability	Preyed upon by introduced mammals such as hedgehogs and mustelids, and fish such as gambusia. They have been recorded eating native *Leiopelma* frogs, though in most cases the habitat of these species does not overlap.
Reproductive ability	Spawns spring or early summer. Vectors of spread: often moved by people to populated ponds or by keeping tadpoles as pets.
Resistance to control	Already very widespread in the region.
Benefits	Valued pond frog and tadpoles kept as pets especially by children.

Water bodies occupied

Water body type	Current water body infested	Potential water body infested
Lakes	High	High

Water body type	Current water body infested	Potential water body infested
Rivers and streams	Low	Low
Wetlands	High	High
Ponds and dams	High	High
Drains and canals	High	Low
Troughs	Low	Low

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Farming	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	L	L	Diet includes lizards and a wide range of invertebrate taxa. High abundance of *L. aurea* could therefore potentially reduce local populations of some prey taxa. *L. aurea* themselves are preyed upon by invasive mammals such as hedgehogs, mustelids and cats. Therefore, where frogs are abundant, they could provide an additional prey source contributing to hyper-predation of native taxa.	Pyke and White, 2001; Bishop, 2008.
Threatened species	L	L	*L. aurea* is susceptible to chytridiomycosis and therefore could act as a disease reservoir. However, endemic frogs *Leiopelma* spp. appear to be at relatively low risk from chytridiomycosis.	Ohmer et al., 2013; Pyke and White, 2001; Bishop, 2008.

Category	Current	Potential	Comment	Source
			Will consume other frogs as part of general diet, and predation of *Leiopelma archeyi* has been documented on at least one occasion , therefore some risk of predation of endemic species in situations where the two occur sympatrically. However, *L. aurea* typically occupy different habitat from endemic frogs, therefore, such predation events are likely of low incidence.	
Social/cultural				
Human health	-	-		
Recreation and aesthetics	L	L	Positive impacts on recreation as tadpoles are valued as pets for children, and some people place aesthetic value on seeing frogs in the wild. Negative impacts on recreation possible where high abundances of frogs vocalising causes a nuisance.	
Māori culture	L	L	See 'Species diversity' and 'Threatened species'. There is also potential to affect the mauri of waterbodies.	

L = low; M= moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs to the council associated with this species.	If no management action is undertaken there will be no short-term financial costs to the council associated with this species. Green and golden bell frogs are already widespread in Northland and have only low level impacts, so taking no action is unlikely to have long-term cost implications.	Low. The species is already widespread throughout Northland.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Exclusion programme	Not applicable.	Not applicable.	Green and golden bell frogs are already widespread throughout Northland.
Eradication programme	Not applicable.	Not applicable.	Green and golden bell frogs are already widespread throughout Northland, and are therefore an eradication programme is not appropriate or feasible.
Progressive containment programme	Not applicable.	Not applicable.	This type of programme aims to contain or reduce the geographic distribution of the pest to an area over time and usually involves a core infestation area with smaller outlier sites. This species is already widespread throughout Northland so this programme is not appropriate.
Sustained control programme	Could introduce rules preventing people from moving these frogs from place to place but the species is already widespread and such a rule is likely to provide no benefits.	Education/public awareness materials; enforcement costs - no available resources.	High. Unlikely that a rule of this type would have any benefit in the region.
Site-led pest programme	Particular high value places could be defined as site-led areas, and frogs management attempted there. But there are no practical management options.	Education/public awareness materials; enforcement and management costs - no available resources.	High. This type of programme is used to manage pests that are capable of causing damage to a place to an extent that protects the values of that place. Given the low level impacts described above it would be difficult to justify this type of programme
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that green and golden bell frogs do not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be no regional intervention for green and golden bell frogs, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding.		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	While green and golden bell frogs have not been afforded pest status in Northland, it may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes.		

Hornwort

Ceratophyllum demersum

(Family: Ceratophyllaceae)

Status in New Zealand

Hornwort is listed as an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Hornwort is a perennial submerged aquatic plant. It doesn't form true roots, but may be anchored to sediment by stems, or forms free-floating mats. Stems are up to approximately 7m tall, and branched. Leaves are 10-40mm long, narrow, branched and whorled forming complex architecture. Flowers are minute, and there is no evidence of viable seed set in New Zealand. Vegetative spread via stem fragments.
Habitat	Freshwater bodies, including drainage channels, lakes and farm ponds. Prefers shallow shorelines and sediment accumulation, therefore less problematic in steep-sided reservoirs. Tolerates range of lake nutrient levels, from oligotrophic to hypertrophic. Tolerates wide temperature range (5-30°C optimal, but capable of tolerating ice cover). Occupies a range of water depths, down to 15.5m.
Regional distribution	There are now 11 known sites in natural water ways in Northland in three geographically distinct areas; North Cape (Lakes Te Werahi, Ngakeketa and Kihona), South Aupouri (Lakes Heather, Mini, Waimimiha North, Awanui River and drains near Kaitaia and Karikari) and Pouto (Lake Roto-otuauru (Swan) and waterways in the vicinity of Dargaville). There are also other sites in ponds, dams and drains. Weed eradication projects are underway and nearly complete in Lake Rotootuaruru and Lake Heather.
Competitive ability	Forms dense monospecific stands which out-compete native vegetation by smothering and shading. Very rapid spread once established at a site.
Reproductive ability	Vegetative spread only. Establishes from stem fragments moved between water bodies. Vectors of spread: Human movement is the main vector between water bodies. May be spread accidentally, as fragments attach to nets, boats and other gear, or intentionally as habitat for co-released pest fish. Risk factors for infestation of lakes include proximity to areas of dense human habitation, proximity to highways, and large lake area. Natural dispersal by downstream or flood-mediated movement of fragments.
Resistance to control	The aquatic herbicide endothall can work well on hornwort, but is easier to use in small water bodies. Grass carp can be effective in larger water bodies but possible associated risk of vectoring the invasive copepod *Skistodiaptomus pallidus*. Additionally grass carp remove all native co-occurring submerged vegetation, although this may re-establish from seed banks following grass carp removal. Grass carp are also

	unsuitable for water bodies from which they can escape (i.e. those with out-flows). Tolerant of water-level fluctuations.
Benefits	Grown as an aquarium plant.

Water bodies occupied

Water body type	Current water body infested	Potential water body infested
Lakes	Low	High
Rivers and streams	Low	Low
Wetlands	-	Low
Ponds and dams	Low	High
Drains and canals	Low	Low
Troughs	-	Low

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	L	Impedes water flow in irrigation and drainage channels.	Champion and de Winton 2005
Sheep and beef	-	L	As above.	
Forestry	-	-		
Horticulture	-	-		
Other	L	H	Fragments detach and float; potential to clog dams and reduce water quality in water storage reservoirs (highest ranked aquatic weed for impacts in NZ hydroelectric dams).	Clayton and Champion 2006
International trade	-	-		
Environment				
Soil resources	-	L	May be impacted by drainage issue described above.	
Water quality	L	M	Impedes water flow, exacerbating sedimentation and increasing flooding risk. Can	Chamier et al. 2012 Wells 2014

Category	Current	Potential	Comment	Source
			affect dissolved oxygen levels by reducing gas exchange.	
Species diversity	L	H	Forms dense monospecific stands which displace all native vegetation down to approximately 15m depth. Because it can grow to greater depths than other aquatic weeds, it is the species likely to have greatest impacts on deep-water charophyte meadows. Data deficient with respect to impacts on New Zealand invertebrates and fish, but effects highly probable based on profound changes to habitat.	Champion and de Winton 2005 Wells et al. 1997
Threatened species	L	H	As above.	
Social/Cultural				
Human health	-	-		
Recreation and aesthetics	L	H	Impedes recreational water access and negatively affects amenity values.	Champion and de Winton 2005 Wells et al. 1997
Maori culture	L	H	Transformative impacts on freshwater ecosystems including restricted capacity for human usage and impacts on native plant and animal species (See 'Water quality', 'Species diversity' and 'Recreation'.	

L = low M= moderate H = high - = no impact + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	Rather than applying a programme under the Regional Pest Management Plan, the species could come under a 'Connecting Communities' programme outside of the pest management plan, where advice	There would be no immediate costs to council. However, costs in future could be greater if the species continues to spread.	High. By not applying a programme and rules to the species, there would be no provisions under the pest management plan to manage inappropriate practises that are exacerbating the spread.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	and support are provided for sites of interest to communities. This will provide support to communities as and where the species is having impacts. People would still be encouraged not to dump aquarium contents and to be careful not to move aquatic pests around through the 'Check Clean Dry' programme.		
Exclusion programme	Not applicable.	Not applicable.	Exclusion is not an option because hornwort is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Hornwort is present in ponds, dams and drains throughout the region, as well as some lakes and rivers so would not be suitable for an eradication programme.
Progressive containment programme	Not applicable.	Not applicable.	Already present in some high value lakes in Northland, as well as in rivers, ponds and drains throughout the region so would not be suitable for a progressive containment programme.
Sustained control programme	Hornwort could be included in a sustained control programme. The council could include a rule banning dumping/deliberate spread within the Northland region which could help reduce the spread of hornwort.	Education, publicity, responding to reports, enforcement action.	Moderate - although these measures may help, hornwort could still spread in Northland and infest high value water ways.
Site-led pest programme	The council could specify high value lakes as site-led programmes, as an incursion at these sites could have significant impacts. Hornwort could be listed as a progressive containment or eradication species in these lakes, so that if a new incursion is detected through regular surveillance we are ready to act. We could also introduce rules about the species people are allowed to keep in outdoor ponds/dams close to a high value lake.	Rules would only be applicable in the areas defined as site led programmes and could not be enforced elsewhere. Education, publicity, responding to reports, response to new incursions, enforcing rules.	Low - efforts could be targeted to protecting and responding to incursions in the highest value sites in Northland.

<table>
<tr><td>Option</td><td>Explanation of benefits</td><td>Explanation of costs</td><td>Level of risk that programme will not be successful</td></tr>
<tr><td>Summary of alternative assessments and preferred option:</td><td colspan="3">No regional intervention

Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate.

Resulting from this process, the council is of the opinion that hornwort does not meet the ‘tests’ under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a ‘pest’ involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be <u>no regional intervention</u> for hornwort, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding.

While hornwort has not been afforded pest status in Northland, it may be included under a ‘council supported management programme’ outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes.</td></tr>
</table>

Koi carp

Cyprinus carpio

(Family: Cyprinidae)

Status in New Zealand

Naturalised. Koi carp are listed as an unwanted organism under the Biosecurity Act 1993.

Relevant biology

Form	Koi carp are an ornamental strain of common carp. Body colouration is variable, often in a blotchy pattern, which can include black, red, orange, gold and white. They have two pairs of barbels around the mouth. Koi carp grow up to around 700mm long. They are bottom-feeding omnivores, planktivorous as juveniles. Adults mainly eat macroinvertebrates, but also some plant material and fish eggs/larvae. Koi carp live for approximately 8-12 years in New Zealand.
Habitat	Still or slow moving freshwater bodies, especially shallow, warm water. Prefer vegetated areas for spawning. May spend a lot of time in one area, but some individuals undertake long distance movements (greater than 20km in some cases), particularly during spawning season. Tolerate moderately low oxygen levels.
Regional distribution	Koi carp are not common in Northland, and are not known to be present in any of the region's high value waterways. Koi carp are present mainly in isolated ponds/lakes in Northland, some river/stream systems including the Whakanekeneke River, Okaihau River, and Hokianga Harbour. A number of populations have been found in farm ponds and some populations have been eradicated by the Northland Regional Council and Department of Conservation. Koi carp in Lake Parawanui appear to have died out, probably because the original and illicit stocking did not contain both sexes.
Competitive ability	Koi carp grow rapidly, and have wide environmental and habitat tolerances, including poor water quality. When feeding, koi carp suck up and expel material from the bottom, filtering out edible material. They can greatly increase the turbidity of the water because they are constantly stirring up the substrate, and dislodging the substrate. They are invasive overseas.
Reproductive ability	Koi carp reach sexual maturity early in New Zealand; males mature by 2 years old, females by 3 years old. The time to maturation is influenced by water temperature. Multiple spawning events (batches) can occur within one season, and koi carp are highly fertile. Eggs stick to submerged vegetation, and reproduction may be limited in habitats devoid of vegetation. Where available they will seek off-stream wetland habitats for spawning. Reproduction may respond positively to wetland flooding. Koi carp are capable of hybridising with goldfish; there is the potential for gene flow to make them more invasive if the offspring were viable (which may rarely, if ever, be the case). Vectors of spread: Self dispersal, flooding, distributed by people.
Resistance to control	Chemical control (for example, rotenone) is non-selective, therefore has potential for non-target impacts on native fish. Chemical control may also be less effective when

	submerged macrophytes are present. Some sites may have a strong probability of re-invasion due to connections with other water bodies and/or people.
Benefits	Caught for sport by coarse fishing anglers.

Water bodies occupied

Water body type	Current water body infested	Potential water body infested
Lakes	-	High
Rivers and streams	Low	Low
Wetlands	Low	Low
Ponds and dams	Low	High
Drains and canals	Low	Low
Troughs	-	Low

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	L	M-H	Can contribute to poor water clarity through bottom feeding, which causes re-suspension of sediment and nutrients and can have impacts on amounts of zooplankton and macrophytes. Koi carp act as nutrient pumps by eating nutrient-rich sediments and excreting bioavailable nutrients into the water column, potentially leading to increases in algae. Combined effects of planktivory and	Bardiou and Goldsborough, 2015; Bajer and Sorensen, 2015;

Category	Current	Potential	Comment	Source
			benthic feeding can contribute to lakes 'flipping' to alternative stable state devoid of vegetation, with turbid water dominated by phytoplankton. Impacts on water quality appear to be additive/synergistic when multiple species of exotic fish are present.	Barton et al., 2000; Bonneau and Scarnecchia, 2014; Fischer et al., 2013; Gorman et al., 2014; Huser et al., 2015; King et al., 1997; Kloskowski, 2011a; 2011b Lougheed et al., 1998; Nieoczym and Kloskowski, 2014; Parkos et al., 2003; Pinto et al., 2005; Richardson et al., 1990; Roberts et al., 1995; Rowe, 2007; Rowe and Wilding, 2012; Schallenberg and Sorrell, 2009; Vilizzi et al., 2014; 2015; Zambrano and Hinojosa, 1999; Zambrano et al., 1999.

Category	Current	Potential	Comment	Source
Species diversity	L	M-H	Can reduce the amount and density of submerged plants through uprooting of plants and by reducing light penetration. Can reduce density, biomass, size-class distribution and diversity of aquatic macroinvertebrates such as midges and freshwater worms through predation and/or habitat modification. Likely to negatively affect waterfowl, native fish and koura through their feeding methods and/or competition for food and spawning habitat.	Bardiou and Goldsborough, 2015; Bajer and Sorensen, 2015; Bonneau and Scarnecchia, 2015; Daniel, 2009; Fischer et al., 2013; Hinojosa-Garro and Zambrano, 2004; Kloskowski, 2011b; Miller and Crowl, 2006; Nieoczym and Kloskowski, 2014; Roberts et al., 1995; Rowe and Wilding, 2012; Vilizzi et al. 2014; 2015; Wu et al., 2013; Zambrano and Hinojosa,1999; Zambrano et al., 1999.
Threatened species	L	M	As above.	
Social/cultural				
Human health	-	-		
Recreation and aesthetics	L	M	Impacts on water clarity (see 'Water quality') reduce aesthetic appeal of water bodies for swimming and	Rowe and Verburg, 2015.

Category	Current	Potential	Comment	Source
			other recreational uses. May contribute to toxic algal blooms. Can be a contributing factor to public complaints regarding lake water quality.	
Māori culture	L	H	Numerous impacts on mauri of wai Māori (see 'Water quality' and 'Species diversity').	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	Rather than applying a programme under the Regional Pest Management Plan, the species could come under a 'Connecting Communities' programme outside of the pest management plan, where advice and support are provided for specific sites. This will provide support to communities as and where the species is having impacts.	By not applying a programme and rules to the species, there would be no provisions under the pest management plan to manage inappropriate practises that are exacerbating the spread.	High. By not applying a programme and rules to the species, there would be no provisions under the pest management plan to manage inappropriate practises that are exacerbating the spread.
Exclusion programme	Not applicable.	Not applicable.	Koi carp are already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Resources and control tools to eradicate koi carp from rivers are not currently available, so an eradication programme is not an appropriate option.
Progressive containment programme	Koi carp populations are currently limited in Northland. A progressive containment area could be defined around the known rivers, with other populations being controlled over time to minimise the risk of spread to other high value water ways. Rules as described for the sustained control programme would also apply.	Education and publicity. Responding to reports, progressive eradication of outlier sites. A partnership approach with DOC would be required.	Moderate - there may be more koi populations than are currently known about. Deliberate or accidental release of koi by people into new water ways is a possibility.
Sustained control programme	Koi carp could be included in a sustained control programme. The council could include rules banning dumping/deliberate spread within the Northland	Education and publicity. Enforcement of rules; responding to reports.	High -Existing populations would not be subject to control.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	region. A rule requiring that koi carp are on killed on capture could also be considered.		
Site-led pest programme	The council could specify high value lakes as site-led programmes, as an incursion at these sites could have significant impacts. Koi carp could be listed as a progressive containment or eradication species in these lakes, so that if a new incursion is detected through regular surveillance the council is ready to act. The council could also introduce rules about the species people were allowed to keep in outdoor ponds/dams close to a high value lake.	Enforcement of rules (rules would only be applicable in the areas defined as site led programmes and could not be enforced elsewhere); response costs should an incursion occur	Low - as action would take place in specific high value places making better use of limited resources.
Summary of alternative assessments and preferred option:	Progressive containment (and site-led pest) programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for koi carp. In terms of alternative approaches assessed, under <u>no regional intervention</u> (or do nothing), there would be unacceptable loss of biodiversity values in the regions' waterways if koi were to spread uncontrollably. There would be significant public and political concerns and consequences if koi were known to be present and no action was taken to control or limit distribution. <u>Eradication</u> of koi carp is not technically feasible, due to the habitats in which they live (and their ability to travel great distances – 20km plus in one day) and lack of effective, wide-scale control techniques. However, much of the region is free of the pest and some sites may achieve zero density over time. There would be political risks associated with seeking region-wide eradication and then being unable to achieve that goal. A sustained control or site led approach would be unpalatable and seen as a lesser management option and one which would allow koi to slowly spread into new areas. The option considered to carry the least risk is <u>progressive containment,</u> with some <u>site-led programmes</u> in selected places. NRC intends to undertake direct control of this fish pest through its service delivery programme and will work with others on control strategies. Any operational risks are deemed low to moderate and depend very much on the individual sites where koi are found. Electric fishing is effective in small areas; poisoning could require consents and draining waterways is generally not sustainable. Koi, and the spreading of koi, are managed under three different pieces of legislation – the Biosecurity Act 1993, the Freshwater Fishing Regulations 1983 and the Conservation Act 1987 and there is some potential for mixed messaging or gaps to occur as a result, but these are thought to be minor issues. The biggest risk to achieving a progressive containment outcome is through sports fishers not adhering to the proposed rules and intentionally catching and releasing koi to new waterways or others not motivated to report any sightings.		

Lagarosiphon

Lagarosiphon major

(Family: Hydrocharitaceae)

Status in New Zealand

Lagarosiphon is listed as an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Lagarosiphon is a bottom-rooted submerged aquatic herb. It has leaves up to 2 x 16 mm, downward curving, arranged in spirals on the stem. Stems can be up to 2 m long, and branching. All New Zealand plants are female, therefore no viable seed is set. Flowers are minute.
Habitat	Still to moderately fast flowing water bodies including drains, streams and lakes from lake margin to approximately 6m depth. Tolerates low nutrient conditions. Prefers sheltered microhabitats. Tolerates a variety of substrate types but prefers silt. Negatively affected by water temperatures above 25°C. Appears to prefer cooler waters in southern regions to those in Northland.
Regional distribution	Scattered distribution; found right across the region but only in a relatively small proportion of potentially suitable water bodies. Present in Lake Waiparera and Lake Ngatu, and thought to have been eradicated from Lake Phoebe and an eradication project is underway in Lake Ngakapua.
Competitive ability	Can be a superior competitor to native *Myriophyllum triphyllum* and exotic *Elodea canadensis* in cooler waters but less so in warmer waters, such as Northland. Relatively intolerant of turbid low light conditions. May be competitively advantaged by silt accumulation.
Reproductive ability	Vegetative reproduction from stem fragments. No sexual reproduction in New Zealand. Vectors of spread: Moved between water bodies by humans through deliberate releases as well as accidentally on machinery and fishing equipment. Public accessibility of site strongly predicts invasion likelihood. Spreads within catchments via natural water movement.
Resistance to control	Mechanical control can contribute to further spread of stem fragments. Limited range of herbicides acceptable for use in water, and adequate uptake can be difficult to achieve in aquatic environment. However good success has been achieved in two Northland lakes using the species specifid aquatic herbicide endothall,
Benefits	Grown as an ornamental pond and aquarium plant. Can provide habitat for native invertebrates and fish (but at the expense of native macrophyte species which would have provided similar quality habitat).

Water bodies occupied

Water body type	Current water body infested	Potential water body infested
Lakes	Low	High
Rivers and streams	Low	High
Wetlands	-	Low
Ponds and dams	Low	High
Drains and canals	Low	High
Troughs	Low	Low

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	L	Potential to impede drainage and exacerbate flooding.	biosecurity.govt.nz
Sheep and beef	-	L	As above.	
Forestry	-	-		
Horticulture	-	-		
Other	-	M	Major problem for hydroelectric dams. Could be a problem for water reservoirs.	
International trade	-	-		
Environment				
Soil resources	-	L	May be impacted by drainage issue described above.	
Water quality	L	L-M	Dense stands of macrophytes can affect dissolved oxygen levels by reducing gas exchange.	Chamier et al. 2012 Schwarz and Howard-Williams 1993
Species diversity	L	L-M	Capable of forming dense stands, displacing native macrophyte species. Can form stands with higher biomass and surface area than native macrophytes, thus altering	Bickel and Closs 2008; 2009 Howard-Williams and Davies 1988

Category	Current	Potential	Comment	Source
			habitat availability for other species. Can host higher epiphyton biomass and invertebrate abundance than that on displaced native macrophytes. Can alter invertebrate community composition; stress tolerant species such as snails. Can represent similar or better habitat for some native fish (e.g. common bully) compared to native vegetation. Impacts on other fish (for example, eels and pest fish) unknown. May indirectly affect native species by facilitating invasion of exotic water fowl such as black swans. May become less invasive in Northland and Auckland under climate change due to preference for cooler temperatures (although elevated carbon dioxide may have minor reverse effects).	Hussner et al. 2014 Kelly and Hawes 2005 Mckee et al. 2002 Rattray et al. 1994 Riis et al. 2012
Threatened species	-	L-M	As above but depends on sites invaded.	
Social/Cultural				
Human health	-	-		
Recreation and aesthetics	L	L-M	Impedes recreational water access and negatively affects amenity values.	Paynter 2013
Maori culture	L	L-M	Impacts on the mauri of wai māori (see 'Water quality', 'Species diversity' and 'Recreation'). Impact on eels and other cultural harvest species unknown.	

L = low M= moderate H = high - = no impact + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	Rather than applying a programme under the Regional Pest Management Plan, the	There would be no immediate costs to council. However, costs	High. By not applying a programme and rules to the species, there would be no

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	species could come under a 'Connecting Communities' programme outside of the pest management plan, where advice and support are provided for sites of interest to communities. This will provide support to communities as and where the species is having impacts. People would still be encouraged not to dump aquarium contents and to be careful not to move aquatic pests around through the 'Check Clean Dry' programme.	in future could be greater if the species continues to spread.	provisions under the pest management plan to manage inappropriate practises that are exacerbating the spread.
Exclusion programme	Not applicable.	Not applicable.	Exclusion is not an option because lagarosiphon is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Lagarosiphon is present in ponds and drains throughout the region so would not be suitable for an eradication programme.
Progressive containment programme	Not applicable.	Not applicable.	Although only known to be present in a few high value lakes in Northland, lagarosiphon is present in ponds and drains throughout the region so would not be suitable for a progressive containment programme.
Sustained control programme	Lagarosiphon could be included in a sustained control programme. The council could include a rule banning dumping/deliberate spread within the Northland region which could help reduce the spread of lagarosiphon.	Education, publicity, responding to reports, enforcement action.	Moderate - although these measures may help, lagarosiphon could still spread in Northland and infest high value water ways.
Site-led pest programme	The council could specify high value lakes as site-led programmes, as an incursion at these sites could have significant impacts. Lagarosiphon could be listed as a progressive containment or eradication species in these lakes, so that if a new incursion is detected through regular surveillance we are ready to act. We could also introduce rules about the species people	Rules would only be applicable in the areas defined as site led programmes and could not be enforced elsewhere. Education, publicity, responding to reports, response to new incursions, enforcing rules	Low - efforts could be targeted to protecting and responding to incursions in the highest value sites in Northland.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	were allowed to keep in outdoor ponds/dams close to a high value lake.		
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that lagarosiphon does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be <u>no regional intervention</u> for lagarosiphon, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding. While lagarosiphon has not been afforded pest status in Northland, it may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes.		

Marshwort

Nymphoides montana

Also known as: Nymphoides geminata

(Family: Menyanthaceae)

Status in New Zealand

Marshwort is listed as an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Marshwort is a bottom-rooted perennial water lily-like plant. It has long-branched running stems, several metres long. The stems lie just beneath the water surface, producing groups of leaves, roots and flowers. The leaves are 30-80 mm long, broadly ovate and are smaller than the leaves of other water lilies. Marshwort has bright-yellow flowers with five petals and hair-like margins, which sit above the water surface on long stalks that grow in pairs. The flowers are 25-35 mm wide and have fringed wings. Flowers are produced from November through to April.
Habitat	Still or slow-moving water bodies including lake margins, streams, wetlands, drains, farm dams. Grows at wide range of water depths, from exposed mud to water c.2.5 m deep.
Regional distribution	Marshwort is not known to be in Northland. There is one active site in a pond used for nursery irrigation in North Auckland.
Competitive ability	Marshwort rapidly colonises shallow water, forming dense mats which block waterways and smother other aquatic plants. It has a history of invasiveness overseas and closely related taxa are also invasive. It can rapidly out-compete other ornamental lily species. Tolerates fluctuating water levels.
Reproductive ability	Not known to set seed in New Zealand. Vegetative spread from stem and leaf fragments. Deliberate human-mediated dispersal as a pond ornamental.
Resistance to control	Herbicide can result in stems detaching and subsequently establishing new plants, thus exacerbating spread.
Benefits	Attractive ornamental pond plant.

Water bodies occupied

Water body type	Current water body infested	Potential water body infested
Lakes	-	High
Rivers and streams	-	Low
Wetlands	-	High

Water body type	Current water body infested	Potential water body infested
Ponds and dams	-	High
Drains and canals	-	Low
Troughs	-	Low

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	L	Can impede drainage and irrigation and block farm dams.	Williams and Champion 2008; NPPA 2006
Sheep and beef	-	L	As above.	
Forestry	-	-		
Horticulture	-	L	Can impede drainage and irrigation.	NPPA 2006
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-	Lack of information available.	
Water quality	-	L	May reduce dissolved oxygen levels in water column. Likely impacts on water quality by shading/restructuring macrophytes.	Moore et al. 1994
Species diversity	-	M	Smothers other plants. Submerged macrophytes may be completely suppressed by shade cast by marshwort mats. Other foodweb impacts probable.	Williams and Champion 2008; NPPA 2006
Threatened species	-	L-M	As above.	
Social/Cultural				
Human health	-	-		
Recreation and aesthetics	-	M	Potential to interfere with recreational activities such as boating and swimming.	Williams and Champion 2008; NPPA 2006

Category	Current	Potential	Comment	Source
Maori culture	-	M	Invasion of natural ecosystems would result in impacts on the wairua of wai māori (see 'Species diversity', 'Threatened species' and 'Recreation').	

L = low M= moderate H = high - = no impact + = benefit

Proposed management

Option	Explanation of Benefits	Explanation of Costs	Level of risk that programme will not be successful
No regional intervention	Marshwort is not known to be in Northland. If neighbouring regions were relied on to control the species there would be no economic cost to the Northland region.	There would be limited public awareness of marshwort and a risk that it would be intentionally or accidentally introduced. If it is not in the pest management plan there would be no rules to prevent possession of the species in Northland.	Medium-High. Without education and regulation there is a medium-high risk that marshwort could arrive and establish in Northland.
Exclusion programme	Public awareness and education about the risks and impacts of marshwort and a rule banning possession of the species in Northland could prevent it from establishing in the region. If it is included in the pest management plan there is the ability to respond immediately if an infestation is detected in Northland.	Low. There is already educational material available for marshwort. Excluding this species would prevent/reduce expenditure on its control if/when it invades Northland.	Low. People will be aware of the species and its potential impacts. There will be a rule banning possession of the species in Northland, which could help discourage people from bringing it to Northland and allow immediate control should any be found.
Eradication programme	Not applicable.	Not applicable.	Marshwort is not known to be present in Northland.
Progressive containment programme	Not applicable.	Not applicable.	Marshwort is not known to be present in Northland.
Sustained control programme	Not applicable.	Not applicable.	Marshwort is not known to be present in Northland.
Site-led pest programme	Not applicable.	Not applicable.	Marshwort is not known to be present in Northland.
Summary of alternative assessments	Exclusion programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for marshwort. In terms of alternative approaches assessed, under <u>no regional intervention</u> (or do nothing) there would be a moderate risk of public and political		

Option	Explanation of Benefits	Explanation of Costs	Level of risk that programme will not be successful
and preferred option:	criticism of Northland Regional Council for not being more proactive over marshwort management, as it is already known in other North Island regions. Biodiversity values would be impacted if marshwort was discovered and no intervention measures were available. Under a no intervention approach, NRC could rely on non-regulatory methods such as advocacy, education and site-led management, but loses the tool to impose penalties for deliberate liberations of this pest. As marshwort is not currently known in Northland an exclusion programme outcome is the only appropriate option available. An exclusion programme focusing on a comprehensive surveillance programme (actively looking for marshwort and other undesirable aquatic pest plants) will help to mitigate any risks by detecting any infestations very early on. There is a medium to high risk that marshwort will be introduced to Northland. However, the benefits of inclusion in the Plan are that significant waterways would remain free of this pest. The value is difficult to estimate but would be significant, given the high degree of public interest in keeping recreational lakes free of aquatic weeds and maintaining aquatic ecosystems in a natural state. This approach has very little extra cost to NRC, (over and above what is spent on advocacy and education) and provides Council with some regulatory tools to incentivise water users such as boaties, eel fishermen, anglers, and fowl shooters (particularly those outside the region) to stop the spread of aquatic pests to new areas.		

Mexican water lily

Nymphaea mexicana

(Family: Nymphaeaceae)

Status in New Zealand

Mexican water lily is listed as an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Mexican water lily is a perennial aquatic herb. It has floating round, heart-shaped leaves which are green with brown flecks on the upper side, pink underneath, and up to 20cm in diameter. Plants are bottom-rooted with stout erect rhizomes, creeping stems with vegetatively reproductive bunches of buds and roots (brood bodies). Flowers are yellow, up to 15cm across, borne above the water surface from October-December. Fruits are round to oval, up to approximately 2.5cm in diameter, ripening summer-autumn. Seeds are 2-3mm long, 4-56 seeds per fruit.
Habitat	Still and slow-moving water bodies, including lakes, streams, ponds, reservoirs, farm dams. Up to approximately 2m depth. Prefers nutrient-rich water bodies.
Regional distribution	Likely to be sites in ornamental ponds in Northland. None known from natural water ways.
Competitive ability	History of invasiveness overseas, and among closely rated taxa. Spreads rapidly.
Reproductive ability	Reproduces from seed as well as rhizomes and tubers. Insect pollinated. Flowers submerge following pollination. Vectors of spread: Deliberately spread by humans for ornamental ponds. Natural spread by water movement.
Resistance to control	Requires repeated applications of herbicide. Mass dieback of aquatic vegetation following control can have perverse outcomes due to biological oxygen demand during decomposition.
Benefits	Ornamental pond plant.

Water bodies occupied

Water body type	Current water body infested	Potential water body infested
Lakes	-	High
Rivers and streams	-	Low
Wetlands	-	Low
Ponds and dams	Low	High

Water body type	Current water body infested	Potential water body infested
Drains and canals	-	High
Troughs	Low	Low

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	L	Potential to clog farm dams and drainage.	
Sheep and beef	-	L	As above.	
Forestry	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	L	M	Dense mats can reduce dissolved oxygen levels by preventing gas exchange between water and air. Reduced oxygen levels may result in altered sediment chemistry. Restricts water flow.	Dugdale et al. 2013 Hofstra et al. 2013 Moore et al. 1994
Species diversity	-	M	Dense mats may suppress submerged macrophytes by shading. Potential impacts on fish, zooplankton and other taxa resulting from low dissolved oxygen. Other foodweb impacts probable.	Dugdale et al. 2013 Moore et al. 1994 issg.org fao.org
Threatened species	-	M	As above.	

Category	Current	Potential	Comment	Source
Social/Cultural				
Human health	-	-		
Recreation and aesthetics	-	M	Dense mats restrict recreational water use, including boat access and swimming.	Dugdale et al. 2013
Maori culture	-	M	Impacts on mauri of wai māori (see 'Water quality', 'Species diversity' and 'Recreation').	

L = low M= moderate H = high - = no impact + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	Rather than applying a programme under the Regional Pest Management Plan, the species could come under a 'Connecting Communities' programme outside of the pest management plan, where advice and support are provided for sites of interest to communities. This will provide support to communities as and where the species is having impacts. People would still be encouraged not to dump aquarium contents and to be careful not to move aquatic pests around through the 'Check Clean Dry' programme.	There would be no immediate costs to council. However, costs in future could be greater if the species continues to spread.	Moderate. By not applying a programme and rules to the species, there would be no provisions under the pest management plan to manage inappropriate practises that are exacerbating the spread.
Exclusion programme	Not applicable.	Not applicable.	Exclusion is not an option because Mexican water lily is already thought to be present in Northland.
Eradication programme	If all sites could be eradicated, its potential to spread within Northland will be virtually eliminated, avoiding environmental and economic impacts (including long-term control costs if it spreads further). However, it is likely that there are sites in garden ornamental ponds, and it will be difficult to ensure that they are all found and controlled.	Eradication would require education and publicity, responding to reports, enforcement and surveys.	Moderate - difficult to know how feasible this is given the lack of available data on infestations.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Progressive containment programme	Not applicable.	Not applicable.	It is not possible to map existing infestations so would not be suitable for a progressive containment programme.
Sustained control programme	Mexican water lily could be included in a sustained control programme. The council could include a rule banning dumping/deliberate spread within the Northland region which could help reduce likelihood of spread.	Education, publicity, responding to reports, enforcement action.	Moderate - although these measures may help, Mexican water lily could still spread in Northland and infest high value water ways.
Site-led pest programme	The council could specify high value lakes as site-led programmes, as an incursion at these sites could have significant impacts. Mexican water lily, and other Nymphaea species could be listed as progressive containment or eradication species in these lakes, so that if a new incursion is detected through regular surveillance we are ready to act. The council could also introduce rules about the species people are allowed to keep in outdoor ponds/dams close to a high value lake.	Rules would only be applicable in the areas defined as site led programmes and could not be enforced elsewhere. Education, publicity, responding to reports, response to new incursions, enforcing rules.	Low - efforts could be targeted to protecting and responding to incursions in the highest value sites in Northland.
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that Mexican water lily does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be no regional intervention for Mexican water lily, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding. While Mexican water lily has not been afforded pest status in Northland, it may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes.		

Nardoo

Marsilea mutica

Also known as: water clover

(Family: Marsileaceae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Nardoo looks like a member of the clover family, but is actually a freshwater fern. It has flat leaves that resemble a large four-leaf clover. The leaves float on the surface of the water on stalks up to one metre long. The roots form dense, floating masses.
Habitat	Nardoo grows either as an aquatic or on mud, mostly in areas subject to at least temporary inundation. When the plants are growing in the water they have floating leaflets. Suitable habitats include freshwater that is less than one metre deep, such as swamps, dams, lake edges and garden ponds.
Regional distribution	Nardoo has been eradicated from all known sites in Northland, but there is a likelihood of undiscovered infestations - a small, new site was reported in 2015.
Competitive ability	Nardoo can form dense beds of vegetation which can block dams and waterways, impede drainage and disrupt recreational activities. It outcompetes native species, and is also highly toxic to stock.
Reproductive ability	It is thought that Nardoo does not produce spores in New Zealand and spreads only from plant fragments. **Vectors of spread:** In New Zealand, nardoo has been spread deliberately by humans. Fragments could also be spread in soil or water.
Resistance to control	Nardoo can be difficult to control, but can be sprayed with herbicide approved for use over water.
Benefits	Ornamental pond plant.

Water bodies occupied

Water body type	Current water body infested	Potential water body infested
Lakes	-	High
Rivers and streams	-	Low
Wetlands	-	High
Ponds and dams	Low	High

Water body type	Current water body infested	Potential water body infested
Drains and canals	-	High
Troughs	-	Low

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Farming	-	L	Nardoo can obstruct water intakes and block dams and is toxic to stock.	Williams and Champion, 2008; Queensland Govt.
Horticulture	-	L	Nardoo can obstruct water intakes and block dams and is toxic to stock.	Williams and Champion, 2008; Queensland Govt.
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-	Nardoo can obstruct water extraction sites and block dams.	Williams and Champion, 2008.
Species diversity	-	M	Nardoo shades out native, bottom-rooted aquatic plants, and competes with small native plants in wetlands and around lake edges.	Weedbusters
Threatened species	-	M	Nardoo shades out native, bottom-rooted aquatic plants, and competes with small native plants in wetlands and around lake edges.	Weedbusters
Social/Cultural				
Human health	-	-		
Recreation and aesthetics	-	L	Dense growths of nardoo may impede access to waterways and riparian margins.	
Maori culture	-	M	Impacts upon native/taonga species.	

L = low M= moderate H = high - = no impact + = benefit

Proposed management

Option	Explanation of Benefits	Explanation of Costs	Level of risk that programme will not be successful *
No regional intervention	Nardoo is not common in Northland, and all known infestations have been controlled. If neighbouring regions were relied on to control the species there would be no economic cost to the Northland region.	There would be limited public awareness of nardoo and a risk that it would be intentionally introduced for ornamental purposes. If it is not in the pest management plan there would be no rules to prevent possession of the species in Northland.	Medium-high. Without education and regulation there is a medium-high risk that nardoo could spread and establish in Northland.
Exclusion programme	Not applicable.	Not applicable.	Nardoo is still likely to be present in small ornamental sites in Northland.
Eradication programme	Public awareness and education about the risks and impacts this species could have in Northland, and a rule banning possession of the species in Northland could prevent it from spreading and establishing in the region. If it is included in the pest management plan there is the ability to respond immediately if an infestation is detected in Northland.	Low. There is already educational material available for nardoo. Only one small, new site has been found and treated in the last five years so it is unlikely that nardoo is present in large amounts. Minimal expenditure on its control when sites are found will prevent greater costs in future.	Low. People will be aware of the species and its potential impacts. There will be a rule banning possession of the species in Northland, which could help discourage people from bringing it to Northland and allow immediate control should any be found.
Progressive containment programme	Not applicable	Not applicable	It is not possible to define a progressive containment area, as there are no currently known sites which still have nardoo present.
Sustained control programme	Not applicable	Not applicable	Nardoo is not common or widespread in Northland, so a sustained control programme is not applicable.
Site-led pest programme	The council could specify high value lakes as site-led programmes, as an incursion at these sites could have significant impacts. Nardoo could be listed as a progressive containment or eradication species in these lakes, so that if a new incursion is detected through regular surveillance the council is ready to act. The council	Enforcement of rules (rules would only be applicable in the areas defined as site led programmes and could not be enforced elsewhere); response costs should an incursion occur	Low - as action would take place in specific high value places making use of limited resources. However, the currently limited amount of nardoo may increase as people outside of the site-led programme not be subject to rules about possession.

Option	Explanation of Benefits	Explanation of Costs	Level of risk that programme will not be successful *
	could also introduce rules about the species people were allowed to keep in outdoor ponds/dams close to a high value lake.		
Summary of alternative assessments and preferred option:	Eradication programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for nardoo. In terms of alternative approaches assessed, under <u>no regional intervention</u> (or do nothing), there would potentially be unacceptable loss of biodiversity values as there are many suitable habitats for it to thrive in in Northland. Currently, nardoo is very limited in distribution and until recently was thought to have been eradicated. Under a no intervention approach, NRC could rely on non-regulatory methods such as advocacy, education and site-led management, but loses the tools, regionally to take direct control action or impose penalties for possession of or deliberate liberations of this pest. <u>Progressive containment or sustained control</u> approaches would not be appropriate as nardoo is very rare in Northland. It would be highly risky of Council relying on 'lesser' control options when eradication or zero density is achievable. It would be an unacceptable risk to rely only on landowners to control infestations – for example, control of any aquatic pests with herbicides is usually difficult and expensive. Additionally, as the sites involve treatment over water, permissions to use herbicides are required through the Environmental Protection Agency (EPA). These situations require a high level of regional intervention (through professional surveillance and direct control approaches). These operational risks would compromise the outcomes sought if landowners were responsible for control work, therefore council service delivery is the most appropriate control measure. <u>Eradication</u> is the preferred outcome and is realistic given the current level of infestation and the technical challenges involved. There is some level of risk that nardoo will be introduced to Northland or unknown infestations are found. However, NRC intends to undertake direct control of nardoo wherever it occurs in the region. The costs involved under an eradication programme are minor (compared with the risks of doing nothing and allowing it to spread) and this approach provides Council with some regulatory tools to incentivise water users such as boaties, eel fishermen, anglers, and fowl shooters (particularly those outside the region) to stop the spread of wetland and semi-aquatic pests to new areas. The benefits of inclusion in the Plan are that significant wetlands and margins of waterways would in the long-term remain free of this pest. The value is difficult to estimate but would be significant, given the high public interest in maintaining wetlands and aquatic ecosystems in a natural state.		

Orfe

Leusiscus ide

Also known as:
Ide, golden orfe

(Family: Cyprinidae)

Status in New Zealand

No legal status in New Zealand

Relevant biology

Form	Orfe are similiar to rudd in appearance but lack small projections near their anal and pelvic fins.
Habitat	Typically inhabit slow-flowing rivers and lakes or still water areas and are migratory if possible.
Regional distribution	Orfe were illegally released in the 1980's at one location north of Auckland and may have been released into other locations but they have not been observed for many years.
Competitive ability	Orfe are omnivorous, opportunistic feeders that are able to feed within all levels of the water column. However, as they grow older, adults will switch to a mainly vegetative diet.
Reproductive ability	Spawning occurs in spring at depths of 0.5-1.5m and eggs are laid over gravel beds, weeds and muddy substrate, where they will adhere to most surfaces. Optimum water temperature is around 8-10°. egg development is temperature dependent and take up to 23 days at lower temperatures.
Resistance to control	Orfe can be controlled through Rotenone applications
Benefits	Coarse fishing

Water bodies occupied

Water body type	Current water body infested	Potential water body infested
Lakes	-	High
Rivers and streams	-	High
Wetlands	-	Low
Ponds and dams	-	High
Drains and canals	-	Low

Water body type	Current water body infested	Potential water body infested
Troughs	-	Low

High = Most infested/preferred Low = Less infested/preferred.

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Farming	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-	Likely to have an impact on water quality through stirring up benthic sediment	Brabrand, 1985.
Species diversity	-	M	Orfe will reduce the presence of native plants through consumption of young shoots	Brabrand, 1985
Threatened species	-	M	Orfe will compete with native species for food and will predate upon juveniles and fry of native species.	Koli, 1984
Social/Cultural				
Human health	-	-		
Recreation and aesthetics	-	L	Orfe may contribute to poor water quality, reducing use	
Maori culture	-	M	Impacts upon native/taonga species.	

L = low M= moderate H = high - = no impact + = benefit

Proposed management

Option	Explanation of Benefits	Explanation of Costs	Level of risk that programme will not be successful *
No regional intervention	Orfe is currently not known to be present in Northland, but it is possible it persists in small populations. No regional	Should orfe be discovered in Northland, there will be no legal recourse to control the population or restrict movement risks.	Low-medium. There is only a small risk that orfe are still present, based on confiscated records. They have been thought to be eradicated.

Option	Explanation of Benefits	Explanation of Costs	Level of risk that programme will not be successful *
	intervention would not incur any costs to council		
Exclusion programme	Orfe are not known to be present in Northland, yet were discovered in Auckland during the '80's. This category will allow orfe to have a legal classification if they are discovered but will not place undue costs on the council in the interim	Surveys will need to be undertaken and public education carried out at events	Low. Orfe are not likely to be present in Northland
Eradication programme	Not applicable	Not applicable	Orfe are not known to be present in Northland
Progressive containment programme	Not applicable	Not applicable	Orfe are not known to be present in Northland
Sustained control programme	Not applicable	Not applicable	Orfe are not known to be present in Northland
Site-led pest programme	Not applicable	Not applicable	Orfe are not known to be present in Northland
Summary of alternative assessments and preferred option:	Exclusion programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for orfe. In terms of alternative approaches assessed, under <u>no regional intervention</u> (or do nothing), there would potentially be unacceptable loss of biodiversity values as there are many suitable habitats for it to thrive in in Northland. Currently, orfe is thought to have been eradicated, however there is a distinct possibility that it does persist in a few select sites in Northland. Under a no intervention approach, NRC could rely on non-regulatory methods such as advocacy, education and site-led management, but loses the tools, regionally to take direct control action or impose penalties for possession of or deliberate liberations of this pest. An exclusion programme will not place undue costs on the council and will allow for surveys and monitoring to take place to determine if orfe is actually eradicated from New Zealand.		

Parrot's feather

Myriophyllum aquaticum

(Family: Haloragaceae)

Status in New Zealand

Parrots feather is listed as an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Parrot's feather is a submerged, bottom-rooted perennial aquatic herb. The top 10cm of foliage can be emergent, standing above the water. Sprawling foliage is pale grey-green, and stems are up to 2m long. Leaves are finely divided, feathery, and arranged in whorls of 4-6. Emergent and submerged leaves differ in form. It flowers from September – February. Only female plants are present in New Zealand so no seed is set.
Habitat	Still or slow moving water bodies including wetlands, lakes, streams, rivers, drains and ponds to a depth of approximately 5+m. It is unlikely to be severely problematic in large exposed lakes. Tolerates slightly brackish conditions. Favours water bodies with high nutrient (especially nitrogen) and light levels. Tolerates fluctuating water levels, including complete exposure of sediment. Growth rates increase in response to increases in carbon dioxide. May benefit from climate change.
Regional distribution	Parrot's feather is widespread in the drains of the Hikurangi Swamp and is likely to occur in similar habitats elsewhere in Northland. It is not known to be present in any of the regions high value water bodies.
Competitive ability	History of invasiveness overseas. Taller growing form than native *Myriophyllum* species. Rapid growth rate and highly variable growth forms. Allelopathic - releases chemicals that affect the growth of other species. Growth from fragments provides competitive advantage in dynamic environments.
Reproductive ability	Does not set seed in New Zealand. Grows from small fragments. Vectors of spread: Spread by accidental and deliberate human-mediated movement of stem and rhizome fragments. Desiccation tolerant therefore high risk for accidental movement between water bodies as contaminant on drain clearing machinery, boats or other equipment. Downstream dispersal of fragments through water movement.
Resistance to control	Mechanical control can exacerbate vegetative spread. Some herbicides are ineffective, and multiple applications are required.
Benefits	Valued by some as an aquarium and pond ornamental.

Water bodies occupied

Water body type	Current water body infested	Potential water body infested
Lakes	-	High
Rivers and streams	Low	Low
Wetlands	Low	Low
Ponds and dams	Low	High
Drains and canals	Low	High
Troughs	-	Low

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	L	Impedes drainage and exacerbates flooding.	Lafontain et al. 2013 Wersal and Madsen 2007 Champion and de Winton 2005
Sheep and beef	-	L	As above.	
Forestry	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	L	May be impacted by drainage issue described above.	
Water quality	L	M-H	Impedes water flow, exacerbating sedimentation and increasing flooding risk. Can affect dissolved oxygen levels by reducing gas exchange.	Chamier et al. 2012 Lafontain et al. 2013 Nunes et al. 2007 Stiers et al. 2011

Category	Current	Potential	Comment	Source
Species diversity	L	M-H	Can displace other plant species through rapid growth, shading and allelopathy, decreasing native plant species richness. Especially problematic in shallow, sheltered, nutrient rich lakes and wetlands. Increasing cover associated with decreasing macroinvertebrate abundance and taxa richness. Sensitive macroinvertebrate taxa such as mayflies may be particularly negatively affected, while stress tolerant species such as snails, midges and mosquitoes may be common or even advantaged by abundant weed cover and associated structural complexity. Potential impacts on fish and other food web effects lack data.	Cheng et al. 2008 Stiers et al. 2011 Hicks et al. 2006 Orr and Resh 1992 Hofstra et al. 2006 Champion and de Winton 2005
Threatened species	-	-	Depends on sites invaded.	
Social/Cultural				
Human health	-	L	Can provide favourable habitat for mosquitoes.	Orr and Resh 1992
Recreation and aesthetics	-	M	Can impede recreational water use, including swimming and boating.	Wersal and Madsen 2007
Maori culture	L	M	Impacts on the mauri of wai māori (see 'Water quality', 'Species diversity', 'Human health' and 'Recreation'). Impact on eels and other cultural harvest species unknown.	

L = low M= moderate H = high - = no impact + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	Rather than applying a programme under the Regional Pest Management Plan, the species could come under a	There would be no immediate costs to council. However, costs in future could be	High. By not applying a programme and rules to the species, there would be no provisions under the pest

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	'Connecting Communities' programme outside of the pest management plan, where advice and support are provided for sites of interest to communities. This will provide support to communities as and where the species is having impacts. People would still be encouraged not to dump aquarium contents and to be careful not to move aquatic pests around through the 'Check Clean Dry' programme.	greater if the species continues to spread.	management plan to manage inappropriate practises that are exacerbating the spread.
Exclusion programme	Not applicable.	Not applicable.	Exclusion is not an option because parrot's feather is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Parrot's feather is present in ponds and drains throughout the region so would not be suitable for an eradication programme.
Progressive containment programme	Not applicable.	Not applicable.	Although not known to be present in any high value lakes in Northland, parrot's feather is present in ponds and drains throughout the region so would not be suitable for a progressive containment programme.
Sustained control programme	Parrot's feather could be included in a sustained control programme. The council could include a rule banning dumping/deliberate spread within the Northland region which could help reduce the spread of parrot's feather.	Education, publicity, responding to reports, enforcement action.	Moderate - although these measures may help, parrot's feather could still spread in Northland and infest high value water ways.
Site-led pest programme	The council could specify high value lakes as site-led programmes, as an incursion at these sites could have significant impacts. Parrot's feather could be listed as a progressive containment or eradication species in these lakes, so that if a new incursion is detected through regular surveillance we are ready to act. We could also introduce rules about the species people were allowed to keep in outdoor	Rules would only be applicable in the areas defined as site led programmes and could not be enforced elsewhere. Education, publicity, responding to reports, response to new incursions, enforcing rules	Low - efforts could be targeted to protecting and responding to incursions in the highest value sites in Northland.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	ponds/dams close to a high value lake.		
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that parrot's feather does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be no regional intervention for parrot's feather, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding. While parrot's feather has not been afforded pest status in Northland, it may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes.		

Perch

Perca fluviatilis

(Family: Percidae)

Status in New Zealand

Naturalised. Sports fish subject to national sport fishing regulations.

Relevant biology

Form	Perch are olive green-grey, with six or more dark vertical bands across their sides. The pelvic and anal fins and lower half of the tail are bright red-orange. Adults reported at around 400-450mm long, 1-2kg overseas, but most fish in the Auckland region are less than 1kg, less than 400mm. Predominantly active during the day. Maximum recorded age in New Zealand is eight years, but they are known to live to 20 plus years overseas. Perch shoal as young, and are more solitary as adults. Larvae eat free swimming zooplankton. Larger juveniles eat benthic macroinvertebrates. Adults mainly eat other fish (including cannibalising juvenile perch). Perch is a warm-water species, and becomes less active during winter, but tolerates a wide temperature range.
Habitat	Still or slow moving freshwater bodies. Adults tend to utilise lake margins need emergent vegetation. Juveniles also use open waters.
Regional distribution	Perch in Northland are only recorded from two known sites, the Kaikowhiti Stream and Lake Tauanui. The status of perch in Lake Tauanui is currently unclear as none were seen during ecological or fish surveys undertaken during 2011. Although perch can breed in rivers, like tench they prefer lake waters and so the source population of the perch in the stream is probably a small pond to the north. The spread of perch in Northland beyond known locations should be avoided as far as possible as this species has the potential to create major problems in lakes through its effects on water quality and endemic biodiversity.
Competitive ability	Perch prey on zooplankton, macroinvertebrates and fish, and have the potential to significantly alter native freshwater communities, through predation and competition with native fish species. They show habitat and behavioural flexibility and fill a niche not represented within native freshwater fauna. Perch can dominate fish fauna of freshwater bodies and are invasive overseas.
Reproductive ability	High fertility. Most males spawn in the first year, most females not till the second year. They spawn in spring in the northern hemisphere, but there is some evidence that they may have an extended spawning season in Auckland due to the warm climate. Eggs are laid in long strings of between 5000-80,000 eggs. No parental care is provided, and young fish grow rapidly in the first year. Recruitment varies between years in response to environmental variables, resulting in strong year classes being apparent. Cannibalism can regulate recruitment, structuring the population towards low overall abundance and dominance by a few large individuals. Vectors of spread: Human-mediated dispersal by coarse anglers stocking new water bodies.

Resistance to control	Chemical control (e.g. rotenone) is non-selective, therefore has potential for non-target impacts on native fish. Chemical control may also be less effective when submerged macrophytes are present. Some sites may have strong probability of re-invasion due to connections with other water bodies and/or human-mediated dispersal. Selective removal of large individuals via physical removal can have perverse impacts via release of smaller size classes from predation.
Benefits	Caught for sport by coarse anglers.

Water bodies occupied

Water body type	Current water body infested	Potential water body infested
Lakes	Low	High
Rivers and streams	Low	Low
Wetlands	-	Low
Ponds and dams	-	High
Drains and canals	-	Low
Troughs	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and Beef	-	-		
Forestry	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	L	M-H	Can contribute to poor water clarity by consumption of zooplankton, thereby exacerbating algal blooms. Bottome feeding can also cause re-suspension of sediment and	de Winton et al. 2002 Meijer et al. 1990

Category	Current	Potential	Comment	Source
			up-rooting of submerged plants. Excretion of nutrients in faeces exacerbates nutrient re-suspension. Combined effects of eating plankton and bottom feeding can contribute to lakes 'flipping' to an alternative stable state devoid of vegetation, with turbid water dominated by phytoplankton. Impacts on water quality appear to be additive/synergistic when multiple species of exotic fish are present. Impacts likely to be exacerbated by climate change.	Dugdale et al. 2006 Jeppesen et al. 1997 Romare et al. 1999 Rowe 2007 Hicks et al. 2007 Rowe and Verburg 2015 Burns et al. 2014 Smith and Lester 2007
Species diversity	L	H	Ecological impacts in New Zealand relatively poorly understood, but perch are rated as the highest impact exotic fish in New Zealand. Shown to reduce abundance of common bullies, impacts likely on other native fish such as eels, inanga, galaxiids and smelt through predation and/or competition for plankton/invertebrate prey. Implicated in declines of freshwater fish and crustaceans in Australia. Consume wide variety of macroinvertebrates including mayflies, caddisflies, flies and beetles. Impacts on freshwater invertebrate communities via predation are probable but poorly understood. In Lake Rototoa, in the Auckland region, perch feed almost exclusively on kōura (*Paranephrops planifrons*). Potential indirect impacts on submerged vegetation via re-suspension of sediment and increases in phytoplankton combining to reduce light penetration.	Rowe and Wilding 2012 Closs et al. 2001 Ten Winkel and Meulemans 1984 Banda 2014 Griffiths 1976 Ludgate and Closs 2003 Morgan et al. 2002 NIWA n.d. Giles et al. 1990 Rowe et al. 2008 Rowe and Smith 2002 Rowe and Verburg 2015
Threatened species	L	M	As above.	
Social/Cultural				
Human health	L	L	May contribute to toxic algal blooms.	
Recreation and aesthetics	L	M	Impacts on water clarity (see 'Water quality') reduce aesthetic appeal of water bodies for swimming and other recreational uses. Could	Rowe and Verburg 2015

Category	Current	Potential	Comment	Source
			become a contributing factor to public complaints regarding lake water quality.	
Maori culture	L	M	Numerous impacts on mauri of wai māori (see 'Water quality' and 'Species diversity').	

L = low M= moderate H = high - = no impact + = benefit

Proposed management

Option	Explanation of Benefits	Explanation of Costs	Level of risk that programme will not be successful
No regional intervention	Rather than applying a programme under the Regional Pest Management Plan, the species could come under a 'Connecting Communities' programme outside of the pest management plan, where advice and support are provided for specific sites. This will provide support to communities as and where the species is having impacts.	By not applying a programme and rules to the species, there would be no provisions under the pest management plan to manage inappropriate practises that are exacerbating the spread.	High. By not applying a programme and rules to the species, there would be no provisions under the pest management plan to manage inappropriate practises that are exacerbating the spread.
Exclusion programme	Not applicable.	Not applicable.	Perch are already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Resources and control tools to eradicate perch from rivers are not currently available, so an eradication programme is not an appropriate option.
Progressive containment programme	Perch populations are currently limited in Northland. A progressive containment area could be defined around the known stream, with other populations being controlled over time to minimise the risk of spread to other high value water ways. Rules as described for the sustained control programme would also apply.	Education and publicity. Responding to reports, progressive eradication of outlier sites. A partnership approach with DOC would be required.	Moderate - there may be more perch populations than are currently known about. Deliberate or accidental release of perch by people into new water ways is a possibility.
Sustained control programme	Perch could be included in a sustained control programme. The council could include rules banning dumping/deliberate spread within the Northland region. A rule requiring that perch are on killed on capture could also	Education and publicity. Enforcement of rules; responding to reports.	High -Existing populations would not be subject to control.

Option	Explanation of Benefits	Explanation of Costs	Level of risk that programme will not be successful
	be considered, but would need careful consideration as perch are part of the national sports fish regulations.		
Site-led pest programme	The council could specify high value lakes as site-led programmes, as an incursion at these sites could have significant impacts. Perch could be listed as a progressive containment or eradication species in these lakes, so that if a new incursion is detected through regular surveillance the council is ready to act. The council could also introduce rules about the species people were allowed to keep in outdoor ponds/dams close to a high value lake.	Enforcement of rules (rules would only be applicable in the areas defined as site led programmes and could not be enforced elsewhere); response costs should an incursion occur	Low - as action would take place in specific high value places making better use of limited resources.
Summary of alternative assessments and preferred option:	Progressive containment programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for perch. In terms of alternative approaches assessed, under <u>no regional intervention</u> (or do nothing) there would be unacceptable loss of biodiversity values in the regions' waterways if perch were to spread uncontrollably. There would be significant public and political concerns and consequences if perch were known to be present and no action was taken to control or limit distribution. <u>Eradication</u> of perch is not technically feasible, due to the habitats in which they live and lack of effective, wide-scale control techniques. However, much of the region is free of the pest and some sites may achieve zero density over time or at least be contained. There would be political risks associated with seeking region-wide eradication and then being unable to achieve that goal. A <u>sustained control or site led</u> approach would be unpalatable and seen as a lesser management option and one which would allow perch to slowly spread into new areas. The option considered to carry the least risk is <u>progressive containment</u>. NRC intends to undertake direct control of this fish pest through its service delivery programme and will work with others on control strategies. Any operational risks are deemed low to moderate and depend very much on the individual sites where perch are found. Electric fishing is effective in small areas; poisoning could require consents and draining waterways is generally not sustainable. Perch, and the spreading of perch, are managed under three different pieces of legislation – the Biosecurity Act 1993, the Freshwater Fishing Regulations 1983 and the Conservation Act 1987 and there is some potential for mixed messaging or gaps to occur as a result, but these are thought to be minor issues. The biggest risk to achieving a progressive containment outcome is through sports fishers not adhering to the proposed rules and intentionally catching and releasing perch to new waterways or others not motivated to report any sightings.		

Red-eared slider tutle

Trachemys scripta elegans

(Family: Emydidae)

Status in New Zealand

Sold in aquarium trade.

Relevant biology

Form	Red-eared sliders are commonly sold as hatchlings, at a carapace length of approximately 4cm. Adults grow up to 30cm long but are more commonly 15-20cm. The carapace is olive to brown with yellow spots/stripes, and they have a distinctive red stripe behind each eye. Adult weight is approximately1kg, and females are slightly heavier than males. The lifespan is approximately 30 years. The diet is omnivorous, including vegetation (all plant parts), zooplankton, molluscs, frogs, crustaceans, insects, gastropods, birds and small reptiles. Diet composition varies with age, location and food availability.
Habitat	Diurnal. Habitat generalists, inhabiting a wide variety of still/slow-moving water bodies including ponds, lakes,wetlands, rivers (including brackish reaches and salt marshes), and drainage ditches. They are capable of rapid range expansion via overland dispersal, and may seasonally use varied terrestrial habitats including golf courses, farmland and forest. They prefer temperatures between 25-29˚C but can withstand much colder temperatures. Adults can survive extended periods at -10°C. Juveniles more cold sensitive and may die at -0.6°C, although overwintering in nests can provide some protection from freezing temperatures. Pollution tolerant.
Regional distribution	Small numbers known from near Kerikeri, and isolated reports from several other locations in Northland.
Competitive ability	Adult turtles can become aggressive and will attack species larger than themselves. Effective predator avoidance strategies to minimise both predation risk and costs of avoidance behaviour. They take over nesting sites of water birds for use as basking sites. Red-eared slider turtles are classified as one of the "World"s Worst Invasive Alien Species" by the World Conservation Union"s (IUCN) Invasive Species Specialist Group.
Reproductive ability	Sexual maturity appears to be size-related, with males mature when carapace length is approximately 10 cm, females at 17 cm. Females can retain sperm and produce offspring up to 5 years after insemination. They can produce 2-3 clutches per season, occasionally more. Egg number per clutch are variable, generally in the range of 4-15, but as many as 23 per nest have been recorded in South Africa. Successful incubation requires soil temperatures of 22-33°C for 55-80 days. Sex determination is temperature-dependant; males are favoured under cool temperatures (c.27°C or below typically produces all males), females under warmer temperatures (c.30°C or above typically produces all females). Sex ratios of clutches from different individuals exhibit considerable variability even at the same temperature. Females may roam several hundred meters or even several kilometres from water bodies to locate suitable nesting

	sites. Eggs may be buried up to 140cm deep. Juvenile mortality is frequently high due to predation pressure (e.g. from birds). Surviving individuals have rapid growth rates. Wild populations can experience on-going supplementation from the captive pet population. Owners are known to dump unwanted adults. In addition, adults may wander of their own accord. Females are more frequently reported as lost/found, therefore if male-biased reproduction occurred in the wild inputs from the captive population would likely at least partially adjust the sex ratio. Vectors of spread: Pet trade, accidental/intentional release, escape.
Resistance to control	No control tools currently available. Intelligent and difficult to capture.
Benefits	Most common pet reptile in NZ. Sold in the pet trade (800+ sales per annum). Cost from $40+.

Water bodies occupied

Water body type	Current water body infested	Potential water body infested
Lakes	-	High
Rivers and streams	Low	Low
Wetlands	Low	High
Ponds and dams	-	High
Drains and canals	-	Low
Troughs	-	Low

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	L	Risk of disease transmission to livestock.	Kikillus et al. 2011
Sheep and beef	-	L	Risk of disease transmission to livestock.	Kikillus et al. 2011
Forestry	-	-		
Horticulture	-	-		
Other	-	-		

Category	Current	Potential	Comment	Source
International trade	-	-		
Environment				
Soil resources	-	L	Potential for soil disturbance for nesting sites.	
Water quality	-	M	May affect water quality, including increasing pH and conductivity. Turtle activity stirs up sediment, plus potential food web mediated mechanisms due to consumption of macrophytes. Therefore probable impacts on turbidity and possibly also nutrient status of the water column. May accelerate leaf litter breakdown.	Lindsay et al. 2013
Species diversity	-	M-H	Opportunistic omnivores therefore potential impacts via predation on vegetation (all plant parts), zooplankton, molluscs, fish, frogs, crustaceans, insects, gastropods, birds, small reptiles. May impact on wetland bird reproduction success by using bird nests as basking sites. Probable food-web and ecosystem process impacts of feeding and associated activity. Risk of disease transmission to native reptiles and amphibians. Capable of seed dispersal – could be positive or negative impacts depending on whether native or invasive plants present at site.	Outerbridge 2008 Perez-Santiagosa et al. 2011 Prevot-Julliard et al. 2007 Kikillus et al. 2010 Lindsay et al. 2013 Kikillus et al. 2011 Kimmons and Moll 2010
Threatened species	-	M	Vulnerable native freshwater species such as crayfish and mudfish would be at risk from slider predation pressure where these species occurred sympatrically.	
Social/Cultural				
Human health	L	M	Potential disease vector, including Salmonella. Children especially at risk due to increased probability of contact.	Harris et al. 2010
Recreation and aesthetics	-	L	Sand in golf courses utilised as nesting habitat. May also nest in gardens.	Outerbridge 2008
Maori culture			Will impact on the mauri of wai māori (see 'Water quality' and 'Species diversity'). Probable predators of important native freshwater species such as koura.	Perez-Santigosa et al. 2011

L = low M= moderate H = high - = no impact + = benefit

Proposed management

Option	Explanation of Benefits	Explanation of Costs	Level of risk that programme will not be successful
No regional intervention	There would be no short term costs to council if red-eared sliders were not included in the pest management plan. However, they are long-lived, and may be released by owners who no longer want them. If they are released, they could survive in Northland, and possibly breed in the wild.	There would be no short term costs to council.	Medium – risk that a wild population could establish in Northland.
Exclusion programme	Not applicable.	Not applicable.	Red-eared sliders are already known to exist in the wild in Northland.
Eradication programme	Red-eared sliders are currently very limited in the wild in Northland, with only a few sightings. If these sites could be eradicated, its potential to spread within Northland will be virtually eliminated, avoiding environmental and economic impacts (including long-term control costs if it spreads further). As a declared pest they would be banned from sale under the Biosecurity Act. This could help reduce the risk of spread as over time less people would have red-eared sliders in aquariums or ponds in Northland. The council could include a rule banning dumping/deliberate spread within the Northland region. They would also be banned from transportation into and within Northland.	Inspection of pet shops; monitoring Trademe sales; enforcement action; follow-up on reports. Control of any known wild populations. There are two pet shops in Northland currently know to sell small numbers of red-eared sliders.	Medium – need to determine the resources the council would require to undertake an eradication programme for this species.
Progressive containment programme	A progressive containment zone could be defined around areas with confirmed sightings. Red-eared sliders outside of these areas could be progressively controlled. When compared to an eradication programme, a progressive containment programme would incur lower financial cost to the council in the short-term. A progressive containment programme would aim to prevent red-eared sliders from establishing new infestation sites.	Inspection of pet shops; monitoring Trademe sales; enforcement action; follow-up on reports. Control of wild red-eared sliders outside of the containment zone. There are two pet shops in Northland currently know to sell small numbers of red-eared sliders.	Moderate - The time-frame of a progressive containment programme would potentially provide the species with the opportunity (that is, time) to spread. Modelling indicates that they could potentially breed successful in parts of Northland, but there is no evidence that they have done so yet.

Option	Explanation of Benefits	Explanation of Costs	Level of risk that programme will not be successful
	Also, rules as above.		
Sustained control programme	To minimise the risks of pets escaping or being released and forming wild populations, we could include red-eared sliders as a organism not declared a pest. They could still be sold, but council could introduce rules banning release within the Northland region and requiring sightings or pet escapes to be reported.	Publicity/education regarding dumping of pets. Follow up on reports	Low – could be included with other pets that we want to discourage from being dumped.
Sustained control programme	Red-eared sliders could be included in a sustained control programme. As a declared pest they would be banned from sale under the Biosecurity Act. This could help reduce the risk of spread as over time less people would have red-eared sliders in aquariums or ponds in Northland. The council could include a rule banning dumping/deliberate spread within the Northland region. They would also be banned from transportation into and within Northland.	This species could no longer be sold in the aquarium trade. Would have to make allowances for red-eared sliders already held as pets - which is reasonably common. Inspection of pet shops; monitoring Trademe sales; enforcement action. There are two pet shops in Northland currently know to sell small numbers of red-eared sliders.	Moderate. Resource intensive.
Site-led pest programme	The council could specify high value lakes as site-led programmes, as an incursion at these sites could have significant impacts. Red-eared sliders could be listed as a progressive containment or eradication species in these lakes, so that if a new incursion is detected through regular surveillance we are ready to act. We could also introduce rules about the species people were allowed to keep in outdoor ponds/dams close to a high value lake.	Rules would only be applicable in the areas defined as site led programmes and could not be enforced elsewhere.	Low - as action would take place in specific high value places making better use of limited resources.
Summary of alternative assessments and preferred option:	Eradication programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for wild red-eared slider turtles. In terms of alternative approaches assessed, under no regional intervention (or do nothing), there could be potential loss of biodiversity values in the longer term if wild turtle populations were 'allowed' to establish. There is an increasing general awareness about the impacts of these animals if released into the wild. These continued acts will over time raise the level of public concern and there is		

Option	Explanation of Benefits	Explanation of Costs	Level of risk that programme will not be successful
	some political risk in NRC not responding now to the various signals around this animal. No intervention may appeal to some in the community that continue to value red-eared slider turtles as pets, although most responsible owners would probably agree that releasing them into the wild in Northland could lead to long term ecological issues. Progressive containment or sustained control approaches, with corresponding land occupier control rules would not be appropriate as although they are known to exist in the wild in Northland their distribution is very limited and the key stakeholders (NRC and DOC) are better placed to respond to any sightings and take direct control action. It would be risky relying on 'lesser' management options when eradicating red-eared slider turtles from known areas in the wild is achievable and realistic with current tools available (e.g. catch and euthanize). It would be an unacceptable risk to rely on directing landowners to locate and then destroy individual animals. Eradication of wild red-eared slider turtles is the preferred outcome within the region but relies heavily on members of the public firstly encountering an animal in the wild then secondly, being motivated to report it. Awareness around the need to control wild populations of red-eared slider turtles will be stepped up over time. Pet trade issues and the propensity for these animals to be either intentionally released or escape accidentally, creates a moderate risk for achievement of an eradication outcome. Overall, the costs involved under an eradication programme are relatively minor (although greater than for progressive containment of sustained control) but are not expected to adversely affect control outcomes.		

Reed sweet grass

Glyceria maxima

(Family: Poaceae)

Status in New Zealand

Naturalised.

Relevant biology

Form	Erect clumping perennial grass, reaching almost 2m tall. Leaves are up to 2cm wide. Creeping rhizomes, can form mats that are attached at the bank but floating in deeper water. Flowers spring-summer; flower heads are up to 45cm long, branched, with spikelets yellow-green with purple tinge. Seeds small, dark brown, summer-autumn.
Habitat	Still and slow-moving eutrophic water bodies including wetlands, streams and drains, in water up to approximately 1-1.5m deep. It doesn't tolerate heavy frost or full shade, but will grow in light shade. Positively associated with soil nitrogen and phosphorous. Prefers silt and other soft substrates. Temperate climate species.
Regional distribution	Reed sweet grass is widespread throughout Northland.
Competitive ability	History of invasiveness overseas. High variation in responsiveness to nutrient availability compared to New Zealand native sedges, facilitating rapid biomass accumulation and competitive advantage under high nutrient conditions. Grazing tolerant, but spread can be accelerated by release of grazing pressure. Less competitive under dense, woody vegetation.
Reproductive ability	Reproduces by seeds (prolific) and rhizomes. Vectors of spread: Spreads via water movement, plus human-mediated dispersal of contaminated soil, machinery, fishing/boating equipment.
Resistance to control	
Benefits	Can be used as a pasture grass (but carries risk of cyanide poisoning in some circumstances). Can be used to mitigate nutrient inputs into aquatic systems through rapid nutrient uptake.

Water bodies occupied

Water body type	Current water body infested	Potential water body infested
Lakes	-	Low
Rivers and streams	-	Low

Water body type	Current water body infested	Potential water body infested
Wetlands	-	High
Ponds and dams	-	High
Drains and canals	-	High
Troughs	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	L	Can be used as a pasture grass, but carries risk of fatal cyanide poisoning in some circumstances.	Aboling et al. 2014
Sheep and beef	-	L	As above.	
Forestry	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	L	M	Ecosystem engineer. Traps sediment and accumulates decomposing biomass, thereby altering stream morphology, dissolved oxygen levels and other biophysical properties.	Moar and Cunningham 1975 Clarke e al. 2004 Kotze 2006
Species diversity	L	M	Can form monocultures, displacing other plant species. 'Threatens' native vegetation on Ponui. Associated with simplified macroinvertebrate community composition and trophic guild structure.	Cameron 2000 Bagnall and Ogle 1981 Clarke et al. 2004 Wei and Chow-Fraser 2006

Category	Current	Potential	Comment	Source
Threatened species	-	M	Forms dense mats of vegetation which are impenetrable for inanga spawning, thus potentially reducing spawning habitat available in invaded systems.	Mitchell 1993
Social/Cultural				
Human health	-	-		
Recreation and aesthetics	L	L	Dense mats may alter access to and/or enjoyment of aquatic habitats.	
Maori culture	-	M	Impacts on the wairua of wai māori.	

L = low M= moderate H = high - = no impact + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention			
Exclusion programme			
Eradication programme			
Progressive containment programme			
Sustained control programme			
Site-led pest programme			
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate.		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	Resulting from this process, the council is of the opinion that reed sweet grass does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be <u>no regional intervention</u> for reed sweet grass, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding. While reed sweet grass has not been afforded pest status in Northland, it may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes.		

Rudd

Scardinius erythrophthalmus

(Family: Cyprinidae)

Status in New Zealand

'Noxious fish' under the Freshwater Fisheries Regulations (1983), excluding Auckland/Waikato Fish & Game regions. 'Sports fish' under the Freshwater Fisheries Regulations (1983) in the Auckland/Waikato Fish & Game regions only.

Relevant biology

Form	Rudd were illegally imported into New Zealand in 1967, and widely released into freshwater systems. Rudd are darker on their backs than on their bellies and have bronze highlights when the light catches their scales. Their fins are usually bright reddish-orange. They do not have any barbels around their mouth, a feature that tells them apart from koi carp. They do not have spines on the front edge of the dorsal fin, but have projections at the bases of their pectoral and pelvis fins. Rudd are usually 200-250mm long. Juveniles eat plankton and midges. Adults are mainly herbivorous but also consume invertebrates and occasionally small fish.
Habitat	Freshwater, including lakes, ponds, rivers and streams. They also tolerate periods of exposure to brackish water.
Regional distribution	Rudd are restricted mainly to lakes and ponds in Northland. Current data indicates that rudd are present in Lakes Rototuna, Ngatu, Parawanui, Kapoai and Kai Iwi, along with four unnamed lakes/ponds. Comprehensive sampling in the 1990s did not find any in Lake Kai Iwi and it is likely that they have died out there. Populations in other Northland lakes and ponds could, in theory, be eradicated (as with koi carp), but this would be a relatively expensive exercise requiring the use of chemical control. Furthermore, populations have been recorded in the Waitangi River and a small tributary of the Wairoa River, which are not amenable to eradication.
Competitive ability	Juvenile rudd are carnivorous, but as adults their diet consists mainly of aquatic plants. A high-density rudd population could impact on native fish and plant communities, particularly where plant communities are limited. Rudd are prolific breeders and are known to be invasive overseas. They may be advantaged by release from native-range parasites.
Reproductive ability	High fecundity. Sexually mature at around one year old for male, and around two years old for females. Spawn in spring-summer, producing around 1000-100,000 eggs.
Resistance to control	Chemical control (for example, rotenone) is non-selective, therefore has potential for non-target impacts on native fish. Chemical control may also be less effective when submerged macrophytes are present. Some sites may have strong probability of re-invasion due to connections with other water bodies and/or people dispersing them.
Benefits	Caught for sport by coarse anglers.

Water bodies occupied

Water body type	Current water body infested	Potential water body infested
Lakes	Low	High
Rivers and streams	Low	High
Wetlands	-	Low
Ponds and dams	Low	High
Drains and canals	-	Low
Troughs	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	L	L-M	Positively associated with shifting of lakes from clear to turbid water. Juveniles may contribute to poor water clarity by eating zooplankton, causing re-suspension of nutrients via faeces and by reducing plant cover. Impacts on water quality appear to be additive/synergistic when multiple species of exotic fish are present.	Hicks, 2001; Rowe, 2007; Rowe and Wilding, 2012; Schallenberg and Sorrell, 2009.
Species diversity	L-M	M-H	Grazing of plants by rudd can negatively affect plant growth, survival and community composition. Rudd have played a part in macrophyte collapses in New Zealand lakes. Some high impact aquatic weeds, including	De Winton et al., 2001, 2002; Kapuscinski et al., 2014;

Category	Current	Potential	Comment	Source
			hornwort, are selectively avoided relative to some native species, and may be competitively advantaged by rudd grazing, exacerbating a shift to dominance by exotic weed species. May compete with native fish such as smelt and common bullies for invertebrate prey such as midges.	Lake et al., 2002; Nurminen et al., 2003; Rowe, 2007; Van Donk and Otte, 1996.
Threatened species			As above.	
Social/cultural				
Human health	-	-		
Recreation and aesthetics	L	L-M	Impacts on water clarity (see 'Water quality') reduce aesthetic appeal of water bodies for swimming and other recreational uses. Can out-compete preferred sports fish such as trout.	Rowe and Wilding, 2012.
Māori culture	L	M-H	Impacts on mauri of wai māori (see 'Water quality', 'Species diversity' and 'Recreation').	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	Rather than applying a programme under the Regional Pest Management Plan, the species could come under a 'Connecting Communities' programme outside of the pest management plan, where advice and support are provided for specific sites. This will provide support to communities as and where the species is having impacts.	By not applying a programme and rules to the species, there would be no provisions under the pest management plan to manage inappropriate practises that are exacerbating the spread.	High. By not applying a programme and rules to the species, there would be no provisions under the pest management plan to manage inappropriate practises that are exacerbating the spread.
Exclusion programme	Not applicable.	Not applicable.	Rudd are already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Rudd are present throughout the region so would not be suitable for an eradication programme.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Progressive containment programme	Not applicable.	Not applicable.	Rudd are present throughout the region so are unlikely to be suitable for a progressive containment programme.
Sustained control programme	Rudd could be included in a sustained control programme. The council could include a rule banning dumping/deliberate spread within the Northland region. A rule requiring that rudd are on killed on capture could also be considered.	Education and publicity. Enforcement of rules; responding to reports.	Moderate - resources required.
Site-led pest programme	The council could specify high value lakes as site-led programmes, as an incursion at these sites could have significant impacts. Rudd could be listed as a progressive containment or eradication species in these lakes, so that if a new incursion is detected through regular surveillance the council is ready to act. The council could also introduce rules about the species people were allowed to keep in outdoor ponds/dams close to a high value lake.	Enforcement of rules (rules would only be applicable in the areas defined as site led programmes and could not be enforced elsewhere); response costs should an incursion occur.	Low - as action would take place in specific high value places making better use of limited resources.
Summary of alternative assessments and preferred option:	Sustained control programme Summary of alternative assessments and preferred option: In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for rudd. In terms of alternative approaces assessed, under no regional intervention (or do nothing) there could be unacceptable loss of biodiversity values in the regions' waterways if rudd were to spread uncontrollably. There would be significant public and political concerns and consequences if rudd were known to be present and no action was taken to control or further limit distribution or effects. Eradication of rudd is not technically feasible, due to the habitats in which they live, lack of effective, wide-scale control techniques and their current distribution in ponds and lakes. However, many areas of the region are free of the pest and some currently infested sites might be contained in the long-term. There would be political risks associated with seeking region-wide eradication and then being unable to achieve that goal. Due to the extent of populations in the regions' lakes and ponds, progressive containment is not considered achievable and a site led approach would be a lesser management option and one which would allow rudd to slowly spread into new areas. A sustained control programme outcome (to reduce the impacts and spread to other places) is the preferred option and represents the most pragmatic and affordable management measure for the Northland region. There are rules to adhere to around not keeping fish live, not transporting them and killing rudd when caught. NRC intends to undertake direct control of this pest fish in any new sites through its service delivery programme and will work with others on management strategies, including advocacy. Any operational risks are deemed		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	low to moderate and depend very much on the individual sites where rudd are found. The biggest risk to achieving a sustained control outcome is through sports fishers not adhering to the proposed rules and intentionally catching and releasing rudd to new waterways or others not being motivated to adhere to the rules.		

Salvinia

Salvinia molesta

Also known as: kariba weed

(Family: Salviniaceae)

Status in New Zealand

Salvinia is listed as an unwanted organism under the Biosecurity Act 1993, is a Notifiable Organism (Biosecurity (Notifiable Organisms) Order 2010) and is listed in the National Pest Plant Accord 2012. It is also one of eleven pest species that are part of the National Interest Pests Response (NIPR). Management of this pest plant is led by MPI.

Relevant biology

Form	Salvinia is a free-floating aquatic fern that forms large, dense mats. With its hairy leaves and floating habit it can be hard to recognise as a fern. The spongy leaves are green to bronze, up to 5cm long, and their shape varies with the age. Young, small leaves lie flat on the water surface but mature leaves tend to become crowded and fold up. The upper surface of the leaf is water repellent and covered with distinctive white hairs with an egg-beater like tip. Salvinia has no true roots but has a root-like structure underneath each leaf pair.
Habitat	Salvinia grows on wind-protected ponds, small lakes, artificial waterbodies (e.g. dams and reservoirs) and swampy backwaters. It grows best in nutrient enriched waters but can survive in frequently inundated, damp mud.
Regional distribution	Salvinia has been eradicated from a number of sites in Northland, including 2 infestations that were recently reported at Otukairangi. However, new small sites, usually in garden ponds, are discovered regularly.
Competitive ability	Salvinia quickly forms extensive mats, completely smothering waterways. It can double in area within 10 days. The mats exclude native plants, block dams and waterways, impede drainage, disrupt recreational activities and reduce water quality by lowering oxygen levels. The mats also create a drowning risk for people and animals. Salvinia is frost-sensitive and prone to winter die-back and does not tolerate shade.
Reproductive ability	In New Zealand, salvinia does not produce spores. It spreads vegetatively from plants and plant fragments. Vectors of spread: Plants and fragments may be spread by water, currents, wind movement, and machinery. They are also intentionally spread by people.
Resistance to control	Salvinia can be controlled by physical or mechanical means. In other countries, biological controls are also used.
Benefits	Salvinia is valued by some owners of ornamental ponds because it provides shelter and spawning habitat from predators for fish.

Water bodies occupied

Water body type	Current water body infested	Potential water body infested
Lakes	-	High
Rivers and streams	-	Low
Wetlands	-	High
Ponds and dams	Low	High
Drains and canals	-	High
Aquaria or troughs	Low	High

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Farming	-	L	Mats of salvinia can block dams and pumps, impede drainage, and create a drowning risk for people and animals.	Coffey & Clayton 1988
Horticulture	-	M	Mats of salvinia can block dams and pumps and impede drainage.	Coffey & Clayton 1988
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	H	Salvinia degrades water quality when it decomposes, reducing dissolved oxygen levels in the water.	AWC 2012
Species diversity	-	H	Salvinia grows quickly and can form extensive mats that completely smother waterways. The mats shade out submerged aquatic plants, remove the air–water interface, exclude native plants and reduce water quality and habitat availability for native fauna.	Coffey & Clayton 1988 AWC 2012
Threatened species	-	H	Salvinia grows quickly and can form extensive mats that completely smother waterways. The mats exclude native plants and reduce water quality and habitat availability for native fauna.	Coffey & Clayton 1988
Social/Cultural				

Category	Current	Potential	Comment	Source
Human health	-	M	Salvinia can result in high numbers of mosquitoes.	AWC 2012
Recreation and aesthetics	-	H	Salvinia reduces the aesthetic value of water bodies by accumulating litter, stagnating the water and developing fetid odours. Heavy infestations prevent access by boats and recreational fishing is impeded. Swimming is dangerous, if not impossible, in dense infestations	AWC 2012
Maori culture	-	H	Impacts upon native/taonga species and access to water ways.	

L = low M= moderate H = high - = no impact + = benefit

Proposed management

Option	Explanation of Benefits	Explanation of Costs	Level of risk that programme will not be successful *
No regional intervention	If no management action is undertaken there will be no short-term financial cost to the council associated with control of this species.	Salvinia is currently known from limited sites in Northland, but small new sites are found reasonably regularly. If it spreads from these locations to infest lakes, ponds, dams and waterways, there would be serious environmental impacts and considerable economic costs. The economic cost of delaying control until there are larger/more infestations is potentially considerable.	High. Without education and regulation there is a high risk that salvinia could spread and have severe impacts on freshwater habitats.
Exclusion programme	Not applicable.	Not applicable.	Salvinia is currently known to be present in Northland.
Eradication programme	Small, new sites of salvinia are found reasonably regularly, usually contained in aquaria or garden ponds. All sites the council is aware of are reported to MPI who are responsible for managing the control. Salvinia has ornamental value and a continued eradication programme would raise public awareness and education about the risks and impacts of this species. A rule banning	There is already educational material available for salvinia. Responding to reports. Eradication will require a short- to medium-term investment of control effort, which is currently undertaken by MPI..	Low. People will be aware of the species and its potential impacts. There will be a rule banning possession of the species in Northland, which could help discourage people from bringing it to the region and allow immediate control should any be found. However, there is a risk that an eradication programme could fail because there may be undiscovered infestations.

Option	Explanation of Benefits	Explanation of Costs	Level of risk that programme will not be successful *
	possession of the species in Northland could prevent it from establishing more widely.		
Progressive containment programme	Not applicable.	Not applicable.	It is not possible to define a progressive containment area, as there are no currently known sites which still have salvinia present.
Sustained control programme	Not applicable.	Not applicable.	Salvinia is not common or widespread in Northland, so a sustained control programme is not applicable. It would also be in contradiction to the national goal of eradication.
Site-led pest programme	Not applicable.	Not applicable.	A site-led programme would contradict the national goal of eradication.
Summary of alternative assessments and preferred option:	Eradication programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for *Salvinia*. In terms of alternative approaches assessed, under <u>no regional intervention</u> (or do nothing) there would be a medium to high risk of public and political criticism of Council for not being more proactive over *Salvinia* management, as it is one of 11 high threat pests in New Zealand on an MPI watch list (for National Interest Pests). Biodiversity values could be impacted if *Salvinia* was discovered (as seems to be the recent pattern) and no intervention measures were available to the Council. Under a no intervention approach, NRC could rely on MPI solely and non-regulatory methods such as advocacy, education and site-led management, but loses the tools, regionally, to take direct action or impose penalties for deliberate liberations of this pest. <u>Progressive containment or sustained control</u> approaches would not be appropriate as *Salvinia* is rare in Northland. It would be highly risky of Council relying on 'lesser' control options when eradication or zero density is achievable. It would be an unacceptable risk to rely only on landowners to control infestations – for example, control of any aquatic pests with herbicides is usually difficult and expensive. Additionally, as the sites involve treatment over water, permissions to use herbicides are required through the Environmental Protection Agency (EPA). These situations require a high level of regional intervention (through professional surveillance and direct control approaches). These operational risks would compromise the outcomes sought if landowners were responsible for control work, therefore council and/or MPI service delivery is the most appropriate control measure. <u>Eradication</u> is the preferred outcome and is realistic given the current level of infestation and the technical challenges involved. There is some level of risk that small infestations of *Salvinia* will be found again in Northland or unknown infestations are found. However, NRC intends to undertake direct control of *Salvinia* wherever it occurs in the region. The costs involved under an eradication programme are minor (compared with the risks of doing nothing and allowing it to spread) and this approach provides Council with some regulatory tools to incentivise water users such as boaties, eel fishermen, anglers, and fowl shooters to stop the spread of wetland and semi-aquatic pests to new areas. The benefits of inclusion in the Plan are that significant wetlands and margins of waterways would in the long-term remain free of this pest. The value is difficult to estimate but would be significant, given the high public interest in maintaining wetlands and aquatic ecosystems in a natural state.		

Senegal tea

Gymnocoronis spilanthoides

Also known as: temple plant, costata.

(Family: Asteraceae)

Status in New Zealand

Senegal tea is listed as an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Senegal tea is a hardy, semi-aquatic, perennial herb. It can form rounded bushes up to 1.5m tall or scrambling mats of tangled stems that spread out over water bodies. It has dark green, opposite leaves that are shiny and hairless. Larger stems are hollow between the nodes and are buoyant in water. It produces distinctive, white, clover-like flowers during summer. It looks like alligator weed or willow weed, except that the margins of its leaves are bluntly serrated.
Habitat	Senegal tea grows in damp soils. It usually grows rooted on the edge of waterways but can also survive and continue growing when completely inundated. Suitable habitats include wetlands, streams and degraded waterways.
Regional distribution	Senegal tea is currently known from only one location in Northland and has been eradicated from seven others. There is a possibility of undiscovered infestations.
Competitive ability	Senegal tea grows very quickly. It can rapidly cover water bodies with a floating mat of stems that displaces and out-competes native plants. The effects of flooding are made much worse because infestations block drainage channels. Recreational activities and irrigation may also be affected.
Reproductive ability	Senegal tea can reproduce by seed and vegetatively from stem fragments. Recent research has shown that seed production in Queensland is extremely low, which indicates that reproduction by seed is not very important there. Vegetative spread occurs when a stem or leaf breaks off and grows roots. Vectors of spread: the seeds are quite heavy. Most of them drop near the parent plant and they can be spread by animals or machinery. Plant fragments can be transported by water, people and machinery.
Resistance to control	Senegal tea is very hard to kill and herbicides are effective only on the parts of the plant that are above water. Herbicide application should be undertaken during periods of low water levels and prior to undertaking mechanical removal. Plant waste must be disposed of carefully to prevent it from re-growing.
Benefits	Aquarium plant.

Water bodies occupied

Water body type	Current water body infested	Potential water body infested
Lakes	-	Low
Rivers and streams	-	Low
Wetlands	-	High
Ponds and dams	Low	High
Drains and canals	-	High
Troughs	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Farming	-	L	Senegal tea can cause flooding because it blocks drainage channels.	Christchurch Regional Council Weed Management, 2003.
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	M	Senegal tea has the potential to negatively affect water quality if lots of plant material dies off and rots under water. The dense mats alter water flows.	Global invasive Species Database; Williams and Champion, 2008.
Species diversity	-	H	Senegal tea can invade and degrade natural wetlands. It competes strongly with low-growing native plants and the floating mats shade the water column and submerged species, affecting wetland birds and other animals.	Williams and Champion, 2008; Christchurch Regional Council Weed Management, 2003.
Threatened species	-	M	Senegal tea can invade and degrade natural wetlands affecting native plants and animals, including threatened species.	Christchurch Regional Council Weed Management, 2003.
Social/cultural				

Category	Current	Potential	Comment	Source
Human health	-	-		
Recreation and aesthetics	-	M	Senegal tea can form obstructive mats over still or flowing water. These may impede recreational access.	Champion et al., 2008.
Māori culture	-	H	Impacts on native/taonga species.	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial costs to council associated with control of this species.	Senegal tea is currently known from only one location in Northland. If it spreads from this site there could be serious environmental impacts. The economic cost of delaying control until there are larger/more infestations is potentially considerable.	High. Senegal tea is an invasive, semi-aquatic plant with the ability to spread from both plant fragments and seeds. There is extensive habitat for this species throughout Northland (Williams 2008 (a)). Without education and regulation there is a high risk that Senegal tea will spread.
Exclusion programme	Not applicable.	Not applicable.	Senegal tea is already present in Northland.
Eradication programme	Senegal tea is currently present at only one site in Northland. If the species could be eradicated before it spreads elsewhere, it would prevent long-term impacts and financial costs.	There is only one known infestation of Senegal tea in the Northland region. Therefore, eradication would not require a large investment of resources, but it does require ongoing control as it is hard to kill.	Low. Senegal tea is hard to kill but there is only one known infestation and, previously, other infestations have successfully been eradicated. However, there is a moderate risk that the species has already been spread from this site to other locations.
Progressive containment programme	Not applicable.	Not applicable.	There is only one known site in Northland and it is very small.
Sustained control programme	Not applicable.	Not applicable.	There is only one known site in Northland and it is very small.
Site-led pest programme	Not applicable.	Not applicable.	There is only one known site in Northland and it is very small.
Summary of alternative assessments	Eradication programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for Senegal tea. In terms of alternative approaches assessed, under no regional intervention (or do nothing), there would potentially be unacceptable loss of		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
and preferred option:	biodiversity values as there are many suitable habitats for it to thrive in in Northland. Currently, Senegal tea is very limited in distribution. However, there is less likelihood of significant public or political concerns as this pest plant is not widely known. Progressive containment or sustained control approaches would not be appropriate as the plant is thought to be very rare in Northland. It would be risky relying on 'lesser' control options when eradication or zero density is achievable. It would be an unacceptable risk to rely only on landowners to control infestations – for example, it is not readily identified and control with herbicides is known to be difficult and expensive. Additionally, as the sites involve treatment over water, permissions to use herbicides are required from the Environmental Protection Agency (EPA). These situations require a high level of regional intervention (through professional surveillance and direct control approaches). These operational risks would compromise the outcomes sought if landowners were responsible for control work, therefore council service delivery is the most appropriate control measure. Eradication is the preferred outcome and is realistic given the current infestations and the technical challenges involved. NRC intends to undertake direct control of Senegal tea wherever it occurs in the region (through its service delivery programme). The costs involved under an eradication programme are minor (compared with the risks of doing nothing and allowing it to spread) and are not expected to adversely affect control outcomes.		

Snake-necked turtle

Chelodina longicollis

(Family: Chelidae)

Status in New Zealand

Sold in aquarium trade.

Relevant biology

Form	Snake-necked turtles are medium-sized turtles, with an average length of 25cm. They have a black to light brown oval shell that contains a shallow central groove. The underside of the shell (plastron) is cream-coloured with dark seams. Their necks are long and narrow, with a brown to grey upper surface and yellow underneath. On average, the neck is approximately 60% of the shell length and is covered with small bumps. The head is small and pointed and the limbs are dark grey to brown. Sexual dimorphism in this species is subtle. Females are slightly larger than males, and have deeper shells with a shorter, fatter tail that is hidden. Males have longer, thicker tails than females and the platstron is concave. Juveniles tend to be black to dark grey with an orange stripe down either side of the neck and jaw, and they also have orange spots on the plastron. Snake-necked turtles are opportunistic carnivores and feed on a broad range of plankton, bottom-dwelling macro-invertebrates, carrion and terrestrial insects.
Habitat	Snake-necked turtles are endemic to Australia and are found from eastern Queensland down to the south-western border of New South Wales. They are semi-aquatic, preferring slow moving water such as wetlands, lakes, dams and ponds but can also be found in streams and rivers, and can survive in urban environments. Snake-necked turtles are active and can forage at low temperatures widening the amount of suitable available habitat. They are capable of long distance overland migration. In aquatic environments, they are primarily bottom dwelling, but occasionally leave the water to bask in the sun. If conditions are dry, they will seek out new habitat, and are able to aestivate until flood waters return. Aestivation usually occurs under trees in forested habitats where they can burrow into fallen foliage on the forest floor near shrubs and logs. Snake-necked turtles are usually the only turtle species in their immediate environment. Modelling indicates a high risk risk of establishing in the wild in parts of New Zealand.
Regional distribution	There are no known populations established in the wild in Northland or elsewhere in New Zealand. Climatic suitability modelling suggests the northern part of the North Island and coastal areas of the Bay of Plenty, Gisborne, Hawkes Bay and Wanganui-Manawatu could provide suitable conditions for snake-necked turtles.
Competitive ability	Survivorship rates of juveniles and adults in permanent waterbodies in Australia are very high (85-94%) but lower survival rates (55%) have been observed for turtles aestivating near dry ephemeral wetlands. Predation on nests in Australia is high, with approximately 50% of nests destroyed. Predators include Australian native water rats, goannas, and ravens, but most nests are destroyed by introduced foxes.

	Many snake-necked turtles are killed by vehicles on roads in Australia. Riparian habitat modification for agriculture and urban development also threaten populations in Australia, as does declining water quality.
Reproductive ability	Snake-necked turtles are relatively slow to mature; 7-8 years for males and 10-12 years for females. Females lay six to 23 hard-shelled eggs during spring and late summer, and can produce up to three clutches per year. Females may travel up to 500m from water to find preferred nesting sites on crests or ridges, and will nest in a variety of substrates, from soft sand to hard clay, or even gravel roads. Snake-neck turtle embryos are able to withstand a wide range of temperatures and still hatch normally, but a minimum temperature of at least 24°C is required for embryonic development. Incubation takes up to 145 days in the wild in Australia. Data from dataloggers suggests that snake-necked turtles could find suitable nesting sites in some parts of New Zealand, including Auckland and Northland. Vectors of spread in New Zealand: Pet trade, accidental/intentional release, escape from captivity.
Resistance to control	Difficulties catching them due to aquatic environment.
Benefits	Commonly sold in the New Zealand pet trade for $100-150.

Water bodies occupied

Water body type	Current water body infested	Potential water body infested
Lakes	-	High
Rivers and streams	-	Low
Wetlands	-	High
Ponds and dams	-	High
Drains and canals	-	Low
Troughs	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Farming (toxic to stock, and affects drainage)	-	-		
Horticulture	-	-		
Other	-	-		

Category	Current	Potential	Comment	Source
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	-		
Species diversity	-	M	Predation of native species most likely threat posed. Potential for disease transmission to other reptiles (for example, parasites, can transmit *Salmonella*).	Kennett et al., 2009. Kikilus, 2010.
Threatened species	-	L	Potential for predation on native invertebrates as they are opportunistic carnivores.	Kennett et al., 2009. Kikilus, 2010.
Social/cultural				
Human health	-	-		
Recreation and aesthetics	-	-		
Māori culture	-	L	Potential impacts on native/taonga species.	

L = low; M= moderate; H = high; - = No impact; + = Benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful *
No regional intervention	Higher purchase price so are less likely to be released when no longer wanted. However, if they are released, they could survive in Northland.	None	Moderate – some risk that a wild population could establish in Northland.
Exclusion programme	Not applicable.	Not applicable.	Snake-necked turtles are likely to already be present in captivity in Northland.
Eradication programme	Snake-necked turtles could be included in the pest management plan as an organism not declared a pest. They could still be sold by the aquarium industry. To reduce the risk of spread through the deliberate actions of people, the council could include	Publicity/education regarding dumping of pets; follow-up on reports. Control programme if feral turtles were found.	Moderate – this species could still be sold in Northland and over time the numbers held in captivity are likely to grow increasing the risk of escapes and deliberate releases.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful *
	a rule banning dumping/deliberate spread within the Northland region. Council would undertake a control programme if a feral population was discovered.		
Eradication programme	As a declared pest snake-necked turtles would be banned from sale under the Biosecurity Act. This could help reduce the risk of spread as over time less people would have these turtles in aquariums or ponds in Northland. The council could include a rule banning dumping/deliberate spread and transport within the Northland region. Council would undertake a control programme if a feral population was discovered.	Inspection of pet shops; monitoring Trademe sales; enforcement action; follow-up on reports. Control programme if feral turtles were found.	Low-Moderate – need to ensure resources are available.
Progressive containment programme	Not applicable.	Not applicable.	There are no known feral populations of snake-necked turtles in Northland so it is not possible to define a progressive containment area.
Sustained control programme	Snake-necked turtles could be included in the pest management plan as an organism not declared a pest. They could still be sold by the aquarium industry. To reduce the risk of spread through the deliberate actions of people, the council could include a rule banning dumping/deliberate spread within the Northland region.	Publicity/education regarding dumping of pets; follow-up on reports.	Moderate- high – this species could still be sold in Northland and over time the numbers held in captivity are likely to grow increasing the risk of escapes and deliberate releases. A sustained control programme would not allow for council to attempt to control any feral populations found.
Sustained control programme	As a declared pest snake-necked turtles would be banned from sale under the Biosecurity Act. This could help reduce the risk of spread as over time less people would have these turtles in aquariums or ponds in Northland. The council could include a rule banning dumping/deliberate spread and transport within the Northland region.	Inspection of pet shops; monitoring Trademe sales; enforcement action; follow-up on reports.	Moderate – some risk that a wild population could establish in Northland. A sustained control programme would not allow for council to attempt to control any feral populations found.

<table>
<tr><th>Option</th><th>Explanation of benefits</th><th>Explanation of costs</th><th>Level of risk that programme will not be successful *</th></tr>
<tr><td>Summary of alternative assessments and preferred option:</td><td colspan="3">Eradication programme
In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for snake-necked turtles. In terms of alternative approaches assessed, under <u>no regional intervention</u> (or do nothing) there could be potential loss of biodiversity values in the long-term if wild turtle populations were ‘allowed’ to establish. There is an increasing general awareness about the impacts of these animals if released into the wild. These continued acts will over time raise the level of public concern and there is some political risk in NRC not responding now to the various signals around this animal. No intervention may appeal to some in the community that view snake-necked turtles as pets, although the majority of responsible owners would probably agree that releasing them into the wild in Northland could lead to long term ecological issues.
<u>Progressive containment or sustained control</u> approaches, with corresponding land occupier control rules, (or fewer Council resources being deployed) would not be appropriate. Although they are not known to exist in the wild in Northland, the key stakeholders (NRC and DOC) are better placed to respond to any sightings and take direct control action. It would be risky relying on ‘lesser’ management options when eradicating snake-necked turtles from the wild would be achievable and realistic with current tools available (e.g. catch and euthanize). It would be an unacceptable risk to rely on directing landowners to locate and then destroy individual animals.
<u>Eradication</u> of wild snake-necked turtles is the preferred outcome within the region but relies heavily on members of the public firstly encountering an animal in the wild then secondly, being motivated to report it. Awareness around the need to control wild populations of snake-necked turtles will be stepped up over time. Pet trade issues and the propensity for these animals to be either intentionally released or escape accidentally, creates a moderate risk for achievement of an eradication outcome. Overall, the costs involved under an eradication programme are relatively minor (although greater than for progressive containment of sustained control) but are not expected to adversely affect control outcomes.</td></tr>
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Tench

Tinca tinca

(Family: Cyprinidae)

Status in New Zealand

Naturalised. Sports fish subject to national sport fishing regulations.

Relevant biology

Form	Tench were first introduced to New Zealand in 1867 as a sports fish. Tench grow to a large size in New Zealand, and fish over 2kg in weight are not uncommon. Tench are usually olive green-bronze in colour, with red eyes, two barbels, large soft-rayed fins and copious mucous. Adults are approximately 30-40cm long (sometimes up to 70cm), and the lifespan is around five plus years. Male and female fish look slightly different. Juveniles predominantly feed on zooplankton. Adults are primarily bottom feeders, preferring small molluscs when available, but can survive solely on zooplankton when alternative food sources are absent. Tench are predominantly nocturnal foragers, and are a warm-water species, becoming less active during winter.
Habitat	Shallow regions of warm, still or slow-moving freshwater bodies with soft substrates (mud/silt/sand) and preferably some submerged vegetation. They tolerate very low oxygen levels, high turbidity, brackish water and a wide pH range.
Regional distribution	Tench are sparsely distributed in Northland at present, with the only known population in the Waitangi River. The records of tench in the Waitangi River indicate that the source populations are probably a couple of small and unnamed lakes/ponds in the headwaters and these may also hold rudd. Tench live and breed in the still waters of lakes and ponds rather than in the flowing waters of rivers. Eradication of these few lake/pond populations could therefore reduce tench in the river.
Competitive ability	Tench feed on insect larvae, crustaceans and molluscs, and have the potential to significantly alter native freshwater communities. They have few predators in New Zealand. May compete with common bullies as both are bottom dwelling, but no substantiating evidence of effects is available.
Reproductive ability	Tench spawn in shallow water, broadcasting eggs over substrate. Multiple spawning events (batches) can occur within one season. Warmer temperatures favour earlier sexual maturation and higher fecundity. Recruitment varies between years in response to environmental variables, resulting in strong year classes being apparent. Vectors of spread: Human-mediated dispersal by coarse anglers stocking new water bodies. Capable of hybridising with other fish such as carp, rudd and goldfish, but not confirmed as occurring in the wild.
Resistance to control	Chemical control (e.g. rotenone) is non-selective, therefore has potential for non-target impacts on native fish. Chemical control also less effective when submerged macrophytes are present. Some sites may have strong probability of re-invasion due to connections with other water bodies and/or human-mediated dispersal.
Benefits	Caught for sport by coarse anglers.

Water bodies occupied

Water body type	Current water body infested	Potential water body infested
Lakes	-	High
Rivers and streams	Low	Low
Wetlands	-	Low
Ponds and dams	Low	High
Drains and canals	-	Low
Troughs	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	-		
Sheep and beef	-	-		
Forestry	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	L	M	Can contribute to poor water clarity by consumption of zooplankton, exacerbating algal blooms. Bottom feeding also causes re-suspension of sediment and up-rooting of submerged macrophytes. Excretion of nutrients in faeces exacerbates nutrient re-suspension. Combined effects of eating plankton and bottom feeding can contribute to lakes 'flipping' to an alternative state devoid of vegetation, with turbid water dominated by phytoplankton. Impacts on water quality appear to be additive/synergistic when multiple species of exotic fish are present, and tench presence is significantly correlated with the incidence of New Zealand lakes 'flipping'.	Rowe 2004; 2007 Rowe and Champion 1994 Rowe and Verburg 2015 Schallenberg and Sorrell 2009 Beklioglu et al. 2003 Ozen et al. 2014

Category	Current	Potential	Comment	Source
Species diversity	L	L-M	Little information available on potential impacts in New Zealand. Rated as relatively low impact, but based largely on lack of information. Possible indirect effects on native fish species diversity via transmission of the parasite *Ligula intestinalis*, reduced water clarity, and/or competition for invertebrate prey. However, potential impacts on co-occurring native fish such as bullies have not been substantiated. Diet includes wide range of benthic invertebrates, including insects (e.g. midges, maylies, dragonflies, damselflies) and molluscs (snails and bivalves) as well as plankton. Implications for invertebrate communities in New Zealand are unknown. Tench are associated with increased periphyton growth on macrophytes (possibly via consumption of snail grazers). Increased periphyton load can reduce light and nutrient availability for macrophytes, resulting in reductions in macrophytes biomass, although this appears to happen only at high tench densities and therefore is unlikely to be occurring at present in Northland or Auckland water bodies. Substrate disturbance associated with bottom feeding may also impact on submerged macrophytes.	Rowe 2004 Giles et al. 1990 Rowe and Wilding 2012 Rowe et al. 2008 Jones and Sayer 2003 Beklioglu and Moss 1998 Bronmark 1994
Threatened species	L	M	As above.	
Social/Cultural				
Human health	-	-		
Recreation and aesthetics	-	M	Impacts on water clarity (see 'Water quality') reduce aesthetic appeal of water bodies for swimming and other recreational uses. May contribute to toxic algal blooms. Can be a contributing factor to public complaints regarding lake water quality.	Rowe and Verburg 2015
Maori culture	L	M	Numerous impacts on mauri of wai māori (see 'Water quality' and 'Species diversity').	

L = low M= moderate H = high - = no impact + = benefit

Proposed management

Option	Explanation of Benefits	Explanation of Costs	Level of risk that programme will not be successful
No regional intervention	Rather than applying a programme under the Regional Pest Management Plan, the	By not applying a programme and rules to the species, there would	High. By not applying a programme and rules to the species, there would be

Option	Explanation of Benefits	Explanation of Costs	Level of risk that programme will not be successful
	species could come under a 'Connecting Communities' programme outside of the pest management plan, where advice and support are provided for specific sites. This will provide support to communities as and where the species is having impacts.	be no provisions under the pest management plan to manage inappropriate practises that are exacerbating the spread.	no provisions under the pest management plan to manage inappropriate practises that are exacerbating the spread.
Exclusion programme	Not applicable.	Not applicable.	Tench are already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Resources and control tools to eradicate tench from rivers are not currently available, so an eradication programme is not an appropriate option.
Progressive containment programme	Tench populations are currently limited in Northland. A progressive containment area could be defined around the known river, with other populations found being controlled over time to minimise the risk of spread to other high value water ways. Rules as described for the sustained control programme would also apply.	Education and publicity. Responding to reports, progressive eradication of any outlier sites. A partnership approach with DOC would be required.	Moderate - there may be more tench populations than are currently known about. Deliberate or accidental release of tench by people into new water ways is a possibility.
Sustained control programme	Tench could be included in a sustained control programme. The council could include a rule banning dumping/deliberate spread within the Northland region. A rule requiring that tench are on killed on capture could also be considered, but would need careful consideration as Tench are part of the national sports fish regulations..	Education and publicity. Enforcement of rules; responding to reports.	Moderate - resources required.
Site-led pest programme	The council could specify high value lakes as site-led programmes, as an incursion at these sites could have significant impacts. tench could be listed as a progressive containment or eradication species in these lakes, so that if a new incursion is detected through regular surveillance the council is ready to	Enforcement of rules (rules would only be applicable in the areas defined as site led programmes and could not be enforced elsewhere); response costs should an incursion occur.	Low - as action would take place in specific high value places making better use of limited resources.

Option	Explanation of Benefits	Explanation of Costs	Level of risk that programme will not be successful
	act. The council could also introduce rules about the species people were allowed to keep in outdoor ponds/dams close to a high value lake.		
Summary of alternative assessments and preferred option:	Progressive containment programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for tench. In terms of alternative approaches assessed, under no regional intervention (or do nothing) there would be unacceptable loss of biodiversity values in the regions' waterways if tench were to spread uncontrollably. There would be significant public and political concerns and consequences if tench were known to be present and no action was taken to control or limit distribution. Eradication of tench is not technically feasible, due to the habitats in which they live and lack of effective, wide-scale control techniques. However, much of the region is free of the pest and some sites may achieve zero density over time or at least be contained. There would be political risks associated with seeking region-wide eradication and then being unable to achieve that goal. A sustained control or site led approach would be unpalatable and seen as a lesser management option and one which would allow tench to slowly spread into new areas. The option considered to carry the least risk is progressive containment. NRC intends to undertake direct control of this fish pest through its service delivery programme and will work with others on control strategies. Any operational risks are deemed low to moderate and depend very much on the individual sites where perch are found. Electric fishing is effective in small areas; poisoning could require consents and draining waterways is generally not sustainable. Tench, and the spreading of tench, are managed under three different pieces of legislation – the Biosecurity Act 1993, the Freshwater Fishing Regulations 1983 and the Conservation Act 1987 and there is some potential for mixed messaging or gaps to occur as a result, but these are thought to be minor issues. The biggest risk to achieving a progressive containment outcome is through sports fishers not adhering to the proposed rules and intentionally catching and releasing tench to new waterways or others not motivated to report any sightings.		

Water hyacinth

Eichhornia crassipes

(Family: Pontederiaceae)

Status in New Zealand

Water hyacinth is listed as an unwanted organism under the Biosecurity Act 1993, is a notifiable organism (Biosecurity (Notifiable Organisms) Order 2010), and is listed in the National Pest Plant Accord 2012. It is also one of eleven pest species that are part of the National Interest Pests Response (NIPR).

Relevant biology

Form	Water hyacinth is a free-floating aquatic plant that can grow in dense mats. The leaves are glossy, green, leathery and up to 8cm across. The leaf stems are swollen and spongy and act like floats. Each plant has a mass of purple roots. It produces an attractive spike of up to ten large, lilac-mauve flowers, each with a yellow spot in the centre of one of the petals.
Habitat	Water hyacinth grows in still or slow moving freshwater, such as ponds, streams, swamps and dams. In New Zealand, water hyacinth has been most common on small, nutrient-enriched waterbodies.
Regional distribution	Water hyacinth appears to have been eradicated from all known sites in Northland, but there is a possibility of undiscovered infestations as several small pond sites have been found in recent years.
Competitive ability	Water hyacinth forms dense mats which can completely smother waterways and reduce water quality. The mats exclude native plants, block dams and waterways, impede drainage and disrupt recreational activities. Water hyacinth is frost-tender but the dense mats tolerate moderate frosts.
Reproductive ability	Water hyacinth reproduces from seeds which may remain viable for 20 years. It also reproduces vegetatively - young plants can grow from roots and can produce seed within 3-4 weeks. Vectors of spread: Seeds and plants can be dispersed by water movement, wind, movement of machinery and equipment, and planned or accidental planting and release by humans.
Resistance to control	Physical removal is effective in small waterways and the aquatic herbicide diquat can be effectivw.
Benefits	Water hyacinth is highly valued by collectors and fish breeders and as an ornamental plant.

Water bodies occupied

Water body type	Current water body infested	Potential water body infested
Lakes	-	High
Rivers and streams	-	Low
Wetlands	-	High
Ponds and dams	Low	High
Drains and canals	-	High
Troughs	-	High

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Farming	-	L	Water hyacinth can block waterways, exacerbating flooding, and can block pumps.	ISSG
Horticulture	-	L	Water hyacinth can block waterways, exacerbating flooding, and can block pumps.	ISSG
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	H	Mats of water hyacinth can reduce levels of dissolved oxygen and light in the water column, significantly altering ecosystems and reducing biodiversity in plant and animal communities.	ISSG
Species diversity	-	H	Water hyacinth is known internationally as the world's most troublesome aquatic weed and it would have major environmental impacts if it was to establish and spread. It is capable of forming thick mats of vegetation on the surface of waterways that compete with other species of plants and animals for light, oxygen and nutrients.	Coffey & Clayton 1988 ISSG
Threatened species	-	-	Water hyacinth competes with other species including threatened native species.	
Social/Cultural				
Human health	-	-		

Category	Current	Potential	Comment	Source
Recreation and aesthetics	-	H	Water hyacinth can impede access to water bodies.	ISSG
Maori culture	-	H	Impacts on waterways and native/taonga species	

L = low M= moderate H = high - = no impact + = benefit

Proposed management

Option	Explanation of Benefits	Explanation of Costs	Level of risk that programme will not be successful
No regional intervention	If no management action is undertaken there will be no short-term financial cost to council associated with the control of this species.	There are currently no known sites of water hyacinth in Northland. It has been found here before and has been eradicated, however, there are still likely to be small undiscovered infestations. Water hyacinth is part of the National Interest Pest Response, so MPI are currently leading the response nationwide.	Moderate. Water hyacinth is a highly invasive species that may be intentionally introduced to Northland for ornamental purposes. If no action is taken this species could establish and/or spread in the Region. Several sites were found as a result of education and publicity through the 2010-2015 pest management strategy, which are unlikely to be have been found without the council programme.
Exclusion programme	Not applicable.	Not applicable.	Water hyacinth is still likely be present in undiscovered garden sites in Northland.
Eradication programme	There are currently no known sites of water hyacinth in Northland, however it is likely that small sites still exist in garden ponds. The species has ornamental value and an eradication programme would raise public awareness and education about the risks and impacts of this species. A rule banning possession of water hyacinth in Northland could help prevent it from establishing in the region.	There is already educational material available for water hyacinth. Costs of including it in the pest management plan would be minimal - publicity and education, and responding to queries and reports. Control of any sites found is currently undertaken by MPI contractors as part of the National Interest Pest Response.	Low. People will be aware of water hyacinth and its potential impacts. There will be a rule banning possession of the species in Northland, which could help discourage people from bringing it to the region and allow immediate control should any be found.
Progressive containment programme	Not applicable.	Not applicable.	Water hyacinth is part of a National Interest Pest Response aimed at eradicating water hyacinth from New Zealand, so a progressive containment programme is not appropriate.

Option	Explanation of Benefits	Explanation of Costs	Level of risk that programme will not be successful
Sustained control programme	Not applicable.	Not applicable.	Water hyacinth is part of a National Interest Pest Response aimed at eradicating water hyacinth from New Zealand, so a sustained control programme is not appropriate.
Site-led pest programme	Not applicable.	Not applicable.	Water hyacinth is part of a National Interest Pest Response aimed at eradicating water hyacinth from New Zealand, so a site-led programme is not appropriate.
Summary of alternative assessments and preferred option:	Eradication programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for water hyacinth. In terms of alternative approaches assessed, under <u>no regional intervention</u> (or do nothing) there would be a medium to high risk of public and political criticism of Council for not being more proactive over water hyacinth management, as it is one of 11 high threat pests in New Zealand on an MPI watch list (for National Interest Pests). Biodiversity values could be impacted if water hyacinth was discovered (as seems to be the recent pattern) and no intervention measures were available to the Council. Under a no intervention approach, NRC could rely on MPI solely and non-regulatory methods such as advocacy, education and site-led management, but loses the tools, regionally to take direct action or impose penalties for deliberate liberations of this pest. <u>Progressive containment or sustained control</u> approaches would not be appropriate as water hyacinth is rare in Northland. It would be highly risky of Council relying on 'lesser' control options when eradication or zero density is achievable. It would be an unacceptable risk to rely only on landowners to control infestations – for example, control of any aquatic pests with herbicides is usually difficult and expensive. Additionally, as the sites involve treatment over water, permissions to use herbicides are required through the Environmental Protection Agency (EPA). These situations require a high level of regional intervention (through professional surveillance and direct control approaches). These operational risks would compromise the outcomes sought if landowners were responsible for control work, therefore council and/or MPI service delivery is the most appropriate control measure. <u>Eradication is the preferred outcome</u> and is realistic given the current level of infestation and the technical challenges involved. There is some level of risk that small infestations of water hyacinth will be found again in Northland or unknown infestations are found. However, NRC intends to undertake direct control of water hyacinth wherever it occurs in the region. The costs involved under an eradication programme are minor (compared with the risks of doing nothing and allowing it to spread) and this approach provides Council with some regulatory tools to incentivise water users such as boaties, eel fishermen, anglers, and fowl shooters to stop the spread of wetland and semi-aquatic pests to new areas. The benefits of inclusion in the Plan are that significant wetlands and margins of waterways would in the long-term remain free of this pest. The value is difficult to estimate but would be significant, given the high public interest in maintaining wetlands and aquatic ecosystems in a natural state.		

Water poppy

Hydrocleys nymphoides

(Family: Limnocharitaceae)

Status in New Zealand

Water poppy is listed as an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Water poppy looks like a water lily. It has thick, glossy, floating leaves attached to rubbery creeping stems and distinctive yellow flowers with a purple centre. The flowers have three petals and are up to 8cm across.
Habitat	Water poppy can grow in still or slow-flowing water that is less than two metres deep, especially if the water is warm and well-lit. It is an aggressive coloniser of ponds, streams, farm dams and lake margins.
Regional distribution	Water poppy has been eradicated from three known sites in Northland, but it is possible there are undiscovered infestations.
Competitive ability	Water poppy quickly forms mats that block waterways and drains, causing flooding. It is a particular threat to native species that cannot compete with its aggressive growth.
Reproductive ability	In New Zealand, water poppy is not thought to produce seed. It spreads from root fragments and new plantlets that are produced at the end of the growth season. These break away from the main plant and rise to the surface, where they are carried away by water movement to a new location before taking root in the mud. Vectors of spread: water poppy may be spread deliberately by people. Root fragments and plantlets may be spread by water.
Resistance to control	Controlling water poppy with herbicides can be difficult because it grows within water bodies.
Benefits	Ornamental.

Water bodies occupied

Water body type	Current water body infested	Potential water body infested
Lakes	-	High
Rivers and streams	-	High
Wetlands	-	Low

Water body type	Current water body infested	Potential water body infested
Ponds and dams	-	High
Drains and canals	-	High
Troughs	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	-	M	Water poppy is an aggressive coloniser of ponds, streams, and farm dams.	Coffey and Clayton, 1988.
Sheep and beef	-	M	Water poppy is an aggressive coloniser of ponds, streams, and farm dams.	Coffey and Clayton, 1988.
Horticulture	-	L	Water poppy is an aggressive coloniser of ponds, streams, and farm dams.	Coffey and Clayton, 1988.
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	-	L	Water poppy can completely choke streams, shallow ponds and lake margins, causing flooding.	Ministry for Primary Industries.
Species diversity	-	H	Water poppy is an aggressive coloniser of ponds, streams, and lake margins. It can completely choke waterways and exclude native species.	Coffey and Clayton, 1988; Ministry for Primary Industries.
Threatened species	-	H	Water poppy can exclude native species, potentially including threatened species.	Ministry for Primary Industries.
Social/cultural				
Human health	-	-		
Recreation and aesthetics	-	M	Water poppy can completely choke streams, shallow ponds and lake margins. It could impede access and the recreational values of water bodies and reduce the aesthetic values of water bodies.	Ministry for Primary Industries; Williams and Champion, 2008.
Māori culture	-	H	Impacts upon native/taonga species.	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful *
No regional intervention	If no management action is undertaken there will be no short-term financial cost to council associated with the control of this species.	There are currently no known sites of water poppy in Northland. However, it has previously been eradicated from three sites. If there are undiscovered infestations elsewhere and no action is taken, water poppy could spread and there would be serious environmental impacts and economic costs. If water poppy is not present in Northland and no action (for example, advocacy) is undertaken, it may be deliberately introduced for ornamental purposes.	High. Water poppy may be present in Northland or be intentionally introduced. If no action is taken this species could establish and/or spread.
Exclusion programme	Water poppy is not currently known to occur in Northland. The species has ornamental value and an exclusion programme would raise public awareness and education about the risks and impacts of this species. A rule banning possession of the species in Northland could prevent it from establishing in the region. If it is included in the Regional Pest Management Plan there is the ability to respond immediately if an infestation is detected in Northland.	There is already educational material available for water poppy. Excluding this species would prevent expenditure on its control if/when it invades Northland.	Moderate. People will be aware of the species and its potential impacts. There will be a rule banning possession of the species in Northland, which could help discourage people from bringing it to the region and allow immediate control should any be found. However, there is a moderate risk that an exclusion programme could fail because there may already be undiscovered infestations. Therefore, surveys of likely infestation sites will be required and any potential sightings will require follow-up.
Eradication programme	Not applicable.	Not applicable.	Water poppy is not known to be present in Northland.
Progressive containment programme	Not applicable.	Not applicable.	Water poppy is not known to be present in Northland.
Sustained control programme	Not applicable.	Not applicable.	Water poppy is not known to be present in Northland.
Site-led pest programme	Not applicable.	Not applicable.	Water poppy is not known to be present in Northland.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful *
Summary of alternative assessments and preferred option:	Exclusion programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for water poppy. In terms of alternative approaches assessed, under <u>no regional intervention</u> (or do nothing) there would be a moderate risk of public and political criticism of Northland Regional Council for not being more proactive over water poppy management, as it is already known in other North Island regions and may still exist in unknown Northland locations. Biodiversity values would be impacted if water poppy was discovered and no intervention measures were available. Under a no intervention approach, NRC could rely on non-regulatory methods such as advocacy, education and site-led management, but loses the tool to impose penalties for deliberate liberations of this pest. As water poppy is not currently known in Northland (having been previously eradicated) an exclusion programme outcome is the only appropriate option available. An exclusion programme focusing on a comprehensive surveillance programme (actively looking for water poppy and other undesirable aquatic pest plants) will help to mitigate any risks by detecting any infestations very early on. There is a medium to high risk that water poppy will be reintroduced to Northland or previously unknown sites being discovered. However, the benefits of inclusion in the Plan are that significant waterways should in the longterm remain free of this pest. The value is difficult to estimate but would be significant, given the high degree of public interest in keeping recreational lakes free of aquatic weeds and maintaining aquatic ecosystems in a natural state. This approach has very little extra cost to NRC, (over and above what is spent on advocacy and education) and provides Council with some regulatory tools to incentivise water users such as boaties, eel fishermen, anglers, and fowl hunters (particularly those outside the region) to stop the spread of aquatic pests to new areas.		

Water primrose

Ludwigia peploides subsp. montevidensis

Also known as primrose willow.

(Family: Onagraceae)

Status in New Zealand

Water primrose is listed as an unwanted organism under the Biosecurity Act 1993 and is listed in the National Pest Plant Accord 2012.

Relevant biology

Form	Water primrose is a perennial, emergent, aquatic herb, which has creeping or floating stems, with upright flowering stems. Leaves are alternate, up to 3 x 8cm. Flowers are yellow, up to 2cm in diameter, between November-February. The seed capsules are up to approximately 2.7cm long.
Habitat	Prefers the margins of still and slow-moving water bodies including lakes, streams, drains, reservoirs, and damp ground, including pasture. Tolerates water with depleted dissolved oxygen levels (anoxic) and brackish conditions. Prefers full sun and some shelter from wave and wind action. Frost tolerant but growth increases with warm temperatures.
Regional distribution	Water primrose is gradually becoming more widespread in Northland, known to be in most Norhtland ater catchments, but is currently only recorded from two lakes - Lake Waiporohita and Lake Wainui.
Competitive ability	History of invasiveness overseas. Rapid growth rate, broad environmental tolerances and high phenotypic plasticity - it can change appearance in response to changes in the environment. Known to compete strongly against a range of invasive taxa. Allelopathic, suppressing other plants.
Reproductive ability	Reproduces from seed and from stem or rhizome fragments. Natural dispersal via water movement. Human-mediated dispersal on contaminated equipment. Insect pollinated. Vectors of spread: seeds and fragments spread by water and human movement.
Resistance to control	Manual/mechanical control may exacerbate spread via fragmentation.
Benefits	Can be grown as ornamental pond plant.

Water bodies occupied

Water body type	Current water body infested	Potential water body infested
Lakes	Low	High
Rivers and streams	Medium	High

Water body type	Current water body infested	Potential water body infested
Wetlands	Medium	High
Ponds and dams	Medium	High
Drains and canals	Low	High
Troughs	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Production				
Dairy	L	L	Invades damp pasture around margins of invaded water bodies, displacing valuable forage species.	European and Mediterranean Plant Protection Organization, 2011; Robert et al., 2013.
Sheep and beef	L	L	As above.	
Forestry	-	-		
Horticulture	-	-		
Other	-	-		
International trade	-	-		
Environment				
Soil resources	-	-		
Water quality	L	M	Clogs waterways, impeding flow, increasing sedimentation and flood risk, and reducing dissolved oxygen levels. Potential impacts on nutrient cycling in New Zealand unknown. It is unlikely to impact most lakes within Northland, but can form large sprawling mats over shallow, sheltered, nutrient-rich lakes extending into adjacent nutrient-rich swamps.	Callaway et al., 2011; Dandelot et al., 2005; European and Mediterranean Plant Protection Organization, 2011; NIWA, 2014.

Category	Current	Potential	Comment	Source
Species diversity	L	L-M	Can form dense allelopathic mats, displacing other vegetation. Low stature marginal herb fields and turf communities particularly at risk. May adversely affect fish, macroinvertebrates and other fauna through habitat alteration.	Champion et al., 2001; Dandelot et al., 2005; European and Mediterranean Plant Protection Organization, 2011; Thouvenot et al., 2013.
Threatened species	-	L-M	As above.	
Social/cultural				
Human health	-	-		
Recreation and aesthetics	L	L-M	Can impede recreational water use, including boating and fishing.	Robert et al., 2013.
Māori culture	L	M	Impacts on mauri of wai māori (see 'Water quality', 'Species diversity' and 'Recreation').	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Do nothing			
Exclusion programme			
Eradication programme			
Progressive containment programme			
Sustained control programme			
Site-led pest programme			

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that water primrose does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be <u>no regional intervention</u> for water primrose, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding. While water primrose has not been afforded pest status in Northland, it may be included under a 'council supported management programme' outside of the RPMP. At its discretion, the council may provide advice and information to support communities experiencing localised effects of this organism. The council reserves its ability each year to determine (through the Annual Plan) the amount of expenditure and level of service offered through these support programmes.		

Marine pests

Asian date mussel

Arcuatula senhousia

(Family: Mytilidae)

Status in New Zealand

No legal status.

Relevant biology

Form	The Asian date mussel reaches a maximum length of 30mm, but is more commonly only 10-25mm in length, and 12mm in width. It has a smooth olive-green to greenish-brown shell, with straight or zig-zag stripy markings and a protective cocoon of threads. It burrows vertically in to sediment and filters food particles from the water using a short siphon. The Asian date mussel produces a thick cocoon of byssus threads around itself to protect its shell in at mussel densities of over 1500/m^2 these cocoons combine to form a continuous mat on the surface of the sediment.
Habitat	The Asian date mussel is an opportunistic species that can live in intertidal and subtidal areas down to depths of up to 20m. It can tolerate low salinity and low oxygen levels. It prefers to settle onto soft sediments and seagrass but can also be found on hard surfaces.
Regional distribution	The Asian date mussel is found throughout Northland in soft sediment areas including in the Whāngārei, Parengarenga and Kaipara harbours and the Bay of Islands.
Competitive ability	Asian date mussels can reach very high densities in soft sediments. For example in Auckland Harbour it has been recorded at densities of 16,000/m^2 with peak densities of over 150,000/m^2. When densities are high in soft sediments, the protective cocoons will fuse to form carpets which may exclude native shellfish and impact on the growth of eelgrass. Its high rate of reproduction and long, free-swimming larval stage mean the mussel is a successful invader.
Reproductive ability	The Asian date mussel is a prolific breeder with a fast growth rate and a short life span, the adults mature at 9 months of age and have an expected lifespan of 18-24 months. Male and female mussels release eggs and sperm into the water column at the same time. The larvae remain free-swimming for up to 55 days and during this time it can disperse over large distances. Vectors of spread: Larval mussels are dispersed by water currents and could be spread in ballast water. The majority of the incursions worldwide have been attributed to aquaculture gear and stock movements however Asian date mussel could potentially also be transported as fouling on boat hulls.
Resistance to control	Unknown.
Benefits	In small numbers, Asian date mussels may provide food for snapper.

Areas occupied

Area type	Current area infested	Potential area infested
Upper estuarine freshwater	-	-
Estuarine	Low	Low
Tidal mud flats	Low	Low
Rock outcrops/rocky reef	-	Low
Wave-dominated beach	-	-
Seabed	Low	Low
Marine structures incl moorings and marinas	Low	Low
Marine farms	Low	Low

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Coastal management area				
Marine 1 Protection (MM1)	L	L	Asian date mussel are present in Parengarenga harbour and Kaipara harbour (MM1), and Whāngārei Harbour (parts of which are MM1) which have high ecological values. While high densities can occur, dense populations are dominated by a single cohort of mussels, with little recruitment into the mats. Older animals in a mat appear to die in their second year and the mat and dead mussels left behind eventually disintegrates but could alter the structure of the substrate. Although the mussels in these large mats die off small patches of Asian date mussels have the potential to merge and grow into larger populations.	NIWA 2011; Creese et al., 1997
Marine 2 Conservation (MM2)	L	L	While high densities could occur in MM2 areas, dense populations are dominated by a single cohort of mussels, with little recruitment into the mats. Older animals in a mat appear to die in their second year and the mat and dead mussels left behind eventually disintegrates but could later the structure of the substrate. Although the mussels in these large mats die off small patches of Asian date mussels have the potential to merge and grow into larger populations.	NIWA 2011; Creese et al., 1997
Marine 3 Marine farm	L	L	Asian date mussels can establish on structures and grow on marine farm infrastructure, as well as underneath the farms. There have been reports of impacts on oyster farm operations in the Kaipara harbour.	
Marine 4 Mooring	-	L	Asian date mussels can establish on structures however this is a less preferred habitat and is not	

Category	Current	Potential	Comment	Source
			likely to significantly impact moorings due to the size of the mussel.	
Marine 5 Port facilities	-	L	Asian date mussels can establish on structures however this is a less preferred habitat and is not likely to significantly impact moorings due to the size of the mussel.	
Marine 6 Wharves	-	L	Asian date mussels can establish on structures however this is a less preferred habitat and is not likely to significantly impact moorings due to the size of the mussel.	
Environment				
Water quality	-	-		
Species diversity	L	L-M	Significantly more species and abundance of macrofaunal invertebrates occur outside the mats. Because the mussels are so dense within the mats, there is little physical space for other species to inhabit and only smaller species or those which are able to readily move through the mats (e.g., errant polychaetes) can live in the habitat created by Asian date mussels. In addition, the anoxic sediment trapped in or under mussel mats may not be a suitable environment for other animals. These effects are very localised and only occur when extensive mussel beds are formed. As these beds are short-lived, the environmental impacts at a site are also likely to be short lived; however some residual effects on species diversity may persist as the beds of dead mussels and mats disintegrate.	Creese et al., 1997; Global invasive species database
Threatened species	-	L	As above.	
Social/cultural				
Human health	-	L	Large populations of the Asian date mussel are thought to provide food and habitat for a highly toxic sea slug (grey side-gilled sea slugs) that was attributed to the death of dogs in Auckland. Slug populations decreased significantly with the decline of the mussel bed.	Science learning,2012.
Recreation (incl. fishing)	-	L	May cause a decrease in shellfish beds, but effects likely to be local and possibly short-lived.	
Māori culture	-	L	May cause a decrease in shellfish beds, but effects likely to be local and possibly short-lived.	

L = low; M = moderate; H = high

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	Rather than applying a programme under the pest management plan, the species could come under a 'council supported management' programme, where advice and support are provided for specific species. This will provide support to communities where the species is having local impacts.	By not applying a programme and rules to the species, there would be no provisions under the pest management plan to manage inappropriate practises that are exacerbating the spread. Action could be taken under other sections of the Biosecurity Act however, or the Resource Management Act (section 17, or under specific provisions in a regional plan).	Low - impacts are likely to be localised and populations may be short lived.
Exclusion programme	Not applicable.	Not applicable.	Asian date mussel is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Resources and control tools to eradicate Asian date mussel are not currently available, so an eradication programme is not an appropriate option.
Progressive containment programme	Not applicable.	Not applicable.	Resources and control tools to contain Asian date mussel are not currently available, so a progressive containment programme is not an appropriate option.
Sustained control programme	Asian date mussel could be included in a sustained control programme. The council could include rules banning dumping/deliberate spread within the Northland region. This could include controls on dredging and sediment movement.	Education and publicity. Enforcement of rules; responding to reports.	Moderate -Existing populations would not be subject to control but the effects of the dense mats could be short-lived and localised.
Site-led pest programme	Not applicable.	Not applicable.	Resources and control tools to contain Asian date mussel are not currently available, so a site-led programme

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
			is not an appropriate option.
Summary of alternative assessments and preferred option:	No regional intervention - Marine Pathways plan includes some controls on the vectors of spread (aquaculture and hull fouling). Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that the Asian date mussel does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be no regional intervention for the Asian date mussel, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding.		

Asian paddle crab

Charybdis japonica

(Family: Portunidae)

Status in New Zealand

No legal status.

Relevant biology

Form	Asian paddle crabs are relatively large swimming crabs with paddle-like hind legs. The carapace of adults can reach 12cm across and is covered in small hairs (which are not always visible). The adults also have six distinct spines or spikes on each side of the carapace below the eyes. There are also five prominent spines on the upper surface of each claw. The crabs range in colour from pale-green or olive-green to a deep chestnut-brown with purplish markings on the shell.
Habitat	In its native range of South East Asia, the Asian paddle crab occurs in inter-tidal and sub-tidal habitats to depths of about 15m, including sandy, muddy or rocky reefs. In New Zealand they are typically found in estuaries where there is firm sand, muddy fine sand, or muddy-shelly fine sand. They are generalist predators that feed mainly on shellfish, crustaceans, fish and polychaete worms.
Regional distribution	Asian paddle crabs are present in Northland where they have been detected in Whāngārei Harbour, the Bay of Islands, Ngunguru estuary and Kaipara Harbour. Further south, in the Auckland Region they are widespread in the Hauraki Gulf and Waitemata Harbour.
Competitive ability	These crabs are very aggressive and have the potential to compete with native crabs for space and food. They also prey on native species including shellfish, fish, other crustaceans and polychaete worms. This species has a number of life history traits that make it a good invader: a long larval life that facilitates spread, rapid growth to maturity, high reproductive rates, high environmental tolerance and a broad diet.
Reproductive ability	Adult paddle crabs can produce hundreds of thousands of offspring annually; with female egg production averaging at 85,000 eggs which they may release several times per year. The larvae are able to withstand a wide range of water temperatures and salinities and can float in the water for three to four weeks, during which time they can be moved large distances by tides and currents. Vectors of spread: Thelarvae are moved by tides and currents and adults are capable of swimming long distances. Adult crabs and/or larvae can be spread in the sea chests of freighters, ballast water, on heavily fouled vessels, fishing nets and bait tanks. Asian paddle crabs are a sought after food species and could be moved intentionally to stock new fishing grounds.
Resistance to control	Trapping is the only current control option.
Benefits	Asian paddle crabs are a valued fisheries resource in their native range.

Areas occupied

Area type	Current area infested	Potential area infested
Upper estuarine freshwater	-	-
Estuarine	Low	High
Tidal mud flats	Low	High
Rock outcrops/rocky reef	Low	Low
Wave-dominated beach	-	-
Seabed	Low	Low
Marine structures incl moorings and marinas	-	-
Marine farms	-	Low

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Coastal management area				
Marine 1 Protection	L	H	Asian paddle crab are present in the Kaipara harbour (MM1), Ngunguru estuary (MM1) Whangarei harbour and the Bay of Islands (parts of which are MM1). It is currently present in relatively low numbers but it has the potential to have significant impacts because it breeds rapidly and is an aggressive species that preys on a wide variety of native species. It may also displace the native paddle crab and is a carrier of a disease that is a serious threat to crustaceans.	MPI; Global Invasive Species Database; Fowler 2011
Marine 2 Conservation	L	H	Asian paddle crab could impact upon marine conservation areas because it breeds rapidly and is an aggressive species. It preys on shellfish, fish, octopus and squid, may displace the native paddle crab and is a carrier of a disease that is a serious threat to crustaceans	MPI; Global Invasive Species Database;Fowler 2011
Marine 3 Marine farm	L	H	Asian paddle crab are a potential threat to marine farming because it preys on shellfish.	MPI
Marine 4 Mooring	-	-		
Marine 5 Port facilities	-	-		
Marine 6 Wharves	-	-		

Category	Current	Potential	Comment	Source
Environment				
Water quality	-	-		
Species diversity	L	H	The Asian paddle crab breeds rapidly and is an aggressive species. It can impact upon biodiversity by preying on a variety of native species including shellfish, fish, polychaete worms and other crustaceans. It may also displace the native paddle crab and is a carrier of a disease that is a serious threat to crustaceans such as crayfish, crabs and shrimps.	MPI ISSG Fowler 2011
Threatened species	L	H	The Asian paddle crab may adversely effect threatened species by reducing species diversity.	
Social/cultural				
Human health	L	L	The Asian paddle crab is an aggressive species and can inflict a vicious nip if it's disturbed.	MPI
Recreation (incl. fishing)	L	H	In its native range, the Asian paddle crab is a carrier of the white spot syndrome virus, which is a serious threat to crustaceans including species that are harvested by recreational fishers (e.g. crayfish, crabs, shrimps). It also preys on fish and shellfish, including juveniles of recreationally and commercially important shellfish.	ISSG Fowler 2011
Māori culture	L	H	The Asian paddle crab competes with and may displace native/taonga species, including kaimoana species.	

L = low; M = moderate; H = high

Proposed Management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	No operational costs	Should the species remain unmanaged, it may be spread by human activities beyond the scope of normal species spread, and have a significant impact on species diversity and the marine farming industry. Attempted control of a widely expanded population would be more costly than the preventative	Moderate -Existing populations would not be subject to control. Asian paddle crabs may be limited in range by environmental tolerances but could have significant effects due to their predatory behaviour.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
		management of the current populations.	
Exclusion programme	Not applicable.	Not applicable.	Asian paddle crab is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Resources and control tools to eradicate Asian paddle crabs are not currently available, so an eradication programme is not an appropriate option.
Progressive containment programme	Not applicable.	Not applicable.	Resources and control tools to contain Asian paddle crabs are not currently available, so a progressive containment programme is not an appropriate option.
Sustained control programme	Rules on the propagation, transport and release of the species would increase accountability for those who may contribute to its spread, and increase awareness. Programme could also provide the framework for co-ordinated control work.	Education and publicity. Enforcement of rules; responding to new reported sightings.	Moderate -Existing populations would not be subject to control, however the further spread of this species to other areas would be slowed. In areas where Asian paddle crabs are already present they could have significant effects due to their predatory behaviour
Site-led pest programme	The council could specify high value harbours or areas as site-led programmes, as an incursion at these sites could have significant impacts. Japanese paddle crab could be listed as a progressive containment or eradication species in these harbours, so that if a new incursion is detected through regular surveillance we are ready to act.	Rules would only be applicable in the areas defined as site led programmes and could not be enforced elsewhere. Education, publicity, responding to reports, surveillance, response to new incursions, enforcing rules.	Low - efforts could be targeted to protecting and responding to incursions in the highest value sites in Northland.
Summary of alternative assessments and preferred option:	Sustained control programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for Asian paddle crabs. In terms of alternative approaches assessed, under no regional intervention (or do nothing) natural biodiversity values and ecosystems would continue to degrade through predation of shellfish and crustaceans. Doing nothing would be akin to supporting those who see Asian paddle crabs as a resource and would be condoning moving them or releasing them to new areas. There would be moderate to high political and stakeholder risk anticipated with a no regional intervention approach, especially as Asian paddle crabs are managed as one of six marine pest species of interest in the Auckland region.		

<table>
<tr><th>Option</th><th>Explanation of benefits</th><th>Explanation of costs</th><th>Level of risk that programme will not be successful</th></tr>
<tr><td></td><td colspan="3">Due to the widespread nature of Asian paddle crabs in the region, eradication is not technically feasible or realistic and the control costs (even if the tools were available) that would be imposed on regional ratepayers would be unaffordable and unsustainable.
Progressive containment would also be very expensive and potentially a waste of resources, as the necessary control tools are not available. It would be high risk to pursue this outcome.
A site-led approach would encounter similar risks to those outlined above, with no guarantee for outcomes in the selected areas. Working in marine areas is deemed very high risk from a health and safety viewpoint. Overall, there is a high risk of failure under these scenarios due to the lack of control methods and inherent operational risks outlined.
Sustained control, offers the most practicable option as it is the least costly option for regional ratepayers and therefore more palatable (and with less risk). While existing populations would not be controlled, the spread of Asian paddle crabs would potentially be slowed. Enforcement remains an option for clear exacerbators of problem situations. Mitigation measures, through adoption of the sustained control option, combined with a pathway plan approach for marine pests, would allow additional funding to be sought and increase the overall awareness around Asian paddle crabs amongst marine users, particularly the problem of spreading them to new areas.</td></tr>
</table>

Australian droplet tunicate

Eudistoma elongatum

Also known as: Australian droplet tunicate, called "sea snot" in the Warkworth area

(Family: Polycitoridae)

Status in New Zealand

The Australian droplet tunicate is not included in the unwanted organisms register.

Relevant biology

Form	The Australian droplet tunicate is a type of sea squirt. It forms large colonies that attach to hard surfaces and look like clusters of white or cream-coloured cylindrical tubes . Each colony contains numerous small individuals and they can appear orange flecked due to the colour of the larvae within them. The Australian droplet tunicate is firm and gelatinous to the touch and the cylindrical colonies are generally 5-30 cm long, but can occasionally reach 1.5 m in length. Colonies are generally 5-20 mm in diameter and regress and over-winter as small (c.10 mm) cream buds, re-growing the following spring to larger colonies.
Habitat	The Australian droplet tunicate is able to occupy a wide range of lower inter-tidal and shallow sub-tidal habitats in both sheltered bays and semi sheltered coastlines. It is generally found in soft-bottomed tidal habitats and on hard structures such as wharf piles, aquaculture equipment and mangrove roots. It prefers submerged habitats just below the waterline, but can be found out of the water for periods during low tide.
Regional distribution	The Australian droplet tunicate was first reported on oyster farms in Houhora Harbour, in 2005. Since then it has been found in the Kaipara Harbour, Parengarenga Harbour, Rangaunu Harbour, Mangonui Harbour, Whangaroa Harbour, Whangarei Harbour, and on oyster leases and natural areas within the Bay of Islands (including Waikino Creek, Paroa Bay, Orongo Bay, Paihia, Okiato Point and Kerikeri Inlet). It has been found in eelgrass beds, on sand and on hard substrates such as rocky outcrops, cobbles, oyster racks, sticks, pilings, moorings and pieces of shell.
Competitive ability	The Australian droplet tunicate competes with native species for both space and food. It has a rapid growth rate, can inhabit a wide range of habitats, and can reach high abundances. It is also possible that it can ingest and kill the eggs and larvae of native species. When present in high densities the Australian droplet tunicate has the potential to have significant impacts on habitats and species. However some of the competitive ability of this species is minimised by the fact it is only present in large numbers during summer months and dies down during rain events and winter months.
Reproductive ability	The Australian droplet tunicate can reproduce for at least nine months of the year from October through to June (Spring to late Autumn) The larvae are free-swimming for approximately 6 hours before they begin to settle on surfaces. Reproductive output decreases after high rainfall and in the early winter months due to the colony size also decreasing. Vectors of spread: Larvae can disperse naturally with water currents. Australian droplet tunicates can also be spread by as fouling on marine farming equipment or possibly the hulls of boats.

Resistance to control	Acetic acid, hydrated lime, ammonium sulphate solution and heat were tested as potential control agents in the Bay of Islands. Acetic acid was effective but cannot be used on sub-tidal infestations (which can then re-infest inter-tidal sites). Hand removal at inter-tidal sites has also been suggested as a potential control measure.
Benefits	-

Areas occupied

Area type	Current area infested	Potential area infested
Upper estuarine freshwater	-	-
Estuarine	High	High
Tidal mud flats	Low	High
Rock outcrops / rocky reef	Low	Low
Wave-dominated beach	-	-
Seabed	Low	Low
Marine structures incl. moorings	Low	Low
Marine farms	High	High

High = Most infested/preferred area Low = Less infested/preferred area

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Coastal management area				
Marine 1 Protection (MM1)	M	M	The Australian droplet tunicate occurs in Parengarenga harbour, Rangaunu Harbour, Houhora Harbour and Kaipara harbour (MM1), and Whāngārei Harbour (parts of which are MM1) which have high ecological values. . The Australian droplet tunicate could out compete native species for space and food, displace ecologically important infauna and possibly reduce native species diversity by filter feeding out larval stages of native species. While high densities can occur during summer months ,the colonies regress to small buds during winter so any effects would be highly seasonal	Morrisey et al. 2009, Page et al. 2011

Category	Current	Potential	Comment	Source
Marine 2 Conservation (MM2)	M	M	The Australian droplet tunicate has been found in the Bay of Islands and Whāngārei Harbour, large areas of which are MM2 areas. Australian droplet tunicate could out compete native species for space and food, displace ecologically important infauna and possibly reduce native species diversity by filter feeding out larval stages of native species. While high densities can occur during summer months, the colonies regress to small buds during winter so any effects would be highly seasonal	Morrisey et al. 2009, Page et al. 2011
Marine 3 Marine farm (MM3)	H	H	This species is a significant nuisance to marine farming in northern New Zealand. Currently, it accounts for up to 50% of the biofouling waste removed from oyster farms during summer in Northland.	Hauraki Gulf Forum 2014
Marine 4 Mooring (MM4)	L	L	The Australian droplet tunicate can grow on any type of hard substrate and has been found on mooring blocks in the Warkworth area. This can lead to cleaning costs.	Grace 2012
Marine 5 Port facilities (MM5)	L	L	The Australian droplet tunicate can grow on any type of hard substrate including port facilities. It is unsightly and could lead to increased maintenance costs.	Morrisey et al. 2009
Marine 6 Wharves (MM6)	L	L	The Australian droplet tunicate has been found fouling marina infrastructure in Northland. It is unsightly and could lead to increased maintenance costs.	Morrisey et al. 2009
Environment				
Water quality	-	-		
Species diversity	L	M	The Australian droplet tunicate competes with native species for both space and food. It has a rapid growth rate, can inhabit a wide range of habitats, and can reach high abundances. It is also possible that it can ingest	Morrisey et al. 2009

Category	Current	Potential	Comment	Source
			and kill the eggs and larvae of native species. When present in high densities, the Australian droplet tunicate has the potential to have significant impacts on habitats and species. While high densities can occur during summer months, the colonies regress to small buds during winter so any effects would be highly seasonal	
Threatened species	-	L	Indirect impacts on threatened species may occur through alteration of habitats. There is currently no evidence to support direct effects on threatened species.	Morrisey et al. 2009
Social/Cultural				
Human health	-	-		
Recreation (incl. Fishing)	L	L	When it blooms during the summer months, the dense aggregations of Australian droplet tunicate colonies are unsightly and often occur in popular recreational areas. These dense aggregations could have an impact on shellfish and/or fish species that are targeted by recreational fishers.	Grace 2012
Maori culture	L	L	The Australian droplet tunicate has been found in the Waikare Inlet in the Bay of Islands. A taiapure has been established to cover the whole inlet and one has also been proposed for the Te Puna Inlet, which also has suitable habitats for the tunicate. There is some potential that Australian droplet tunicate could affect kai moana species.	Morrisey et al. 2009

L = low M= moderate H = high - = No impact + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful *
No regional intervention	The Australian droplet tunicate occurs in various harbours in the Northland region. If no management action is undertaken there will be no short-term financial cost to the NRC associated with control of this species. Rather than applying a programme under the pest management plan, the species could come under a 'council supported management' programme, where advice and support are provided for specific species. This will provide support to communities as and where the species appears.	In Parengarenga harbour the Australian droplet tunicate can account for up to 50% of the biofouling waste removed from oyster farms during summer causing seasonal, localised economic losses to the aquaculture industry. It can also has the potential to cause ecological, social and cultural impacts.	High. This species is already causing problems and without management of vectors is likely to spread further.
Exclusion programme	Not applicable.	Not applicable	The Australian droplet tunicate is already present in Northland
Eradication programme	Not applicable.	Resources and control tools to eradicate The Australian droplet tunicate are not currently available, so an eradication programme is not an appropriate option.	Resources and reliable control tools to eradicate the Australian droplet tunicate are not currently available, so an eradication programme is not an appropriate option.
Progressive containment programme	Not applicable.	Resources and control tools to contain The Australian droplet tunicate are not currently available, so a progressive containment programme is not an appropriate option.	Resources and reliable control tools to contain the Australian droplet tunicate are not currently available, so a progressive containment programme is not an appropriate option.
Sustained control programme	Rules on the propagation, transport and release of the species would increase accountability for those who may contribute to its spread, and increase awareness. This type of programme could also provide the framework for	Education and publicity. Enforcement of rules; responding to new reported sightings.	Moderate -Existing populations would not be subject to control, however the further spread of this species to other areas would be slowed. In areas where the Australian droplet tunicate is present it still has the

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful *
	co-ordinated control work between agencies.		potential to cause seasonal ecological, social and cultural impacts.
Site-led pest programme	A site-led pest programme may be able to eradicate, contain, or reduce the impacts of the Australian droplet tunicate from areas with significant conservation, economic, social and/or cultural values.	A site-led pest programme requires an ongoing commitment to funding for surveillance and control, and local community or industry buy in.	High. This species is widespread in Northland harbours, it can spread naturally and by human vectors so it is likely that it will re-establish itself.
Summary of alternative assessments and preferred option:	**Sustained control programme** In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for Australian droplet tunicate. In terms of alternative approaches assessed, under no regional intervention (or do nothing) production values through marine farms would be heavily impacted and natural biodiversity values and ecosystems would continue to degrade through competition for space and food. Doing nothing would be akin to 'supporting' uncontrolled spread and vectoring of this significant nuisance marine pest to new areas. There would be moderate to high political and stakeholder risk anticipated with a no regional intervention approach, especially as Australian droplet tunicate is managed as one of six marine pest species of interest in the Auckland region. Due to the widespread nature of Australian droplet tunicate in the regions' harbours and marine areas, eradication is not technically feasible or realistic and the control costs (even if the tools were available) that would be imposed on regional ratepayers would be unaffordable and unsustainable. Progressive containment would also be very expensive and potentially a waste of resources, as the necessary control tools are not available. It would be high risk to pursue this outcome. A site-led approach would encounter similar risks to those outlined above, with no guarantee for outcomes in the selected areas. Working in marine areas is deemed very high risk from a health and safety viewpoint. Overall, there is a high risk of failure under these scenarios due to the lack of control methods and inherent operational risks outlined. Sustained control, offers the most practicable option as it is the least costly option for regional ratepayers and therefore more palatable (and with less risk). While existing populations would not be controlled, the spread of Australian droplet tunicate could potentially be slowed, especially to susceptible marine farms. Infestations naturally tail off during winter, so there is some natural suppression of populations. Enforcement remains an option for clear exacerbators of problem situations, e.g. those people with infested structures who might move large amounts of material around the region. Mitigation measures, through adoption of the sustained control option, combined with a pathway plan approach for marine pests, would allow additional funding to be sought and increase the overall awareness around Australian droplet tunicate amongst marine users, particularly the problem of spreading them to new areas.		

Australian greasyback prawn

Metapenaeus bennettae

Also known as: Australian greasyback prawn, greentail prawn

(Family: Penaeidae)

Status in New Zealand

No legal status

Relevant biology

Form	The Australian greasyback prawn is a relatively small prawn that grows up to a maximum of 13 cm but more commonly grows to 11 cm total length. Like other prawns It has five pairs of swimming legs and five pairs of walking legs with the front three pairs of walking legs having claws. The Australian greasyback prawn is generally translucent with has patches of fine hairs over its body that give it a 'rough' or 'greasy' feel, hence its name. The tip of the tail fins are often brown.
Habitat	The Australian greasyback prawn is found in marine, estuarine and freshwater habitats. Juveniles usually live in sheltered habitats such as mangrove mudflats and seagrass beds, but have been found up to 35 km upriver from the sea. Adults are more common in shallow harbour and marine environments up to 15 m deep. They spend quite a large percentage of their time buried in soft sediments and generally prefers muddy bottoms over sandy ones. Australian greasyback prawns are generalist feeders they eat plant material, microorganisms, small shellfish and worms.
Regional distribution	The Australian greasyback prawn is native to the east coast of Australia and was first caught in Auckland Harbour in August 2009. Since then it has also been found in Whangarei Harbour where it is present at multiple locations in the upper reaches of the harbour including: The town basin marina and Port Nikau, and sparsely distributed at Kaiwaka Point, Limestone Island, Portland Reach and Parua Bay.
Competitive ability	When abundant, Australian greasyback prawns can compete with native crustaceans for food and space. Australian greasyback prawns have a high tolerance to variations in salinity and habitat and can produce tens of thousands of juveniles.
Reproductive ability	Unlike other prawn species that must move to sea Australian greasyback prawns can complete their entire life cycle in estuaries. They reach maturity about one year after hatching, when the males are about 7.7cm long and females are 10cm total length. The eggs of the Australian greasyback prawn are fertilised internally with one female producing tens of thousands of eggs. Hatching success and larval survival are affected by water temperature and salinity and are highest in waters of the same temperature and salinity as that where spawning took place. Vectors of spread: Prawns can disperse in the water column and be transported by water currents. The most likely human driven vector of spread is as larvae in ballast water.
Resistance to control	-

Benefits	Australian greasyback prawns are an important commercial fishery in Australia and are a target species for recreational fishers.

Areas occupied

Area type	Current area infested	Potential area infested
Upper estuarine freshwater	Low	Low
Estuarine	Low	High
Tidal mud flats	Low	Low
Rock outcrops / rocky reef	-	-
Wave-dominated beach	-	-
Seabed	Low	Low
Marine structures incl. moorings	-	-
Marine farms	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Coastal management area				
Marine 1 Protection	-	-	The Australian greasyback prawn is not known to be invasive and there is not evidence to suggest it will be in New Zealand. A different species of Panaeid prawn was assessed as low risk to the New Zealand environment and health and culture.	Woods & Inglis 2011
Marine 2 Conservation	-	-	The Australian greasyback prawn is not known to be invasive and there is not evidence to suggest it will be in New Zealand. A different species of Panaeid prawn was assessed as low risk to the New Zealand environment and health and culture.	Woods & Inglis 2011
Marine 3 Marine farm	-	-	The Australian greasyback prawn is not known to be invasive and there is not evidence to suggest it will be in New Zealand. A different species of Panaeid	Woods & Inglis 2011

Category	Current	Potential	Comment	Source
			prawn was assessed as low risk to the New Zealand environment and health and culture.	
Marine 4 Mooring	-	-	The Australian greasyback prawn is not known to be invasive and there is not evidence to suggest it will be in New Zealand. A different species of Panaeid prawn was assessed as low risk to the New Zealand environment and health and culture.	Woods & Inglis 2011
Marine 5 Port facilities	-	-	The Australian greasyback prawn is not known to be invasive and there is not evidence to suggest it will be in New Zealand. A different species of Panaeid prawn was assessed as low risk to the New Zealand environment and health and culture.	Woods & Inglis 2011
Marine 6 Wharves	-	-	The Australian greasyback prawn is not known to be invasive and there is not evidence to suggest it will be in New Zealand. A different species of Panaeid prawn was assessed as low risk to the New Zealand environment and health and culture.	Woods & Inglis 2011
Environment				
Water quality	-	-	The Australian greasyback prawn is not known to be invasive and there is not evidence to suggest it will be in New Zealand. A different species of Panaeid prawn was assessed as low risk to the New Zealand environment and health and culture.	Woods & Inglis 2011
Species diversity	-	-	The Australian greasyback prawn is not known to be invasive and there is not evidence to suggest it will be in New Zealand. A different species of Panaeid prawn was assessed as low risk to the New Zealand environment and health and culture.	Woods & Inglis 2011

Category	Current	Potential	Comment	Source
Threatened species	-	-	The Australian greasyback prawn is not known to be invasive and there is not evidence to suggest it will be in New Zealand. A different species of Panaeid prawn was assessed as low risk to the New Zealand environment and health and culture.	Woods & Inglis 2011
Social/Cultural				
Human health	-	-	The Australian greasyback prawn is not known to be invasive and there is not evidence to suggest it will be in New Zealand. A different species of Panaeid prawn was assessed as low risk to the New Zealand environment and health and culture.	Woods & Inglis 2011
Recreation (incl. Fishing)	-	+	The Australian greasyback prawn is not known to be invasive and there is not evidence to suggest it will be in New Zealand. A different species of Panaeid prawn was assessed as low risk to the New Zealand environment and health and culture. In Australia this species supports an important commercial and recreational fishery.	Woods & Inglis 2011
Maori culture	-	-	The Australian greasyback prawn is not known to be invasive and there is not evidence to suggest it will be in New Zealand. A different species of Panaeid prawn was assessed as low risk to the New Zealand environment and health and culture.	Woods & Inglis 2011

L = low M= moderate H = high - = No impact + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	The Australian greasyback prawn is present at several locations in Whangarei Harbour. If no management action is undertaken there will be no short-term financial cost to the NRC associated with control of this species. In Australia this species supports an important commercial and recreational fishery. Rather than applying a programme under the pest management plan, the species could come under a 'council supported management' programme, where advice and support are provided for specific species. This will provide support to communities as and where the species appears or has impacts.	This species may become more abundant in Whangarei Harbour and may spread to other areas in Northland. How ever this species is not known as an invasive species that can cause significant impacts.	Moderate. This species was first caught in Auckland Harbour, but since its discovery has also been found in Whangarei Harbour. This species may spread with or without human vectors, however its range will be restricted by its environmental tolerances.
Exclusion programme	Not applicable.	Not applicable.	The Australian greasyback prawn is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Resources and control tools to contain the Australian greasyback prawn are not currently available, so a progressive containment programme is not an appropriate option. And this species is not known to be invasive or cause significant impacts.
Progressive containment programme	Not applicable.	Not applicable.	Resources and control tools to contain Australian greasyback prawn are not currently available, so a progressive containment programme is not an appropriate option. And this species is not known to be invasive or cause significant impacts.
Sustained control programme	Not applicable.	Not applicable.	Resources and control tools to contain Australian greasyback prawn are not currently available, so a

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
			progressive containment programme is not an appropriate option. And this species is not known to be invasive or cause significant impacts.
Site-led pest programme	Not applicable.	Not applicable.	Resources and control tools to contain Australian greasyback prawn are not currently available, so a progressive containment programme is not an appropriate option. And this species is not known to be invasive or cause significant impacts.
Summary of alternative assessments and preferred option:	No regional intervention (given that there is no evidence to suggest this species has invasive nature and is not known to cause significant impacts). The Marine Pathways plan includes some controls on the vectors of spread (aquaculture and hull fouling). Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that the Australian greasyback prawn does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be no regional intervention for Australian greasyback prawn, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding.		

Australian tubeworm

Ficopomatus enigmaticus

Also known as:

(family: Serpulidae)

Status in New Zealand

No legal status

Relevant biology

Form	The Australian tubeworm is a small polychaete worm that builds and inhabits white calcareous tubes. The worm is approximately 20-25mm in length but can reach 40mm, with an extensive crown of filter-feeding tentacles ranging in colour from grey, green, or brown. The ringed calcareous tubes are up to 100mm long, 2mm in diameter with flared openings, and are built alongside each other to form large areas of reef-like structure reaching up to 7m in diameter.
Habitat	Australian tubeworm prefers estuarine and lagoon habitats with brackish waters. It will attach to various surfaces but demonstrates a preference for hard surfaces including the shells of other species (particularly gastropods and bivalves) and submerged structures and vessels to a depth of 3m. The species will tolerate both temperate and subtropical climates and a very wide range of salinities. It is resistant to pollution and prefers a high water nutrient content.
Regional distribution	Found in several upper estuary locations throughout Northland, including Whāngārei, Doves Bay and Ōpua, with low numbers at Port Nikau and Marsden Cove.
Competitive ability	Australian tubeworm is very fast-growing, and its calcareous structures can alter habitats, water conditions, and particle dynamics. It is tolerant of a wide range of conditions and faces little competition, often depleting resources from any native competitors, or replacing them entirely (ISSG database, *Ficopomatus enigmaticus*).
Reproductive ability	Female worms spawn one or two times, with planktonic larvae that settle onto a substrate after 20-25 days. Once settled, the organism produces its own calcareous tube. Vectors of spread: larvae can be transported in ballast water tanks; Australian tubeworm is also known to be a biofouling can be moved by vessels or the relocation of equipment.
Resistance to control	
Benefits	In enclosed waters Australian tubeworm can be beneficial by reducing particulate loads and improving oxygen and nutrient levels making waters less eutrophic.

Areas occupied

Area type	Current area infested	Potential area infested
Upper estuarine freshwater	Low	Low
Estuarine	Low	Low
Tidal mud flats	-	-
Rock outcrops/rocky reef	-	-
Wave-dominated beach	-	-
Seabed	Low	Low
Marine structures incl moorings and marinas	Low	Low
Marine farms	Low	Low

High = Most infested/preferred area Low = Less infested/preferred area

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Coastal management area				
Marine 1 Protection (MM1)	-	L	This species is currently not found in any MM1 areas in Northland however there are estuarine areas that are listed as MM1 that could provide the right environmental conditions for Australian tubeworm to survive; namely in the Kaipara Harbour and inner Bay of Islands. However this species has been present in Northland for over 50 years and has not yet been detected in these areas	http://marinebiosecurity.org.nz
Marine 2 Conservation (MM2)	-	L	There are MM2 listed estuarine areas that could provide the right environmental conditions for Australian tubeworm to survive; namely in the Hokianga, Kaipara, and Whangarei harbours and inner Bay of Islands. However this species has been present in Northland for over 50 years and has not yet spread significantly from the initial MM5 and MM6 incursion areas.	http://marinebiosecurity.org.nz
Marine 3 Marine farm (MM3)	-	L	Some oyster farm structures may be a favourable environment for Australian tubeworm to establish, particularly as they are generally in	http://marinebiosecurity.org.nz

Category	Current	Potential	Comment	Source
			estuarine environments and in areas of good nutrient content.However this species has been present in Northland for over 50 years and has not yet spread significantly from the initial MM5 and MM6 incursion areas.	
Marine 4 Mooring (MM4)	-	L	Species can establish on vessels and associated structures. However this species has been present in Northland for over 50 years and has not yet spread significantly from the initial MM5 and MM6 incursion areas.	ISSG database, 2008.
Marine 5 Port facilities (MM5)	L	L	Australian tubeworm is established on a number of wharf and marina structures in the upper reaches of Whangarei harbour. However this species has been present in Northland for over 50 years and has not yet spread significantly from the initial incursion areas.	http://marinebiosecurity.org.nz
Marine 6 Wharves	L	L	Australian tubeworm is established on a number of wharf and marina structures in the upper reaches of Whangarei harbour. However this species has been present in Northland for over 50 years and has not yet spread significantly from the initial incursion areas.	http://marinebiosecurity.org.nz
Environment				
Water quality	-	L	The Australian tubeworm can reduce particle loads and improving oxygen and nutrient levels, particularly in enclosed waters which may be viewed as beneficial, but these changes can have adverse effects on native communities.	http://www.iucngisd.org/
Species diversity	-	+	They provide substrate and food to many species that grow either in or on the Australian tubeworm reefs and shelter to shellfish, shrimp, crabs, and worms.	http://www.iucngisd.org/
Threatened species	-	-		
Social/cultural				

Category	Current	Potential	Comment	Source
Human health	-	-		
Recreation (incl. fishing)	-	L	In ideal conditions the Australian tubeworm can form large reef-like structures, these can be detrimental to recreational and aesthetic values of water bodies. However in Northland the Australian tubeworm has not formed reef structures and is only found as encrusting growth as a nuisance fouler.	http://www.iucngisd.org/
Māori culture	-	-		

L = low; M = moderate; H = high

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	No operational cost. Rather than applying a programme under the Regional Pest Management Plan, the species could come under a 'council supported management' programme, where advice and support are provided for specific species. This will provide support to communities as and where the species is having local impact.	By not applying a programme and rules to the species, there would be no provisions under the pest management plan to manage inappropriate practises that are exacerbating the spread. Action could be taken under other sections of the Biosecurity Act however, or the Resource Management Act (section 17, or under specific provisions in a regional plan).	Low. This species is a nuisance fouler but has not spread significantly through the regions since it was first detected in the 1960's
Exclusion programme	Not applicable.	Not applicable.	Australian tubeworm is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Resources and control tools to eradicate Australian tubeworm are not currently available, so an eradication programme is not an appropriate option. This species has not spread significantly through the regions since it was first detected in the 1960's
Progressive containment programme	Not applicable.	Not applicable.	Resources and control tools to eradicate Australian tubeworm are not currently available, so an eradication programme is not an appropriate option. This species has

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
			not spread significantly through the regions since it was first detected in the 1960's
Sustained control programme	Not applicable.	Not applicable.	Resources and control tools to eradicate Australian tubeworm are not currently available, so an eradication programme is not an appropriate option. This species has not spread significantly through the regions since it was first detected in the 1960's
Site-led pest programme	Not applicable.	Not applicable.	Resources and control tools to eradicate Australian tubeworm are not currently available, so an eradication programme is not an appropriate option. This species has not spread significantly through the regions since it was first detected in the 1960's
Summary of alternative assessments and preferred option:	No regional intervention - the Marine Pathways plan includes some controls on the vectors of spread (aquaculture and hull fouling) and the lack of spread of this species since its discovery in the 1960's). Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that the Australian tubeworm does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be <u>no regional intervention</u> for Australian tubeworm, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding.		

Colonial sea squirt

Botrylloides giganteum

(Family: Styelidae)

Status in New Zealand

No legal status.

Relevant biology

Form	The colonial sea squirt can occur in a variety of forms, from mats to thick lobes or projections. Rows of pores can be seen across much of its surface, there is empty space that looks like veins running between the pores. And although it looks similar to other species of *Botrylloides* the surface of the colonial seasquirt is stiff and rubbery to touch (the others are soft and often very delicate).
Habitat	In New Zealand the colonial sea squirt seems to prefer artificial structures and human altered environments in harbours, marinas and break waters. In its introduced range of South America it is also often found on marine farms.
Regional distribution	The colonial sea squirt was discovered in Whangarei Harbour in 2014, where it is known from Marsden Cove Marina and One Tree Point. Since then it has also been found in the Waitemata and Tauranga Harbours.
Competitive ability	The colonial sea squirt can overgrow native species and compete with them for space and food.
Reproductive ability	Colonial sea squirts are hermaphrodites and generally release sperm and eggs into the water, where fertilisation occurs. The eggs hatch into free-swimming larvae which settle on suitable hard surfaces. Colonial ascidians also have the ability to reproduce from fragments and will often spread by this means. Vectors of spread: Fertilised eggs and larvae may be dispersed by water currents. Colonial sea squirts may also be transported by hull fouling and the transfer of stock and gear used in marine farming.
Resistance to control	High pressure application of seawater can be used as anti-fouling method however there is a risk of fragments surviving. Immersion in 4% acetic acid (in seawater) for as little as 1 minute can eliminate many soft-bodied fouling organisms like ascidians.
Benefits	-

Areas occupied

Area type	Current area infested	Potential area infested
Upper estuarine freshwater	-	-
Estuarine	-	Low
Tidal mud flats	-	-

Area type	Current area infested	Potential area infested
Rock outcrops / rocky reef	-	Low
Wave-dominated beach	-	-
Seabed	-	Low
Marine structures incl. moorings	Low	High
Marine farms	-	High

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Coastal management area				
Marine 1 Protection	-	L	Colonial seasquirt has been observed growing amongst and over seagrass in Marsden Cove Marina. In many of the MM1 areas in Northland there are large areas of subtidal seagrass that may be affected by colonial seasquirt.	NRC staff, Middleton pers. comm. 2015
Marine 2 Conservation	-	L	Colonial seasquirt has been observed growing amongst and over seagrass in Marsden Cove Marina. In some of the MM2 areas in Northland there are areas of subtidal seagrass that may be affected by colonial seasquirt.	NRC staff, Middleton pers. comm. 2015
Marine 3 Marine farm	-	M	The colonial sea squirt could threaten shellfish farming by smothering or weighing down underwater structures and equipment.	MPI 2015
Marine 4 Mooring	-	L	Colonial seasquirt may be able to establish on moorings. Several other *Botrylloides* species are common on moorings in ports and harbour around New Zealand.	Page & Kelly 2013
Marine 5 Port facilities	L	M	Colonial sea squirt has been found at Marsden Cove Marina and One Tree Point and could spread elsewhere.	Woods et al. 2015

Category	Current	Potential	Comment	Source
Marine 6 Wharves	L	M	Colonial sea squirt has been found at Marsden Cove Marina and One Tree Point and could spread elsewhere.	Woods et al. 2015
Environment				
Water quality	-	-		
Species diversity	-	L	Other species of *Botrylloides* have been known to overgrow mussels, barnacles, encrusting bryozoans and solitary sea squirts. However, this species prefers artificial structures such as jetties, wharf pilings and moorings.	http://www.exoticsguide.org/node/175
Threatened species	-	-		
Social/Cultural				
Human health	-	-		
Recreation (incl. Fishing)	-	-		
Maori culture	-	L	Other species of *Botrylloides* have been known to overgrow bivalve species like mussels and oysters which may be important Kai moana species.	http://www.exoticsguide.org/node/175

L = low M= moderate H = high - = No impact + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	Colonial sea squirt is present at Marsden Cove and One Tree Point in Whangarei Harbour. If no management action is undertaken there will be no short-term financial costs to NRC associated with control of this species.	By not applying a programme and rules to the species, there would be no provisions under the pest management plan to manage inappropriate practises that are exacerbating the spread. Action could be taken under other sections of the Biosecurity Act however, or the Resource Management	Moderate. Colonial sea squirt is present in Auckland and Tauranga and is a cryptic species. It is likely more widespread than its current known distribution and has been observed as bio-fouling on yachts. It could easily be reintroduced and spread around the region.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
		Act (section 17, or under specific provisions in a regional plan). Without management actions colonial seasquirt may spread to mussel farms where it may result in economic losses.	
Exclusion programme	Not applicable	Not applicable.	Colonial sea squirt is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Resources and control tools to eradicate colonial sea squirt are not currently available, so an eradication programme is not an appropriate option.
Progressive containment programme	Not applicable.	Not applicable.	Resources and control tools to contain colonial sea squirt are not currently available, so a progressive containment programme is not an appropriate option.
Sustained control programme	Colonial sea squirt could be included in a sustained control programme. The council could include rules banning dumping/deliberate spread within the Northland region. This could include controls on spread of contaminated aquaculture equipment and stock.	Education and publicity. Enforcement of rules; responding to reports.	Moderate -Existing populations would not be subject to control but the populations are currently fairly confined to marinas and moorings.
Site-led pest programme	A site-led pest programme may be able to eradicate, contain, reduce and/or control colonial sea squirt from localised areas with significant conservation, economic, social and/or cultural values.	A site-led pest programme requires an ongoing commitment to funding for surveillance and control.	Moderate. Colonial sea squirt is present in Auckland and Tauranga and is a cryptic species. It is likely more widespread than its current known distribution and has been observed as bio-fouling on yachts. It could easily be reintroduced and spread around the region.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Summary of alternative assessments and preferred option:	No regional intervention. Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that the colonial sea squirt does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be no regional intervention for colonial sea squirt, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding.		

Dead man's fingers

Codium fragile subsp. *tomentosoides*

(Family: Codiaceae)

Also known as: green sea fingers, Dead Man's Fingers, Felty Fingers, Oyster Thief

Status in New Zealand

No legal status.

Relevant biology

Form	Green sea fingers is a large, branching, dark-green seaweed. It can reach lengths of 1 metre and can weigh up to 3.5kg. It can look like a fuzzy patch of tubular fingers that hang down from rocks during low tide, hence its common name. The "fingers" are branches up to 1cm wide and sometimes over 30cm long. There are several native *Codium* species (including another subspecies –the perennial *C. fragile novaezealandiae*) that are difficult to differentiate from Green Sea Fingers.
Habitat	Green Sea Fingers prefers the intertidal and subtidal zone in sheltered estuarine and marine habitats such as harbours and bays. It can survive and grow in tide pools on wave-swept shores, on natural hard surfaces such as rocks, boulders, pebbles, and on both living and dead shellfish. It can also be found on artificial structures such as wharves, jetties, ropes and mussel lines or oyster racks. It can tolerate large variations in salinity and temperature but optimal growth conditions seem to be around 24°C .
Regional distribution	Green Sea Fingers is not known to be present in Northland. Elsewhere in New Zealand, it has been recorded at the Port of Auckland and throughout the Hauraki Gulf.
Competitive ability	Green Sea Fingers is native to Japan but has established itself worldwide, and is found along the coasts of Europe, New Zealand, Australia, Chile, the Mediterranean and the East Coast of North America. It has the capacity to spread rapidly and can tolerate wide ranges of temperature and salinity. It has negative impacts on benthic communities and can dominate the habitats it invades and alter community composition and function.
Reproductive ability	With separate sexes, Green Sea Fingers reproduces sexually releasing eggs and sperm into the water and asexually both by producing free-swimming 'swarmers' and also from fragments that break off and grow into separate individuals. Vectors of spread: Spores and fragments are dispersed by water currents and the action of wind and waves and may be spread in ballast water. Plants that attach to the hulls of boats or marine equipment may be transported in this way. When growing on small objects such as shells, the buoyancy of Green Sea Fingers may result in it being displaced and moved by currents and wave action.
Resistance to control	It is difficult to differentiate Green Sea Fingers from native species of *Codium* making the appropriate application of any control measures difficult. Herbicides are ineffective and can harm the surrounding environment. Mechanical removal is costly and populations can quickly reestablish. Manual removal by hand is ineffective as small fragments reproduce.
Benefits	-

Areas occupied

Area type	Current area infested	Potential area infested
Upper estuarine freshwater	-	-
Estuarine	-	High
Tidal mud flats	-	Low
Rock outcrops/rocky reef	-	High
Wave-dominated beach	-	Low
Seabed	-	Low
Marine structures including moorings and marinas	-	High
Marine farms	-	High

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Coastal management area				
Marine 1 Protection (MM1)	-	L	Green Sea Fingers has the potential to spread to Northland, including to protected marine areas. If this was to occur it could dominate the habitats it invades and alter community composition and function.	ISSG Chavanich & Harris 2004
Marine 2 Conservation (MM2)	-	L	Green Sea Fingers has the potential to spread to Northland, including to areas that have high ecological values. If this was to occur it could dominate the habitats it invades and alter community composition and function.	ISSG Chavanich & Harris 2004
Marine 3 Marine farm (MM3)	-	M	Green Sea Fingers has serious economic implications for oyster farming. Its ability to grow on oyster shell, then be washed away carrying the oyster with it has earned it the nickname 'oyster thief'.	Provan et al. 2005
Marine 4 Mooring (MM4)	-	L	Green Sea Fingers can attach to ropes and vessels.	ISSG
Marine 5 Port facilities (MM5)	-	L	Green Sea Fingers can attach to structures, equipment, and vessels.	ISSG

Marine 6 Wharves (MM6)	-	L	Green Sea Fingers can attach to structures, equipment, and vessels.	ISSG
Environment				
Water quality	-	-		
Species diversity	-	L	Green Sea Fingers can smother and out compete native species, altering community composition and function and reducing species diversity. The algae has, however, been present in low numbers on the northeast coast of the North Island for over 40 years, with little noticeable impact	ISSG Dromgoole & Foster 1983; Chavanich & Harris 2004
Threatened species	-	L	Green Sea Fingers can smother and out compete native species. This could affect threatened species either directly or indirectly (by altering community composition and function).	ISSG Chavanich & Harris 2004
Social/cultural				
Human health	-	-		
Recreation (incl. fishing)	-	H	Green Sea Fingers can become an aesthetic nuisance and rotting plants that have washed up on beaches produce a foul smell. It can grow over and smother shellfish.	ISSG McDonald et al. 2014
Māori culture	-	L	Impacts on native/taonga species including kaimoana.	

L = low; M = moderate; H = high

Proposed Management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful *
No Regional Intervention	If no management action is undertaken there will be no short-term financial cost to the NRC associated with control of this species.	*C. fragile tomentosoides* is not known to be present in Northland and in the Auckland region the algae has yet (after over 40 years) to reach nuisance levels	High. Once present in the Northland this approach will have no effect on populations.
Exclusion programme	Exclusion of *C. fragile tomentosoides* s from Northland would prevent	An exclusion programme would be limited to managing the vectors of this alga, including marine farming	Moderate. Managing the vectors of spread can limit the likelihood of introduction, but the alga

	potential impacts on native habitats and marine farming activities	equipment and heavily fouled vessels. Costs would be relatively low as it would form part of a broader programme of vector and pathways management	has a high capacity for long distance dispersal through both sexual and asexual reproduction
Eradication programme	If detected in Northland, eradication of *C. fragile tomentosoides* would prevent potential impacts on native habitats and marine farming activities	An eradication programme can be very expensive and would require an ongoing commitment to funding for several years for surveillance and remedial eradication.	High. Chemical herbicides are not suitably specific and mechanical removal techniques are likely to be unsuccessful as the alga readily reproduces from fragments.
Progressive containment programme	A progressive containment programme to contain or reduce the geographic distribution may reduce its impacts on values and spread to other areas, but would still provide an opportunity for this species to spread to and within the region.	The costs for a progressive containment programme would be less than the costs for a full eradication programme, but still requires an ongoing commitment to funding for surveillance and control and could still be significant.	Moderate. Should the alga be introduced to Northland, its high dispersive capacity suggests that it would naturally spread from any contained populations
Sustained control programme	A sustained control programme to provide for the ongoing control of this species if it is introduced may reduce its impacts on values and spread to other areas, but would still provide an opportunity for this species to spread from within the region.	The costs for a sustained control programme would be less than the costs for eradication but will require and ongoing commitment to funding for surveillance and control and could still be significant	Moderate. Should the alga be introduced to Northland, its high dispersive capacity suggests that it would naturally spread from any contained populations
Site-led pest programme	A site-led pest programme may be able to eradicate, contain, reduce and/or control *C. fragile tomentosoides* from areas with significant conservation, economic, social and/or cultural values.	A site-led pest programme requires an ongoing commitment to funding for surveillance and control.	Low to moderate. A site-led pest programme must be well coordinated to prevent any infestation from spreading.
Summary of alternative assessments and preferred option:	**No regional intervention** - the Marine Pathways plan includes some controls on the vectors of spread (aquaculture and hull fouling). Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that dead man's fingers do not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful		

	organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be no regional intervention for dead man's fingers, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding.

Didemnum sea squirt

Didemnum vexillum

Also known as: Carpet sea squirt, Whangamata sea squirt, D-vex

(Family: Didemnidae)

Status in New Zealand

No legal status

Relevant biology

Form	Carpet sea squirts grow attached to hard surfaces. The carpet sea squirt is leathery or spongey and light mustard in colour. It can look like a yellowish wax dripping over a structure such as a rope or mussel line. It can be distinguished from native species by its colour and non-slimy feel.
Habitat	Colonies of Carpet sea squirt can be found from the intertidal zone in salinities greater than about 25 PSU, down to depths of at least 65 meters. It is more common on artificial structures but has been found growing on rocks, seaweed, and seagrass in tide pools, estuaries, lagoons and open coastal areas. In New Zealand, it is generally found on structures such as wharves, mooring lines and vessel hulls and appears to have only a limited ability to establish in natural habitats.
Regional distribution	In the Northland Region, Carpet sea squirt is known from Whangarei Harbour. Elsewhere in the country it has been recorded in Whangamata, the Malborough Sounds, Tauranga Harbour, Port Nelson, Golden Bay, and Wellington Harbour.
Competitive ability	Carpet sea squirt can tolerate a wide range of environmental conditions, has a high reproductive ability, and high population growth rates. The absence of natural predators and/or diseases outside its native range also gives it a competitive advantage. Carpet sea squirt has the ability to grow over other organisms and can hinder the settlement of larvae through the production of chemical compounds.
Reproductive ability	Carpet sea squirt can reproduce sexually and releases larvae that are carried in water currents. It can also reproduce from fragments that break off the "parent" and grow into new colonies. The reproductive season of the carpet sea squirt in New Zealand is considerably longer than comparable northern-hemisphere populations (at least 9 months of the year compared with 3 to 5 months in the USA). Vectors of spread: Larvae can be dispersed relatively short distances by water currents and in ballast water. Carpet sea squirt may also be transported by marine farming activities (e.g. transfer of aquaculture stock between harbours) and hull fouling.
Resistance to control	A range of methods was used to eliminate carpet sea squirt from Shakespeare Bay near Picton including smothering soft-sediment habitats with uncontaminated dredge spoil, wrapping wharf piles with plastic, smothering rip-rap habitats using a geotextile fabric, water blasting, air drying or chlorine dosing. Many tools were completely effective but the program overall failed to eradicate the organism from the region due to various other reasons, including as lack of commitment of funding and lack of rapid decision-making processes, among other reasons
Benefits	-

Areas occupied

Area type	Current area infested	Potential area infested
Upper estuarine freshwater	-	-
Estuarine	-	Low (on marine farms in estuaries where salinity > 25 PSU)
Tidal mud flats	-	-
Rock outcrops / rocky reef	-	-
Wave-dominated beach	-	-
Seabed	-	Low
Marine structures incl. moorings	High	High
Marine farms	-	High

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Coastal management area				
Marine 1 Protection (MM1)	-	L	In New Zealand, Carpet sea squirt is generally found on artificial structures such as wharf pylons, mooring lines and vessel hulls, and appears to have only a limited ability to establish in natural habitats.	MPI 2007; Forrest et al. 2013
Marine 2 Conservation (MM2)	-	L	In New Zealand, Carpet sea squirt is generally found on artificial structures such as wharf pylons, mooring lines and vessel hulls, and appears to have only a limited ability to establish in natural habitats.	MPI 2007; Forrest et al. 2013
Marine 3 Marine farm (MM3)	-	M	This species has not been reported from marine farms in Northland yet. However, it has been found on a mussel line near Picton in 2005. Experiments have shown that Carpet sea squirt adversely effects the number and condition of mussels, particularly in the smaller size classes. It can cover mussel lines in three	Fletcher et al. 2013

			months and can badly foul salmon cages, imposing additional handling costs on farmers. There is a potential to grow on oyster farm structures and/or oyster shells	
Marine 4 Mooring (MM4)	-	M	In New Zealand this species is found on wharf pylons, mooring lines and vessel hulls.	MPI 2007
Marine 5 Port facilities (MM5)	-	M	This species has been found in Whangarei Harbour and may spread itself to (other) artificial structures.	Woods et al. draft 2015
Marine 6 Wharves (MM6)	-	M	This species has been found in Whangarei Harbour and may spread itself to (other) artificial structures.	Woods et al. draft 2015
Environment				
Water quality	-	-		
Species diversity	-	L	Carpet sea squirt can out-compete other organisms, decreasing species diversity. It can also hinder the settlement of larvae through the production of chemical compounds. However, in New Zealand it is generally found on artificial structures and has a limited ability to establish on natural surfaces.	Gittenberger 2010; Forrest et al. 2013
Threatened species	-	L	Indirect impacts on threatened species may occur through alteration of habitat.	
Social/Cultural				
Human health	-	-		
Recreation (incl. Fishing)	-	L	Alteration of habitat may have an impact on benthic and/or fish species that are targeted by recreational fishers.	
Maori culture	-	L	Replacement of native species by non-indigenous species (e.g. macro-algae, benthic species)	

			and impacts caused by habitat modification may impact on cultural values in coastal and marine areas.	

L = low M= moderate H = high - = No impact + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful *
No Regional Intervention	In the Northland region *D. vexillum* is present in Whangarei Harbour. If no management action is undertaken there will be no short-term financial costs to NRC associated with control of this species. If no action is undertaken to determine its presence in the Northland region outside of the Whangarei Harbour and Opua marina, then there will be no financial costs.	This species is present in Whangarei Harbour and may spread itself to other regions. This species can overgrow artificial substrates such as wharf pylons, mooring lines, vessel hulls and mussel lines which may lead to cleaning costs and/or economic losses to the aquaculture industry. Overseas studies have shown that this species can also have ecological impacts (e.g. decrease biodiversity).	High. *D. vexillum* is already present in Whangarei Harbour and is likely to spread itself from there.
Exclusion programme	n/a. *D. vexillum* is already present in Whangarei Harbour.		
Eradication programme	*D. vexillum* has only been reported from the Whangarei Harbour. If the species could be eradicated in this harbour, it would prevent further spread from this area.	An eradication programme can be very expensive and would require an ongoing commitment to funding for surveillance and eradication.	Moderate. *D. vexillum* is present in several other New Zealand Ports (probably including the Auckland region where *Didemnum* species have been found since 2008). Re-introduction from those areas is possible.
Progressive containment programme	A progressive containment programme to contain or reduce the geographic distribution may reduce its impacts on values and spread to other areas, but would still provide an opportunity for this species to spread from within the region.	The costs for a progressive containment programme would be less than the costs for a full eradication programme, but still requires an ongoing commitment to funding for surveillance and control and could still be significant.	Moderate. *D. vexillum* is present in several other New Zealand Ports (probably including the Auckland region where *Didemnum* species have been found since 2008). Re-introduction from those areas is possible.
Sustained control programme	A sustained control programme to provide for the ongoing control of this species may reduce its impacts on	The costs for a sustained control would be less than the costs for a full eradication programme, but still requires	Moderate. *D. vexillum* is present in several other New Zealand Ports (probably including the Auckland

	values and spread to other areas, but would still provide an opportunity for this species to spread from within the region.	an ongoing commitment to funding for surveillance and control and could still be significant.	region where *Didemnum* species have been found since 2008). Re-introduction from those areas is possible.
Site-led pest programme	A site-led pest programme may be able to eradicate, contain, reduce and/or control *D. vexillum* from areas with significant conservation, economic, social and/or cultural values.	A site-led pest programme requires an ongoing commitment to funding for surveillance and control.	Moderate. *D. vexillum* is present in several other New Zealand Ports (probably including the Auckland region where *Didemnum* species have been found since 2008). Re-introduction from those areas is possible.
Summary of alternative assessments and preferred option:	No regional intervention - the Marine Pathways plan includes some controls on the vectors of spread (aquaculture and hull fouling). Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that *Didemnum* species do not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be <u>no regional intervention</u> for *Didemnum* species, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding.		

File shell

Limaria orientalis

Also known as: File Shell

(Family: Limidae)

Status in New Zealand

No legal status

Relevant biology

Form	The file shell is a small bivalve (a shellfish with two shells) that can reach 20-28mm in length. The shell is thin and brittle and oblique (un-symmetrical) in shape with a straight hinge line. The file shell has a pale, thin, brittle shell with finely sculptured ribs and a thick mantle of tentacles which protrude from the shell.
Habitat	File shells occupy lower inter-tidal and subtidal habitats. It will establish in a range of sediments including muddy, shelly, fine sand, shell gravel, coarse shell, and cobbles. The species has also been found in water at up to 80m deep, in coarse substrates. In Waitemata Harbour it is most commonly found in the muddy, shelly, gravels in the main harbour channels at depths of 10-30m.
Regional distribution	In the Northland Region, file shells have been recorded in Whangarei Harbour and at Opua.
Competitive ability	The file shell is native to Japan, the Philippines and Indo-Pacific. It has been able to spread to New Zealand and establish at a number of sites, which suggests it has some competitive ability. However, studies have concluded that it decreased in abundance in the Waitemata Harbour between the 1970s and the mid- 2000s.
Reproductive ability	File shells release eggs and sperm into the water, where fertilisation occurs. The eggs hatch into free-swimming larvae that settle and change into adults. Spawning is triggered by environmental factors such as water temperature. Vectors of spread: The file shell is thought to have been introduced to New Zealand in the ballast water of ships. The free-swimming larvae can be spread by water currents.
Resistance to control	-
Benefits	Where present, file shell can form a significant portion of the diet of snapper.

Areas occupied

Area type	Current area infested	Potential area infested
Upper estuarine freshwater	-	-
Estuarine	Low	High

Tidal mud flats	Low	High
Rock outcrops/rocky reef	-	-
Wave-dominated beach	-	-
Seabed	-	Low
Marine structures incl. moorings and marinas	-	-
Marine farms	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Coastal management area				
Marine 1 Protection (MM1)	L	M	The file shell is present in Whangarei Harbour and, if it has not already done so, it could establish in marine protected areas within the Harbour.	
Marine 2 Conservation (MM2)	L	M	The file shell could establish in areas with high marine conservation values.	
Marine 3 Marine farm (MM3)	-	-		
Marine 4 Mooring (MM4)	-	-		
Marine 5 Port facilities (MM5)	-	-		
Marine 6 Wharves (MM6)	-	-		
Environment				

Water quality	-	-		
Species diversity	-	L/M	The file shell can out-compete native species for food and space. However, it decreased in abundance in the Waitemata Harbour between the 1970s and mid-2000s.	Hayward 1997a,b NIWA 2008
Threatened species	-	L	The file shell may have indirect effects on threatened species.	
Social/cultural				
Human health	-	-		
Recreation (incl. fishing)	-	-	The file shell provides a good source of food for snapper and other bottom-foraging fish. However, it can outcompete native shellfish species.	Hayward 1997a,b NIWA 2008
Māori culture	-	L	Impacts on native species.	

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful *
No Regional Intervention	No operational costs. Populations are likely to be kept under control by predation from snapper and bottom-foraging fish.	Not applicable.	High. Populations of *L. orientalis* will likely continue to spread naturally in the absence of any management intervention
Exclusion programme	n/a *L. orientalis* are already present in Northland		
Eradication programme	*L. orientalis* have only been reported in two locations in Northland. If the species could be eradicated, it would prevent further spread from these locations.	An eradication programme would be very expensive and would require an ongoing commitment to funding for several years for surveillance and remedial eradication	High. The high reproductive output of the species indicates that there could be extensive undetected populations present in the region. Re-infestation from unmanaged vectors (ballast water, dredged sediments) is possible
Progressive containment programme	A progressive containment programme to contain or reduce the geographic distribution may reduce its impacts on values and spread to other areas, but would still provide an opportunity for this species to spread from within the region.	The costs for a progressive containment programme would be less than the costs for a full eradication programme, but still requires an ongoing commitment to funding for surveillance and control and could still be significant.	Moderate. *L. orientalis* are already established in Northland and as such re-introduction from unmanaged areas is likely

Sustained control programme	A sustained control programme to provide for the ongoing control of this species may reduce its impacts on values and spread to other areas, but would still provide an opportunity for this species to spread from within the region.	Unlikely to have any impact on the spread of the species as it is not valued for shellfish collection, it's unlikely to be transported, and rules are unlikely to have any impact.	Moderate. The species is already present in the region and as such re-introduction from within the Northland region is highly likely.
Site-led pest programme	A site-led pest programme may be able to eradicate, contain, reduce and/or control *L. orientalis* from areas with significant conservation, economic, social and/or cultural values.	A site-led pest programme requires an ongoing commitment to funding for surveillance and control.	Low to moderate. A site-led pest programme must be well coordinated to prevent an existing infestation from spreading.
Summary of alternative assessments and preferred option:	No regional intervention. Populations likely to be kept under control by predation by snapper and bottom-foraging fish. Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that the file shell does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be <u>no regional intervention</u> for file shell, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding.		

Horseshoe worm

Phoronis ijimai

Also known as: Horseshoe worm, White tubeworm, Phoronid worm

(Family: Phoronidae)

Status in New Zealand

No legal status

Relevant biology

Form	Horseshoe worms build thin tubes to support and protect their soft bodies and have a U-shaped crown of 110-150 tentacles for filtering for filtering food from the water. Horseshoe worms are white and translucent and can measure up to 17 mm long with a diameter of 0.3-1.0 mm.
Habitat	Horseshoe worms prefer hard substrates and have been found on pontoons in Marsden Cove at a depth of about 0.5 m. Overseas it has been reported on natural hard substrates such as rocks, bivalve shells, and wood down to depths of 10m. It is thought to be native to the northern Pacific including Japan.
Regional distribution	In 2013 the Horseshoe worm was found on pontoons at Marsden Cove Marina. This was the first record of the species in New Zealand.
Competitive ability	Overseas studies have shown that *Phoronis* species can form dense populations of up to 15,000 per m^2. Fish are known to graze the crowns which can be regrown by the horseshoe worm. There are no reports of adverse impacts from Horseshoe wormsand it is not listed in the global invasive species database. MPI consider the species to pose a low biosecurity risk to New Zealand.
Reproductive ability	Horseshoe worms breed from spring to autumn and can produce up to 400 eggs per individual. The fertilised eggs develop into larvae that are free-swimming for anywhere between 3 days to 20 days. Vectors of spread: The larvae can be dispersed by water currents and, potentially, in ballast water. It is not known how they spread to New Zealand, however due to the fact they were only found inside a marina an assumption is made that it was as hull fouling.
Resistance to control	-
Benefits	-

Areas occupied

Area type	Current area infested	Potential area infested
Upper estuarine freshwater	-	-
Estuarine	-	-

Tidal mud flats	-	-
Rock outcrops / rocky reef	-	Low
Wave-dominated beach	-	-
Seabed	-	Low
Marine structures incl. moorings	Low	Low
Marine farms	-	Low

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Coastal management area				
Marine 1 Protection (MM1)	-	-	Overseas the Horseshoe worm is known from a wide range of natural hard substrate types. This species has no known invasive history and it is considered unlikely that Horseshoe worm will have adverse effects.	MPI 2014
Marine 2 Conservation (MM2)	-	-	Overseas the Horseshoe worm is known from a wide range of natural hard substrate types. This species has no known invasive history and it is considered unlikely that Horseshoe worm will have adverse effects.	MPI 2014
Marine 3 Marine farm (MM3)	-	-		
Marine 4 Mooring (MM4)	-	-		
Marine 5 Port facilities (MM5)	-	-	This species has no known invasive history and has only been found on pontoons in Whangarei harbour. It is considered unlikely that Horseshoe worm will have adverse effects.	MPI 2014
Marine 6 Wharves (MM6)	-	-	This species has no known invasive history and has only been found on pontoons in Whangarei harbour. It is considered unlikely that Horseshoe worm will have adverse effects.	MPI 2014

Environment				
Water quality	-	-	As filter feeders, Horseshoe worms can affect water quality, but this is a small species and the affect is likely to be negligible.	
Species diversity	-	-		
Threatened species	-	-		
Social/Cultural				
Human health	-	-		
Recreation (incl. Fishing)	-	-		
Maori culture	-	-		

L = low M= moderate H = high - = No impact + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful *
No Regional Intervention	If no management action is undertaken there will be no short-term financial costs to NRC associated with control of this species.	*P. ijimai* was discovered on wharf pilings at Marsden Cove Marina in 2013. It has the potential to spread naturally from there, but is not known as an invasive species that causes significant impacts.	Low. Vectors of spread appear to be limited as it is not known as a hull and/or marine farm fouling species, nor have larvae been reported from ballast water. This species is not known as an invasive species that causes significant impacts.
Exclusion programme	Not applicable.	Not applicable.	High. *P. ijimai* is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	High. Phoronid worms have never been considered to be species of concern and thus resources and techniques to eradicate Horseshoe worm are not currently available; an eradication programme is not feasible.
Progressive containment programme	A progressive containment programme does provide obvious benefits. This species is not known to	A progressive containment programme would be less expensive than an eradication programme, but	Moderate. Progressive containment could be feasible, because vectors for new introductions appear to be limited. A delimiting survey

	result in significant impacts and vectors for its spread appear to be limited.	would require an ongoing commitment to funding for surveillance and eradication.	would be required, however, to confirm that the species is not more widespread.
Sustained control programme	A sustained control programme does provide obvious benefits. This species is not known to result in significant impacts and vectors for its spread appear to be limited.	A sustained control programme would be less expensive than an eradication programme, but would require an ongoing commitment to funding for surveillance and eradication.	Moderate. Sustained control could be feasible, because vectors for new introductions appear to be limited. A delimiting survey would be required, however, to confirm that the species is not more widespread.
Site-led pest programme	A side-led pest programme does not seem to be very beneficial. This species is not known as an invasive species causing significant impacts and vectors for spread appear to be limited.	A site-led programme can be less expensive than an eradication programme, but would require an ongoing commitment to funding for surveillance and eradication.	Moderate. Site-led control could be feasible, because vectors for new introductions appear to be limited. A delimiting survey would be required, however, to confirm that the species is not more widespread.
Summary of alternative assessments and preferred option:	No regional intervention - the Marine Pathways plan includes some controls on the vectors of spread (aquaculture and hull fouling), although this organism is deemed a low Biosecurity risk. Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that the horseshoe worm does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be no regional intervention for horseshoe worm, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding.		

Japanese kelp

Undaria pinnatifida

Also known as: wakame, Japanese kelp or *Undaria*

(Family: Alariaceae)

Status in New Zealand

The wakame kelp is listed as an unwanted organism under the Biosecurity Act 1993.

Relevant biology

Form	The wakame kelp is a large seaweed that can reach lengths of nearly 3m, though are more typically 1-2m long. Plants are golden brown in colour, crinkly in appearance and slightly slimy to the touch. Plants more than about 5cm long have a distinct midrib. Juvenile plants have an undivided blade which looks like a single leaf, while in larger and mature plants the blade divides into finger-like projections. They have a holdfast (which anchors them to a surface), a stipe (or stem) and a sporophyll (a frilly-shaped reproductive structure which produces spores) at the base of the stipe.
Habitat	Wakame can rapidly colonise virtually any hard, permanently wet surface, including artificial substrates such as ropes, pylons, buoys, the hulls of vessels, bottles, floating pontoons and plastic. On natural substrates, it inhabits stable rocky reefs, mobile cobble habitats, mudstone, and in soft sediments will attach to hard surfaces such as shells. It grows in a wide range of wave exposures from sheltered marinas to the open coast, and extends vertically from the low intertidal zone to depths of approximately 18m (although it is most common between 1m and 3m depth). In New Zealand, wakame is generally restricted to ports and harbours and areas utilised for marine farming
Regional distribution	Wakame is found throughout most of New Zealand. In 2013, wakame was discovered at Opua marina and growing on a subtidal rocky outcrop at the entrance to Rangaunu Harbour. The few plants detected at Rangaunu ranged from 10-30cm long and 'frills' (the spore-bearing sporophylls) were present on three plants.
Competitive ability	The wakame kelp can produce millions of spores, tolerate a wide range of light levels (from full sunlight to deep shade), and grow on a variety of natural and artificial surfaces. These characteristics allow it to grow rapidly in favourable conditions and form dense underwater forests. Through competition for light and space, stands of wakame can displace native species and alter habitats.
Reproductive ability	The frill near the base of the seaweed produces millions of spores that are released into the water and float for a short time (1-3 days) before settling onto the seabed or other hard surfaces. Field observations suggest that it may spread at a rate of between 50 m and 10 km per year. Once settled onto a surface, they develop into an invisible-to-the-naked-eye (microscopic) life stage called a gametophyte. Gametophytes, which are in effect a 'seed bank' for wakame, can remain dormant for over 2 years before reproducing to form the large kelp stage of the life cycle. Vectors of spread: The spores are dispersed by water currents and in ballast water. Large sporophytes as well as the microscopic gametophytes may also be spread while attached to vessel hulls and through marine farming activities.

Resistance to control	Manual removal of mature plants may be possible, but this technique cannot be used to remove the microscopic gametophytes. Anecdotal evidence suggest that spores from removed or handled plants can contaminate dive equipment, creating a further potential vector for spread.
Benefits	Wakame kelp is used for food and in many health and personal care products. In some overseas countries it is the basis of a multi-million dollar industry.

Areas occupied

Area type	Current area infested	Potential area infested
Upper estuarine freshwater	-	-
Estuarine	-	Low
Tidal mud flats	-	Low
Rock outcrops / rocky reef	Low	Low
Wave-dominated beach	-	Low
Seabed	-	Low
Marine structures incl. moorings	-	High
Marine farms	-	High

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Coastal management area				
Marine 1 Protection (MM1)	-	M	In New Zealand, the wakame kelp is generally restricted to ports, harbours and areas utilised for marine farming. It can grow on natural hard substrates in marine protected areas, growth conditions only appear to be favourable in the southern part of the Northland Region.	Stuart 2004.
Marine 2 Conservation (MM2)	-	M	In New Zealand, the wakame kelp is generally restricted to ports, harbours and areas utilised for marine farming. It can grow on natural hard substrates in marine protected areas, growth conditions only appear to be favourable in the southern part of the Northland Region.	Stuart 2004

Marine 3 Marine farm (MM3)	-	M	The waters of the Hauraki Gulf had been considered too warm to be optimal for wakame kelp but a survey in 2011-2012 revealed that 11 from 31 marine farms in that region were heavily infested and only 3 farms were free of the species. Dense populations of wakame kelp in marine farms can have impacts on light availability, nutrient cycling and food availability for the shellfish growing in these farms. It may increase the handling time for farm operations.	James & Shears 2012
Marine 4 Mooring (MM4)	-	M	Hull fouling is one of the vectors responsible for the spread of wakame kelp. When an infested boat is attached to a mooring, the mooring can easily become infested. Moorings may also become infested by natural dispersal.	
Marine 5 Port facilities (MM5)	M	M	Wakame was collected from the Opua marina in 2012-2013. It is also present year-round on pontoons in marinas in the Auckland Region and could be introduced via hull fouling to wharves in Northland.	James & Shears 2012
Marine 6 Wharves (MM6)	M	M	Wakame was collected from the Opua marina in 2012-2013. It is also present year-round on pontoons in marinas in the Auckland Region and could be introduced via hull fouling to wharves in Northland.	Riding et al. 2013 James & Shears 2012
Environment				
Water quality	-	-	No known effects on water quality	
Species diversity	-	L	In the southern part of it's range in NZ, wakame can form dense monospecific stands through competition for light and space, displacing native species and altering habitats.	Stuart 2004
Threatened species	-	-	No known effects on threatened species	
Social/Cultural				

Human health	-	-	No known effects on human health	
Recreation (incl. fishing)	-	L	Alteration of habitats may have an impact on shellfish and/or fish species that are targeted by recreational fishers.	Stuart 2004
Maori culture	-	L	Replacement of native species by wakame kelp and habitat modification may impact on cultural values in coastal and marine areas.	

L = low M= moderate H = high - = No impact + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No Regional Intervention	*U. pinnatifida* has been reported from two locations in Northland. If no management action is undertaken there will be no short-term financial cost to the NRC associated with control of this species.	*U. pinnatifida* has been reported from two locations in Northland and may spread to other areas including marine farms. Dense populations of *U. pinnatifida* in marine farms potentially have strong impacts on light availability, nutrient cycling and food availability for the mussels growing in these farms and may increase the handling time to harvest the mussels.	High. *U. pinnatifida* is already present in the Northland region from which it can spread. It can also easily reach the Northland region from the Hauraki Gulf where it is widespread on marine farms and marinas.
Exclusion programme	n/a; *U. pinnatifida* is already present in the Northland region.		
Eradication programme	*U. pinnatifida* has only been reported from two locations in Northland. If the species could be eradicated, it would prevent further spread from these locations.	An eradication programme can be very expensive and would require an ongoing commitment to funding for several years for surveillance and remedial eradication.	High. *U. pinnatifida* is widespread on marine farms in the Hauraki Gulf, and is present in almost all of New Zealand's international ports and harbours ranging from Auckland to Bluff. Therefore re-introduction from outside the Northland region is very likely.
Progressive containment programme	A progressive containment programme to contain or reduce the geographic distribution may reduce its impacts on values and spread to other areas, but	The costs for a progressive containment programme would be less than the costs for a full eradication programme, but still requires an ongoing commitment to	Moderate. *U. pinnatifida* is widespread on marine farms in the Hauraki Gulf, and is present in almost all of New Zealand's international ports and harbours ranging from

	would still provide an opportunity for this species to spread from within the region.	funding for surveillance and control and could still be significant.	Auckland to Bluff. Therefore re-introduction from outside the Northland region is very likely
Sustained control programme	A sustained control programme to provide for the ongoing control of this species may reduce its impacts on values and spread to other areas, but would still provide an opportunity for this species to spread from within the region.	The costs for a sustained control programme would be less than the costs for a progressive containment programme, but still requires an ongoing commitment to funding for surveillance and control and could still be significant.	Moderate. *U. pinnatifida* is widespread on marine farms in the Hauraki Gulf, and is present in almost all of New Zealand's international ports and harbours ranging from Auckland to Bluff. Therefore re-introduction from outside the Northland region is very likely.
Site-led pest programme	A site-led pest programme may be able to eradicate, contain, reduce and/or control *Undaria* from areas with significant conservation, economic, social and/or cultural values.	A site-led pest programme requires an ongoing commitment to funding for surveillance and control. One of the infested areas, Rangaunu Harbour, was ranked as a nationally-important wildlife habitat by the New Zealand Wildlife Service.	Low to moderate. A site-led pest programme must be well coordinated to prevent an existing infestation from spreading.
Summary of alternative assessments and preferred option:	Sustained control programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for *Undaria*. In terms of alternative approaches assessed, under <u>no regional intervention</u> (or do nothing) production values (loss of time and competition with farmed species) and natural biodiversity values and ecosystems would continue to degrade through competition for space and displacement of native species. Doing nothing would be akin to 'supporting' the uncontrolled spread and vectoring of this significant marine pest (as it is in other parts of New Zealand) to new areas. There would be high political and stakeholder risk anticipated with a no regional intervention approach, especially as *Undaria* is managed as one of six marine pest species of interest in the Auckland region. Although *Undaria* is restricted to only two known locations in the region, <u>eradication</u> is not technically feasible or realistic (hand removal may assist in vectoring this pest) and the control costs (even if other tools were available) would probably be unsustainable. <u>Progressive containment</u> would also be very expensive and potentially a similar waste of resources, as the necessary control tools are not available. It would be high risk to pursue this outcome. A <u>site-led approach</u> would encounter similar risks to those outlined above, with no guarantee for outcomes in the selected areas. Working in marine areas is deemed very high risk from a health and safety viewpoint. Overall, there is a high risk of failure under these scenarios due to the lack of control methods and inherent operational risks outlined. <u>Sustained control</u>, offers the most practicable option as it is the least costly option for regional ratepayers and therefore more palatable (and with less risk). While existing populations would not be controlled, the spread of Undaria could potentially be slowed, especially to currently clear areas. Mitigation measures, through adoption of the sustained control option, combined with a pathway plan approach for marine pests, would allow additional funding to be sought and increase the overall awareness around *Undaria* amongst marine users, particularly the problem of spreading it to new areas.		

Japanese mantis shrimp

Oratosquilla oratoria

Also known as: Japanese mantis shrimp, Burrowing mantis shrimp

(Family: Squillidae)

Status in New Zealand

No legal status

Relevant biology

Form	The Japanese mantis shrimp is light grey and can grow up to 185mm long (18.5cm). It has two spiny claws to capture food. Japanese mantis shrimp can easily be confused with a native species that is of similar size and colour. However, Japanese mantis shrimp has red-maroon ridges running down the mid-length of its body and the outer surface of the tail fan is blue and yellow (it is grey and yellow in the native species).
Habitat	Japanese mantis shrimp live in burrows in soft sediments, sand and mud in sheltered bays and estuaries. It is native to the north-western Pacific where it is most common in temperate waters of China and Japan.
Regional distribution	In New Zealand, Japanese mantis shrimp has been reported in harbours along the west coast of the North Island. It was found in the Kaipara Harbour in 2009 and has subsequently been discovered in the Hokianga Harbour.
Competitive ability	The Japanese mantis shrimp preys on shrimps, crabs and thin-shelled molluscs and can alter habitats through its burrowing activities. When abundant, they can play a role in structuring benthic communities and may compete for food and space with other crustaceans.
Reproductive ability	In its native range, Japanese mantis shrimps live for 3 to 3.5 years. Males attained sexual maturity at 4-5 cm body length and females at 7 cm. Females can brood a maximum of 50,000 eggs and remain in their burrows when caring for the embryos. After hatching, larvae pass through several free-swimming stages, with an estimated larval life of around 2 months. Vectors of spread: Japanese mantis shrimps may be spread by water currents, in ballast water, or as a consequence of aquaculture and fishing activities.
Resistance to control	-
Benefits	The Japanese mantis shrimp is an important commercial species in Japan. Since the 1990s it has also commercially harvested in Australia.

Areas occupied

Area type	Current area infested*	Potential area infested
Upper estuarine freshwater	-	-
Estuarine	Low	High

Tidal mud flats	Low	High
Rock outcrops / rocky reef	-	-
Wave-dominated beach	-	-
Seabed	Low	High
Marine structures incl. moorings	-	-
Marine farms	-	-

High = Most infested/preferred Low = Less infested/preferred

* Reports of Japanese mantis shrimp have been reported at Waikere Inlet, Kaipara and Hokianga harbour.

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Coastal management area				
Marine 1 Protection (MM1)	-	M	The Japanese mantis shrimp preys on shrimps, crabs and thin-shelled molluscs and can alter habitats through their burrowing activities. When abundant, they can play a role in structuring benthic communities through habitat alteration and competition for food and space.	Ahyong 2010
Marine 2 Conservation (MM2)	-	M	The Japanese mantis shrimp preys on shrimps, crabs and thin-shelled molluscs and can alter habitats through their burrowing activities. When abundant, they can play a role in structuring benthic communities through habitat alteration and competition for food and space.	Ahyong 2010
Marine 3 Marine farm (MM3)	-	-		
Marine 4 Mooring (MM4)	-	-		
Marine 5 Port facilities (MM5)	-	-		

Marine 6 Wharves (MM6)	-	-		
Environment				
Water quality	-	L	When abundant, Japanese mantis shrimp may have an impact on water quality through their burrowing activities.	-
Species diversity	-	L	The Japanese mantis shrimp preys on shrimps, crabs and thin-shelled molluscs and can alter habitats through their burrowing activities. When abundant, they can play a role in structuring benthic communities through habitat alteration and competition for food and space.	Ahyong 2010
Threatened species	-	-		
Social/Cultural				
Human health	-	-		
Recreation (incl. Fishing)	-	L +	Alteration of habitats may have an impact on benthic and/or fish species that are targeted by recreational fishers. When abundant, Japanese mantis shrimp can be a species of interest for recreational fishers.	
Maori culture	-	L	Habitat modification may impact on cultural values in coastal and marine areas.	

L = low M= moderate H = high - = No impact + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful *
No Regional Intervention	*O. oratoria* is already present in Hokianga Harbour. If no management action is undertaken there will be no short-term financial cost to the NRC associated with control of this species.	*O. oratoria* is already present in Hokianga Harbour and may spread itself from there, for example through the transfer of equipment used in aquaculture to other areas in Northland.	Moderate. *O. oratoria* is already present in the Hokianga Harbour from which it can spread itself. It can alter habitats and replace native species, but actual impacts in New Zealand are unknown.

		It can alter habitats and replace native species, but actual impacts in New Zealand are unknown. In Japan and Australia the species is commercially harvested.	
Exclusion programme	n/a *O. oratoria* is already present in the Hokianga Harbour.		
Eradication programme	*O. oratoria* is present in the Hokianga Harbour. If the species could be eradicated in this harbour, it would prevent further spread from this area.	An eradication programme can be very expensive and would require an ongoing commitment to funding for surveillance and eradication.	Moderate. *O. oratoria* was first discovered in the Kaipara Harbour in the Auckland Region where it has become an established species. Re-introduction from that area is highly likely.
Progressive containment programme	A progressive containment programme to contain or reduce the geographic distribution may reduce its potential impacts on values and spread to other areas. However, it would still provide an opportunity for this species to spread.	The costs for a progressive containment programme would likely be less than the costs for a full eradication programme, but still requires an ongoing commitment to funding for surveillance and control.	Moderate. *O. oratoria* was first discovered in the Kaipara Harbour in the Auckland Region where it has become an established species. Re-introduction from that area is possible.
Sustained control programme	A sustained control programme to provide for the ongoing control of this species may reduce its potential impacts on values and spread to other areas. However, it would still provide an opportunity for this species to spread, because it is not eradicated.	The costs for a sustained control programme would likely be less than the costs for a full eradication programme, but still requires an ongoing commitment to funding for surveillance and control.	Moderate. *O. oratoria* was first discovered in the Kaipara Harbour in the Auckland Region where it has become an established species. Re-introduction from that area is possible.
Site-led pest programme	A site-led pest programme may be able to eradicate, contain, reduce and/or control *O. oratoria* from areas with significant conservation, economic, social and/or cultural values.	A sit-led pest programme in Hokianga harbour requires an ongoing commitment to funding for surveillance and control.	Moderate. The species is already well established in the Kaipara harbour Auckland region) and could be re-introduced from that area.
Summary of alternative assessments and preferred option:	Sustained control programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for Japanese mantis shrimps. In terms of alternative approaches assessed, under <u>no regional intervention</u> (or do nothing) natural biodiversity values and ecosystems would continue to degrade through predation of shellfish and crustaceans. Doing nothing		

	would be akin to supporting those who might see Japanese mantis shrimps as a resource and would be condoning moving them or releasing them to new areas. There would be moderate to high political and stakeholder risk anticipated with a no regional intervention approach. Due to the relatively widespread nature of Japanese mantis shrimps in western harbours of the region, eradication is not technically feasible or realistic and the control costs (even if the tools were available) that would be imposed on regional ratepayers would be unaffordable and unsustainable. Progressive containment would also be very expensive and potentially a waste of resources, as the necessary control tools are not available. It would be high risk to pursue this outcome as it is well established in Kaipara Harbour. A site-led approach would encounter similar risks to those outlined above, with no guarantee for outcomes in the selected areas. Working in marine areas is deemed very high risk from a health and safety viewpoint. Overall, there is a high risk of failure under these scenarios due to the lack of control methods and inherent operational risks outlined. Sustained control, offers the most practicable option as it is the least costly option for regional ratepayers and therefore more palatable (and with less risk). While existing populations would not be controlled, the spread of Japanese mantis shrimps would potentially be slowed, particularly to eastern harbours in the region. Enforcement remains an option for clear exacerbators of problem situations and three management rules are proposed. Mitigation measures, through adoption of the sustained control option, combined with a pathway plan approach for marine pests, would allow additional funding to be sought and increase the overall awareness around Japanese mantis shrimps amongst marine users, particularly the problem of spreading them to new areas.

* In accordance with clause 6(2)(g) of the NPD *'take into account any risks that each option will not achieve its objective'*

Mediterranean fanworm

Sabella spallanzanii

Also known as: fanworm

(Family: Sabellidae)

Status in New Zealand

Mediterranean fanworm is listed as an unwanted organism under the Biosecurity Act 1993.

Relevant biology

Form	Mediterranean fanworm is a large, tube-dwelling worm. It is the largest fanworm in New Zealand with its body measuring up to 20mm wide and 800mm long. It has a prominent crown of feeding tentacles that extend out of the tube and can be 150mm wide. The crown is often banded orange, purple or white. The tubes are leathery, flexible and muddy-looking and are generally found on hard sub-tidal structures, but can also be buried up to 10cm deep in soft substrates.
Habitat	Mediterranean fanworm can live in most artificial and natural habitats in the marine environment but it will not tolerate freshwater. It prefers sheltered, nutrient-enriched waters and is generally found in shallow subtidal areas in depths from 1 to 30m. It attaches to a range of solid surfaces including artificial materials (rocks, concrete, wood, steel), and benthic organisms (ascidians, mussels, oysters). It is also a common fouling species on moored vessels including car ferries, fishing boats and pleasure craft. It can also be found on soft substrates, generally attached to a small buried fragment of shell or rock.
Regional distribution	Mediterranean fanworm is established in the Whāngārei Harbour and has been detected on structures in Tutukaka and on vessels in Whangaroa and the Bay of Islands but is not known to be established in these locations. Mediterranean fanworm is well- established in the Waitemata Harbour and elsewhere in the Auckland region and in Lyttelton Harbour. It has been detected in Nelson Harbour, Tauranga Harbour and the Coromandel.
Competitive ability	Mediterranean fanworm can form dense beds that are likely to out-compete other species and interfere with biological processes. Specifically, it has the potential to compete with native filter-feeding organisms for food and space, and in high densities is likely to impact commercially important species (mussels, oysters, scallops, etc). Mediterranean fanworm will readily settle on mussel grow-out lines and may reduce mussel growth by altering water flow around the lines and competing with mussels for suspended food (CSIRO 2001). The ability of the species to attach to a wide range of surfaces in varying environmental conditions, its fast rate of growth, and its prolific breeding habits, make it particularly competitive. It has no known predators in New Zealand, and has particularly high concentrations of heavy metals in the branchial crown which has been suggested to be an anti-predatory strategy (Fattorini et al. 2004, in NIMPIS 2002).
Reproductive ability	Male Mediterranean fanworm release sperm into the water to be captured by the females. Fertilisation takes place inside the worm's tube, where the egg is released. Mature female worms can produce more than 50,000 eggs during each spawning event. Spawning occurs over a prolonged autumn-winter period and a female may

	release multiple batches of eggs. The reproductive cycles are influenced by local environmental conditions, particularly water temperature and light exposure. Larvae may drift in the water column for up to 14 days. If worms are damaged they are are able to regenerate parts while the worm continues to function. Vectors of spread: Larvae may be spread in water currents and ballast water. Mature fanworm and larvae may attach to the hulls of boats, aquaculture gear and marina structures (e.g. pontoons) and may either be sheared off and spread in that way or reproduce in new locations while attached to a mobile substrate.
Resistance to control	Manual removal via diver collection is generally the only tool used in Mediterranean fanworm management and is only useful for new incursions and before the fan worm has begun to reproduce. Recent work by mussel growers in Port Phillip Bay indicates that 24 hour air exposure of mussel ropes kills small native seastars and many epiphytic biota (such as *Sabella spallanzanii*) (Garnham 1998, in NIMPIS 2002). However there is always the likelihood of some individuals surviving in amongst the denser clusters of mussels. Care must be taken during removals to take the entire worm and remove it from the water as it will regrow from fragments and/or reattach if dislodged.
Benefits	The ability of the Mediterranean fanworm to accumulate microbial pollution indicators suggests this species can be employed as a bioindicator for monitoring water quality. The European fan worm is able to concentrate microbial pollutants by removing them from the surrounding environment allowing the detection of these bacteria even when they are present in the water column at very low concentrations (Stabilia et al. 2006). In its native Mediterranean region this European fan worm can be used in the treatment of waste from aquaculture plants (particularly fish and mussel farming) in coastal areas which are rapidly expanding (Stabilia et al. 2006). It is used to feed leatherjackets in aquaria in Australia (Clapin and Evans 1995, in NIMPIS 2002), and used as bait for Sparidae fish in Italy (Gambi et al. 1994, in NIMPIS 2002). While suitable for bait in its native range, Mediterranean fanworm is unsuitable for bait in introduced habitats and its use is discouraged (NIMPIS 2002)

Areas occupied

Area type	Current area infested	Potential area infested
Estuarine	Low	High
Upper estuarine freshwater	-	-
Tidal mud flats	Low	High
Rocky reef	Low	High
Wave dominated beach	-	-
Seabed	Low	High
Rock outcrops	Low	Low
Marine structures incl moorings	Low	High
Marine farms	Low	High

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Commercial operations				
Marinas and moorings	M	M	Mediterranean fanworm can become the dominant fouling species in a marina, weighing down structures and spreading to moored vessels. Control in marinas is costly and shared between the council, structure owners and MPI.	Northland Regional Council
Shipping	L	M	Mediterranean fanworm has the potential to incur costs to the shipping industry as more frequent hull cleaning may be necessary when vessels are docked in an infested area.	Fletcher 2014
Commercial fishing	L	M	Mediterranean fanworm has the potential to incur costs to the fishing industry as more frequent hull cleaning may be necessary when vessels are docked in an infested area.	Fletcher 2014
Marine farming	L	M	Established colonies on marine structures would be very costly to remove. The species can quickly become established in a wide range of habitats and can attach directly to shellfish. However Mediterranean fanworm will not survive in intertidal oyster farms of which most of Northland's current aquaculture is.	Fletcher 2014
International trade	-	-		
Environment				
Water quality	-	-		
Species diversity	L	M	Mediterranean fanworm can out-compete native suspension feeders. However some ecosystems offer natural resilience as marine pest species often colonise bare space and newly cleared areas; if this space is not available they may struggle to become established.	Fletcher 2014
Threatened species	-	-		
Social/cultural				
Human health	-	-		
Recreation (incl. fishing)	L	H	Mediterranean fanworm has the potential to have significant impacts on boating activities due to need for increased hull hygiene. It may impact on fishing resources by altering the local ecology in infested areas.	Fletcher 2014
Māori culture	-	L	Change in local ecology and decrease in species diversity may impact on cultural values.	

L = low; M = moderate; H = high

Proposed Management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	If no regional intervention is undertaken there will be no short-term financial costs incurred by the council under the pest management plan in relation to this species.	Should the species remain unmanaged, it may be spread by human activities beyond the scope of normal species spread, and have a significant impact on species diversity and the marine farming industry. Attempted control of the effects of a widely expanded population would be more costly than the preventative management of the current populations.	Moderate - Existing populations would not be subject to control. Mediterranean fanworm may be limited in range by environmental tolerances but could have significant effects due to their highly competitive and gregarious nature. A pathways plan will help slow the spread to new places.
Exclusion programme	Not applicable.	Not applicable.	Mediterranean fanworm is already present in Northland.
Eradication programme	Not applicable.	Not applicable.	Council has been attempting eradication since the discovery of Mediterranean fanworm in Whangarei 2012 and has not been successful in achieving a reduction to zero levels. Resources and control tools to eradicate Mediterranean fanworm (reduce the infestation to zero density) are not currently available. Eradication and removal tools are limited to diver hand removals and wrapping or smothering infestations. These options are expensive and only effective in newly infected areas. There are a number of infected areas in Whangarei harbour that would cost millions of dollars annually to assess and control using current techniques.
Progressive containment programme	Currently Mediterranean fanworm populations in Northland are limited to Whangarei harbour. A progressive containment zone could be defined around Whangarei harbour with rules	Education and publicity. Responding to reports and enforcing movement/transport rules. A comprehensive surveillance programme by divers of potential nearby habitat and high value areas to monitor spread outside of the progressive control area. A partnership approach with MPI may be required. Response to new incursions in other places would be required.	Moderate -Mediterranean fanworm is primarily spread as hull fouling but may also spread naturally as eggs or larvae. Recent modelling of potential natural spread of Mediterranean fanworm larvae in the Coromandel suggested they could spread over 15km naturally. Marine pests are difficult to detect and new incursions may occur without the council being aware of these immediately. Council would need

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	in place to minimise the risk of spread from the harbour to other places. The main vector of spread for Mediterranean fanworm is as fouling on vessel hulls and equipment so rules should focus on these vectors of spread. A progressive containment programme will increase awareness of vectors of spread and safeguard other high value areas of northland from Mediterranean fanworm incursions.		support from boat owners and general public to undertake passive surveillance. A progressive control programme is more likely to be successful in conjunction with a marine pathways management plan.
Sustained control programme	Rules on the propagation, transport and release of the species would increase accountability for those who may contribute to its spread, and increase awareness. Pest specific rules would add value where a pathway plan does not apply. A sustained control programme would incur less costs to council than an eradication programme. This programme would	A sustained control programme would require a significant investment of time and resources by the council and affected structure owners. It would not aim to eradicate Mediterranean fanworm but maintain it at a level that minimises impacts on values and spread to other areas. Regular monitoring of infected sites may be required. Mediterranean fanworm control tools are limited to diver hand removals and wrapping or smothering infestations. These options are expensive and only effective if continually maintained. A long term commitment to control would be required from both council and structure owners. Along with control of existing populations the vectors of spread would need to be controlled and monitored. Control of existing populations as well as vectors of	Moderate -Existing populations would not be subject to control, new incursions would be assessed and management may be undertaken. If marina or marine structure owners wanted to attempt control NRC would provide support. But the further spread of this species to other areas would be slowed. It would only be successful if council had good buy in from both the marine industry and boat owners. A sustained control programme is more likely to be successful in conjunction with a marine pathways management plan.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	aim to control the spread of Mediterranean fanworm in Northland *and* reduce the impacts it has on both ecological and economic values. For example council may get science advice to set a threshold value for an acceptable density of fanworm on structures and seafloor.	spread would require on-going significant allocation of time and resources.	
Site-led pest programme	The council could specify high value harbours or areas as site-led programmes, as an incursion of Mediterranean fanworm would have significant impacts on values in these areas. Mediterranean fanworm could be listed as a progressive containment species in just these harbours or areas, so that if a new incursion is detected through regular surveillance we are ready to act. This programme allocated limited resources to the areas of highest value to ensure we are getting the highest return for investment.	Rules would only be applicable in the areas defined as site-led programmes and could not be enforced elsewhere. The biggest cost would be a comprehensive surveillance programme to ensure council is aware of any new incursions into areas defined as site-led, however by increasing efforts into publicity and education passive surveillance by members of the public may also increase. Education, publicity, responding to reports, response to new incursions and enforcing rules would be other cost components.	Moderate - efforts could be targeted to protecting and responding to incursions in the highest value sites in Northland. However current populations of Mediterranean fanworm would not be controlled. A site-led programme is more likely to be successful in conjunction with a marine pathways management plan.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Summary of alternative assessments and preferred option:	Sustained control programme In relation to NPD considerations (section 6(1)outlines four criteria) a **medium-level analysis** was deemed appropriate for Sabella. In terms of alternative approaches assessed, under no regional intervention (or do nothing) maintaining the gains of prior control and awareness efforts would be lost. Any control, especially where found at new locations, would become voluntary, haphazard and unenforceable. This would be unacceptable for many marine users (e.g. marina operators) with high political and stakeholder fallout anticipated. Due to the widespread nature of Sabella in Whangarei Harbour, eradication is not technically feasible or realistic and the control costs that would be imposed on the regional ratepayers would be ineffective and unsustainable. There would be no guarantees that the eradication effort would result in positive outcomes and would be deemed to be a high socio-political risk. Intensive control work may also bring Resource Management Act issues into consideration (e.g. wrapping and treatment methods requiring resource consent). Progressive containment may potentially be achieved through the imposition of rules around hull fouling, but there is uncertainty over the natural reproductive ability of Sabella, in relation to spread, which would negate a full-blown regulatory regime. It would be high risk to pursue this outcome. A site-led approach would encounter similar risks to those outlined above, with no guarantee for outcomes in the selected areas. There is a high risk of failure under this scenario due to the inherent operational risks outlined. Sustained control, offers the best and most practicable option as it is likely to be less costly to regional ratepayers and therefore more palatable (hence less risk). Reducing impacts and slowing spread has proven beneficial over the last four years and would be well supported by many marine users. Enforcement may remain an option for clear exacerbators of problem situations. Mitigation measures, through adoption of the sustained control option, combined with a pathway plan approach for marine pests, would allow additional funding to be sought and increase the overall awareness around Sabella amongst marine users, particularly the problem of hull fouling.		

Quantitative analysis

The high level analysis for Sabella was undertaken using a benefit-cost model. The model was developed using a logistic model for spread, per hectare benefit estimates that take into account the ecosystem services of different marine environments, Northland specific data and NRC staff expertise. The benefit of the alternative programmes assessed are determined, in dollar terms, as the difference between unmanaged and managed risk. The model takes into account a reduction in the spread rate associated with a Pathways Plan in place, i.e. the modelled results discussed below are to be viewed as additional to the benefits of a Pathways Plan. The sustained control programme for fanworm and all of the sustained control marine species is inextricably linked.

Impact Evaluation

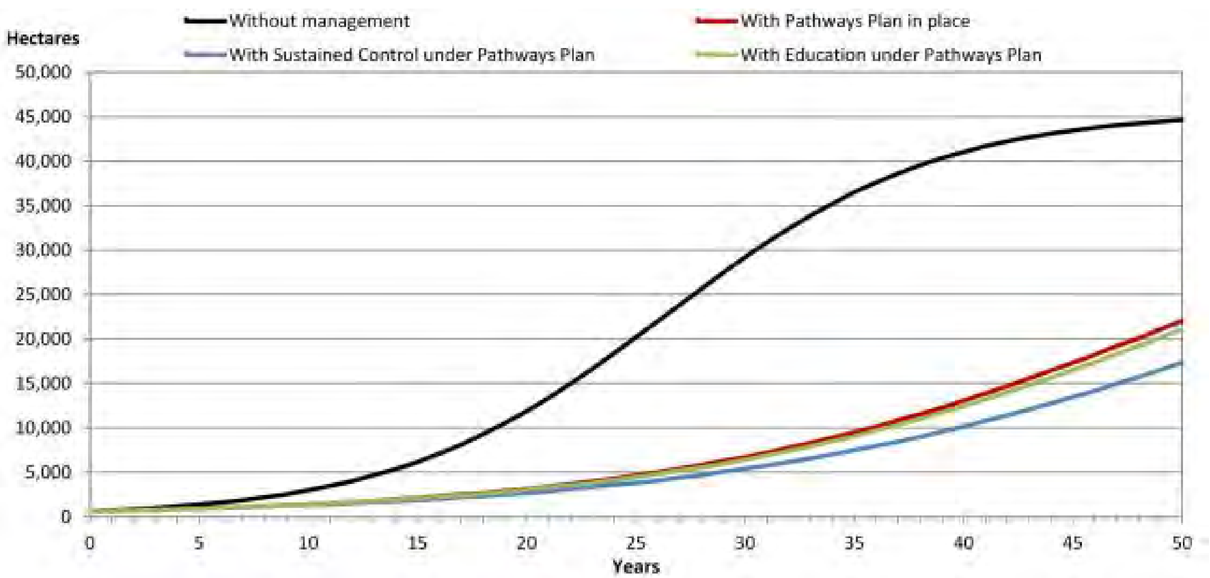
The following table outlines the specific programme assumptions that have been used in the benefit cost analysis for Sabella. Two programme options are consider: a simple education programme and a sustained control programme. The education programme will cost council $5,000 per annum with no occupier costs, while the sustained control programme will cost council $30,000 per annum. The occupier compliance cost is based on the number of vessels expected to be required to lift and wash their vessels because of the finding of Sabella on their hulls. A sustained control programme is expected to have a larger reduction in spread rate than education alone, although the effectiveness of both options in reducing the spread of Sabella is relatively low.

Programme specific assumptions

	Management regime with Pathways	
Variables for analysis	Education	Sustained control
Council costs ($/pa)	$5,000	$30,000
Occupier compliance costs ($/pa)	$0	$98,342
Reduction in spread rate	2%	10%
Likelihood of programme failure	High	Moderate
Likelihood of programme failure	75%	30%

The following graph shows the projected invasion trajectory of Sabella under the pathways plan, the pathways plan + education and the pathways plan + sustained control. The graph shows that with the use of the pathways plan + sustained control the invasion trajectory is reduced to a greater degree than pathways alone or pathways + education.

The following table summarises the benefits and costs of the programme options over ten year and fifty year time frames. While ten years is the standard assessment duration for regional council pest management plans, a fifty year assessment is included because pests typically take many decades to reach their full extent in the region. The net benefit is negative for the 10 year assessment but positive over 50 years. The benefit cost analysis indicates that the sustained control programme will be cost-beneficial over a 50 year time frame but not over a 10 year period. Under the education only option there is almost a neutral net benefit ($-0.02M) over 10 years and over 50 years the programme yields a positive net result of $0.87M. The short term cost of the sustained control option over ten years is -$0.75M. However over a 50 year period the net benefit of the programme yields the highest result of $10.22M. The robustness of the model and conservative nature of the figures used in the model means that this value is still largely positive for the net benefit even if the parameters change (see sensitivity analysis). For example, if the reduction in the rate of spread of the sustained control programme is only half as effective as assumed (a 5% rather than a 10% reduction in spread rate), the sustained control programmes still yields a net benefit of $4.0M.



Marine pests

Summary table

Cumulative present value of additional benefits and costs for fanworm programmes with Pathways Plan in place				
	Ten years		Fifty years	
	Sustained Control	Education	Sustained Control	Education
Benefit ($M)	$0.29	$0.02	$12.98	$0.98
Cost ($M)	$1.04	$0.04	$2.76	$0.11
Net benefit (B-C) ($M)	-$0.75	-$0.02	$10.22	$0.87

Assumptions and sensitivity of the model

Standard assumptions of the model

Suitability of land use type for pest (to determine potential area occupied)	
Unsuitable	0%
Secondary (1-4% of land use type)	3%
Primary (5-25% of land use type)	15%
Impact of pest on land use type values	
Not applicable	0%
Low (1-4%)	3%
Medium (5-9%)	7%
High (10-50%)	30%
Likelihood of programme failure	
Low (1-9%)	5%
Moderate (10-50%)	30%
High (>50%)	75%
Discount rate	4%

The following table outlines the area types where Sabella is currently found, the suitability of the area for the pest, and the maximum area where fanworm could establish in Northland based on this suitability. The table also includes a dollar value on the area types based on the ecosystem services and intrinsic values these areas offer. The estimate value per ha was derived from a number of resources namely Marjan van der Belt and Anthony Cole (2014) and Murray Patterson and Anthony Cole (2013). In this analysis only four area types were used to calculate the pest specific assumptions as these area types have a high estimated value per hectare and additional area types would likely have very little influence over the model. The weighted impact of potential impact was calculated using the impacts of pest on land use type values (for example the impact of fan worm on reefs is high = 30%). All values used in these calculation have been conservative in using the mean value of the risk assumption.

Pest specific assumptions

	Marine water body type				
Variables for analysis	Reefs	Salt marshes / wetland	Estuary / lagoon / intertidal / mangroves / seagrass	Commercial structures / marinas	Total
Total Northland area (ha)	242,545	749	61,457	18	
Estimated value per ha	$4,146	$15,008	$1,943	$0	
Current infestation by water body type (ha)	10	0	610	2	622
Suitability of land use type for pest (to determine potential area occupied)	Primary	Unsuitable	Primary	Primary	
Maximum area of infestation (ha)	36,382	0	9,219	3	45,603
Share of maximum infested area by land use / water body type (%)	80%	0%	20%	0%	100%
Weighted value of land at risk	$3,308	$0	$393	$0	$3,700
Impact of pest on land use type values	High	Not applicable	High	Low	
Weighted impact of potential impact	$992	$0	$118	$0	$1,110

Sensitivity Analysis

Fifty year cumulative net present value of fanworm programmes with Pathways Plan in place		
Change in assumption (all other variables remain constant)	$M	
	Sustained Control	Education
Baseline	$10.22	$0.87
Discount rate doubled to 8%	$2.15	$0.22
Maximum area of infestation only half as large	$11.82	$0.97
Years to reach 90% of maximum area 50% longer	$1.94	$0.25
Years to reach 90% of maximum area 50% shorter	$28.37	$2.04
Pathways Plan only 50% as effective	$22.06	$1.74

Fifty year cumulative net present value of fanworm programmes with Pathways Plan in place		
Reduction in spread rate achieved by programme halved	$3.97	$0.39
Dollar value of benefit halved	$3.73	$0.38
Impact of fanworm on values 50% less	$3.73	$0.38
Impact of fanworm on values 50% greater	$16.72	$1.36
Cost (public and private) double	$7.47	$0.77

Pacific oyster

Crassostrea gigas

Also known as: Pacific oyster

(Family: Ostreidae)

Status in New Zealand

Commercial species used in the aquaculture industry

Relevant biology

Form	The shells of Pacific oysters are usually whitish with many purple streaks and spots and a white interior. It is extremely variable and irregular in shape, depending on the type of surface its growing on and the degree of crowding. It has two shells, with one shell usually entirely cemented to a substrate, such as a rock, artificial structure or other oysters. The shells are usually 80-200 mm long, but exceptional specimens can reach 400 mm.
Habitat	The Pacific oyster is an estuarine species, found in the intertidal and subtidal zones. They prefer to attach to hard or rocky surfaces in shallow or sheltered waters, but also attach to shell fragments in muddy or sandy areas and subsequently form their own substrate. They can grow in temperatures of 4 to 35°C but for reproduction they need temperatures above 20°C.
Regional distribution	The Pacific oyster is cultivated on marine farms in the Northland Region and is widespread in estuaries and harbours on both the west and east coasts including Hokianga Harbour, Parengarenga Harbour, Houhora Harbour, Rangaunu Harbour, Whangaroa Harbour, Whangarei Harbour and the Bay of Islands.
Competitive ability	Pacific oysters have very high growth rates, tolerate a wide range of salinities and temperatures and have a high reproductive rate. These characteristics make the species a strong competitor for space and food and they may out-compete native bivalves, such as rock oysters.
Reproductive ability	For reproduction to occur, water temperatures must be above 20°C. Each female then releases 50-100 million eggs. After hatching, the larvae are free-swimming for a period of 3 to 4 weeks before they settle on a suitable hard surface and become attached. A Pacific oyster may live up to thirty years. Vectors of spread: The free-swimming larvae are spread by water currents and have been documented spreading up to 1,300 km through ocean currents. They are also spread by hull fouling and are cultivated and spread by marine farming activities.
Resistance to control	Physical removal has been undertaken overseas where they are causing problems for recreational users and/or are posing a threat to valuable marine areas . However, because of its strong reproductive and competitive abilities this species is very hard to control.
Benefits	Pacific oysters are the basis of New Zealand's oyster farming industry. 51% of the oysters cultivated in New Zealand originate in Northland.

Areas occupied

Area type	Current area infested	Potential area infested
Upper estuarine freshwater	-	-
Estuarine	High	High
Tidal mud flats	Low	Low
Rock outcrops / rocky reef	High	High
Wave-dominated beach	-	-
Seabed	High	High
Marine structures incl. moorings	High	High
Marine farms	High	High

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Coastal management area				
Marine 1 Protection	L	M	Pacific oysters are widespread in estuaries and harbours in the Northland Region. They can modify habitats and have impacts through their filter feeding activities and may out-compete native bivalves (e.g. rock oysters).	Woods & Inglis 2011 Troost 2010
Marine 2 Conservation	L	M		
Marine 3 Marine farm	+	+	Pacific oysters are a commercial species cultivated in Northland since the mid-1970s	
Marine 4 Mooring	L	L		
Marine 5 Port facilities	L	L		
Marine 6 Wharves	L	L		
Environment				
Water quality	L	L	Pacific oysters can affect water quality through their physical presence (influencing water	

Category	Current	Potential	Comment	Source
			flows and sediment characteristics) and their filter feeding activity.	
Species diversity	M	M	Pacific oysters may out-compete native bivalves and induce cascading effects on other trophic levels.	Troost 2010
Threatened species	L	L		
Social/Cultural				
Human health	L	L	Pacific oysters can cause problems for recreational users who can injure themselves or damage their equipment on the sharp edges of the shells.	
Recreation (incl. Fishing)	M +	M +	Pacific oysters can cause problems for recreational users who can injure themselves or damage their equipment on the sharp edges of the shells. However, they are also harvested for human consumption.	
Maori culture	M +	M +	Pacific oysters can impact on cultural values through their ability to modify habitats. However, they can also be harvested for human consumption.	

L = low M= moderate H = high - = No impact + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful *
Do nothing	Crassostrea gigas occurs widespread in the Northland region. If no management action is undertaken there will be no financial cost to the NRC associated with control of this species.	Pacific oysters can have both negative ecological impacts through their ability to modify habitats and change environments through their filter feeding activities. They can also cause problems for recreational users who can injure themselves or	High. Crassostrea gigas already occurs widespread in the Northland region.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful *
		damage their equipment on the sharp edges of these oysters.	
Exclusion programme	N.A. Crassostrea gigas is used as a commercial species in the aquaculture industry, and already occurs widespread in the Northland region outside of marine farms.		
Eradication programme	N.A. Crassostrea gigas is used as a commercial species in the aquaculture industry, and already occurs widespread in the Northland region outside of marine farms.		
Progressive containment programme	N.A. Crassostrea gigas is used as a commercial species in the aquaculture industry, and already occurs widespread in the Northland region outside of marine farms.		
Sustained control programme	N.A. Crassostrea gigas is used as a commercial species in the aquaculture industry, and already occurs widespread in the Northland region outside of marine farms.		
Site-led pest programme	Control of Pacific oysters in frequently used recreational areas and/or areas of high conservation value reduces the risk of injuries and/or potential negative ecological impacts.	Crassostrea gigas occurs widespread in the Northland region. Therefore any control programme would require an ongoing commitment to funding.	High. This species occurs widespread in Northland harbours. It is likely that it will re-establish itself.
Summary of alternative assessments and preferred option:	No regional intervention Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that the Pacific oyster does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. It is also acknowledged that this oyster is at the heart of a significant farming industry in the region and plays a large part in the Northland economy. Overall, any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be no regional intervention for Pacific		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful *
	oyster, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding.		

Parchment worm

Chaetopterus variopedatus

Also known as: parchment worm

(Family: Chaetopteridae)

Status in New Zealand

No legal status

Relevant biology

Form	The parchment worm is a segmented worm that lives in a U-shaped, tough, flexible tube of a whitish, paper-like material. Its body is yellowish or greenish-white with mature females becoming pinkish. They can grow up to 25 mm long (with a diameter of up to 40 mm) and can form dense beds.
Habitat	The parchment worm can colonise a wide range of habitats including rocky reefs and soft sediments from the shallow intertidal zone to depths of more than 60 m. It can tolerate a wide range of temperatures, but prefers warmer temperate to tropical waters to thrive. It can be found in a variety of salinities, from brackish estuaries to coastal marine waters. During easterly storms, tubes of the parchment worm have washed up in large numbers on beaches in north-eastern New Zealand.
Regional distribution	This species is widespread in the Northland and Auckland Regions. It may have been present as early as the 1960s but in the mid-1990s, parchment worms suddenly became very abundant in the Hauraki Gulf, occupying rock crevices, carpeting large areas of sheltered seafloor and appearing in the digestive tracts of ground feeding recreational fish species (notably the snapper Pagrus auratus). This species is cryptogenic- meaning it is unclear if it is native to New Zealand or was introduced.
Competitive ability	Parchment worms can out-compete native species that live in soft sediments, such as worms and bivalves. It is able to tolerate a wide range of temperatures and salinities, has a high reproductive capacity and can form dense beds (up to 1,000 individuals per m^2). As an anti-predator strategy, parchment worms can emit a luminescent cloud of mucus.
Reproductive ability	A female parchment worm can produce 150,000 to 1 million eggs. The larvae drift for some weeks until they settle. If a worm becomes injured, it has the ability to regenerate its entire body from a single segment. Most specimens that have been studied live for a period of about one year or less Vectors of spread: Larvae can disperse naturally with water currents. Parchment worms can also be transferred to new sites on aquaculture equipment and the hulls of boats.
Resistance to control	Prolifically breeding and capable of asexual reproduction by regeneration, this species is resistant to control options
Benefits	-

Areas occupied

Area type	Current area infested	Potential area infested
Upper estuarine freshwater	-	Low
Estuarine	High	High
Tidal mud flats	-	Low
Rock outcrops / rocky reef	High	High
Wave-dominated beach	-	-
Seabed	High	High
Marine structures incl. moorings	Low	Low
Marine farms	-	-

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Coastal management area				
Marine 1 Protection (MM1)	-	M	Parchment worms are widespread in the Northland Region and can form very dense aggregations, as observed in the mid-1990s.	Grace 2014
Marine 2 Conservation (MM2)	-	M	Parchment worms are widespread in the Northland Region and can form very dense aggregations, as observed in the mid-1990s.	Grace 2014
Marine 3 Marine farm (MM3)	-	-	This species is generally found in shallow soft sediments and also occurs on rocky reefs. No information was found indicating that it heavily infests marine farms.	
Marine 4 Mooring (MM4)	-	-	This species is generally found in shallow soft sediments and also occurs on rocky reefs. No information was found indicating that it forms dense aggregations on artificial structures.	
Marine 5 Port facilities (MM5)	-	L	Parchment worms have been recorded in reclaimed areas in the Port of Auckland	McClary et al 2001

Category	Current	Potential	Comment	Source
Marine 6 Wharves (MM6)	-	-	This species is generally found in shallow soft sediments and also occurs on rocky reefs. No information was found indicating that it forms dense aggregations on artificial structures.	
Environment				
Water quality	-	L	Parchment worms are filter feeders and, when they occur in high densities, may affect the local water quality.	
Species diversity	-	L	Parchment worms can out-compete native species, causing a reduction in available food resources; the presence of worm tubes in sediments is also associated with increased benthic biodiversity	Schaffner 1990
Threatened species	-	-		
Social/Cultural				
Human health	-	-		
Recreation (incl. Fishing)	-	M	The tubes of parchment worms can clog fishing nets and reduce catch efficiency. Anecdotal evidence suggests that ground feeding fish may consume large quantities of parchment worms Large numbers of tubes washing up on beaches after easterly storms can pose an amenity nuisance.	Allen & Lee 2006
Maori culture	-	M	Replacement of native species and impacts fishing and recreation may impact on cultural values in coastal and marine areas.	

L = low M= moderate H = high - = No impact + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful *
No Regional Intervention	If no management action is undertaken there will be no short-term financial costs to NRC associated with control of this species.	From time to time this species may form dense aggregations that may alter benthic communities, cause impacts on fisheries and wash up on beaches effecting beach recreation.	Moderate. This species already occurs widespread in the Northland region and rarely forms dense aggregations as shown in the mid-1990s.
Exclusion programme	n/a This species is already widespread in the Northland region.		
Eradication programme	n/a Eradication not possible due to its wide distribution, high temperature and salinity tolerances and high reproductive ability.		
Progressive containment programme	n/a This species is already widespread in the Northland region		
Sustained control programme	A sustained control programme to provide for the ongoing control of this species may reduce its potential impacts. However, this species rarely forms dense aggregations as were seen in the mid-1990s, so the benefits appear to be limited.	A sustained control programme in the entire Northland region would be very expensive, because of its wide distribution. It would require an ongoing commitment to funding.	High. This species is widespread in Northand, has high temperature and salinity tolerances and a high reproductive ability.
Site-led pest programme	If this species suddenly forms dense aggregations and is causing problems in local areas, a site-led programme may be able to reduce impacts	A site-led programme can be expensive, depending for example on the density of tubeworms present and the type of area infested.	Moderate. Control is unlikely to be successful because of its wide distribution and high reproductive potential. However, the removal of local aggregations may reduce (potential) site specific impacts.
Summary of alternative assessments and preferred option:	No regional intervention - the Marine Pathways plan includes some controls on the vectors of spread (aquaculture and hull fouling). Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that the parchment worm does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be <u>no regional intervention</u> for parchment worm, the council has		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful *
	also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding.		

Pink-mouthed clustered hydroid

Ectopleura crocea

Also known as: Pink-mouthed hydroid, Pink-mouthed clustered hydroid, Pink-hearted hydroid, Tubular hydroid

(Family: Tubulariidae)

Status in New Zealand

No legal status

Relevant biology

Form	The Pink-mouthed hydroid grows in tangled masses up to 10-12cm tall. A colony consist of up to several hundred unbranched stems, each crowned by threadlike tentacles (the feeding polyp or hydranth). The stems are gray and the hydranths are Pink.
Habitat	The Pink-mouthed hydroid occurs on a variety of substrates, including rocks, shells, concrete, pilings, buoys, jetties, pipes, and ships' hulls and is common in harbours and polluted waters. It occurs in the low intertidal zone to depths of 40m. It tolerates a wide range of temperatures (from 0 to 30℃) and salinities and is native to the Atlantic coast of North America .
Regional distribution	The Pink-mouthed hydroid is nearly cosmopolitan in its global distribution and has become established in Whangarei Harbour. Another introduced hydroid, *Ectopleura larynx* is also present in Whangarei Harbour and at Opua marina.
Competitive ability	Tolerating a wide salinity and temperature range, this rapidly growing species fouls cultured mussels with adverse effects on growth and condition. The Pink-mouthed hydroid is a potential competitor with other filter feeding species, including mussels and will be a predator of their larvae.
Reproductive ability	Sexes are separate, with eggs and sperm are released into the water column, where fertilisation occurs. The egg hatches into a larvae which is free-swimming for about 24 hours before settling on a surface. Vectors of spread: The Pink-mouthed hydroid can be spread by marine farming activities (e.g. transfer of aquaculture stock between harbours), hull-fouling and the natural dispersal of larvae by water currents.
Resistance to control	-
Benefits	-

Areas occupied

Area type	Current area infested*	Potential area infested
Upper estuarine freshwater	-	-
Estuarine	-	Low

Area type	Current area infested*	Potential area infested
Tidal mud flats	-	-
Rock outcrops / rocky reef	-	Low
Wave-dominated beach	-	-
Seabed	Low	Low
Marine structures incl. moorings	Low	High
Marine farms	-	High

High = Most infested/preferred Low = Less infested/preferred

* Reports of Pink-mouthed clustered hydroid have been found in NIWA port surveys in Whangarei, Tutukaka and Opua but are extremely difficult to identify by field analysis.

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Coastal management area				
Marine 1 Protection (MM1)	-	L	The Pink-mouthed hydroid is established in Whangarei Harbour, and may be present or become established in the two marine protected areas in this harbour. Given the known impacts of this species on shellfish condition and growth, it has the potential to affect wild/native species in marine reserves.	Woods & Inglis 2011 Hayes et al. 2005
Marine 2 Conservation (MM2)	-	L	The Pink-mouthed hydroid is established in Whangarei Harbour, and may be present or become established in other marine areas in this harbour. Given the known impacts of this species on shellfish condition and growth, it has the potential to affect wild/native species in MM2 areas.	Woods & Inglis 2011 Hayes et al. 2005
Marine 3 Marine farm (MM3)	-	L	Pink-mouthed hydroids foul cultured mussels and have adverse effects on their growth and condition as well as consuming mussel larvae. These	Fitridge 2011 Fitridge 2013 Okamura 1986

Category	Current	Potential	Comment	Source
			impacts could occur if this species became abundant on marine farms in Northland. In Norway it has become a problematic fouling species for salmon farmers. If finfish farming is to become established in Northland this may become a nuisance species for these farmers.	Woods & Inglis 2011
Marine 4 Mooring (MM4)	L	L	The Pink-mouthed hydroid is established in Whangarei Harbour and may foul artificial structures such as moorings.	Woods & Inglis 2011
Marine 5 Port facilities (MM5)	L	L	The Pink-mouthed hydroid is established in Whangarei Harbour and may foul artificial structures such as port facilities.	Woods & Inglis 2011
Marine 6 Wharves (MM6)	L	L	The Pink-mouthed clustered hydroid is established in Whangarei Harbour and may foul artificial structures such as wharves.	Woods & Inglis 2011
Environment				
Water quality	-	-		
Species diversity	-	L	These species may have both positive and negative effects. As a filter feeder it can consume the larvae of native species, but studies in the United States suggest that Pink-mouthed hydroid colonise support a diverse community including caprellid and tube-building amphipods, isopods, copepods, and mussels.	Piazzola 2015
Threatened species	-	L	As a filter feeder Pink-mouthed hydrozoans may eat the planktonic larvae of threatened species	
Social/Cultural				
Human health	-	-		

Category	Current	Potential	Comment	Source
Recreation (incl. Fishing)	-	-		
Maori culture	-	-		

L = low M= moderate H = high - = No impact + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful *
No Regional Intervention	In Northland *E. crocea* is established in Whangarei Harbour. If no management action is undertaken there will be no short-term financial costs to NRC associated with control of this species.	*E. crocea* is established in Whangarei Harbour and may spread to other areas in Northland including mussel farms where (based on overseas studies) it may have negative economic impacts	Low. *E. crocea* is already established in Whangarei Harbour and can easily reach the Northland region from other regions such as Auckland and/or Tauranga. However, *Ectopleura* species have not caused significant problems in New Zealand; in Australia *E. crocea* has been rated as a species with low impact and invasive potential.
Exclusion programme	n/a *Ectopleura* species have already established themselves in Whangarei Harbour and Opua marina.		
Eradication programme	*Ectopleura* species have not caused significant problems in New Zealand, and in Australia *E. crocea* has been rated as a species with low impact and invasive potential. Therefore an eradication programme does not seem very beneficial.	An eradication programme can be very expensive, because *Ectopleura* species are already established. It would require an ongoing commitment to funding for surveillance and eradication.	High. The species has already established itself in *Ectopleura* species are already established in Whangarei Harbour and Opua marina and can easily reach the Northland region from other regions such as Auckland and/or Tauranga.
Progressive containment programme	*Ectopleura* species have not caused significant problems in New Zealand, and in Australia *E. crocea* has been rated as a species with low impact and invasive potential. Therefore a progressive containment programme does not seem very beneficial.	A progressive containment programme would be less expensive than an eradication programme, but would require an ongoing commitment to funding for surveillance and control.	High. *Ectopleura* species are already established in Whangarei Harbour and Opua marina and can easily reach the Northland region from other regions such as Auckland and/or Tauranga.
Sustained control programme	*Ectopleura* species have not caused significant problems in New Zealand, and in Australia *E. crocea* a has been rated as	A sustained containment programme would be less expensive than an eradication programme,	High. *Ectopleura* species are already established in Whangarei Harbour and Opua marina and can easily

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful *
	a species with low impact and invasive potential. Therefore sustained control programme does not seem very beneficial.	but would require an ongoing commitment to funding for surveillance and control.	reach the Northland region from other regions such as Auckland and/or Tauranga.
Site-led pest programme	*Ectopleura* species have not caused significant problems in New Zealand, and in Australia *E. crocea* has been rated as a species with low impact and invasive potential. Therefore a site-led pest programme does not seem very beneficial.	A sustained site-led programme would be less expensive than an eradication programme, but would require an ongoing commitment to funding for surveillance and control.	High. *Ectopleura* species are already established in Whangarei Harbour and Opua marina and can easily reach the Northland region from other regions such as Auckland and/or Tauranga.
Summary of alternative assessments and preferred option:	No regional intervention - the Marine Pathways plan includes some controls on the vectors of spread (aquaculture and hull fouling). Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that the pink-mouthed clustered hydroid does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be no regional intervention for the pink-mouthed clustered hydroid , the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding.		

Pyura sea squirt

Pyura doppelgangera

Also known as: Australian sea squirt

(Previously known as *Pyura stolonifera praeputialis* and *Pyura praeputialis*)

(Family: Pyuridae)

Status in New Zealand

No legal status

Relevant biology

Form	The pyura sea squirt has a sack-like body with a brown, or reddish-brown, leathery skin. There is sometimes sand and shell material incorporated into the outer skin, and other sea life such as sea lettuce can grow on and around them. Adults grow up to 15 cm or more in height and around 3–5 cm in diameter.
Habitat	The pyura sea squirt is native to Australia. It generally inhabits the low- to mid-intertidal zone as well as shallow subtidal areas less than 12m deep. In New Zealand, it mainly colonises rocky platforms and outcrops, rock pools and the underside of rock overhangs, but it is also found on artificial structures such as oyster farms and wharf piles. Aggregations are often in very exposed areas with strong wave action.
Regional distribution	In 2007 a large population of pyura sea squirt was discovered on rocks near Cape Reinga. A subsequent survey of Northland discovered a further 21 locations and concluded that the species is widespread north of Herekino Harbour. Since that survey, it has been found at Tokatoka Point, Rangiputa, Mitimiti, Houhora Harbour, an oyster farm in Orongo Bay (Bay of Islands) and Okiato Point.
Competitive ability	The pyura sea squirt is an aggressive competitor for space and has the potential to significantly alter the structure and composition of intertidal communities. Dense mats have already engulfed and displaced native green-lipped mussel beds in some areas of the Far North.
Reproductive ability	Pyura sea squirts are hermaphrodites and are believed to be self-fertile. They release both eggs and sperm into the water column where fertilisation and development of the embryos occurs. The larvae hatch approximately 12 hours after fertilisation and are free-swimming for 1-3 hours before they settle. Vectors of spread: Pyura sea squirts can be spread by hull fouling, marine farming activities (e.g. transfer of stock and gear between harbours) and the natural dispersal of larvae through water currents (short distance),
Resistance to control	Removal by hand is considered a feasible method to control pyura sea squirts, but this is time-consuming and it is easy to overlook smaller specimens.
Benefits	Native starfish and whelks feed on pyura sea squirts, and in Australia it is harvested by recreational fishers who use it as bait.

Areas occupied

Area type	Current area infested	Potential area infested
Upper estuarine freshwater	-	-
Estuarine	High	High
Tidal mud flats	-	-
Rock outcrops / rocky reef	High	High
Wave-dominated beach	High	High
Seabed	High	High
Marine structures incl. moorings	Low	Low
Marine farms	Low	Low

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Coastal management area				
Marine 1 Protection (MM1)	L	M	The pyura sea squirt is present in several harbours that have significant conservation values. It may have negative impacts on those values.	Fletcher 2014
Marine 2 Conservation (MM2)	L	M	The pyura sea squirt is present in several harbours that have significant conservation values. It may have negative impacts on those values.	Fletcher 2014
Marine 3 Marine farm (MM3)	L	M	The pyura sea squirt is established on oyster farms in Parengarenga Harbour and the Bay of Islands but farmers have not reported any significant problems with this species. However, it could become a nuisance fouling species, increasing costs for harvesting, transport and factory processing. Through its high filtering capacity it could also become a competitor with cultured species such as oysters and mussels. When it overgrows mussels, less	Fletcher 2014

Category	Current	Potential	Comment	Source
			mussel spat may become available for the mussel farming industry.	
Marine 4 Mooring (MM4)	-	L	The pyura sea squirt can grow on artificial structures, but has not been found on moorings yet.	
Marine 5 Port facilities (MM5)	-	L	The pyura sea squirt grow on artificial structures, but has not been found on port facilities other than wharf piles yet.	
Marine 6 Wharves (MM6)	L	L	The pyura sea squirt has been found on wharf piles in Houhora Harbour and may spread.	
Environment				
Water quality	L	L	Through its strong filtering capacity, the pyura sea squirt may have impacts on the water quality.	No reference provided
Species diversity	L	M	The pyura sea squirt is an aggressive competitor for space and has the potential to significantly alter the structure and composition of intertidal communities. Dense mats of the species have already engulfed and displaced native green-lipped mussel beds in some areas of the Far North.	Hayward & Morely 2009
Threatened species	-	L-M	Adverse effects on species diversity could extend to threatened species.	
Social/Cultural				
Human health	-	-		
Recreation (incl. Fishing)	L	M	Local replacement of green-lipped mussels has already been observed and if this species continues to spread it may affect recreational harvesting of mussels over large areas.	Fletcher 2014

Category	Current	Potential	Comment	Source
			Any significant decline in mussel populations could also affect the levels of available 'Kaitaia Spat' which is the primary seed-stock source for the mussel farming industry in NZ	
Maori culture	L	M	Local replacement of green-lipped mussels has already been observed and if this species continues to spread it may affect traditional kaimoana harvesting over large areas.	Fletcher 2014

L = low M= moderate H = high - = No impact + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful *
No Regional Intervention	*P. doppelgangera* occurs widespread in the Northland region. If no management action is undertaken there will be no short-term financial cost to the NRC associated with control of this species.	Without any management action this species is likely to spread itself and may cause ecological, economic and cultural impacts.	High. *P. doppelgangera* is an aggressive interspecific competitor for space and has the potential to significantly alter intertidal community structure and composition. In New Zealand dense mats of *P. doppelgangera* have already engulfed and displaced native green-lipped mussel beds in some areas of the far north.
Exclusion programme	N.A. *P. doppelgangera* occurs widespread in the Northland region.		
Eradication programme	N.A. *P. doppelgangera* occurs widespread in the Northland region.		
Progressive containment programme	A progressive containment programme to contain or reduce the geographic distribution may reduce its impacts on values and spread to other areas, but would still provide an opportunity for this species to spread.	*P. doppelgangera* occurs widespread in the Northland region. Therefore the costs for a progressive containment programme would be very high.	High. *P. doppelgangera* occurs widespread in the Northland region, so re-infestation is likely. Removal by hand is considered a feasible method to control *P. doppelgangera*, but this is time-consuming and it is easy to overlook smaller specimens.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful *
Sustained control programme	A sustained control programme to provide for the ongoing control of this species may reduce its impacts on values and spread to other areas, but would still provide an opportunity for this species to spread from within the region.	*P. doppelgangera* occurs widespread in the Northland region. Therefore the costs for a sustained control programme would be very high.	High. *P. doppelgangera* occurs widespread in the Northland region, so re-infestation is likely. Removal by hand is considered a feasible method to control *P. doppelgangera*, but this is time-consuming and it is easy to overlook smaller specimens.
Site-led pest programme	A site-led pest programme may be able to control *P. doppelgangera* populations reducing potential impacts on areas with significant conservation, economic, social and/or cultural values.	A site-led pest programme requires an ongoing commitment to funding for surveillance and control.	Moderate –restricting activity to specific sites will optimise outcomes, though ongoing control will be essential as local source populations of *P. doppelgangera* could re-seed controlled areas
Summary of alternative assessments and preferred option:	Sustained control programme n relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for the aggressive, colonising pyura seasquirt. In terms of alternative approaches assessed, under <u>no regional intervention</u> (or do nothing) production values (marine farming) would be impacted over time and natural biodiversity values would continue to degrade through competition for space and food. Doing nothing would be akin to 'supporting' uncontrolled spread and vectoring of this nuisance marine pest to new areas. There would be moderate to high political and stakeholder risk anticipated with a no regional intervention approach, especially as pyura seasquirt is managed as one of six marine pest species of interest in the Auckland region. Due to the current distribution of pyura seasquirt in the Far North and more recently other parts of the region, <u>eradication</u> is not technically feasible or realistic (despite some success with hand removal) and the control costs (if the tools were available for widespread control) that would be imposed on regional ratepayers would be unaffordable and unsustainable. <u>Progressive containment</u> would also be very expensive and potentially a waste of resources, as the necessary control tools are not available. It would be high risk to pursue this outcome. A <u>site-led approach</u> would encounter similar risks to those outlined above, with no guarantee for outcomes in the selected areas from hand removal techniques. Working in marine areas is deemed very high risk from a health and safety viewpoint. Overall, there is a high risk of failure under these scenarios due to the lack of control methods and inherent operational risks outlined. <u>Sustained control</u>, offers the most practicable option as it is the least costly option for regional ratepayers and therefore more palatable (and with less risk). While existing populations would not be controlled, the spread of pyura seasquirt could potentially be slowed, especially to uninfested marinas, wharves and marine farms. Mitigation measures, through adoption of the sustained control option, combined with a pathway plan approach for marine pests, would allow additional funding to be sought and increase the overall awareness around pyura seasquirt amongst marine users, particularly the problem of spreading them to new areas.		

Red algae

Grateloupia turuturu

Also known as: Devil's Tongue Weed; Asian Red Seaweed; Red algae, Asian Grateloupia

(Family: Halymeniaceae)

Status in New Zealand

No legal status

Relevant biology

Form	The Devil's Tongue Weed is a large seaweed with blades (leaves) that are red, burgundy, or maroon in colour; blade colour tends to be lighter in the summer and darker during the winter. The blades are attached to a hold-fast that red algae uses to fasten itself to hard surfaces. It can grow as single blades or, more commonly, in clumps of several individuals. It has been reported to grow to 300 cm in length and 15 cm wide. Devil's Tongue Weed grows to its full length over summer then reduces to a crust-like form for overwintering.
Habitat	Devil's Tongue Weed is native to Japan and Korea, but has been introduced to many other regions. Overseas, it grows at depths of up to 2 m and prefers sheltered subtidal areas and rockpools but has been found in exposed areas. It grows attached to variety of surfaces including natural substrates (e.g. rocks, shells and coralline algae) and artificial substrates (e.g. boat hulls, pontoons).
Regional distribution	Devil's Tongue Weed has not been recorded in Northland. In New Zealand, it has been recorded in Wellington Harbour, the Port of Nelson, Tauranga and Picton.
Competitive ability	The ability of Devil's Tongue Weed to attach to a variety of surfaces, tolerate a range of temperatures (4-29°C) and salinities (12-52ppt), and use different reproductive strategies (see below) allows this species to establish in a wide range of sites and spread rapidly. It can spread rapidly to fill available habitat.
Reproductive ability	Devil's Tongue Weed reproduces both vegetatively from the edges of its blades by budding off new blades, and by spores. Each plant can produce tens of thousands of spores. In its introduced range in the United States red algae has four major recruitments strategies: 1) spores develop into small crusts that give rise to filaments and blades; 2) filaments and/or crusts produce new crusts; 3) new blades develop from old crust; and 4) blades regenerate from old damaged blades. The use of several different recruitment strategies greatly enhances the plant's ability to survive unfavourable conditions as well as spread widely Vectors of spread: Spores and fragments can be spread by water currents and in ballast water. Devil's Tongue Weed is also spread as fouling on boat hulls, floating vegetation or marine farming equipment.
Resistance to control	Manual removal of mature plants may be possible, but this technique cannot be used to remove the microscopic buds, spores or the crust-like winter resting phase.
Benefits	Devil's Tongue Weed is edible and extracts can be used in the biochemical and cosmetic industries.

Areas occupied

Area type	Current area infested	Potential area infested
Upper estuarine freshwater	-	-
Estuarine	-	Low
Tidal mud flats	-	-
Rock outcrops / rocky reef	-	Low
Wave-dominated beach	-	-
Seabed	-	Low
Marine structures incl. moorings	-	High
Marine farms	-	High

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Coastal management area				
Marine 1 Protection (MM1)	-	L	In most introduced areas Devil's Tongue Weed is regarded as an invasive species and is considered to be having a negative impact on native flora and invertebrates. Although there is both suitable shallow sub-tidal habitat in MM1 areas and the right environmental variables in Northland, it has not displayed invasive behaviour in Wellington Harbour since its first discovery in 2005, but has spread to Tauranga, New Plymouth, Christchurch and Nelson.	Morrisey et al., 2009, D'Archino et al., 2007, http://www.cabi.org/isc/datasheet/109142
Marine 2 Conservation (MM2)	-	L	In most introduced areas Devil's Tongue Weed is regarded as an invasive species and is considered to be having a negative impact on native flora and invertebrates. Although there is both suitable shallow sub-tidal habitat in MM1 areas and the right environmental variables in Northland. Since its first discovery in Wellington Harbour in 2005 Devil's Tongue Weed has not displayed invasive behaviour, but has spread to Tauranga, New Plymouth, Christchurch and Nelson.	Morrisey et al., 2009, D'Archino et al., 2007, http://www.cabi.org/isc/datasheet/109142
Marine 3 Marine farm (MM3)	-	M	European studies have indicated that Devil's Tongue Weed can have negative impacts by fouling shellfish and aquaculture facilities in coastal lagoons. Oyster aquaculture	Katsanevakis et al. 2014, http://www.cabi.org/isc/datasheet/109142

Category	Current	Potential	Comment	Source
			structures in Northland would provide ideal substrate and are within the environmental tolerances for this species.	
Marine 4 Mooring (MM4)	-	L	Devil's Tongue Weed can attach to a wide range of hard surfaces including moorings.	Simon et al., 2001
Marine 5 Port facilities (MM5)	-	M	Devil's Tongue Weed is well adapted to floating and artificial structures such as piers or pontoons that are often in contact with boat hulls. It can become a nuisance fouler and weigh down structures.	Simon et al., 2001
Marine 6 Wharves (MM6)	-	M	Devil's Tongue Weed is well adapted to floating and artificial structures such as piers or pontoons that are often in contact with boat hulls. It can become a nuisance fouler and weigh down structures.	Simon et al., 2001
Environment				
Water quality	-	-		
Species diversity	-	L	Overseas studies have indicated that Devil's Tongue Weed can reduce the abundance and diversity of algae living in its proximity due to the fact red algae is a large species and it reduces light to the understory. In its introduced range on the west coast of the US it was found that Devil's Tongue Weed had significantly lower diversity of invertebrates associated with it than the native species. However due to the fact Devil's Tongue Weed is a seasonal species and is restricted to the shallow sub-tidal area, the overall effect of species diversity would therefore be low.	Katsanevakis et al. 2014, http://www.cabi.org/isc/datasheet/109142
Threatened species	-	-		
Social/Cultural				
Human health	-	-		
Recreation (incl. Fishing)	-	L	Devil's Tongue Weed is a nuisance fouling species on vessel hulls and may clog intakes.	Katsanevakis et al. 2014

Category	Current	Potential	Comment	Source
Maori culture	-	L	Ecological impacts may affect cultural values in coastal environments. Particularly in inter-tidal Kai moana gathering areas.	http://www.cabi.org/isc/datasheet/109142, D'Archino et al., 2007

L = low M= moderate H = high - = No impact + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful *
No Regional Intervention	To date *G. turuturu* has not been reported from the Northland and/or Auckland regions. If no surveys are undertaken to determine its presence in the Northland region (e.g. outside of the Whangarei Harbour and Opua marina) then there will be no financial costs.	Determination of the presence of this species in the Northland region requires sampling efforts and microbiological testing as this species is difficult to distinguish from native red algae species. If this species is present in the Northland region then it may spread naturally with potential seasonal ecological impacts and impacts on marine farms.	Low. *G. turuturu* has been found at various other locations in New Zealand however it is generally at low densities. If it was to increase in density it would most likely be spread as fouling on boat hulls and equipment and the chance of continued reintroduction is high.
Exclusion programme	To date, *G. turuturu* has not been reported from the Northland and/or Auckland regions. Preventing establishment of this species would prevent potential impacts and related costs.	Prevention of establishment may be achieved through example awareness campaigns, identification tools and/or vector management approaches. Both require financial resources.	Low. *G. turuturu* species can be introduced from other regions such as Wellington, Nelson, Picton, Tauranga and/or Taranaki. But it is generally at very low densities at these sites.
Eradication programme	Not applicable.	Not applicable.	*G. turuturu* is currently not known to be present in Northland.
Progressive containment programme	Not applicable.	Not applicable.	*G. turuturu* is currently not known to be present in Northland.
Sustained control programme	Not applicable.	Not applicable.	*G. turuturu* is currently not known to be present in Northland.
Site-led pest programme	Not applicable.	Not applicable.	*G. turuturu* is currently not known to be present in Northland.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful *
Summary of alternative assessments and preferred option:	No regional intervention - the Marine Pathways plan includes some controls on the vectors of spread (aquaculture and hull fouling). Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that red algae does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be no regional intervention for red algae, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding.		

Spaghetti bryozoan

Amathia verticillatum

Also known as: *Zoobotryon verticillatum*

(Family: Vesiculariidae)

Status in New Zealand

No legal status.

Relevant biology

Form	The spaghetti bryozoan forms many-branched bushy colonies that can grow to 20-30cm in diameter and up to a metre or more in length. Often said to resemble stringy gelatinous vermicelli noodles, young colonies are transparent but they become dirty-white in appearance with age and growth. The abundance of spaghetti bryozoan varies significantly throughout the year with rapid growth occurring in summer months and die back reducing biomass as the water temperature drops.
Habitat	The spaghetti bryozoan is usually found growing on hard surfaces such as rocks, pilings, boat hulls or attached to shells. It has also been observed drifting in the water and forming large aggregations in some areas of the southern Kaipara Harbour, Whangarei Harbour Rangaunu Harbour and Pārengarenga Harbour. In many harbours in Northland it has also been found growing on and over subtidal seagrass and shell beds. It grows best at water temperatures above 22°C and can tolerate a wide range of salinities.
Regional distribution	In the Northland Region, spaghetti bryozoan is widespread and present in most harbours on both the east and west coast.
Competitive ability	The spaghetti bryozoan is widely distributed in warm temperate and tropical waters in the western Atlantic and the Caribbean. It has been recorded as an invasive species in many places all over the world, such as the United States, Australia and the Seychelles. It can reduce the level of light reaching seagrass blades, and compete with or smother native filter-feeding and bottom dwelling species. Colonies of spaghetti bryozoan produce chemicals that discourage other organisms from eating it or settling on it. Rapid growth occurs in summer months however the spaghetti bryozoan dies back as the water temperature drops.
Reproductive ability	The spaghetti bryozoan can re-grow from fragments; in 24 hours over 73% of broken fragments will reattach. Sexual reproduction may occur infrequently, with temperature being the major influence on larval production. Vectors of spread: the main vector of spread globally of spaghetti bryozoan is as hull fouling on vessels or the transfer of gear and aquaculture equpment. Locally fragments of spaghetti bryozoan can be transported by water currents and wave action.
Resistance to control	Spaghetti bryozoan was listed as having the highest ecological risk score and least feasibility for control and/or eradication in parts of the USA. Although its soft colonies can be easily detached from hulls by mechanical removal, stolons are likely to persist and regenerate new colonies, whilst viable fragments dislodged during manual removal may survive and subsequently reattach once the environmental conditions become favourable.

Benefits	Drifting mats of spaghetti bryozoan on soft sediment seafloors may provide habitat, cover and structure for juvenile fish and invertebrates

Areas occupied

Area type	Current area infested	Potential area infested
Upper estuarine freshwater	-	-
Estuarine	Low	Low
Tidal mud flats	-	Low
Rock outcrops/rocky reef	-	Low
Wave-dominated beach	-	-
Seabed	Low	Low
Marine structures including moorings	Low	High
Marine farms	Low	High

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Coastal management area				
Marine 1 Protection (MM1)	M	M	International research suggests that spaghetti bryozoan can reduce the level of light reaching seagrass blades and can cause canopy collapse. There are large areas of seagrass in MM1 Zoned areas in Northland that provide suitable environmental parameters for spaghetti bryzoan. For example, Rangaunu Harbour and Pārengarenga Harbour have high conservation values, particularly due to their seagrass beds but also have high seasonal abundance of spaghetti bryozoan. However this species has been present in New Zealand since the 1960's so it's distribution and effects may have reached their peak.	Williams, 2007; Morrison et al., 2014.
Marine 2 Conservation (MM2)	L	L	International research suggests that spaghetti bryozoan can reduce the level of light reaching seagrass blades and can cause	Williams, 2007; Morrison et al., 2014.

Category	Current	Potential	Comment	Source
			canopy collapse. There are large areas of seagrass in MM2 Zoned areas in Northland that provide suitable environmental parameters for spaghetti bryzoan. However this species has been present in New Zealand since the 1960's so it's distribution and effects may have reached their peak.	
Marine 3 Marine farm (MM3)	L	L	In Korea spaghetti bryozoan is a major fouling species on pearl oyster farms, affecting their productivity. However the extent of these effects will be moderated by the seasonality of this species lifecycle.	Je et al., 1988.
Marine 4 Mooring (MM4)	L	L	Spaghetti bryozoan is a known fouling species that is reported to cause fouling problems on boats and structures like marinas and moorings in its introduced range.	Johnson et al., 2006.
Marine 5 Port facilities (MM5)	M	M	Spaghetti bryozoan is a known fouling species that is reported to cause fouling problems on boats and structures like marinas and moorings in its introduced range.	Johnson et al., 2006.
Marine 6 Wharves (MM6)	M	M	Spaghetti bryozoan is a known fouling species that is reported to cause fouling problems on boats and structures like marinas and moorings in its introduced range.	Johnson et al., 2006
Environment				
Water quality	-	+	The spaghetti bryozoan is a suspension feeder that is considered to play a role in maintaining good water quality in the lagoons within its introduced range.	http://www.sms.si.edu/irlSpec/Zoobot_vertic.htm
Species diversity	-	-	International research suggests that spaghetti bryozoan can reduce the level of light reaching seagrass blades and cause canopy collapse. However drifting mats of detached spaghetti bryozoan also form an	Pederson and Peterson. 2002, Morrison et al., 2014

Category	Current	Potential	Comment	Source
			important habitat for a wide variety of invertebrate taxa on muddy bottoms.	
Threatened species	-	-		
Social/cultural				
Human health	-	-		
Recreation (including fishing)	-	L	The spaghetti bryozoan can clog fishing nets, affecting commercial and recreational fisheries.	http://issg.org/database/species/ecology.asp?si=1491&fr=1&sts=&lang=EN
Māori culture	-	-		

L = low; M = moderate; H = high; - = no impact; + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	Spaghetti bryozoan is already present in the majority of Northland harbours. If no management action is undertaken there will be no short-term financial cost to the council associated with control of this species.	Spaghetti bryozoan can clog fishing nets and local aggregations may effect biodiversity locally.	Low. Since its introduction before the 1960s it has not caused significant problems in New Zealand and in Australia it has been assessed as having a low impact and invasion potential.
Exclusion programme	Not applicable.	Not applicable.	Spaghetti bryozoan is already present in the majority of Northland harbours.
Eradication programme	Not applicable.	Not applicable.	Resources and control tools to eradicate spaghetti bryozoan are not currently available, so an eradication programme is not an appropriate option. It is unfeasible to eradicate a species that is widespread, present on the hull of many vessels in Northland and regenerates so readily from fragments. Continued reintroduction would occur from within and outside our region.
Progressive containment programme	Not applicable.	Not applicable.	Resources and control tools to contain spaghetti bryozoan are not currently available, so a progressive containment programme is not an appropriate option. It is unfeasible to contain a species that is widespread, present on the hull of many vessels in Northland

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
			and regenerates so readily from fragments. Continued reintroduction would occur from within and outside our region.
Sustained control programme	Not applicable.	Not applicable.	Resources and control tools to contain spaghetti bryozoan are not currently available, so a progressive containment programme is not an appropriate option. It is unfeasible to contain a species that is widespread, present on the hull of many vessels in Northland and regenerates so readily from fragments. Continued reintroduction would occur from within and outside our region.
Site-led pest programme	A site-led pest control programme could reduce potential local impacts in high value areas like Rangaunu and Pārengarenga harbours. However, since its introduction in the 1960s spaghetti bryozoan has not caused significant problems in New Zealand other than being a nuisance fouler. Therefore, potential benefits appear to be limited.	A site-led pest programme in Rangaunu and/or Pārengarenga harbour(s) requires an ongoing commitment to funding for surveillance and control.	Low-moderate. Spaghetti bryozoan can form large aggregations in Rangaunu and Pārengarenga harbours. If these aggregations are local, then it may be able to control them and reduce potential impacts. However, it has been present in the Auckland region for more than 55 years. Continued reintroduction would occur from within and outside our region.
Summary of alternative assessments and preferred option:	No regional intervention - the Marine Pathways plan includes some controls on the vectors of spread (aquaculture and hull fouling). Many organisms in the Northland region are considered undesirable or a nuisance and have varying invasiveness tendencies or characteristics. In the preparation of the Plan, the council undertook an extensive screening process (as required under Biosecurity Act, section 71 criteria) for each organism nominated to determine what (if any) regional intervention would be appropriate. Resulting from this process, the council is of the opinion that spaghetti bryozoan does not meet the 'tests' under the Act, even though it is present in the region and may be causing impacts (generally unknown and unmeasured) on regional values. Any decision to declare a harmful organism a 'pest' involves a degree of subjectivity when ranking, weighting and assessing impacts. Varying professional and political judgments are necessarily used. In determining that there will be <u>no regional intervention</u> for spaghetti bryozoan, the council has also had regard to those pests that are considered to be of greater risk to the region and has made judgments on what it can most effectively and efficiently achieve given finite resources and limited funding.		

Styela sea squirt

Styela clava

Also known as: styela sea squirt, Asian sea squirt, clubbed tunicate

(Family: Styelidae)

Status in New Zealand

The Styela sea squirt is listed as an unwanted organism under the Biosecurity Act 1993.

Relevant biology

Form	Sea squirts grow attached to hard surfaces. The styela sea squirt has a long, club-shaped body on a short, tough stalk. Its surface is tough, leathery, rumpled, and knobbly, ranging in colour from brownish-white through to reddish-brown and can grow up to 160 mm long. The styela sea squirt can be mistaken for a native New Zealand species that is white/purple with a much longer stalk (2/3 to 3/4 the overall length of the animal).
Habitat	The styela sea squirt has been found from the low intertidal zone to water about 40m deep, but is most common at depths of less than 25m. In addition to growing on rocks, shell fragments and other organisms (e.g. oysters) it can also grow on a wide range of artificial surfaces such as pylons, buoys, mussel lines, wharves and jetties. In New Zealand, it has a preference for sheltered sites but overseas also is found in semi-protected waters on more exposed coasts.
Regional distribution	The styela sea squirt is present at the Marsden Cove Marina and Opua Marina. It was removed from Tutukaka Marina in 2005/06 and has not been observed there since. Further south, it is present in the Waitemata Harbour and throughout the Hauraki Gulf.
Competitive ability	The styela sea squirt is able to colonise a variety of hard surfaces and tolerate wide ranges of salinity and temperature. It is also a highly efficient filter feeder, straining food particles from the water. These features make it a strong competitor and it is capable of forming monospecific stands and potentially out-competing native species.
Reproductive ability	The styela sea squirt is a hermaphrodite but is not considered to be self-fertile, except possibly by mechanical disturbance (McClary et al 2009). Animals release eggs and sperm into the water and the larvae are free-swimming for a 12-24h period before settling on suitable surfaces and metamorphosing into sessile adults. Spawning is believed to occur in waters above 15°C (McClary et al 2009; Wong et al 2011). Vectors of spread: The free-swimming larvae are dispersed by water currents and ballast water; adults may be spread via hull fouling and marine farming activities (e.g. transfer of aquaculture stock between harbours).
Resistance to control	It is hard to detect all styela sea squirts in an infested area. Manual removal can result in causing mature animals to reproduce hence if attempted should be restricted to periods when water temperature is less than 15°C
Benefits	-

Areas occupied

Area type	Current area infested	Potential area infested
Upper estuarine freshwater	-	-
Estuarine	High	High
Tidal mud flats	Low	Low
Rock outcrops / rocky reef	Low	Low
Wave-dominated beach	-	-
Seabed	Low	Low
Marine structures incl. moorings	High	High
Marine farms	High	High

High = Most infested/preferred Low = Less infested/preferred

Qualitative impact assessment

Category	Current	Potential	Comment	Source
Coastal management area				
Marine 1 Protection (MM1)	-	L	The styela sea squirt is established in Whangarei Harbour and may be or may become established in the two marine protected areas in this harbour.	Woods & Inglis 2011
Marine 2 Conservation (MM2)	-	L	The styela sea squirt is established in Whangarei Harbour and may be or may become established in the two marine protected areas in this harbour.	Woods & Inglis 2011
Marine 3 Marine farm (MM3)	L	H (mussel lines) M (oyster racks)	The styela sea squirt is not known to be present on marine farms in Northland, but it has caused major problems in the Auckland and Waikato regions. *Styela* sea squirt could account for up to 20% of the weight of mussel long-lines, increasing times and costs of harvesting, transporting and factory processing. The cost was estimated to be 0.1-9.3 million dollars during 2006-2011. *Styela* sea squirts are implicated in reduced mussel production in	Thomson & McNair 2004; Davis and Davis 2010; Deloitte 2011

Category	Current	Potential	Comment	Source
			Canada oyster production in France due to their competitive feeding ability.	
Marine 4 Mooring (MM4)	L	L	*Styela* sea squirt is established in Whangarei Harbour and can grow on artificial structures such as moorings.	
Marine 5 Port facilities (MM5)	L	L	*Styela* sea squirt is established in Marsden Cove marina, but no significant impacts have been reported	
Marine 6 Wharves (MM6)	L	L	*Styela* sea squirt is established in Marsden Cove marina, but no significant impacts have been reported.	
Environment				
Water quality	-	L	*Styela* sea squirt can affect water quality through their physical presence (influencing water flows and sediment characteristics) and their filter feeding activity	
Species diversity	-	L-M	*Styela* sea squirt is capable of forming monospecific stands on natural surfaces, potentially outcompeting native taxa for space. "Blankets" of the species may reduce habitat complexity which impacts upon biodiversity. It may also outcompete native filter-feeders for food.	Kluza et al. 2006
Threatened species	L	L	Potential impacts on threatened species could occur as a consequence of reduced species diversity.	
Social/Cultural				
Human health	-	L	Oyster processors working in poorly ventilated areas overseas have experienced asthma when opening oysters infested with styela sea squirt.	Forrest 2013

Category	Current	Potential	Comment	Source
Recreation (incl. Fishing)	-	L	Alteration of habitats may have an impact on benthic and/or fish species that are targeted by recreational fishers.	
Maori culture	-	L	Replacement of native species by non-indigenous species and impacts caused by habitat modification may impact on cultural values in coastal and marine areas.	

L = low M= moderate H = high - = No impact + = benefit

Proposed management

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful *
No Regional Intervention	*S.clava* is established in Whangarei Harbour and Opua marina. If no management action is undertaken there will be no short-term financial costs to NRC associated with control of this species.	This species is established in Whangarei Harbour and Opua marina and may spread itself to other regions. This species can overgrow artificial substrates such as mussel lines which may lead to economic losses to the aquaculture industry similar to those observed in the Auckland and Waikato regions. Overseas studies have shown that this species can also have ecological impacts (e.g. decrease biodiversity).	High. *S.clava* is already established in Whangarei Harbour and Opua marina and can readily be spread to other areas including mussel farms.
Exclusion programme	n/a *S.clava* is already established in Whangarei Harbour and Opua marina.		
Eradication programme	*S.clava* has only established populations in Whangarei Harbour and Opua marina and may not be present yet in other east coast harbours and/or on the west coast. If known established populations could be eradicated then it would prevent further spread from those areas.	An eradication programme is likely to be very expensive and would require an ongoing commitment to funding for surveillance and eradication.	High. As a habitat generalist with strong competitive and reproductive abilities, it would be very difficult to detect and eradicate all *S.clava* specimens in an infested area. Re-infestation from the Hauraki Gulf, where this species is widespread is highly likely.

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful *
Progressive containment programme	A progressive containment programme to contain or reduce the geographic distribution may reduce its spread to other areas. However, it would still provide an opportunity for this species to spread from within the region.	The costs for a progressive containment programme would be less than the costs for a full eradication programme, but would require an ongoing commitment to funding for surveillance and control and could still be significant.	High. As a habitat generalist with strong competitive and reproductive abilities, it would be very difficult to detect and contain all *S.clava* specimens in an infested area. Re-infestation from the Hauraki Gulf, where this species is widespread is highly likely.cessful.
Sustained control programme	A sustained control programme to provide for the ongoing control of this species may reduce its impacts on values and spread to other areas, but would still provide an opportunity for this species to spread from within the region.	The costs for a sustained control programme would be less than the costs for a full eradication programme, but would require an ongoing commitment to funding for surveillance and control and could still be significant.	High. As a habitat generalist with strong competitive and reproductive abilities, it would be very difficult to detect and control all *S.clava* specimens in an infested area. Re-infestation from the Hauraki Gulf, where this species is widespread is highly likely.l
Site-led pest programme	A site-led pest programme may be able to reduce and/or control *S.clava* in areas with significant conservation, economic, social and/or cultural values.	A site-led pest programme requires an ongoing commitment to funding for surveillance and control.	High. As a habitat generalist with strong competitive and reproductive abilities, it would be very difficult to detect and control all *S.clava* specimens in an infested area. Re-infestation from the Hauraki Gulf, where this species is widespread is highly likely.
Summary of alternative assessments and preferred option:	Sustained control programme In relation to NPD considerations (section 6(1) outlines four criteria) a low-level analysis was deemed appropriate for styela seasquirt. In terms of alternative approaches assessed, under no regional intervention (or do nothing) production values (marine farming) would be impacted over time and natural biodiversity values would continue to degrade through competition for space and food. Doing nothing would be akin to 'supporting' uncontrolled spread and vectoring of this significant nuisance marine pest to new areas. There would be moderate to high political and stakeholder risk anticipated with a no regional intervention approach, especially as styela seasquirt is managed as one of six marine pest species of interest in the Auckland region (Hauraki Gulf and Waitemata). Due to the current distribution of styela seasquirt in marina areas, eradication is not technically feasible or realistic (despite some success at Tutukaka) and the control costs (if the tools were available) that would be imposed on regional ratepayers would be unaffordable and unsustainable. Progressive containment would also be very expensive and potentially a waste		

Option	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful *
	of resources, as the necessary control tools are not available. It would be high risk to pursue this outcome. A site-led approach would encounter similar risks to those outlined above, with no guarantee for outcomes in the selected areas. Working in marine areas is deemed very high risk from a health and safety viewpoint. Overall, there is a high risk of failure under these scenarios due to the lack of control methods and inherent operational risks outlined. Sustained control, offers the most practicable option as it is the least costly option for regional ratepayers and therefore more palatable (and with less risk). While existing populations would not be controlled, the spread of styela seasquirt could potentially be slowed, especially to uninfested marinas and marine farms. Enforcement remains an option for clear exacerbators of problem situations, e.g. those people with infested structures who might move large amounts of material around the region. Mitigation measures, through adoption of the sustained control option, combined with a pathway plan approach for marine pests, would allow additional funding to be sought and increase the overall awareness around styela seasquirt amongst marine users, particularly the problem of spreading them to new areas.		

* In accordance with clause 6(2)(g) of the NPD *'take into account any risks that each option will not achieve its objective'*

Pathway Management Plan

Assessing the benefits and costs of implementing a Pathway Management Plan is a requirement under the Biosecurity Act 1993. A national guiding document released in 2015 accompanying the National Policy Direction provides the relevant components required for cost benefit analysis and assessment of implementation costs.

The analysis of benefits and costs associated with the pathway plan were assessed using a benefit-cost model originally developed for Top of the South (which compromises the three Top of the South councils, MPI, local ports, the aquaculture industry, tangata whenua and other regional stakeholders in marine biosecurity). The model was further developed and refined by Cawthron Institute to better fit Northland and the pathway management scenario of reducing hull bioufouling to a low level.

The model is a four-step risk management process (risk identification, risk assessment, analysis of the risk treatment options, and risk evaluation) designed to assess risk according to the likelihood of marine pest introduction and spread with and without pathway management, and the consequences of their impact on regional values. Benefits are determined, in dollar terms, as the difference between unmanaged and managed risk.

Aquaculture

Description	Aquaculture (or marine farming) is the breeding and growing of animals and plants in the water for profit. It can take place on land or in ponds or tanks, but most aquaculture in New Zealand occurs in the sea. The main commercial species farmed in New Zealand are green lipped mussels and pacific oysters. Green lipped mussels are grown on lines suspended from floats on the surface, while Pacific oysters are grown on inter-tidal racks. Other species farmed include chinook salmon, paua, snapper and kingfish.
Risk	Aquaculture is a known vector for the spread of marine pests and diseases. The spread of these pests is usually associated with biofouling species and the movement of aquaculture equipment and stock between marine farms. Marine pest impacts are largely related to the fouling of marine farms which can result in the loss of stock, reduced growth rates and increased costs associated with handling and cleaning. In addition, once established, marine pests are more likely to spread to the adjacent environment which can result in adverse effects on the surrounding natural habitat. In some instances the species being farmed can escape into the surrounding environment, becoming invasive.
Ability to move organisms	It is common practise within the aquaculture industry to share and reuse gear or move stock between farms and other regions. If the gear is not clean or treated prior to relocation - 'hitchhiking' marine pests can be transferred between marine farms. Similarly, the movement of stock, in particular spat, which must be kept alive, also favours 'hitchhiking' marine pests. Should transfers occur between regions, gear should be thoroughly cleaned and details of the transfer kept.
Regional distribution	Northland is one of New Zealand's major marine farming regions, producing nearly half the country's exports of Pacific oysters and three-quarters of its mussel spat. The oyster farming industry is concentrated in the Bay of Islands, Parengarenga, Houhora, Whangaroa and Kaipara harbours. There are approximately 120 developed marine farms with ongoing interest in the development of additional oyster growout farms in the Far North harbours, and in oyster spat catching in the Kaipara. Northland has 841 hectares of consented marine farm area - although only approximately half of this is actually developed. On land, there is the National Institute of Water and Atmospheric Research (NIWA) fin-fish aquaculture research facility and a commercial abalone farm owned by OceaNZ Blue, both are located at Bream Bay near the entrance to Whangarei harbour.
Current controls	- An organism new to New Zealand is managed by MPI until its identified. - MPI has protocols in place to reduce the risk of marine pest spread associated with aquaculture activities. - Codes of practise have been developed by oyster, mussel and salmon producers which are aimed at reducing biosecurity risks associated with their operations.

	- A notice of direction can be given to a marine farm that is found to be harbouring a pest that is identified in the RPMS. - A notice of direction can be given under Section 122 of the Biosecurity Act for any unwanted organism. - An infringement notice can be given to a marine farm that is found to be harbouring/ releasing any 'exotic organism' in Northland under the Regional Coastal Plan for Northland. - Air drying and/ or waterblasting are the two most common forms of treatment for biofouling marine pests on aquaculture gear. - Biosecurity management plans have been developed by some marine farms although this approach is voluntary and hasn't been implemented industry wide. The Ministry of Fisheries (now MPI) was responsible for monitoring compliance of marine farmers with leases and licences for marine farming issued under the Marine Farming Act 1971. Responsibility for approving and monitoring marine farms has now passed to regional councils under the Resource Management Act 1991, although in the case of derelict or abandoned marine farms, any forfeiture action begun by the Ministry of Fisheries under the Marine Farming Act will be concluded. Upon the granting of a coastal permit for a marine farm, MPI must make an aquaculture decision. This involves MPI making a formal assessment on whether the proposed aquaculture activity will have an undue adverse effect on customary, recreational or commercial fishing.
Benefits	Aquaculture is one of the fastest growing primary industries and holds significant commercial, ecological and cultural value. In 2011 approximately 3000 people were employed nationally by the industry, generating over $400 million in revenue with a goal of reaching $1 billion in sales by 2025.

The Northland Scenario

In 2013, aquaculture in Northland was estimated to have produced over $18.5m in regional gross domestic product and directly employed more than 380 people. In addition to aquaculture activities, spat collection from Northland significantly supports aquaculture activities in other parts of New Zealand. Mussel spat collected from seaweed at Ninety Mile Beach supplies over 75% of seed to mussel farms throughout New Zealand. Kaipara Harbour provides oyster spat.

Aquaculture has the potential to be an increasingly important contributor to the social, economic, and cultural wellbeing and health of Northland, especially in the more remote parts of the region.

Pacific oysters (Crassostrea gigas) and Green-lipped mussels (Perna canaliculus) are the two main species grown in Northland. There is currently 841 hectares of consented marine farm area - although approximately only half of this is actually developed. Currently, approximately 120 developed marine farms are located in 10 of the region's 15 harbours, utilising the extensive intertidal flats, warm waters, and generally high water quality of the coastal marine area.

Aquaculture has recognised potential for expansion in the Northland region, subject to the identification and use of suitable and appropriate sites and the adoption of management controls.

To date, *Eudistoma elongatum, Didemnum vexillum* and *Styela clava* have been found on marine farms in Northland.

Common aquaculture stock transfers in and out of Northland:

- Wild mussel spat collected from 90 Mile-Beach and transferred to various marine farms throughout New Zealand;
- Wild oyster spat collected from sites such as the Kaipara harbour and transferred to marine farms within the upper North Island; and
- Oyster spat from Nelson and Marlborough Sounds transferred to Northland.

Species risk assessment

Organism	Suitability for translocation via aquaculture	Current status	Potential to become a pest if introduced	Potential financial implications	
				Potential economic loss	Potential cost of management
Asian clam	More likely via ballast water than aquaculture	Unwanted Organism Not established Notifiable organism	Strongly inferred impact on both economic values and biodiversity. Thought to be responsible for the collapse of commercial fisheries and the decline of biodiversity in California. Can live in fresh and salt water and is highly resistant to changes in salinity and temperature. In San Francisco Estuary average densities average 2,000/m2. Feeds at multiple levels in the food chain, can place pressure on native organisms and significantly disturb surface sediment layers	High	High
Caulerpa seaweed	Most likely way of arriving in New Zealand is through importation for use in aquariums and subsequently released into the marine environment	Unwanted Organism Not established Notifiable organism	A rapidly growing saltwater weed that can cause major ecological and economic damage. Ability to live in a wide range of temperatures, depths and substrates. Forms dense fields and can prevent the establishment of native seaweeds. Can cause reduction of fishing catches due to elimination of fish habitat.	Medium	Medium
Chinese mitten crab	Juveniles could be transported through oyster aquaculture	Unwanted Organism Not established	Potential to undermine the integrity of stream banks through burrowing, accelerating erosion. Ability to live in both fresh and salt water with a wide diet, infers a significant impact	High	Medium

Organism	Suitability for translocation via aquaculture	Current status	Potential to become a pest if introduced	Potential financial implications	
				Potential economic loss	Potential cost of management
		Notifiable organism	on ecosystems. Can affect human health as a host for parasitic lung flukes. In Europe, high densities have damaged commercial fishing nets and catches.		
European shore crab	Juveniles could be transported through oyster aquaculture. Tolerates a wide range of salinities and temperatures	Unwanted Organism Not established Notifiable organism	Voracious predator, can negatively impact shellfish population including those being farmed. Significant potential impact on both economic values and biodiversity. May out-compete native crabs and cause decline in native shellfish populations Ability to spread – first recorded in Port Phillip Bay, Victoria in 1900 and now occurs widely in Southeast Australia.	Medium	Medium
Mediterranean fanworm	Can be transported via aquaculture Is known from mussel farms in the Waikato and Auckland Regions	Unwanted Organism Notifiable organism Well established in Auckland harbour. Present in some areas of Whangarei harbour.	Highly invasive species, can form dense groups that could affect native species by competing for food and space. Can filter large amounts of water which could affect nutrient flow.	High	High
Northern pacific Seastar	Juveniles could be transported through aquaculture	Unwanted Organism Not established Notifiable organism	Strongly inferred impact on biodiversity and shellfish farming. Is a voracious predator and can multiply rapidly. Has potential to cause major problems for local communities and commercial shellfish operations.	High	High

Organism	Suitability for translocation via aquaculture	Current status	Potential to become a pest if introduced	Potential financial implications	
				Potential economic loss	Potential cost of management
Asian paddle crab	Juveniles could be transported through aquaculture	Widespread in the Hauraki Gulf, has been detected in Whangarei harbour and Opua/Waitangi.	Aggressive crab, potential to compete with native crabs, preys on shellfish and as such can threaten marine farming. Not reported to be a pest in its native habitat or in other countries.	High	Medium
Didemnum sea squirt	Can be transported via aquaculture	Established in Marlborough Sounds, Whangamata and Tauranga.	Strongly inferred impact on marine farming. Can smother man made structures including mussel lines, and spreads easily.	High	High

What pests already existing may have been introduced by aquaculture?

As outlined in the above Species Risk Assessment Table, all but Caulerpa Seaweed and Asian clam could be introduced via aquaculture.

To date, *Eudistoma elongatum, Didemnum vexillum* and *Styela clava* have been found on marine farms in Northland.

Mediterranean fanworm has become established in Whangarei Harbour (Northland Regional Council in conjunction with the Whangarei Marine Biosecurity Charter Group, 2013. *Whangarei Marine Biosecurity Charter*), although this has occurred through hull biofouling there is the potential for it to be spread via aquaculture.

Styela clava can now be found in the Bay of Islands, Whangarei and the Houhora harbours; *Eudistoma elongatum* is found in the Parengarenga, Rangaunu and Hohoura harbours as well as in the Bay of Islands; *Didemnum vexillum* is found in Whangarei and Houhora harbours; Pyura sea squirt is in Russell and Oronga Bay in the Bay of Islands, Hokianga, and the far north; Undaria is found in Houhora and Rangaunu harbours.

Ballast water

(referenced: Cawthron reports part A and B (2013), Convention for the control and management of ships ballast water and sediments(2004), and Vessel movements within NZ (MAF 2008))

Description	Ballast water is used by vessels to increase the draft, change the trim or regulate stability. If a vessel is unladen it will usually be ballasted and will discharge its ballast water to account for the amount of cargo being loaded. When taken on, ballast water may include sediments and biological constituents which may then be discharged with the water in a different port. Ballast water is discharged by both domestic and foreign vessels in New Zealand ports.
Risk	Ballast water can potentially carry unwanted marine organisms and discharge them, live, in to a new country or region. Due to the process of taking on and discharging ballast, it is most likely that marine organisms would be transported as larvae, spores or fragments. Ballast water can also introduce algal blooms. Once introduced to a new environment these organisms can establish quickly and affect marine biodiversity. Ballast water is recognised as a mechanism of spread for marine organisms.
Ability to move organisms	The translocation of marine organisms via ballast water is dependent on the volume of water being taken on and expelled, the number of marine organisms in the port of origin and the ability of any organisms to survive in the receiving environment, season and lifecycle of the organism, and transit time.
Regional distribution All data, excluding that on cruise ship movements, is referenced is from MPI Technical paper No 2014/04 'Vessel Movements within New Zealand' June 2009	Ballasted vessels are constantly travelling throughout New Zealand and being received from overseas. The majority of movements of large merchant vessels between NZ ports between January 2000 and December 2005 were either lightly or moderately ballasted, with 21.3% being heavily ballasted. Whangarei exceeds this national average, with 55% of vessels being heavily ballasted, and 43.6% moderately ballasted (see appendix 1). This is due to the higher than average number of bulk carrier vessel arrivals in Whangarei (see appendix 2). There is little seasonal variation in large vessel movements. The majority of movements of ballasted vessels occur on the Eastern coast of New Zealand, from Whangarei to Bluff, including the ports of Auckland, Tauranga, Gisborne, Napier, Wellington, Picton and Nelson, Lyttelton, Timaru, and Dunedin. New Plymouth is the only port on the West Coast to have significant movement of large vessels. Between January 2000 and December 2005 there was an average of 7,210 movements of large merchant vessels between New Zealand ports each year. Analysis of mean annual vessel movements of vessels greater than 99 tonne show that the majority of domestic movements *to* Whangarei originate from Tauranga (30 – 82 annual movements) followed by Auckland, Napier, Wellington, Lyttelton, Dunedin and New Plymouth (8 – 29 annual movements for each). The majority of movements *from* Whangarei are to Tauranga (83 – 198 annual movements) and Auckland (30 – 82 annual movements). Data on international vessels is limited, however mean annual movements to and from Whangarei (see appendix 3) show that there were a greater number of large vessels leaving Whangarei for domestic ports than those arriving from domestic ports, indicating that there were a greater number of arrivals from international ports than departures to international ports. This discounts Whangarei as a 'last port of call' location. The other main port of arrival and departure of international vessels in Northland is Opua and the Bay of Islands. The majority of the vessels arriving and departing from Opua marina are recreational and not likely to be ballasted. Cruise ships visiting the Bay of

	Islands are most likely to be arriving from or departing to a domestic location with approximately 26% of cruise ships during the last high season arriving from an international location, and approximately 17% departing to international locations (see appendix 4). This discounts the Opua and the bay of Islands as primarily being a 'last port of call' for large vessels.
Current controls	Central government is responsible for the control of ballast water discharge from international vessels or vessels that have been outside NZ territorial waters, and manages this under section 22 of the Biosecurity Act through the Import Health Standard for Ballast Water (2005). This requires that if not freshwater, the ballast must have been either exchanged en route, treated, or discharged to an onshore treatment facility. There are few, if any, restrictions on ballast water domestically.
Benefits	Ballast water provides an effective way to ensure that ships can travel safely between ports with little or no cargo on board.

The Northland scenario

As ballast water is generally only required by large merchant vessels, the East coast of Northland is at the greatest risk due to the operation of the port of Whangarei, and visiting cruise ships in the Bay of Islands.

Vessels servicing the cement works in Whangarei travel to the upper reaches of the harbour where they will discharge 1800 tonnes of ballast water approximately 90 time a year. Half of the time, this water is taken up in Auckland. Northport, at the mouth of the harbour, receives a higher volume of shipping traffic, with domestic movements predominantly coming from the top of the South Island and the East Coast of the North Island.

Domestic coastal tankers at Marsden Point Refining Company make approximately 120 visits, and discharge 18,000 tonnes of seawater, taken up from various locations between Auckland and Bluff.

Over 50 cruise ship arrivals are expected to visit the Bay of Islands in the high season from October 2015 – May 2016. While some of these vessels arrive from outside of New Zealand territorial waters and are held by national standards for ballast water, the majority arrive from other areas in New Zealand.

Species risk assessment

A preliminary assessment of the risk that ballast water presents based on species that are currently included in the Northland Marine Pest Management Strategy, the majority of which are not currently in New Zealand, and are capable of being transported via ballast water.

Organism	*Suitability for translocation via ballast*	*Current status*	*Potential to become a pest if introduced*	*Potential financial implications*	
				Potential economic loss	*Potential cost of management*
Asian clam	Larvae of Asian clam can be transported in ballast water. Able to survive in both salt water and fresh water, risk of being	Unwanted Organism Not established Notifiable organism	Strongly inferred impact on both economic values and biodiversity. Thought to be responsible for the collapse of commercial fisheries and the decline of biodiversity in California. Can live in fresh and salt water and is highly resistant to changes in salinity and temperature.	High	MPI lead agency

Organism	*Suitability for translocation via ballast*	*Current status*	*Potential to become a pest if introduced*	*Potential financial implications*	
				Potential economic loss	*Potential cost of management*
	introduced in fresh ballast water.		In San Francisco Estuary average densities average 2,000/m2. Feeds at multiple levels in the food chain, can place pressure on native organisms and significantly disturb surface sediment layers		
Caulerpa seaweed	Most likely way of arriving in New Zealand is through importation for use in aquariums and subsequently released into the marine environment.	Unwanted Organism Not established Notifiable organism	A rapidly growing saltwater weed that can cause major ecological and economic damage. Ability to live in a wide range of temperatures, depths and substrates. Forms dense fields and can prevent the establishment of native seaweeds. Can cause reduction of fishing catches due to elimination of fish habitat.	High	MPI lead agency
Chinese mitten crab	Larvae and juveniles can be transported in ballast water. Post-larval stages can survive in both salt and fresh ballast water. Larvae are planktonic for 1 – 2 months.	Unwanted Organism Not established Notifiable organism	Potential to undermine the integrity of stream banks through burrowing, accelerating erosion. Ability to live in both fresh and salt water with a wide diet, infers a significant impact on ecosystems. Can affect human health as a host for parasitic lung flukes. In Europe, high densities have damaged commercial fishing nets and catches.	High	MPI lead agency
European shore crab	Larval and juvenile stages of the crab can be transported in ballast water. Tolerates a wide range of salinities and temperatures	Unwanted Organism Not established Notifiable organism	Voracious predator, can negatively impact shellfish population including those being farmed. Significant potential impact on both economic values and biodiversity. May outcompete native crabs and cause decline in native shellfish populations	High	MPI lead agency

Organism	*Suitability for translocation via ballast*	*Current status*	*Potential to become a pest if introduced*	*Potential financial implications*	
				Potential economic loss	*Potential cost of management*
			Ability to spread – first recorded in Port Phillip Bay, Victoria in 1900 and now occurs widely in Southeast Australia.		
Mediterranean fanworm	Can be transported in ballast water as larvae, although most likely to be transported via hull biofouling.	Unwanted Organism Notifiable organism Well established in Auckland harbour. Present in some areas of Whangarei harbour.	Highly invasive species, can form dense groups that could affect native species by competing for food and space. Can filter large amounts of water which could affect nutrient flow.	High	High
Northern pacific Seastar	Can be transported in ballast water as larvae.	Unwanted Organism Not established Notifiable organism	Strongly inferred impact on biodiversity and shellfish farming. Is a voracious predator and can multiply rapidly. Has potential to cause major problems for local communities and commercial shellfish operations.	High	MPI lead agency
Asian paddle crab	Can be transported in ballast water as larvae. Larvae can float in the water for 3 – 4 weeks.	Widespread in the Hauraki Gulf, has been detected in Whangarei harbour and Opua/Waitangi.	Aggressive crab, potential to compete with native crabs, preys on shellfish and as such can threaten marine farming. Not reported to be a pest in its native habitat or in other countries.	Medium	Medium
Didemnum sea squirt	Can be transported as fragments in ballast water. Releases tailed larvae into the water column.	Established in Marlborough Sounds, Whangamata and Tauranga.	Strongly inferred impact on marine farming. Can smother man made structures including mussel lines, and spreads easily.	Medium	Medium

What pests already existing may have been introduced by ballast water?

As outlined above in the Species Risk Assessment Table, all but Caulerpa seaweed, could be introduced via ballast water.

Mediterranean fanworm has become established in Whangarei Harbour (Northland Regional Council in conjunction with the Whangarei Marine Biosecurity Charter Group, 2013. *Whangarei Marine Biosecurity Charter*), although this has occurred through hull biofouling there is the potential for this to occur via ballast water.

Styela clava can now be found in the Bay of Islands, Whangarei and the Houhora harbours; *Eudistoma elongatum* is found in the Parengarenga, Rangaunu and Hohoura harbours as well as in the Bay of Islands; *Didemnum vexillum* is found in Whangarei and Houhora harbours; Pyura sea squirt is in Russell and Oronga Bay in the Bay of Islands, Hokianga, and the far north; Undaria is found in Houhora and Rangaunu harbours.

Appendix 1

Table 10: 'Vessel movements within NZ'

Arrival port	Light	Medium	Heavy	Fishing	Slow	Total
Whangarei	22	833	1051	4	1	1911
Total of NZ ports % of NZ total	16 836 38.9%	15 846 36.6%	9 200 21.3%	1 274 2.9%	106 0.2%	43 262

Appendix 2

Table 11: 'Vessel movements within NZ'

Arrival port	Container	Cargo	Bulk	VPL	Tanker	Fishing	LNG/LPG	Other	Dredge	Bulk/oil	Total
Whangarei	20	472	1 043	2	361	4	1	1	1	6	1 911
Total of all ports % of total	15,540 35.9%	10,215 23.6%	7,210 16.7%	3,807 8.8%	3,594 8.3%	1,275 2.9%	1,030 2.4%	214 0.5%	31 0.1%	16 0.0%	43,262

Appendix 3

Table C23: 'Vessel movements within NZ'

Mean annual movements in and out of Whangarei

From Whangarei					
Total	Heavy	Medium	Light	Fishing	Slow
225.5	109.2	112.7	3.2	0.3	0.2

To Whangarei					
Total	Heavy	Medium	Light	Fishing	Slow

192.0	89.3	101.7	0.7	0.2	0.2

Appendix 4

2014/2015 Expected cruise ship arrivals, Bay of Islands

New Zealand Locations

	Auckland	New Plymouth	White Island	Tauranga	Fiordland	Wellington	Domestic Total
Arriving from	21	1	1	1	0	0	24
Departing to	15	0	0	4	5	2	26

International Locations

	Norfolk Island	Fiji	New Caledonia	Sydney	Rarotonga	Pitcairn Islands	International Total
Arriving from	1	1	2	3	2	0	9
Departing to	3	0	0	2	0	1	6

Biofouling

Description	Hull biofouling is the accumulation of aquatic organisms on vessel surfaces (including attachments, pontoons, hull surfaces, internal sea-water systems, niche areas; excluding ballast tanks) immersed in, or exposed to, the aquatic environment (Inglis, G., Floerl, O. and Woods, C., for MAF, 2012. *Scenarios of Vessel Bioufouling Risk and their Management).* Biofouling on vessel hulls is a known mechanism for the movement and introduction of marine organisms including marine pests from one place to another.
Risk	Vessels with an accumulation of hull biofouling are susceptible to marine pest attachment and infestation. In addition to the risk presented by biofouling on the smooth surfaces of the hull , there is a significant biofouling risk associated with the niche areas of vessels which are often overlooked. Niche areas are the non-hull submerged areas of the hull (including rudders, propellors, seachests, intakes etc)that due to their nature, position and/or structure are difficult to antifoul, clean and inspect In Northland both recreational and commercial vessel movements have been identified as primary mechanisms for the transport of marine pests (Northland Regional Council, 2015. *Immediate Options for Marine Pathways Management - A scoping document prepared by the Northland Regional Council on behalf of the Domestic Marine Pathway Management Project Working Group.).* Vessels that have long lay-up periods and slow voyages (barges and pleasure boats) often have proportionally higher levels of biofouling and pose a higher risk of introducing non-indigenous species to new locations. Whereas commercial vessels often have more incentive to maintain clean hulls to minimise drag and increase fuel efficiency however they have a larger surface area and more niche areas which are vulnerable to biofouling *(Ministry of Agriculture and Forestry, 2011. Risk Analysis: Vessel Biofouling.)* Once introduced to a new environment these organisms can establish quickly and have the potential to impact on the region's economy, environment, human health, and indigenous values. As biofouling, they can also interfere with vessel performance by causing drag - requiring more power and fuel, and block essential seawater and cooling systems. Northland receives a high volume of international traffic particularly visiting pleasure boats from the south pacific - however the risk associated with international traffic is primarily the responsibility of Ministry of Primary Industry (MPI), and will be managed by the introduction of the Craft Risk Management Standard, which will be in force by 2018. This will set 'clean hull' requirements for visiting vessels at the border with thresholds around what is considered a 'clean hull' that are dependent upon the length of stay of the vessel. Overall this will ensure a high standard of hull cleanliness for all international vessels (commercial and recreational) including those entering Northland. Not only the movements of vessels *entering* Northland pose a risk of introducing marine pests to new areas. Northland has a number of established marine pest species that are of concern to other regions. Customs data demonstrating that most international vessels arriving in New Zealand in 2009-10 cleared customs in Opua or Whangarei, and continued on to visit more than one other port during their stay (Inglis, G., Floerl, O. and Woods, C., for MAF, 2012. *Scenarios of Vessel Bioufouling Risk and their Management).* There are also strong connections between Northland and other recreational vessel hubs like Tauranga and Auckland. Vessels

	travelling from Northland, particularly those that have been laid up in Northland for extended periods and not regularly maintained, pose a significant risk of transferring unwanted marine organisms to new areas as biofouling.
Ability to move organisms	Each time a vessel moves from one port to another it presents a risk of transferring any species that may be associated with, or attached to the hull. Although if the hull and niche areas are well maintained and kept clean of any fouling this risk is virtually non-existent. The translocation success of marine pests via hull biofouling is also dependent on a number of factors: 1) the number of non indigenous marine organisms present at the vessels' place of origin or berth, 2) the ability of the organisms to survive in the receiving environment, 3) season and life cycle of the organisms, and 4) vessel transit time. Accumulation of hull biofouling will occur: - as anti-fouling ages; - if anti-foul has been damaged or incorrectly applied; or - during extended periods of inactivity, particularly in areas of low water flow and high fouling organism density. Marine pests transported by hull biofouling can enter the receiving environment by active in-water cleaning of hulls (i.e. scraping or brushing organisms off the hull) or by passive discharge. Passive discharge includes reproductive processes and the organism being dislodged off the hull during vessel movement.
Regional distribution	Vessels are constantly entering New Zealand waters and travelling from harbour to harbour, most of these vessels will have some level of accumulated hull biofouling. Furthermore stationary vessels either on moorings or in berths often have high levels of biofouling due to inactivity and lack of maintenance; derelict or poorly maintained vessels are common in some areas of Northland and are often heavily fouled. Due to the popularity and accessibility of Northland's east coast it is at higher risk of marine pest introduction than the west coast harbours. Most of the recreational vessels visiting Northland from other parts of New Zealand will spend most of their time on th east coast. Both of the customs clearance ports in Northland are also located on the Region's east coast (Bay of Islands and Whangarei Harbour). Recreational vessels constitute the bulk of vessel traffic into Northland and models have shown that approximately 50% of these recreational vessel movements are from Auckland marinas. The greatest domestic risk associated with hull biofouling arises from vessel movements from Auckland (NIWA for Northland Regional Council, 2011. *Scoping and development of a regional surveillance plan for marine pests in Northland.*). Auckland is known as a risk node for vessel biofouling not only due to the large volume of vessel movements originating form the region but also due to the fact it has a large number of established marine pests species. Nationally more than half the annual yacht movements begin and/or conclude in one of the following marinas: Westhaven Marina (2,186), Opua (1,283), Gulf Harbour Marina (1,249), Picton (1,195), Great Barrier Island (1,178) or Westpark Marina (790). Just over half the recreational vessel movements occur in the summer months with 90% of international vessels arriving during the summer months into Opua, Whangarei, Auckland and Tauranga.; with over 86% of recreational vessel arrivals to Northland originating from other areas of New Zealand (Ministry of Primary industries for Ministry of Agriculture and Forestry, 2009. *Vessel Movements within New Zealand* (MPI Technical Paper No: 2014/04).

	Although recreational vessels make up the bulk of vessel movements; Northland still receives a number of vessels greater than 99 tonne annually. Unlike the recreational movements most of the domestic large commercial vessels that visit Whangarei originate from Tauranga (30 – 82 annual movements) followed by Auckland, Napier, Wellington, Lyttelton, Dunedin and New Plymouth (8 – 29 annual movements for each). The majority of movements of these vessels departing Whangarei are to Tauranga (83 – 198 annual movements) and Auckland (30 – 82 annual movements) (Ministry of Primary industries for Ministry of Agriculture and Forestry, 2009. *Vessel Movements within New Zealand* (MPI Technical Paper No: 2014/04). Data on the number of international large commercial vessel movements to Northland is limited, however the only receiving harbour for international bulk carriers and tankers in the region is Whangarei. On average Whangarei receives 20 large commercial vessels a fortnight, of which 60% are international in origin (*Northport August expected arrivals data* 2016). Mean annual movements to and from Whangarei show that there were a greater number of large vessels leaving Whangarei for domestic ports than those arriving from domestic ports, indicating that the shortfall must have comprised international vessels.
Current controls	- All international vessel arrivals fall under the jurisdiction of MPI to be cleared at the border. - Any new to New Zealand organism is responded to by MPI until its identified and risk assessed. - A Notice of Direction can be given to a vessel that is found to be harbouring a pest that is identified in the RPMS, this notice will direct vessel owners to remove marine pests in a manner approved by an Authorised Person. - A Notice of Direction can be given under Section 122 of the BSA for any unwanted organism even if it is not listed in the RPMS. - An infringement notice can be given to a vessel that is found to be harbouring/releasing any 'exotic organism' into or within Northland under the Regional Coastal Plan for Northland. - Heavily fouled vessels are free to move around the region providing they are not harbouring an unwanted organism or a pest identified in the RPMS (and are not in breach of maritime safety laws). - Northland Marinas - as well as all marinas on the eastern seaboard of the Coromandel Peninsula down to and including Tauranga - with regional council support, are putting in place the 'six or one' programme, requiring proof of either a new antifoul within the previous six months, or a lift-and-wash within one month of arrival. - Marine pest surveillance checks occur annually throughout Northland. In the 2014/2015 summer season over 300 hulls were dived and checked - the council intends to inspected over 1000 hulls during the 2015/2016 summer period. In 2016/2017 the number of inspections will increase to 1500.
Benefits	Nil benefits of hull biofouling.

The Northland scenario

Hull biofouling represents the greatest risk of pest incursion to the Northland coastal environment, and was almost certainly responsible for the introduction of the Mediterranean fanworm (designated as an unwanted organism) to the Whangarei Harbour, which subsequently became established. Fanworm is not the only marine pest that presents a risk. *Styela clava* can now be found in the Bay of Islands, Whangarei and the Houhora harbours; *Eudistoma elongatum* is found in the Parengarenga, Rangaunu and Hohoura harbours as well as in the Bay of Islands; *Didemnum vexillum* is found in Whangarei and Houhora harbours; Pyura sea squirt is in Russell and Oronga Bay in the Bay of Islands, Hokianga, and the far north; and Undaria is found in Houhora and Rangaunu harbours.

A high number of the Notices of direction issued by Northland Regional Council staff during the summer hull-check period were associated with biofouling of niche areas.

The east coast of Northland hosts the busy commercial shipping activities at Marsden Point and Portland. Domestic coastal tankers at Marsden Point Refining Company make approximately 120 visits, from various locations between Auckland and Bluff.

There are a number of 'high value' areas within close proximity to Northlands harbours, such as the Poor Knight Islands and Three King Islands - consideration needs to be given to the risk of incursion to such areas.

Northland is unique in that it shares the statutory management of the Kaipara Harbour with Auckland Regional Council. The jurisdiction of both councils under the Resource Management Act 1991 (RMA) ends at the boundary line within the Kaipara Harbour, meaning individual rules cannot be enforced across that boundary. However there is an opportunity to align rules pertaining to marine biosecurity so that, while the management agent will change, the rules will be similar across the boundary.

Currently there are no commercial port facilities or marinas located on the west coast of Northland. However, both Kaipara and Hokianga Harbours are the home ports for local fishing fleets.

Over 50 cruise ship arrivals are expected to visit the Bay of Islands in the high season from October 2015 – May 2016. While some of these vessels arrive from outside of New Zealand territorial waters, the majority arrive from other areas of New Zealand.

Northland's marine industry employs approximately 1000 people and contributes at least $80 million to the regional economy (NRC in conjunction with the Whangarei Marine Biosecurity Charter Group, 2013. *Whangarei Marine Biosecurity Charter*). Haul out facilities at Whangarei and Opua Harbours attract a number of international recreational vessels (and New Zealand based recreational and commercial vessels) to undergo maintenance, cleaning and repairs (Inglis, G., Floerl, O. and Woods, C., for MAF, 2012. *Scenarios of Vessel Bioufouling Risk and their Management).*

Species risk assessment

A preliminary assessment of the risk that hull biofouling presents based on species that are currently included in the RPMS, the majority of which are not currently in New Zealand, and are capable of being transported via hull biofouling.

Organism	Suitability for translocation via hull biofouling	Current status	Potential to become a pest if introduced	Potential financial implications	
				Potential economic loss	Potential cost of management
Asian Clam	Able to survive in both salt water and fresh water, not transferred as hull biofouling.	Unwanted Organism Not established in New Zealand Notifiable organism	Strongly inferred impact on both economic values and biodiversity. Thought to be responsible for the collapse of commercial fisheries and the decline of biodiversity in California. Can live in fresh and salt water and is highly resistant to changes in salinity and temperature. In San Francisco Estuary average densities average 2,000/m2. Feeds at multiple levels in the food chain, can place pressure on native organisms and significantly disturb surface sediment layers	High	High (very few succesful control measures)
Caulerpa Seaweed	Most likely way of arriving in New Zealand is through importation for use in aquariums and subsequently released into the marine environment.	Unwanted Organism Not established in New Zealand Notifiable organism	A rapidly growing saltwater weed that can cause major ecological and econimc damage. Ability to live in a wide range of temperatures, depths and substrates. Forms dense fields and can prevent the establishment of native seaweeds. Can cause reduction of fishing catches due to elimination of fish habitat.	Medium	Medium (if caught early benthic mats can be used to treat)
Chinese mitten crab	Likely pathways for introduction include live importation and ballast water however there is a risk of them being introduced amongst hull biofouling.	Unwanted Organism Not established in New Zealand Notifiable organism	Potential to undermine the integrity of stream banks through burrowing, accelerating erosion. Ability to live in both fresh and salt water with a wide diet, infers a significant impact on ecosystems. Can affect human health as a host for parasitic lung flukes. In Europe, high densities have damaged commercial fishing nets and catches.	High	Very high (Difficult to detect, no known control measures and wide habitat distribution)

Organism	Suitability for translocation via hull biofouling	Current status	Potential to become a pest if introduced	Potential financial implications	
				Potential economic loss	Potential cost of management
European shore crab	The transport vectors implicated in introduction of this species globally include, hull fouling but also: natural dispersal, solid ballast, ballast water, and contaminated packing material shipped with commercial shellfish	Unwanted Organism Not established in New Zealand Notifiable organism	Voracious predator, can negatively impact shellfish populations including those being farmed. In its introduced range in the United States it has had significant impacts on both economic values and biodiversity, to the sum of $22 million annually. It is not only a voracious predator but also aggressive competitor and may outcompete native crabs and cause decline in native shellfish populations One of its major invasive characteristic is the ability to spread – first recorded in Port Phillip Bay, Victoria in 1900 and now occurs widely in Southeast Australia.	High	Very high (Difficult to detect, no known control measures and wide habitat distribution)
Mediterra-nean fanworm	Transported via hull biofouling and as larvae in ballast water.	Unwanted Organism Notifiable organism Well established in Auckland Harbour. Established in some areas of Whangarei Harbour.	Highly invasive species, can form dense groups that could affect native species by competing for food and space. Can filter large amounts of water which could affect nutrient flow.	Medium-High	Medium (if caught early benthic mats, chemical treatments or diver removals can be used to control)
Northern Pacific Seastar	Main vectors of spread are aquaculture stock and gear, ballast and live bait tanks. Risk of being introduced amongst	Unwanted Organism Not established in New Zealand Notifiable organism	Proven impact on biodiversity and shellfish farming in its introduced ranges in Australia. Is a voracious predator and scavenger and prefers bivalve prey (including commercially important species like scallops and mussels) It has a long larval phase and can multiply rapidly and has a tendency to form	High	High (difficult and costly to control mobile species)

Organism	Suitability for translocation via hull biofouling	Current status	Potential to become a pest if introduced	Potential financial implications	
				Potential economic loss	Potential cost of management
	severe hull biofouling or in seachests.		dense aggregations. Has potential to cause major losses in both recreational and commercial shellfish harvests.		
Asian paddle crab	The three main vectors of spread are deliberate introduction, ballast water and hull/niche biofouling.	Widespread in the Hauraki Gulf, has been detected in Whangarei Harbour and Opua/Waitangi.	Aggressive crab, potential to compete with native crabs, preys on shellfish and as such can threaten marine farming. Not reported to be a pest in its native habitat or in other countries.	Low (currently already present and only causing small losses to commercial flounder fishermen)	High (difficult and costly to control mobile species)
Didemnum sea squirt	Transported via hull biofouling and contaminated shellfish stock.	Established in Marlborough Sounds, Whangamata and Tauranga. Has been detected within Whangarei and Houhora Harbours.	Strongly inferred impact on marine farming. Can smother man made structures including mussel lines, and spreads easily.	Low (few mussel farms in Northland)	Medium (there has been research done on containment and chemical controls.)

What pests already existing may have been introduced by hull biofouling?

As outlined in the above Species Risk Assessment Table, all but Caulerpa seaweed and Asian clam, could or have been introduced via hull bioufouling.

All known Mediterranean fanworm incursions in New Zealand have been traced back to a heavily infested barge located in Auckland Harbour. Mediterranean fanworm subsequently spread to Whangarei Harbour and become established (Northland Regional Council in conjunction with the Whangarei Marine Biosecurity Charter Group, 2013. *Whangarei Marine Biosecurity Charter*).

Styela clava can now be found in the Bay of Islands, Whangarei and the Houhora harbours; Eudistoma sea squirt is found in the Parengarenga, Rangaunu and Hohoura harbours as well as in the Bay of Islands; Didemnum sea squirt is found in Whangarei and Houhora harbours; Pyura sea squirt is in Russell and Oronga Bay in the Bay of Islands, Hokianga, and the far north; Undaria is found in Houhora and Rangaunu harbours.

Proposed management

Option	Programme description	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
No regional intervention	Status quo.	Currently there are no specific rules relating to hull biofouling unless an unwanted organism or RPMS listed marine pest is present. However, the Regional Coastal Plan for Northland prohibits the intentional introduction and spread of marine pests. Sections 52 and 53 of the Biosecurity Act contain provisions to manage, reduce and eliminate marine pests - but only once they have been discovered and identified. There would be no additional costs to council if there was no pathway plan to administer. New benchmarks are being set as industries impose their own initiatives, for example, Northland marinas, have in place a 'six-or-one' programme, requiring proof of either a new antifoul within the previous six months, or a lift-and-wash within one month of arriving at marinas.	An amendment to the Biosecurity Act in November 2012 made provisions for the development of pathway management plans as a measure to help manage the spread of harmful marine organisms in New Zealand. There would be no provisions under the pathway plan to control the introduction and spread of marine pests by way of hull biofouling which is known to be one of the main ways that marine organisms, including marine pests, are moved from one place to another. Should biofouling remain unmanaged, it may cause the spread of unwanted species by human activities beyond the scope of normal species spread. The spread of these unwanted species could have a significant impact on native species diversity and the marine farming industry. Attempted control of a widely expanded populations of marine pests would be more costly than the preventative management of the current populations or populations caused by by natural spread.	High. If a pathway is not identified in the marine pathways plan the council cannot take any legal actions. By not applying rules in the pathway plan to hull biofouling, there would be no provisions to control the introduction and spread of marine pests by this vector (other than on an unwanted species basis through the current provisions in the Biosecurity Act and/ or Regional Coastal Plan for Northland).

Option	Programme description	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Pathway programme: Slime layer only	No more than a slime layer and goose barnacles present on all below water surfaces of vessel hull. Any vessel with more hull biofouling than this could be subject to enforcement or risk minimisation actions by the council. The definition of a 'slime layer and goose barnacles' is unambiguous and legally robust. A 'slime layer and goose barnacles' has been adopted by the International Marine Organisation (IMO) and incorporated into its guidelines as a standard that will not facilitate pest attachment. It is also consistent with the *'Craft Risk Management Standard - Biofouling Vessels Arriving to New Zealand'* , set and implememted by MPI. Environment Southland has just released the marine pathways plan for Fiordland which also requires vessels visiting Fiordland can prove they only have a slime layer and/or goose barnacles on their hull during their visit to the area.	A pathway plan would provide more effective protection from marine pests through increased education/ understanding and statutory measures. A marine pathways plan could minimise the risk of new marine pest incursions into Northland. Rather than working reactively to try to eradicate a pest once it has been detected in Northland we would be managing the vector of spread before the pest enters our region. Overall hull cleanliness would improve, reducing the likelihood of marine pests entering the region and or being spread around Northland as hull biofouling. A marine pathways plan that allowes only minimal fouling would compliment the 'six-or-one' marina driven programme to keep hulls clean, and assist with its implementation.	Pathway plans are arguably the most cost-effective and efficient way forward as they are proactive, and aimed at preventing new marine pests from entering Northland and being spread around. However allowing only minimal fouling will incur costs with vessel owners. To maintain vessels at this level of biofouling extra lift and washes and antifouling more regularly will have to occur. This increased cost to vessel owners may encourage un-authorised in-water cleaning and antifouling activities which are inconsistent with the current (and proposed) regional plan rules.	Low-Moderate. It could be difficult to enforce and would require ongoing education. The rate of voluntary compliance from vessel owners will likely be low and would require a lot of ongoing resources for continued hull inspections and also significant council resources for the follow up of enforcement procedures under both the biosecurity act and RMA.

Option	Programme description	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
Pathway programme: Light fouling	1-5% of visible surface covered by patchy macrofouling or filamentous algae. Usually remaining area covered in slime.	'Light fouling' is very similar to Top of the Souths proposed pathway plan (their definition of light fouling is described slightly differently). A pathway plan would provide more effective protection from marine pests through increased education/ understanding and statutory measures. Supports the marina 'six or one' programme. Lower risk than the status quo. Easier to comply with, less onerous and more cost effective than 'a slime layer and goose barnacles'. Overall hull cleanliness would improve, reducing the likelihood of marine pests entering and or being spread around Northland.	Pathway plans are arguably the most cost-effective and efficient way forward as they are proactive, and aimed at preventing new marine pests from entering Northland and being spread around. There could be difficulties in interpretation by both authorities and boat owners. May encourage un-authorised in-water cleaning and antifouling activities which are inconsistent with the current (and proposed) regional plan rules. Does not completely remove the risk of marine pest incursion - council hull survey data indicates the highest risk of pest incursion occurred on hulls categorised between 'light fouling' and 'extensive fouling'.	Moderate. It could be difficult for authorities and boat owners to determine their own compliance. It could be difficult to enforce and would require education, resources for ongoing hull inspections, following up on, for example, notices of direction and abatement notices.
Pathway programme: Considerable fouling	Macrofouling clearly visible but still patchy. 6-15% of visible hull surface covered by macrofouling or filamentous algae. Usually remaining area covered in slime.	Not applicable.	Not applicable.	Equivalent to the status quo of no regional intervention.
Pathway programme: Extensive fouling	16-40% of visible hull covered in marcofouling or filamentous algae.	Not applicable.	Not applicable.	Equivalent to the status quo of no regional intervention.

Option	Programme description	Explanation of benefits	Explanation of costs	Level of risk that programme will not be successful
	Usually remaining area covered in slime.			
Pathway programme: Very heavy fouling	41-100% of visible hull surface covered by macrofouling or filamentous algae. Usually remaining area covered in slime.	Not applicable.	Not applicable.	Equivalent to the status quo of no regional intervention.
Site led programme	Site-led Pest Programme: that the subject, or an organism being spread by the subject, that is capable of causing damage to a place is excluded or eradicated from that place, or is contained, reduced, or controlled within the place to an extent that protects the values of that place. Clean vessel destination pass - specific to a vessel and is to be on that vessel at all times. Would be defined with maps.	Consistent with parts of Fiordlands proposed pathway plan. A pathway plan would provide more effective protection from marine pests through increased education/ understanding and statutory measures. There are a number of 'high value' areas within close proximity to Northlands harbours, such as the Poor Knight Islands and Three King Islands. A clean vessel destination pass would remove the risk of incursion by way of hull biofouling in such areas.	Rules relating to hull biofouling would only be applicable to craft in areas defined as 'destination areas' and could not be enforced elsewhere. Response costs should an incursion occur. Marine pests would spread elsewhere. A partnership approach with the Department of Conservation would be required.	Low - as action would take place in specific destination/ high value places making use of limited resources.
Preferred option:	**Pathway programme - Light fouling + movement** In relation to NPD considerations (section 6(1) outlines four criteria) a **medium-level analysis** was deemed appropriate for the marine pathway plan. In terms of alternative approaches assessed, under no regional intervention (or do nothing) three types of hull fouling were considered; Considerable, extensive and heavy fouling. Reducing the risk of transporting marine pests(identified or otherwise) by reducing hull biofouling would be a voluntary measure. Control over reducing the risk of transportation of marine pests in Northland via biofouling on moving vessels would be negligible. This would be unacceptable for many users of the marine environment with high political and stakeholder fallout anticipated.			

<table>
<tr><th>Option</th><th>Programme description</th><th>Explanation of benefits</th><th>Explanation of costs</th><th>Level of risk that programme will not be successful</th></tr>
<tr><td></td><td colspan="4">Due to the difficult nature of controlling and managing marine pests consideration of a site led programme in the form of a 'clean vessel pass' was considered. However this targeted approach would see marine pests spread outside of the high value defined areas and this approach would not yield the same benefits as a Northland wide pathway plan approach. There would be no guarantee of outcomes in the selected areas.

A hull biofouling level of a 'slime layer only' for vessels in Northland was considered but was deemed to be an unrealistic provision both technically and economically, the cost to the vessel owner of maintaining a 'slime layer only' would be unsustainable. Even though this option would reduce the risk of transportation of marine pests in Northland to the lowest level, the result in positive outcomes would be outweighed by a high socio-political risk.

Light fouling + movement, offers the best and most practicable option as it is likely to; be easily identified by vessel owners, be easier to comply with than a 'slime layer only' level of fouling and from previous hull surveys 60% of vessel owners are already compliant with this level of fouling. Slowing the spread of marine pests and preventing the establishment of new marine pests by setting a minimum standard for hull fouling upon movement is considered the most efficient and cost effective option. Enforcement will remain an option for exacerbators of problem situations.</td></tr>
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Quantitative analysis

The high level analysis model for the marine pathways plan was created using a benefit-cost model originally developed by Cawthron Research (Forrest and Sinner, 2016) but adapted for the Northland situation. The model was populated with a NRC staff assessment based on data collection of the current programme for managing sustained control marine pests in Northland. The model includes not only the public costs of a pathways plan such as surveillance, administration and enforcement but also the private costs to vessel owners in meeting various levels of hull biofouling. The benefits to the Northland marine environment by preventing the spread and establishment of marine pests by managing the movement of fouled vessels have been quantified by using model inputs from numerous sources, namely Marjan van der Belt and Anthony Cole (2014), Murray Patterson and Anthony Cole (2013), and Vince Kerr (2010). The benefit of the alternative programmes assessed are determined, in dollar terms, as the difference between unmanaged and managed risk.

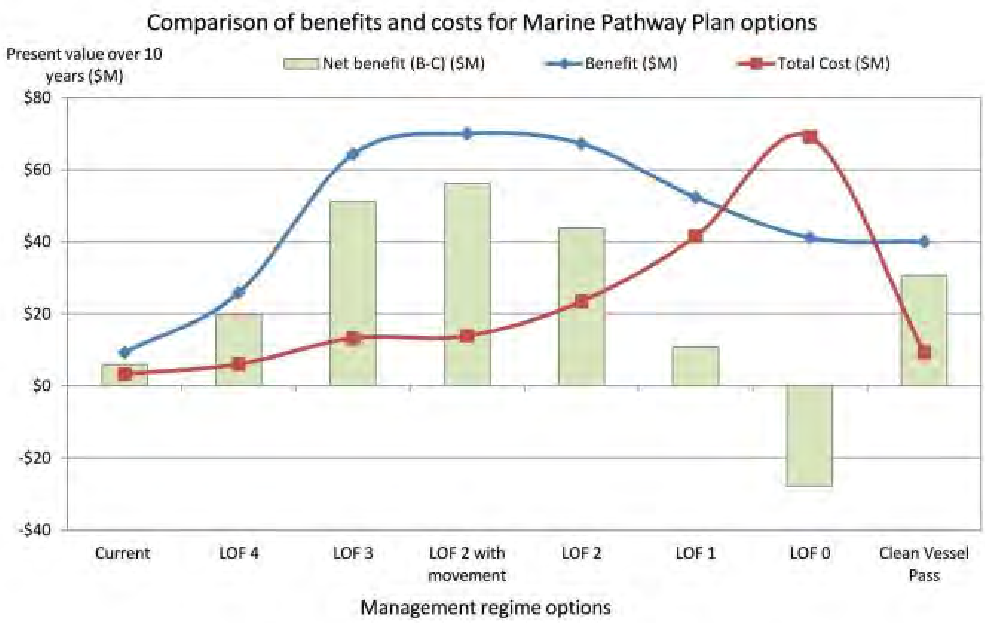
An important point of the pathway plan is that the proposed level of fouling (LOF 2) is only required when moving from one "place" to another, for example, from Whangarei Harbour to Tutukaka. It was determined that the risk imposed by a vessel which has a fouling level of more than LOF 2 is higher when moving that fouling from one place to another. A vessel staying in one location or moving within the defined place (for example Whangarei Harbour) with a level of fouling more than LOF 2 has a relatively lower risk of transferring new marine species that are not already present. This is with the exception of the sustained control species in which any vessel found with any of the sustained control species as fouling will be directed to remove these species as per the RPMP rules. A Clean Vessel Pass regime option was also analysed.

Key results

Present value of benefits and costs for a ten-year period

	Management regime							
	Current	LOF 4	LOF 3	LOF 2 movement	LOF 2	LOF 1	LOF 0	Clean Vessel Pass
Benefit ($M)	$9.2	$25.9	$64.3	$70.0	$67.2	$52.3	$41.2	$40.0
Private costs ($M)	$0.0	$1.6	$8.4	$9.0	$17.3	$31.7	$57.6	$4.0
Public costs ($M)	$3.3	$4.5	$4.7	$4.9	$6.1	$9.9	$11.4	$5.3
Total Cost ($M)	$3.3	$6.1	$13.1	$13.9	$23.4	$41.6	$69.1	$9.3
Net benefit (B-C) ($M)	$5.9	$19.8	$51.2	$56.1	$43.8	$10.8	-$27.9	$30.7
Benefit/Cost ratio	2.8	4.2	4.9	5.0	2.9	1.3	0.6	4.3

The table above and figure below summarise of key results comparing the existing species led approach for marine pest with various levels of biofouling under a potential Pathways Plan. For each management option, consideration was given to the extent to which it would reduce both the introduction and spread of marine pests in Northland. The cost increased across the options; both council costs such as administration and enforcement and private sector costs (lifting and washing, application of antifoul, etc) in meeting the LOF requirement. All but the LOF 0 option yielded a positive net benefit. The net benefit for the LOF 2 + movement management regime was the highest among the eight options considered.



The benefit cost analysis for the marine pathway plan suggests that the LOF 2 + movement management regime will produce the highest net benefit over a 10 year timeframe ($56M over 10 years). The public good in preventing new marine threat species from becoming established and current marine threat species from spreading is significant using the pathway approach. This approach will reduce the potential impacts and costs to the region in the future by preventing the need for incursions responses. The costs of redirecting the existing hull surveillance programme to compliance inspections for the biofouling levels (and continued sustained control marine species inspections) and lifting the number of vessels inspected per year returns a high positive net benefit result in terms of offsetting marine pest species risk and targeting multiple marine species, especially those not yet present in the region or identified as risk species. The combined impact of a species led and pathways plan approach is considered the most effective and efficient way of managing marine pests.

Key assumptions to the model

Calculation of risk assumptions

75%			Likelihood of marine pest being introduced in any one year					
90%			Likelihood of that introduction being attributed to hull fouling					
Efficacy 1 - Probability of treatment success								
	LOF 4	LOF 3	LOF 2 movement	LOF 2	LOF 1	LOF 0	Clean Vessel Pass	
	80%	85%	85%	90%	95%	95%	95%	
Efficacy 2 - Probability of uptake								
	LOF 4	LOF 3	LOF 2	LOF 2	LOF 1	LOF 0	Clean Vessel Pass	
	85%	75%	58%	58%	11%	4%	4%	Proportion of Northland boats in conformity based on hull survey data, i.e. at that level or below
	75%	66%	75%	50%	40%	30%	95%	Proportion on non-conformity vessels likely to move to requirement
	96%	91%	90%	79%	47%	33%	95%	Probability of uptake

Ecosystem values per/ha

	Ecosystem biome					
	Open sea/ocean	Continental shelf	Reefs	Salt marshes / wetland	Estuary / lagoon / intertidal / mangroves / seagrass	Total
Economic value ($ per ha)	112	378	4,146	15,008	1,943	
Northland area (ha)[3]	n.a.	n.a.	242,545	749	61,457	304,751
Total Northland value	n.a.	n.a.	1,005,469,635	11,240,676	119,410,982	1,136,121,293

Based on ver der Belt and Cole (2014), and follow Patterson and Cole (2013).

Value of marine environment at risk in Northland

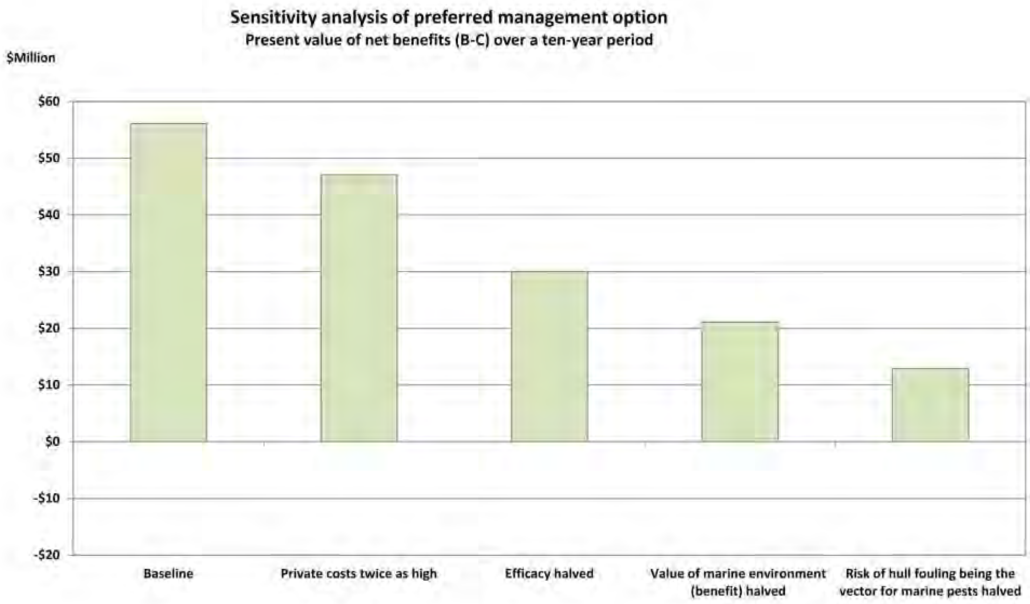
Estimation of values	
$1,100,000,000	Value of marine environment at risk

Sensitivity analysis

A sensitivity analysis was carried out to test the most uncertain values associated with the key assumptions. Four key assumptions were tested and the results in terms of the impact on the present value of net benefits are reported in the following table for the eight management options. The figure shows the impact of the changed assumptions on the net present value of the preferred management option.

Sensitivity analysis of Marine Pathway Plan options
Present value of net benefits (B-C) over a ten-year period ($M)

	Management regime options							
	Current	LOF 4	LOF 3	LOF 2 movement	LOF 2	LOF 1	LOF 0	Clean Vessel Pass
Baseline result	$5.9	$19.8	$51.2	$56.1	$43.8	$10.8	-$27.9	$30.7
Private sector costs twice as high	$5.9	$18.2	$42.7	$47.1	$26.4	-$21.0	-$85.6	$26.7
Efficacy halved (whether caused by a reduction in either treatment success and/or lower level of uptake	$5.9	-$45	$26.8	$30.0	$18.5	-$9.2	-$43.2	$15.9
Value of marine environment (benefit) being affected halved	$1.3	$6.8	$19.0	$21.1	$10.2	-$15.4	-$48.5	$10.7
Likelihood of hull fouling being the vector for marine pests reduced by half to 45%	$5.9	-$18.4	$11.5	$12.9	$2.3	-$20.9	-$51.7	$7.7



In all four cases, the preferred management option provided the highest positive net present value. The assumption that makes the biggest impact on the net present value calculation is the likelihood of hull fouling being the vector for the introduction of marine pests in any one year. Reducing the standard assumption by half - from 90% to 45% - reduces the present value of net benefit by 77% from the baseline result. A net present value of close to $0 for the preferred management scenario is calculated by the model when the likelihood of hull fouling being the vector for the introduction of a marine pest is 18%, equivalent to 20% of the baseline assumption, all other assumptions held constant.

Cost allocation

Introduction

The Biosecurity Act 1993 (the Act) requires that those who are required to meet directly any or all of the costs of implementing a national or regional pest or pathway management plan are beneficiaries and/or exacerbators of the plan. A beneficiary is a party who benefits from the plan. An exacerbator is a party that contributes to the creation, continuance or exacerbation of the problems that plan proposes to resolve, such as those who pose a risk to spreading the pest through their activities, the characteristics of their land, or how they use their land (MPI, September 2015).

Information presented in the following section follows the requirements of the National Policy Direction. Where relevant, species have been grouped by category and the cost allocation undertaken for that category as a whole.

Overview of Cost allocation for RPMP and Marine Pathways Plan.

Cost allocation for RPMP and Marine Pathways Plan

	Revenue				Expenditure		
Programme	Targeted rates	Other Agency	Marine biosecurity charge	Total	Education	Inspection, monitoring and response	Total
Exclusion	88,743			88,743	25,000	75,000	100,000
Eradication	630,075			630,075	60,000	650,000	710,000
Progressive containment	8,874	300,000		308,874	70,000	160,000	230,000
Sustained Control	1,375,515	40,000	30,000	1,415,515	200,000	1,630,000	1,830,000
Marine Pathways	-	-	450,000	450,000	30,000	420,000	450,000
	2,103,207	340,000	480,000	2,893,207	385,000	2,935,000	3,320,000

* Presently rates are not set to cover the full cost associated with council's activity. Council has other forms of revenue, such as dividends and interest which are used to fund the balance of costs not funded by rates. The portion funded by rates may vary from year to year.

Exclusion pests

Exclusion pests have been grouped for cost allocation analysis. The following table lists the entities and individuals that will benefit from species being listed as Exclusion Pests (i.e., the beneficiaries) and the entities and individuals that may contribute to the pest problem through their action or inaction (i.e., the exacerbators).

Plant Species		
Asiatic knotweed and Giant knotweed	Holly-leaved senecio	Phragmites
Chinese knotweed	Houttuynia	Purple loosestrife
Climbing spindle berry	Noogoora bur	Sea Spurge
Giant hogweed	Old man's beard	Velvet leaf

Animal Species		
Bearded dragon	Indian ring-necked parakeet	Sulphur crested cockatoo
Big headed ant	Rainbow lorikeet	Wallaby
Blue tongued skink	Rook	

Freshwater Species
Orfe
Marshwort
Water poppy

The exclusion pests have similar groups of beneficiaries and exacerbators as identified below. The exacerbators have similar existing legislative responsibilities and rights as identified below. The subjects are at a similar stage of infestation in Northland, none are known to be present.

The management objective is the same for all exclusion pests - to prevent the exclusion pests becoming established in Northland.

Beneficiaries, along with the benefits they are expected to receive, and proposed costs they will bear, include:

Beneficiary group	Nature of benefits	Value of benefits (where possible)	Direct costs to be borne	Indirect costs to be borne	Do costs outweigh benefits?
Regional community (including the public, communities and individuals)	Prevention of future pest impacts, including environmental, economic and human health impacts. Derive direct and indirect benefits from terrestrial and freshwater biodiversity values being protected.	Not monetised	100%	None identified	Yes
Forestry and horticulture sectors (Chinese knotweed, Climbing spindleberry, Old man's beard)	Prevention of future pest impacts	Not monetised	None	None identified	Yes
Property owners and/or occupiers	Prevention of pests establishing on property and water bodies.	Not monetised	None	None identified	Yes

Exacerbators, along with the proposed costs they will bear, include:

Exacerbator type	Exacerbator group	Nature of exacerbation	Value of exacerbation	Direct costs to be borne	Indirect costs to be borne
Active exacerbators	People or organisations who propagate, sell or distribute terrestrial or freshwater pest plants i.e. Gardeners People or organisations who liberate pest animals into or within the Northland Region Machinery operators/farmers/ industry moving stock or goods with addociated risk of spreading pests.	Knowingly growing and spreading pest plants. Knowingly bringing pest plants into the Northland region. Knowingly liberating pest animals into or within the Northland Region Spreading pests through poor machine hygiene	Moderate. Many of the exclusion plants were introduced to New Zealand as ornamental plants, and some are used for herbal medicines. High. Pest animals such as Indian ring-necked parakeets are already present in Northland as pets. Moderate (for Noogoora bur, Nut grass and Velverleaf)	None	None
Passive exacerbators	Owners and/or occupiers (including Crown agencies) who do not undertake pest management on their properties The regional community, including the public, communities and individuals who do not take action to reduce the risk of pests entering and/or spreading within Northland Region.	Pests present on their land due to factors other than their own activity. Pests unknowingly present on their land and/or water bodies	Low.	None	None

Clause 7 (1(a)) of the NPD requires that Northland consider whether the group of pests has similar groups of beneficiaries and exacerbators. The above tables show that all Exclusion Pests share similar groups of beneficiaries and exacerbators and, therefore, they can be grouped together for the purposes of cost allocation. No other relevant legislative responsibilities and rights of beneficiaries and exacerbators have been identified.

The most effective agent to undertake the control to meet the objectives of the programme(s) is Northland Regional Council. A single agency is best placed to manage an exclusion programme due to consistency and certainty and the need for appropriate expertise and rapid responses.

The degree of urgency to make the plan is medium, as the previous Northland Regional Pest Management Strategies are still operative but increasingly out of date operationally and a new plan is required to comply with the National Policy Direction.

The proposed cost allocation and cost allocation method are considered efficient and effective, and avoid perverse incentives. The proposed cost allocation and cost allocation methods are considered practical. This simple allocation formula avoids the risk of compliance or cost recovery difficulties jeopardising exclusion success. The proposed cost allocation and cost allocation method are considered administratively efficient.

Security of funding for the programme(s) will depend on continuing funding allocations for biosecurity activities under the LTP.

The proposed cost allocation is considered fair. Beneficiaries are contributing in proportion to their benefits from the plan. The proposed cost allocation is considered reasonable. No significant indirect costs of management have been identified for the programmes. Transitional cost allocation arrangements will not be required.

General rates, targeted rates, charges and rules imposing requirements are all possible mechanisms by which to impose the cost allocation.

After considering the cost allocation method chosen, the most effective control tools and agents to undertake the control to meet the objectives of the plan, practicality, administrative efficiency, security of funding and statutory requirements, the mechanism to be used to impose the cost allocation is general rates.

The table below identifies the direct and indirect costs of the Plan, who will bear the cost (in brackets), the rationales for the cost allocations and the best mechanisms available to impose costs.

Cost type	Description	Cost
Direct cost of the Plan	Annual advocacy and education, and any surveillance	$88,743 per annum (The cost of compliance is zero).
Indirect Cost of the Plan	None identified	(MPI's contribution would exist with or without the Plan)
Best Cost Allocation Method for the Plan: 100% Regional and national community (as beneficiary) Rationale: There is justification for heavy weighting toward the regional and national community due to the economic and biodiversity benefits that accrue. There is no mechanism to attribute the degree of exacerbation, so exacerbators can't bear costs. It is not practical to fund or run the programme as a split between "environmental" and "production" pests. Best Cost Allocation Method for incursion: 100% exacerbator if they can be identified 100% Northland Regional Council (representing beneficiaries) for passive incursions. 100% Crown (representing occupiers of Crown lands) for incursions on Crown estates. Rationale: The cost of managing an incursion is not factored into the Plan because they are not supposed to occur. However, there is a chance that they will occur and the costs should lie with the agent or agency responsible. Non-compliance should lie wholly with the exacerbator, should they be identified. The costs will otherwise have to lie with beneficiaries.		
Best Cost Imposition Mechanism for the Plan: 100% targeted rate.		

Cost type	Description	Cost
100% targeted rate. Rationale: the benefits of managing Exclusion Pests accrue equally across the Region so a Uniform Annual Charge (UAC), in the form of a targeted rate, is the fairest way to attribute costs.		
Best Cost Imposition Mechanism for new incursion (throughout the region) – assuming exacerbator can be identified: A fine under the Biosecurity Act. Rationale: Full cost recovery of control work and any associated administration and court costs incentives compliance.		
Best Cost Imposition Mechanism for new incursion on non- crown land,– exacerbator not identified: 100% Targeted rate. Rationale: UAC is an efficient means of allocating costs to regional beneficiaries.		

Eradication pests

The following table lists the entities and individuals that will benefit from species being listed as Eradication Pests (i.e., the beneficiaries) and the entities and individuals that may contribute to the pest problem through their action or inaction (i.e., the exacerbators). The following eradication pests are grouped for cost allocation analysis:

Plant species		
Akebia	Evergreen buckthorn	Mickey mouse plant
Balloon vine	Field horsetail	Monkey musk
Bat-wing passionflower	Firethorn	Nasella tussock
Cape tulip	Gypsy wort	Wild kiwifruit
Cathedral bells	Lesser knotweed	
Chilean rhubarb	Mexican feather grass	

Animal species
Feral deer

Freshwater species		
Eelgrass	Red-eared slider turtle	Snake-neck turtle
Eastern water dragon	Salvinia	Water hyacinth
Nardoo	Senegal tea	

These eradication pests have similar groups of beneficiaries and exacerbators as identified below. The exacerbators have similar existing legislative responsibilities and rights as identified below. The subjects are at a similar stage of infestation in Northland, known to be present in small amounts.

The management objective is the same for these eradication pests - to prevent the eradication pests becoming established in Northland.

Beneficiaries, along with the benefits they are expected to receive, and proposed costs they will bear, include:

Beneficiary group	Nature of benefits	Value of benefits (where possible)	Direct costs to be borne	Indirect costs to be borne	Do costs outweigh benefits?
Regional community (including the public, communities and individuals	Prevention of future pest impacts, including environmental, economic and human health impacts. Derive direct or indirect benefit from terrestrial and freshwater pest control and biodiversity values being protected (including tourism, local iwi etc.)	Not monetised	100%	None identified	Yes
Primary industry Sectoral public (industries and interest groups)	Prevention of future pest impacts namely economic values being protected including production values	Not monetised	None	None identified	Yes
Property owners and/or occupiers	Neighbouring property owners and/or occupiers, who benefit from pests not crossing the boundary onto their property	Not monetised	None	None identified	Yes

Exacerbators, along with the proposed costs they will bear, include:

Exacerbator type	Exacerbator group	Nature of exacerbation	Value of exacerbation	Direct costs to be borne	Indirect costs to be borne
Active exacerbators	People or organisations who propagate, sell or distribute terrestrial or freshwater pest animals and/or plants (knowingly) ; i.e. Gardeners	Knowingly growing and spreading pest plants and animals. Knowingly bringing pest plants and animals into the Northland region.	Moderate. Many of the exclusion plants were introduced to New Zealand as	None	None

Exacerbator type	Exacerbator group	Nature of exacerbation	Value of exacerbation	Direct costs to be borne	Indirect costs to be borne
	Owners and/or occupiers (including Crown agencies) who do not undertake pest management on their properties; People or organisations (including Primary industry) who liberate pest animals or plants into or within the Northland Region (knowingly or otherwise);	Moving stock or goods with associated risk of spreading pests	ornamental plants, and some are used for herbal medicine. The three freshwater pest species are common pets which have been release by owners (knowingly or otherwise) Low		
Passive exacerbators	People or organisations who propagate, sell or distribute terrestrial or freshwater pest animals and/or plants (unknowingly) Owners and/or occupiers (including Crown agencies) who do not undertake pest management on their properties The regional community, including the public, communities and individuals who do not take action to reduce the risk of pests spreading within Northland Region.	Pests present on their land due to factors other than their own activity. People who are unaware of pest species.	Low.	None	None

No other relevant legislative responsibilities and rights of beneficiaries and exacerbators have been identified.

The most effective agent to undertake the control to meet the objectives of the programme(s) is Northland Regional Council. A single agency is best placed to manage an eradication programme due to consistency and certainty and the need for appropriate expertise and rapid responses.

The degree of urgency to make the plan is medium, as the previous Northland Regional Pest Management Strategies are still operative but increasingly out of date operationally and a new plan is required to comply with the National Policy Direction.

The proposed cost allocation and cost allocation method are considered efficient and effective, and avoid perverse incentives. The proposed cost allocation and cost allocation methods are considered practical. This simple allocation formula avoids the risk of compliance or cost recovery difficulties jeopardising exclusion success. The proposed cost allocation and cost allocation method are considered administratively efficient.

Security of funding for the programme(s) will depend on continuing funding allocations for biosecurity activities under the Long term Plan.

The proposed cost allocation is considered fair. Beneficiaries are contributing in proportion to their benefits from the plan. The proposed cost allocation is considered reasonable. No significant indirect costs of management have been identified for the programmes. Transitional cost allocation arrangements will not be required.

General rates, targeted rates, charges and rules imposing requirements are all possible mechanisms by which to impose the cost allocation.

After considering the cost allocation method chosen, the most effective control tools and agents to undertake the control to meet the objectives of the plan, practicality, administrative efficiency, security of funding and statutory requirements, the mechanism to be used to impose the cost allocation is general rates.

Cost type	Description	Cost
Direct cost of the Plan	Education and inspection , monitoring and response	$630,075
Indirect Cost of the Plan	None identified	
Best Cost Allocation Method for the Plan: 100% Regional and national community (as beneficiary) Rationale: There is justification for heavy weighting toward the regional and national community due to the economic and biodiversity benefits that accrue. There is no mechanism to attribute the degree of exacerbation, so exacerbators can't bear costs. It is not practical to fund or run the programme as a split between "environmental" and "production" pests.		
Best Cost Imposition Mechanism for the Plan: Targeted rate with the remainder funded by Council dividends and interest. Rationale: the benefits of managing Eradication Pests accrue equally across the Region so a Uniform Annual Charge (UAC), in the form of a targeted rate, is the fairest way to attribute costs.		

Progressive containment pests

The following table lists the entities and individuals that will benefit from species being listed as Progressive Containment Pests (i.e., the beneficiaries) and the entities and individuals that may contribute to the pest problem through their action or inaction (i.e., the exacerbators).

Plant species		
African feather grass	Mile-a-minute	
Lantana	Pultenaea	
Manchurian wild rice		

Freshwater species
Koi carp
Perch
Tench

These progressive containment pests have similar groups of beneficiaries and exacerbators as identified below. The exacerbators have similar existing legislative responsibilities and rights as identified below. The subjects are at a similar stage of infestation in Northland, known to be present in small amounts.

The management objective is the same for these progressive containment pests - to roll back the spread of these pests from identified areas of Northland.

Beneficiaries, along with the benefits they are expected to receive, and proposed costs they will bear, include

Beneficiary group	Nature of benefits	Value of benefits (where possible)	Direct costs to be borne	Indirect costs to be borne	Do costs outweigh benefits?
Regional community (including the public, communities and individuals	Prevention of future pest impacts, including environmental, economic and human health impacts. Derive direct or indirect benefit from terrestrial and freshwater pest control and biodiversity values being protected (including tourism, local iwi etc.)	Not monetised	100%	None identified	Yes
Primary industry Sectoral public (industries and interest groups)	Prevention of future pest impacts namely economic values being protected including production values	Not monetised	None	None identified	Yes
Property owners and/or occupiers	Neighbouring property owners and/or occupiers, who benefit from pests not crossing the boundary onto their property	Not monetised	None	None identified	Yes

Exacerbators, along with the proposed costs they will bear, include:

Exacerbator type	Exacerbator group	Nature of exacerbation	Value of exacerbation	Direct costs to be borne	Indirect costs to be borne
Active exacerbators	People or organisations who propagate, sell or distribute terrestrial or freshwater pest animals and/or plants (knowingly) ; i.e. Gardeners Owners and/or occupiers (including Crown agencies) who do not undertake pest management on their properties; People or organisations (including Primary industry) who liberate pest animals or plants into or within the Northland Region (knowingly or otherwise);	Knowingly growing and spreading pest plants and animals. Knowingly bringing pest plants and animals into the Northland region. Moving stock or goods with associated risk of spreading pests	Moderate. Many of the progressive containment plants were introduced to New Zealand as ornamental plants, and some are used for herbal medicine. The three freshwater pest species have been released accidentally or intentionally Low	None	None
Passive exacerbators	People or organisations who propagate, sell or distribute terrestrial or freshwater pest animals and/or plants (unknowingly) Owners and/or occupiers (including Crown agencies) who do not undertake pest management on their properties The regional community, including the public, communities and individuals who do not take action to reduce the risk of pests spreading within Northland Region.	Pests present on their land due to factors other than their own activity. People who are unaware of pest species.	Low.	None	None

Cost type	Description	Cost
Direct cost of the Plan	Education and inspection , monitoring and response	$308,874
Best Cost Allocation Method for the Plan:		

Cost allocation

Cost type	Description	Cost
100% Regional and national community (as beneficiary) Rationale: There is justification for heavy weighting toward the regional and national community due to the economic and biodiversity benefits that accrue. There is no mechanism to attribute the degree of exacerbation, so exacerbators can't bear costs. It is not practical to fund or run the programme as a split between "environmental" and "production" pests. Best Cost Allocation Method: 100% exacerbator if they can be identified 100% Northland Regional Council (representing beneficiaries) . 100% Crown (representing occupiers of Crown lands) for progressive containment of the pest on Crown estates. Rationale: Costs of non-compliance should lie wholly with the exacerbator, should they be identified. The costs will otherwise have to lie with beneficiaries.		
Best Cost Imposition Mechanism for the Plan: Targeted rate with the remainder funded by Council dividends and interest. Rationale: the benefits of managing Progressive Containment Pests accrue equally across the Region so a Uniform Annual Charge (UAC), in the form of a targeted rate, is the fairest way to attribute costs.		

The cost allocation described above is considered and efficient and effective way of apportioning costs, is practical, secure, fair and reasonable efficient in terms administrative procedures. It is considered there is no need for any transitional cost allocation arrangements and collection by way of or cost share UAC as beneficiaries would be the most appropriate way to impose the cost.

The most effective agent to undertake the control to meet the objectives of the programme(s) is Northland Regional Council. A single agency is best placed to manage the programme due to consistency and certainty and the need for appropriate expertise and rapid responses.

The degree of urgency to make the plan is medium, as the previous Northland Regional Pest Management Strategies are still operative but increasingly out of date operationally and a new plan is required to comply with the National Policy Direction.

The proposed cost allocation and cost allocation method are considered efficient and effective, and avoid perverse incentives. The proposed cost allocation and cost allocation methods are considered practical. This simple allocation formula avoids the risk of compliance or cost recovery difficulties jeopardising success. The proposed cost allocation and cost allocation method are considered administratively efficient.

Security of funding for the programme(s) will depend on continuing funding allocations for biosecurity activities under the Annual Plan and Long term Plan and other sources .

The proposed cost allocation is considered fair and reasonable.. Beneficiaries are contributing in proportion to their benefits from the plan. No significant indirect costs of management have been identified for the programmes. Transitional cost allocation arrangements will not be required.

General rates, targeted rates, charges and rules imposing requirements are all possible mechanisms by which to impose the cost allocation.

After considering the cost allocation method chosen, the most effective control tools and agents to undertake the control to meet the objectives of the plan, practicality, administrative efficiency, security of funding and statutory requirements, the mechanism to be used to impose the cost allocation is a uniform annual charge.

Sustained control pests

The following table lists the entities and individuals that will benefit from species listed as Sustained Control Pests (i.e., the beneficiaries) and the entities and individuals that may contribute to the pest problem through their action or inaction (i.e., the exacerbators).

Plant species		
Bathurst bur	Phoenix palm	Wild ginger - yellow & kahili
Brazilian pepper tree	Privet	Wilding conifers
Gorse	Queen of the night	Woolly nightshade
Gravel groundsel	Rhus tree	

Animal species		
Argentine ant	Feral goat	Possum
Cats	Feral pig	Rabbits
Feral deer	Mustelids	Rats

Diseases and pathogens species
Kauri dieback disease

Freshwater species
Brown bullhead catfish
Rudd

These progressive containment pests have similar groups of beneficiaries and exacerbators as identified below. The exacerbators have similar existing legislative responsibilities and rights as identified below. The subjects are at a similar stage of infestation in Northland, known to be present in small amounts.

The management objective is the same for these sustained control pests - to roll back the spread of these pests from identified areas of Northland.

Beneficiaries, along with the benefits they are expected to receive, and proposed costs they will bear, include;

Beneficiary group	Nature of benefits	Value of benefits (where possible)	Direct costs to be borne	Indirect costs to be borne	Do costs outweigh benefits?
Regional community (including the	Prevention of future pest impacts, including environmental, economic and human health impacts. Derive direct or indirect	Not monetised	100%	None identified	Yes

Beneficiary group	Nature of benefits	Value of benefits (where possible)	Direct costs to be borne	Indirect costs to be borne	Do costs outweigh benefits?
public, communities and individuals	benefit from terrestrial and freshwater pest control and biodiversity values being protected (including tourism, local iwi etc.)				
Primary industry Sectoral public (industries and interest groups)	Prevention of future pest impacts namely economic values being protected including production values	Not monetised	None	None identified	Yes
Property owners and/or occupiers	Neighbouring property owners and/or occupiers, who benefit from pests not crossing the boundary onto their property	Not monetised	None	None identified	Yes

Exacerbators, along with the proposed costs they will bear, include:

Exacerbator type	Exacerbator group	Nature of exacerbation	Value of exacerbation	Direct costs to be borne	Indirect costs to be borne
Active exacerbators	People or organisations who propagate, sell or distribute terrestrial or freshwater pest animals and/or plants (knowingly) ; i.e. Gardeners People or organisations who do not take action to reduce the risk of diseases spreading Owners and/or occupiers (including Crown agencies) who do not undertake pest management on their properties; People or organisations (including Primary industry) who liberate pest animals or plants into or within the Northland Region (knowingly or otherwise);	Knowingly growing and spreading pest plants and animals. Knowingly bringing pest plants and animals into the Northland region. Moving stock or goods with associated risk of spreading pests/diseases	Moderate. Many of the sustained control pests were introduced to New Zealand as ornamental plants, for game hunting or proposed pest control. Low	None	None

Exacerbator type	Exacerbator group	Nature of exacerbation	Value of exacerbation	Direct costs to be borne	Indirect costs to be borne
Passive exacerbators	People or organisations who propagate, sell or distribute terrestrial or freshwater pest animals and/or plants (unknowingly) people or organisations who do not take action to reduce the risk of diseases spreading Owners and/or occupiers (including Crown agencies) who do not undertake pest management on their properties The regional community, including the public, communities and individuals who do not take action to reduce the risk of pests spreading within Northland Region.	Pests present on their land due to factors other than their own activity. People who are unaware of pest species.	Low.	None	None

Sustained control marine pests

Marine species		
Asian paddle crab	Mediterranean fanworm	Undaria seaweed
Australian droplet tunicate	Pyura sea squirt	
Japanese mantis shrimp	Styela seasquirt	

These progressive containment pests have similar groups of beneficiaries and exacerbators as identified below. The exacerbators have similar existing legislative responsibilities and rights as identified below. The subjects are at a similar stage of infestation in Northland, known to be present in small amounts.

The management objective is the same for these sustained control pests - to roll back the spread of these pests from identified areas of Northland.

Beneficiaries and exacerbators

Beneficiaries, along with the benefits they are expected to receive, and proposed costs they will bear, include;

Beneficiary group	Nature of benefits	Value of benefits (where possible)	Direct costs to be borne	Indirect costs to be borne	Do costs outweigh benefits?
Regional community (including the public, communities and individuals	Prevention of future pest impacts, including environmental, economic and human health impacts. Derive direct or indirect benefit from	Not monetised	100%	None identified	Yes

Beneficiary group	Nature of benefits	Value of benefits (where possible)	Direct costs to be borne	Indirect costs to be borne	Do costs outweigh benefits?
	marine pest control and biodiversity values being protected (including tourism, local iwi etc.)				
Primary industry Sectoral public (industries and interest groups)	Prevention of future pest impacts namely economic values being protected including production values (i.e. Aquaculture)	Not monetised	None	None identified	Yes
Occupiers of the Coastal Marine Area	Mooring lisence holders, structure owners and/or occupiers, who benefit from pests not being transported or transferred onto structures	Not monetised	None	None identified	Yes

Exacerbators, along with the proposed costs they will bear, include:

Exacerbator type	Exacerbator group	Nature of exacerbation	Value of exacerbation	Direct costs to be borne	Indirect costs to be borne
Active exacerbators	People or organisations who propagate, sell or distribute, transport marine pest animals and/or plants (knowingly) ; Owners and/or occupiers (including Crown agencies) who do not undertake pest management on their properties/vessels; People or organisations (including Primary industry) who liberate marine pests into or within the Northland Region (knowingly or otherwise);	Knowingly growing and spreading pest plants and animals. Knowingly bringing pest plants and animals into the Northland region. Moving vessels, barges, equipment etc. with associated risk of spreading pests	Moderate Moderate	Not monetised cost of hull cleaning where exacerbaters are detected	None

Exacerbator type	Exacerbator group	Nature of exacerbation	Value of exacerbation	Direct costs to be borne	Indirect costs to be borne
Passive exacerbators	People or organisations who propagate, sell or distribute, transport marine pests (unknowingly) Owners and/or occupiers (including Crown agencies) who do not undertake pest management on their properties/vessels; The regional community, including the public, communities and individuals who do not take action to reduce the risk of pests spreading within Northland Region.	Pests present on their structures, vessels etc. due to factors other than their own activity. Individuals who do not take action to reduce the risk of pests spreading within Northland Region, including vessel owners/operators who do not maintain their vessel free of marine pests. People who are unaware of pest species.	Moderate	$30000 for marine pest response and structure survey other sustained control pests are not monetised	None

Who should pay for the proposed management approach?

Mediterranean fan worm is established in some parts of the Whangarei Harbour and in well established throughout the Waitemata harbour in Auckland. Mature fanworm and larvae may attach to the hulls of boats, aquaculture gear and marina structures (e.g. pontoons) and may either be sheared off and spread in that way or reproduce in new locations while attached to a mobile substrate. Vessel users with infestations or those who intentionally or unknowingly spread the organism are best placed to change behaviours or practises to better control the organism. The council is proposing a sustained control programme for Mediterranean fan worm. This option is the most practicable option as it is likely to be less costly to regional ratepayers and therefore more palatable (hence less risk). Given the benefits of protection of marine biodiversity are a public good it is appropriate that the costs are paid for this programme by Council on behalf of the regional community. However, as vessels are a main vector for Mediteranean Fan worm, the cost of the existing vessel hull inspection programme is proposed to be shifted to the exacerbators. With the ability to implement a pathways plan under the Biosecurity Act 1993, the pathway plan can be used to control the vectors of spread for existing threats to Northland such as Sabella and prevent or exclude other marine pest species from establishing. The regional community is able to assess the cost and benefits and effectiveness of the programme through the annual planning and reporting processes under the Local Government Act 2002 and through the review of future pest management plans.

Cost allocation for Sustained Control Pests (incl. Marine)

Cost type	Description	Cost
Direct cost of the Plan	Education and inspection , monitoring and response	$1,415,515
Indirect Cost of the Plan		

Cost type	Description	Cost
Best Cost Allocation Method for the Plan: 100% Regional and national community (as beneficiary) Rationale: There is justification for heavy weighting toward the regional and national community due to the economic and biodiversity benefits that accrue. There is no mechanism to attribute the degree of exacerbation, so exacerbators can't bear costs. It is not practical to fund or run the programme as a split between "environmental" and "production" pests.		
Best Cost Imposition Mechanism for the Plan: Targeted rate with the remainder funded by Council dividends and interest. Rationale: the benefits of managing Sustained Control Pests accrue equally across the Region so a Uniform Annual Charge (UAC), in the form of a targeted rate, is the fairest way to attribute costs. The cost allocation described above is considered and efficient and effective way of apportioning costs, is practical, secure, fair and reasonable efficient in terms administrative procedures. It is considered there is no need for any transitional cost allocation arrangements and collection by way of or cost share UAC as beneficiaries would be the most appropriate way to impose the cost. The most effective agent to undertake the control to meet the objectives of the programme(s) is Northland Regional Council. A single agency is best placed to manage the programme due to consistency and certainty and the need for appropriate expertise and rapid responses. The degree of urgency to make the plan is medium, as the previous Northland Regional Pest Management Strategies are still operative but increasingly out of date operationally and a new plan is required to comply with the National Policy Direction. The proposed cost allocation and cost allocation method are considered efficient and effective, and avoid perverse incentives. The proposed cost allocation and cost allocation methods are considered practical. This simple allocation formula avoids the risk of compliance or cost recovery difficulties jeopardising success. The proposed cost allocation and cost allocation method are considered administratively efficient. Security of funding for the programme(s) will depend on continuing funding allocations for biosecurity activities under the Annual Plan and Long term Plan and other sources . The proposed cost allocation is considered fair and reasonable.. Beneficiaries are contributing in proportion to their benefits from the plan. No significant indirect costs of management have been identified for the programmes. Transitional cost allocation arrangements will not be required. General rates, targeted rates, charges and rules imposing requirements are all possible mechanisms by which to impose the cost allocation. After considering the cost allocation method chosen, the most effective control tools and agents to undertake the control to meet the objectives of the plan, practicality, administrative efficiency, security of funding and statutory requirements, the mechanism to be used to impose the cost allocation is a uniform annual charge.		

Pathway plan

The management objective of the pathway plan is to prevent the movement of established marine pests and exclusion pests becoming established in Northland and the following table lists the entities and individuals that will benefit from the Marine Pathways Plan (i.e the beneficiaries) and those that may contribute to the pest problem through their action or inaction (i.e. the exacerbators).

Organism	Beneficiaries	Exacerbators
marine pests	Vessel owners who are at a reduced risk of their vessel hull incurring a marine pest infection. Regional community, including the public, communities and individuals who derive direct or indirect benefit from marine pest and pathway management (tourism, local iwi, etc); •Occupiers of the coastal marine area; •Sectoral public (industries, interest groups); and •Regional community, including the public, communities and individuals who benefit from marine biodiversity cultural, environmental and economic values being protected. The crown as occupier of the marine space and vessel owner	Vessel owners/operators whose vessel hulls are able to grow hull fouling; Vessel owners/operators who do not maintain their vessel hulls to an acceptable level; active exacerbator •Regional community, including the public, communities and individuals who do not take action to reduce the risk of marine pests spreading from one place to another;- passive excerbator •People or organisations that transport, spread or provide habitat for marine pests (knowingly or otherwise); passive and active •People or organisations including the crown that liberate marine pests into or within the Northland region (knowingly or otherwise).Passive and active

Clause 7 (1(a)) of the NPD requires that Northland consider whether the pests being spread by vessel hulls have similar groups of beneficiaries and exacerbators. Regardless of the type of vessel (pathway) it is considered all marine pests have the potential to be transported via biofouling on vessel hulls and therefore, they can be grouped together for the purposes of cost allocation.

Clause 7(1(b) and 7(2) (b) of the NPD requires consideration of whether the exacerbators and beneficiaries have similar existing legislative responsibilities and rights. It is considered that the legislative rights under the Biosecurity Act and all other Acts of Parliament are the same for all potential exacerbators and beneficiaries.

Clause 7(1)(c) of the NPD requires consideration of whether the organisms in a proposed pest management plan are at a similar stage of infestation and similar management objectives for the organisms. It is considered this is not applicable to a pathways plan which aims to set rules on the level of biofouling.

Clause 7(2) (a) of the NPD requires the direct and indirect costs to be identified. The table and narrative below identifies the direct and indirect costs of the Pathways Plan, who will bear the cost , the rationale for the cost allocations and the best mechanisms available to impose costs. In doing so the management objectives of the plan have been considered as described in the proposed Northland Regional Marine Pathway Management Plan along with the current level of marine pest infestation as required by clause 7(2) (d) (ii))

Cost type	Description	Cost
Direct Cost	Diver survey, compliance education and publicity	$450,000 per annum
Indirect Cost	None Identified	(MPI's contribution would exist with or without the plan)

The following cost allocation has taken into consideration all matters set out in the NPD specifically clause 7(2)(d) (subsections i-xv))

Best cost allocation method for the plan:

User charge on beneficiaries and exacerbators where possible or a combination of general rate and user charge.

Rationale: A user charge is recommended to be applied to selected commercial port owners, boatsheds, marinas and mooring owners, as these structure owners are the major host of vessels and best placed to pass this charge onto vessel owners. A combination of user charge and general rate used (to be confirmed by the annual plan process) may also be considered. Vessels are the primary pathway of marine pests and an analysis of benefits and costs describes a net benefit of more than $9 to the region for every one dollar of input. Thus there is a clear economic benefit in undertaking a Marine Pathway Plan, in addition the net benefit of the Pathway Plan is more than ten times that of the current practice of the current species led approach. There is also urgency needed to slow the spread of marine pests and the rule is expected to accelerate behaviour change of vessel owners as exacerbators will be required to clean their hulls at their own cost when they exceed the minimum bio-fouling standards set by the rule.

Cost allocation method

Direct costs are shared between beneficiaries and excaerbators and 100% user charge on marinas, boatsheds and mooring owners and major commercial ports (as beneficiary and exacerbator) or a cost share divided between regional community and selected structure owners. This may vary from year to year and is dependent on Annual Plan and Long Term Plan decisons. Indirect costs are not monetised.

The cost allocation described above is considered and efficient and effective way of apportioning costs, is practical, secure, fair and reasonable efficient in terms administrative procedures. It is considered there is no need for any transitional cost allocation arrangements and collection by way of a user charge or cost share by the regional community as beneficiaries would be the most appropriate way to impose the cost.

The most effective agent to undertake the control to meet the objectives of the programme(s) is Northland Regional Council. A single agency is best placed to manage an exclusion programme due to consistency and certainty and the need for appropriate expertise and rapid responses.

The degree of urgency to make the plan is medium, as the previous Northland Regional Pest Management Strategies are still operative but increasingly out of date operationally and a new plan is required to comply with the National Policy Direction.

The proposed cost allocation and cost allocation method are considered efficient and effective, and avoid perverse incentives. The proposed cost allocation and cost allocation methods are considered practical. This simple allocation formula avoids the risk of compliance or cost recovery difficulties jeopardising exclusion success. The proposed cost allocation and cost allocation method are considered administratively efficient.

Security of funding for the programme(s) will depend on continuing funding allocations for biosecurity activities under the Annual Plan and Long term Plan and other sources .

The proposed cost allocation is considered fair and reasonable. Beneficiaries and exacerbators are contributing in proportion to their benefits from the plan. Equity dictates that users or beneficiaries of an activity or service, or those whose actions give rise to an activity or service, will generally be required to fund the cost of providing that service at a level that reflects their use or benefit. No significant indirect costs of management have been identified for the programmes. Transitional cost allocation arrangements will not be required.

General rates, targeted rates, charges and rules imposing requirements are all possible mechanisms by which to impose the cost allocation.

After considering the cost allocation method chosen, the most effective control tools and agents to undertake the control to meet the objectives of the plan, practicality, administrative efficiency, security of funding and statutory requirements, the mechanism to be used to impose the cost allocation is a user charge or combination of user charge and uniform annual charge.

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