Exotic Fish & Water-Weed Survey Results

Ngā Rangahau o ngā Ika rereke me ngā Wai-taru

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Northland REGIONAL COUNCIL

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Whakatauaki

Manākitia te whenua, manākitia ngā tangata, manāki to tātou taiao

(Caring for the land, the people and our environment)

This survey is part of the NRC's Freshwater Improvement Fund (FIF) Northland Dune Lakes Strategic Water Quality Improvement project. Information from this survey will inform the prioritised selection of waterbodies where pest fish control will occur and will further feed into a Northland Freshwater Pests Pathways Management Plan. The FIF is administered by the Ministry for the Environment and the overall project is being conducted in partnership with mana whenua iwi and hapu.

A total of 372 lakes, ponds or dams, larger than half a hectare, were selected for the survey. This excluded around 100 lakes which NRC and NIWA ecologically monitor on a 5-10 yearly rotational basis and have good biological data for. The survey waterbodies were either on or were bordered by 399 land-parcels, owned by 338 landowners. This resulted in 377 surveys mailed out. These landowners were posted a survey with both a return envelope and an alternative opportunity to complete the survey online.

A total of 141 responses were received (36.72%) from 121 individual landowners, covering 143 waterbodies (36.67 %). Some responses covered more than one waterbody on a single property and some waterbodies were addressed in more than one landowner response, due to multiple properties bordering some waterbodies.

Egeria was the most commonly reported weed, while gambusia and rudd were the most common fish reported in waterbodies.

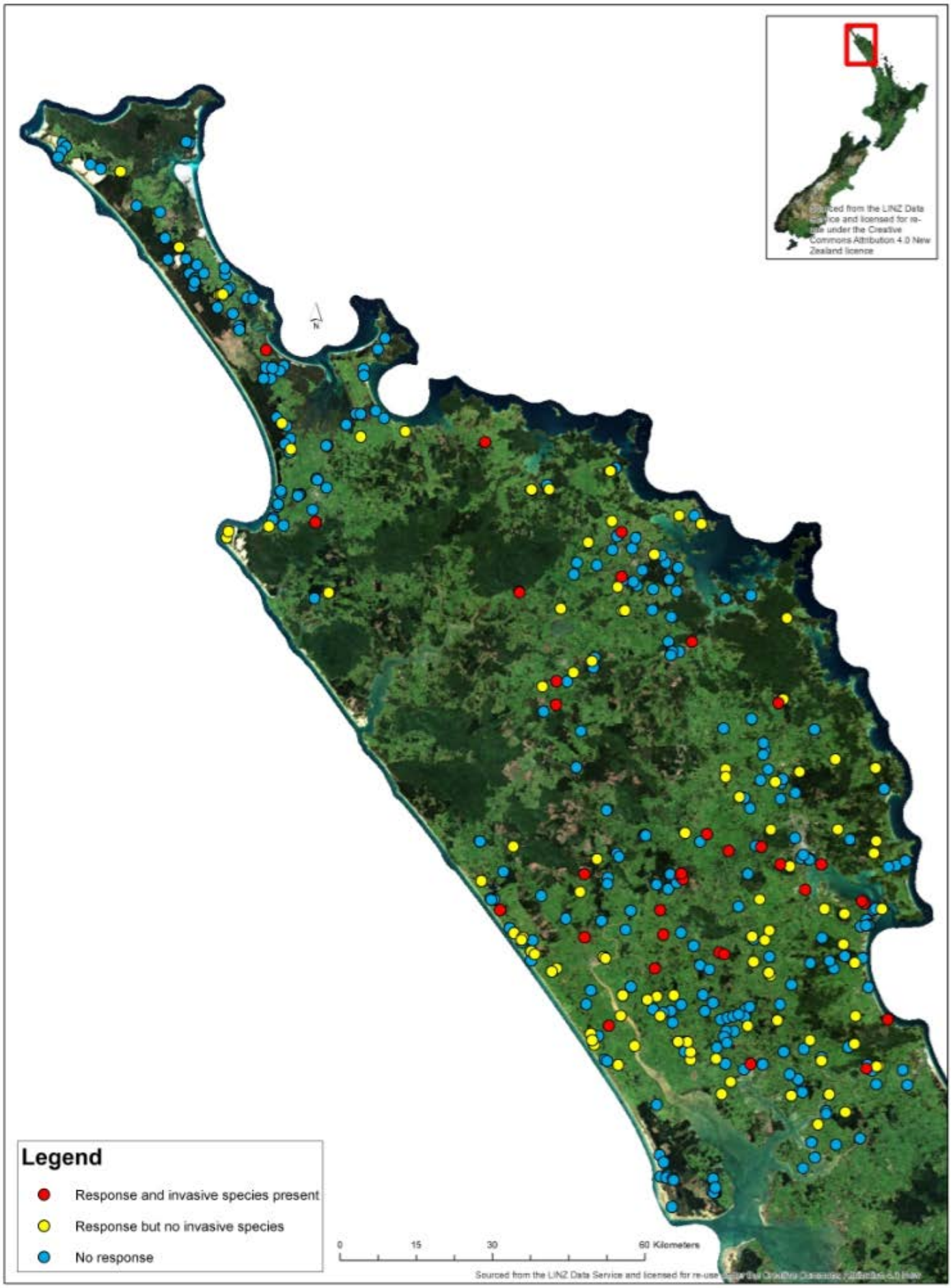
Introduction - Whakataki

The Northland Regional Council (NRC) has responsibility for the sustainable resource management of the Northland Region, including environmental, economic, social and cultural well-being. The work undertaken by the Council is diverse and covers a wide range of issues and a broad range of stakeholders in the community.

Lakes, ponds and dams are an integral part of the lives of many Northland residents. They provide water, kai, aesthetic and recreational benefits, as well as being important refuges for a variety of native flora and fauna.

As part of the Freshwater Improvement Fund (FIF) Dune Lakes project, a mail survey was conducted to obtain information on the distribution of four invasive water weeds and exotic fish. The survey was conducted in June/July 2018 and this document presents the findings from the survey. The results from this survey will prioritise the location of pest fish control operations and will contribute to a Freshwater Pests Pathway Management Plan.

We predicted a high response rate due to the nature of the survey and the vested interests people have with freshwater systems (e.g. eel fishing, improving water quality, etc.).


Legend
Response and invasive species present
Response but no invasive species
No response
0
15
30
60 Kilometers
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Objectives - Ngā Whāinga

The Exotic Fish & Water-Weed Survey reported here was designed to provide data to assist the Northland Regional Council in tracking the:

- distribution of exotic, invasive aquatic species in Northland;
- pathways of spread of invasive aquatic species; and
- awareness of invasive species in the community.

It also allowed for secondary outcomes such as:

- building relationships with the community;
- confirming survey responses by including neighbouring property owners in survey recipients.

This survey relied on the awareness and knowledge of the community. The survey covered four primary research areas:

1. Distribution of exotic, invasive aquatic species in Northland;
2. Where invasive species are likely to spread naturally – whether through connected waterways such as inflow/outflow streams or during flood events – and prioritising catchments based on their likelihood of invasion;
3. Human vectors of spread such as eel fishers or duck hunters; and
4. Awareness and knowledge of invasive aquatic species in Northland.

Koi carp among emergent vegetation

Method - Ngā Tikanga

A total of 372 lakes, ponds or dams larger than half a hectare were selected for the survey. This excluded around 100 lakes which NRC and NIWA ecologically monitor on a 5-10 yearly rotational basis and have good biological data for. Data from the NIWA Freshwater Fish Database (NFFD) confirmed the presence of exotic fish throughout Northland but waterbodies where those records exist were surveyed to serve as confirmation and to measure responses against. The surveyed waterbodies were either on or were bordered by 399 land-parcels, owned by 338 landowners. Total surveys sent were 377.

The survey included waterbodies from all three local government areas in the Northland region; Far North District (n = 149), Whāngārei District (n = 98), and Kaipara District (n = 144). Therefore, the responses represent a thorough geographical coverage of the region.

Some survey forms covered more than one waterbody per property. Some landowners owned more than one property. Many waterbodies were surrounded by more than one property/landowner and all landowners were surveyed, even when they did not own the waterbody bed. Hence, the final statistics may not seem intuitive, but are based on this complex of situations.

Images of each exotic species were presented, but no further biological key identification (other than fish size) was provided. This may assist in the accuracy of responses in future surveys. Questions were predominantly 'Yes/No/Unsure', with the option to include more information on how long the species had been present and how they were thought to have arrived in a waterbody.

Landowners were mailed a survey, a Freepost return envelope, and a single page with common native freshwater fish that may have been present in the waterbodies. The survey was also accompanied by brochures from MPI's Check, Clean, Dry biosecurity campaign. An alternative option to complete the survey online at the NRC website through Survey Monkey was also provided. An incentive to complete the survey was offered, with a chance to win one of two $100 Countdown vouchers if the survey was returned within a one-month timeframe. A reminder postcard was sent to non-respondents after two weeks of the initial survey being sent, which resulted in a second pulse of returns.

Lake Wahakari

Results and discussion - Ngā hua me ngā kōrero

Of the 384 surveys mailed out on 6 June 2018, 141 (36.67%) were returned. Although the deadline date was set at one month after the mail out, data from after the deadline was included in these results to increase the sample size. However, winners of the Countdown incentive vouchers were only chosen from respondents that had returned a survey within the specified timeframe.

Responses were from 121 individual landowners, covering 143 waterbodies (36.67%). Some responses addressed more than one waterbody on a single property and some waterbodies were addressed in more than one landowner response, due to multiple properties bordering some waterbodies.

Of the final 141 responses, 43% were returned within two weeks of the survey initially being sent. A reminder postcard was sent to the landowners who had not responded within these two weeks and this initiated a second influx of responses. Consequently, 38% of the total responses were received within two weeks of the postcard reminder being sent. This is an effective means of generating maximum participation.

The number of landowners, waterbodies and surveys sent in each district are presented in Table 1.

Table 1. *Total number of properties, waterbodies and surveys sent during this mail survey.*

	Far North	Whangārei	Kaipara
Landowners/properties	110	94	126
Waterbodies	134	97	136
Surveys sent	149	98	144

The Kaipara District (39%) returned the most responses, followed by the Whangārei District (34%), then the Far North (27%), shown in Figure 1.

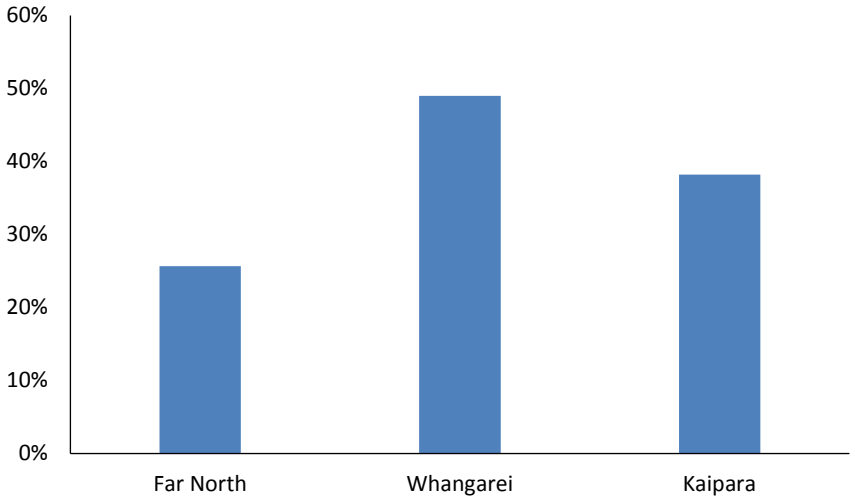


Figure 1. *Responses to the mail survey by district.*

A total of 79 individual landowners responded to the survey, while the remainder of responses were from companies, Māori trusts, district councils or similar.

Most respondents (n = 106) indicated ‘no’, ‘unsure’ or did not answer some or all species questions. The rest either explicitly stated a species was present (by circling ‘yes’) or stated in the comments section that they thought a species was present, or that they had something in their/their neighbour’s

waterbody that looked similar to a species shown in pictures provided in the survey. Only 35 survey responses indicated an invasive species was present, by a 'yes' response.

It is unknown whether the 'unsure' responses represent knowledge of fish being present but the actual species is unknown, or simply that the landowner did not know if any fish were present. Alternatively, circling 'unsure' may have been a fast way for respondents to complete the survey. Future surveys will clarify these uncertainties.

Lake use - Whakamahinga o ngā roto

The most common use of lakes was duck hunting, with 42.25% of respondents indicating duck hunting was previously, or currently, an activity conducted at their waterbody. The use of pumps, hoses and tanks in or around waterbodies was the next common use, with 41.30% of respondents indicating they have used or are using pumps, hoses and tanks in relation to their waterbody. 'Kayaks, canoes and dinghies' were also common uses (25.36%) as well as eel fishing (24.64%).

Table 2. *Lake uses by most common use.*

Activity	Responses
Duck hunting	42.75%
Pumps, hoses, tanks	41.30%
Kayaks, canoes, dinghies	25.36%
Eel fishers	24.64%
Stock access	18.84%
Diggers/other machinery	13.04%
Power boats	2.90%
Freshwater anglers	1.45%

Duck hunting, small boat (e.g. kayak/canoe) use and eel fishing are likely to be the greatest risk vectors in terms of moving water weeds and invasive fish between waterbodies. These lake uses will be included as part of a Freshwater Pest Pathways Management Plan that will be developed in the near future.

No respondents indicated vehicle washing, ornamental fish keeping or waka ama as an activity undertaken in their waterbodies. This is possibly due to the distance of most waterbodies from houses – many are located on farms and would not be readily accessible to the public for waka ama or to some landowners for vehicle washing. Similarly, where stock are able to access a waterbody, the waterbody would potentially not be suitable for ornamental fish keeping. Likewise, the size (>0.5ha) and location of the waterbodies could be impractical for fish keeping.

- Weeds - Wai-taru

Where a weed species was indicated, duck hunters were found to be the most common use of the waterbody, followed by kayaks/small boats, pumps/hoses then eel fishers.

Table 3. *Most common lake uses where aquatic weeds were recorded.*

Activity	Occurrence
Duck hunters	24.24%
Kayaks/small boats	24.24%
Pumps/hoses/tanks	18.18%
Eel fishers	12.12%
Stock access	9.09%
Machinery (e.g. diggers)	6.06%

It should be noted that just because a particular waterbody use was identified by the respondents, this does not mean the activity introduced the aquatic weed. Instead, this survey has identified potential vectors of spread that will be investigated further in the Freshwater Pest Pathways Management Plan.

- Fish - Ngā Ika rereke

Where a fish species was indicated, kayaks and other small boats were found to be the most common use of the waterbody, followed by duck hunters, eel fishers then machinery.

Table 4. *Most common lake uses where exotic fish were recorded.*

Activity	Occurrence
Kayaks/small boats	54.55%
Duck hunters	45.45%
Eel fishers	36.36%
Machinery (e.g. diggers)	33.33%
Pumps/hoses/tanks	33.33%
Stock access	24.24%

It should be noted that just because a particular waterbody use was identified by the respondents, this does not mean the activity introduced the invasive fish. Instead, this survey has identified potential vectors of spread that will be investigated further in the Freshwater Pest Pathways Management Plan.

When compared against each other, pest fish and weeds have much different relationships with lake uses (Figure 2). For example, where duck hunting is correlated with only 24% of weed occurrences, duck hunting is correlated with 45% of fish occurrences. Likewise, where kayak and small boat use was correlated with 55% of fish occurrences, their use was only correlated with 24% of weed occurrences.

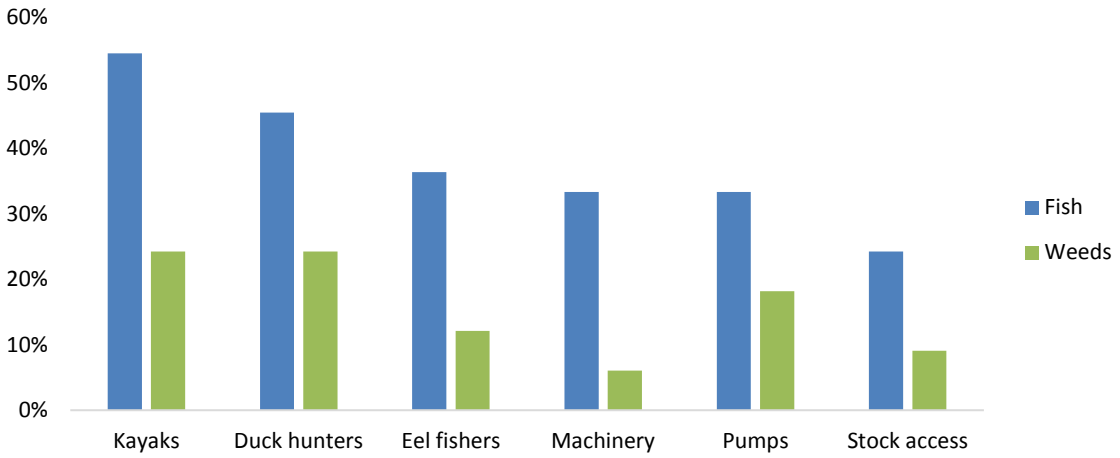
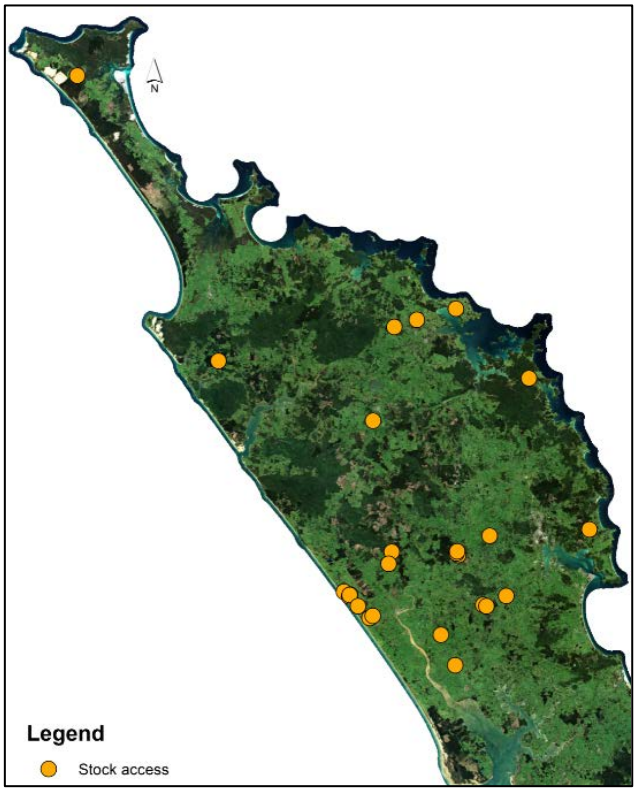


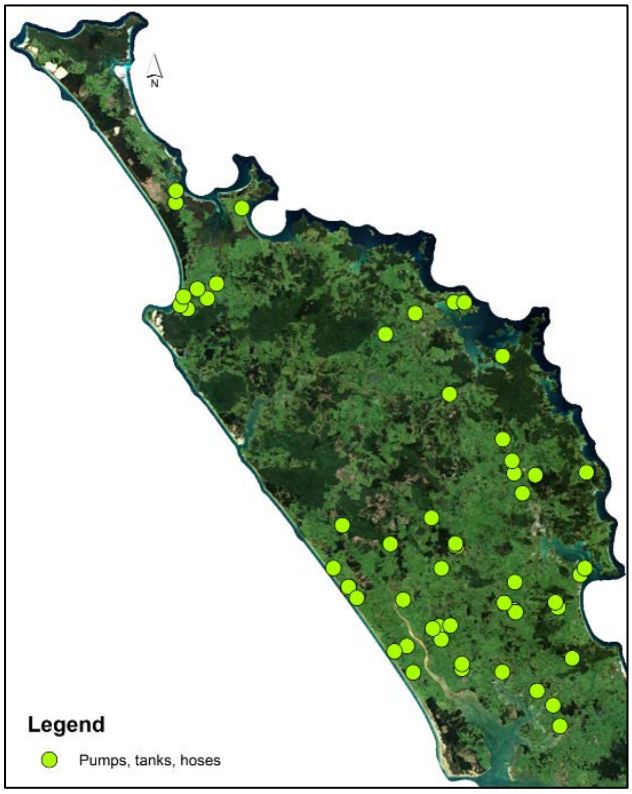
Figure 2. *Comparison of lake uses in relation to the presence of exotic fish and aquatic weeds.*

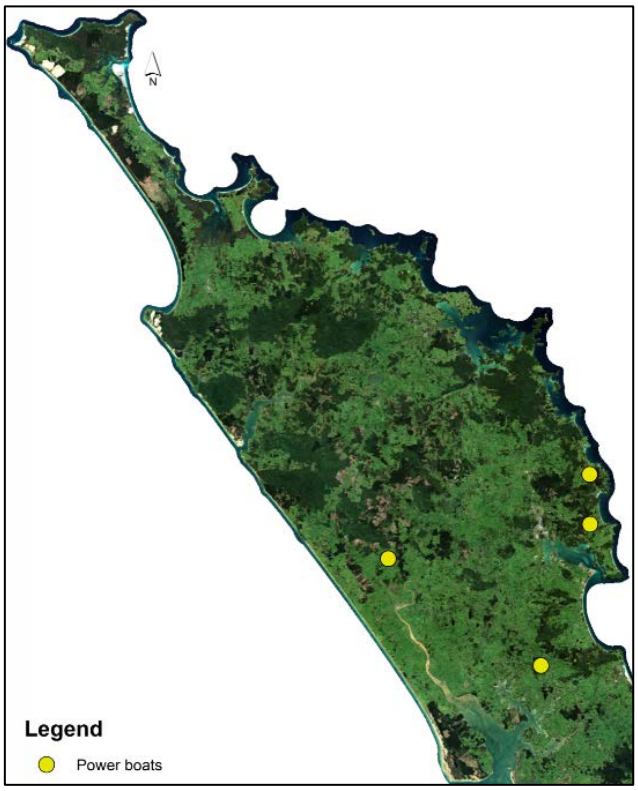
It is important to reiterate that just because an activity is conducted at a particular waterbody, this does not mean that activity introduced the pest organism. Instead, we will use this information to be aware of potential vectors of spread of these organisms. This information will inform the previously discussed Freshwater Pathways Management Plan.

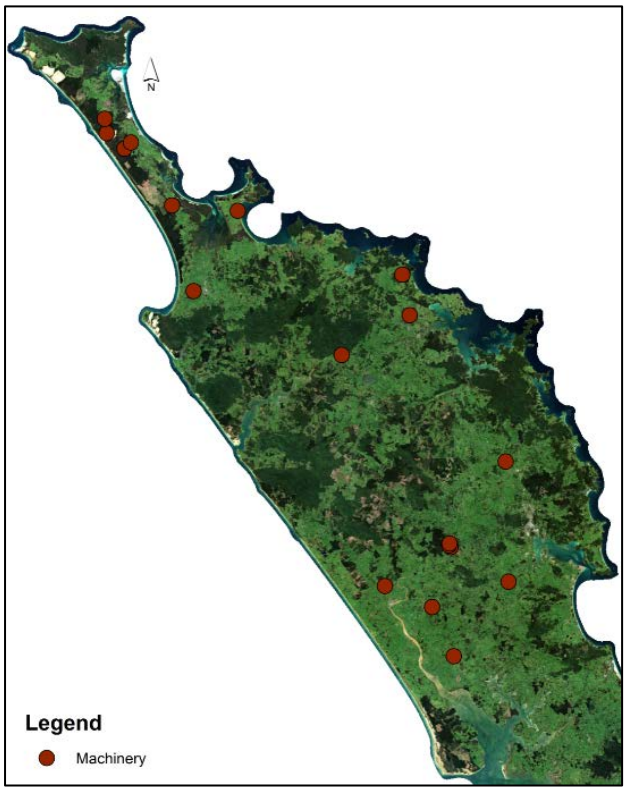
Diver surveys hornwort in Lake Swan

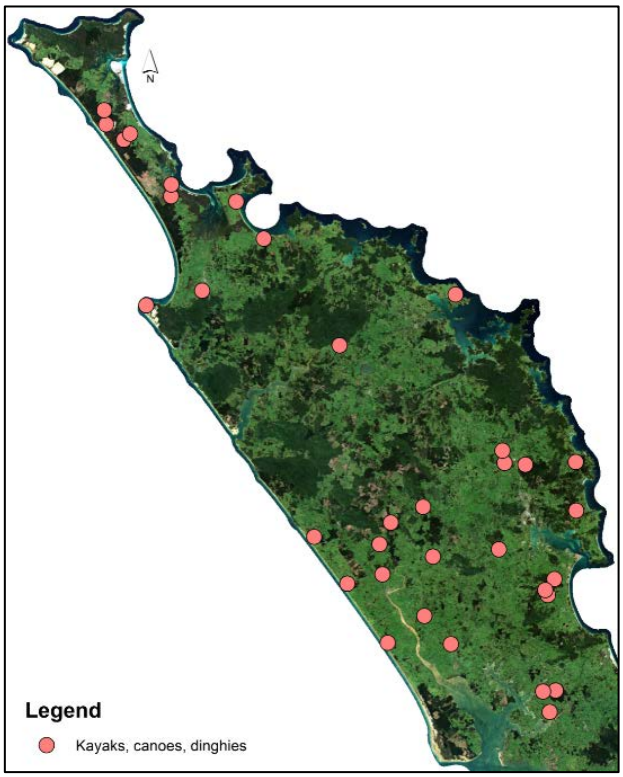
The following maps show the distribution of waterbodies by different uses throughout the Northland region, as identified during this survey.



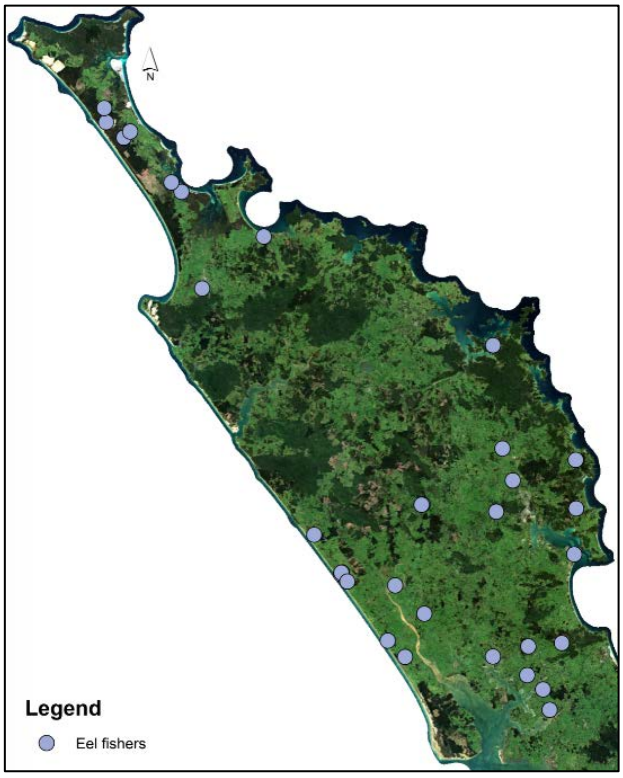


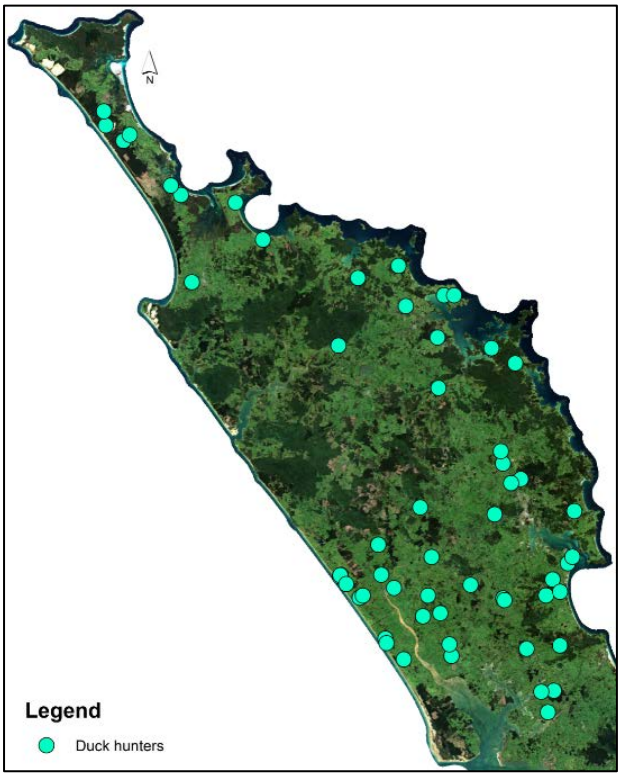





N
Legend
Kayaks, canoes, dinghies


N
Legend
Freshwater anglers


N
Legend
Eel fishers


N
Legend
Duck hunters

Water-weeds – Wai-taru

Fifteen respondents out of 137 indicated they had one or more aquatic weeds in their waterbody by circling 'yes'. A further 5 respondents commented at the end of the survey that a type of water weed was present but were unsure exactly which weed it was. Other aquatic weeds such as alligator weed (*Alternanthera philoxeroides*) and willow weed (*Persicaria maculosa*) were responses provided in the 'further information' section at the end of the survey.

The following graphs show the percentage of responses from the survey for each weed and the maps show distribution of 'yes' presence responses.

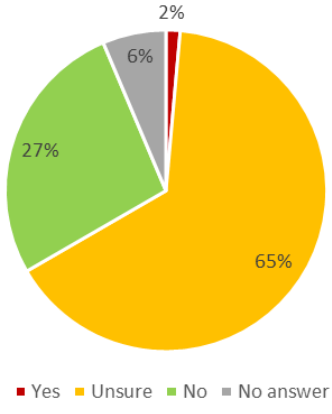
We are unable to confirm the accuracy of these results as we do not have the resources to ground-truth some 400 waterbodies. It is likely that some of the 'unsure' responses are from landowners that may have some form of weed in their waterbody but cannot identify which it is.

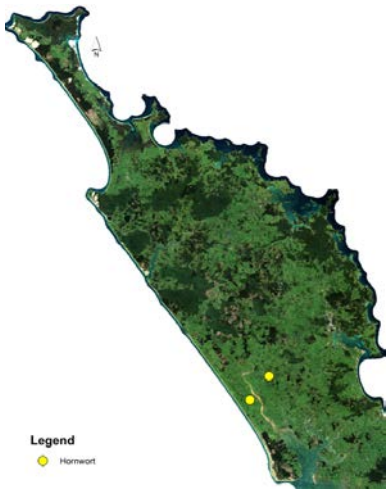
Other weeds

Some respondents identified alligator weed (n = 3) or willow weed (n = 5) as a problem in their waterbodies. These weeds are common in Northland and were probably correctly identified by the respondents. One landowner mentioned that swamp lily (*Ottelia ovalifolia*) is present at their property.

Hornwort (*Ceratophyllum demersum*)

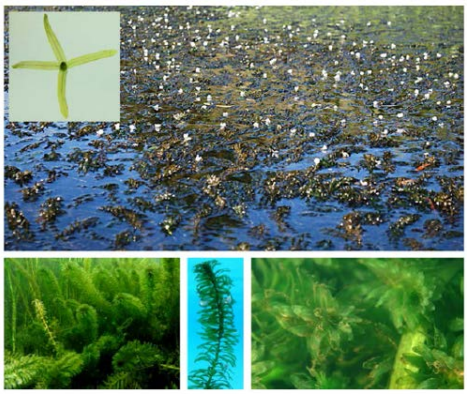
Only 2 respondents indicated hornwort was present in their waterbodies, while 92 respondents indicated it was not present. One respondent indicated the weed had been present for 7 years, and the other for more than 20 years. Both respondents were unsure how the weed had arrived.

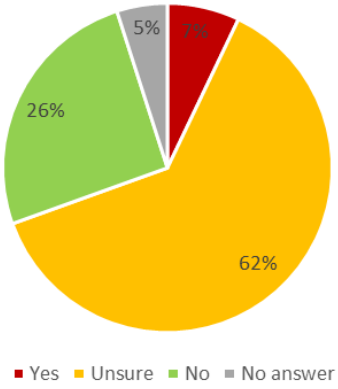


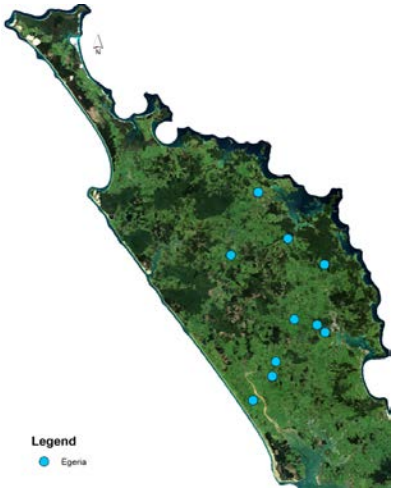


Egeria (*Egeria densa*)

Ten respondents indicated egeria was present in their waterbodies, while 88 indicated it was not present. There were a range of establishment lengths for egeria, from 2 years to >20 years. Respondents indicated ducks, other waterfowl, flooding from rivers (e.g. Wairoa and Mangonui) and deliberate planting as the weed introduction mechanisms.



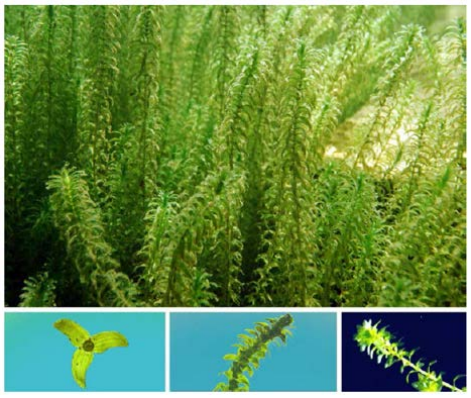


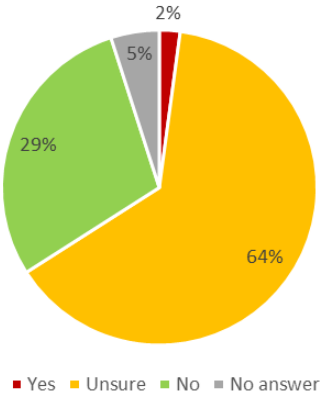


Elodea (*Elodea canadensis*)

Three respondents indicated elodea was present in their waterbodies, while 90 indicated it was not present.

Respondents indicated the weed had been present for 5 years in one waterbody and 7 years in the other, and both were unsure how the weed had arrived. One respondent noted the weed dies off in winter and had not returned this past summer.

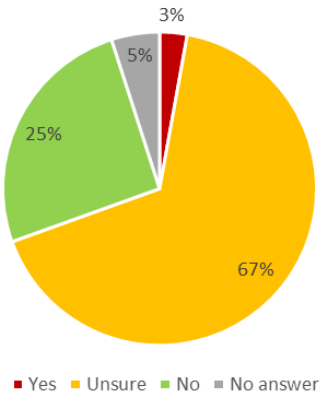




Lagarosiphon (*Lagarosiphon major*)

Four respondents indicated lagarosiphon was present in their waterbodies, while 94 indicated it was not present.

Only two respondents indicated how long the weed had been present; one since 2006 and the other for around 10 years. Respondents indicated ducks, other waterfowl, and intentional planting (obtained via a pet shop) were responsible for introducing the weed. One respondent had sprayed the lagarosiphon (Lake 40) and noted that it had not returned since.



Exotic fish - Ngā Ika Rereke

Twenty-three out of 137 respondents said 'yes' to having exotic fish present in their own or their neighbours' waterbodies. Two respondents noted trout were present. In the 'further information' section at the end of the survey, some respondents indicated they had fish in their waterbody but could not identify the species.

The following maps show both the distributions of exotic fish based from the survey and from the NIWA Freshwater Fish Database (the exotic fish records from the 100 lakes that are ecologically surveyed by NRC are included in the NIWA database maps). The NIWA dataset has been verified and includes data from rivers and streams as well as waterbodies. There are no catfish or orfe records from the survey to compare to NIWA data.

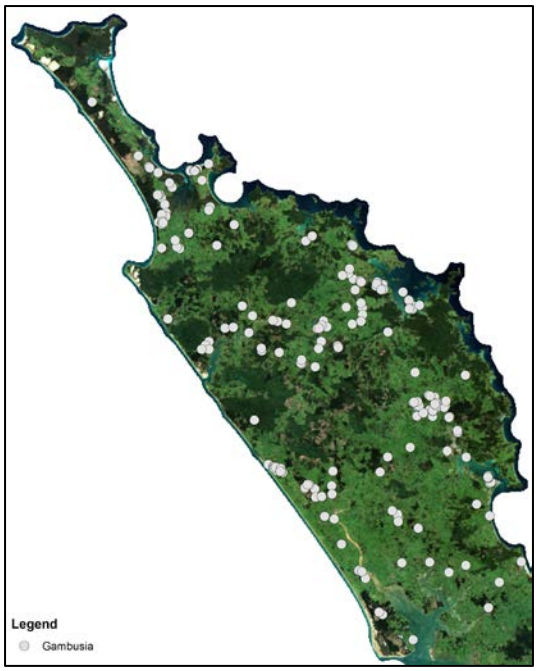
Gambusia (*Gambusia affinis*)

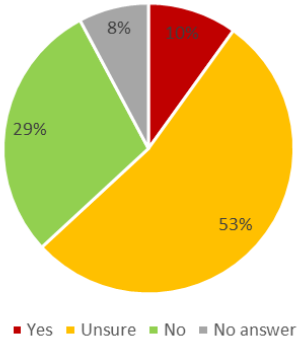
Gambusia were the most common fish to be indicated as present from this survey, with 14 respondents indicating gambusia were present in their waterbodies.

Respondents said that gambusia arrived at their waterbodies from as early as the 1970s and as late as 2012. They believe that gambusia arrived via flooding from the Huehue Stream, Awakino River and Wairua River, as well as through a storm water drain and via deliberate introductions from people assuming they would control mosquitos. Note that gambusia are not an effective means of controlling mosquito larvae, with native fish being a better predator.

Survey

NIWA Database

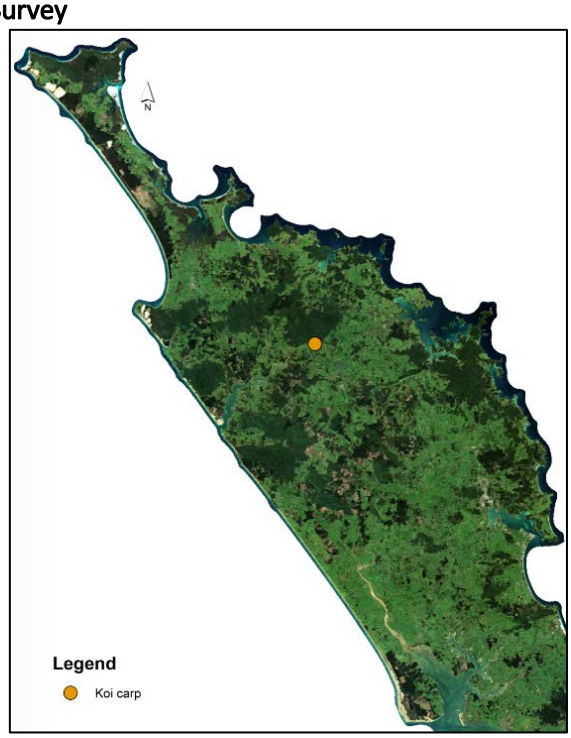




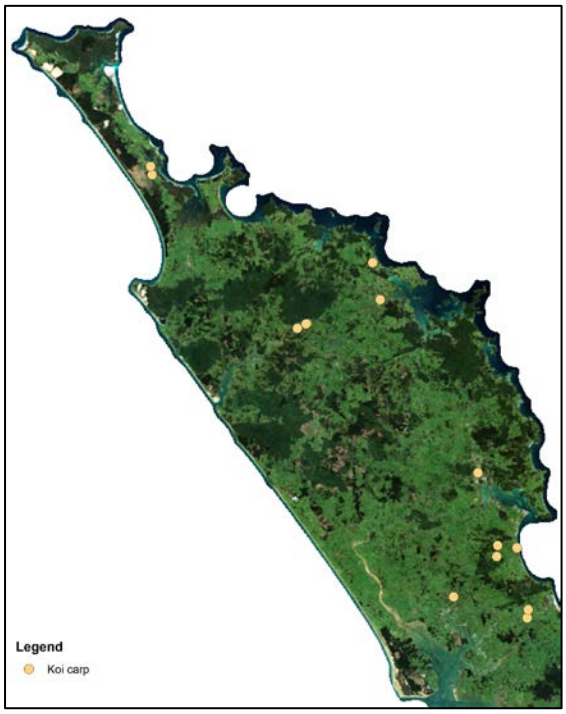
Koi carp (*Cyprinus carpio*)

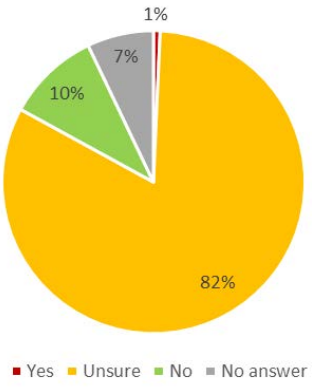
Only one record of koi carp was obtained via this survey. The respondent indicated koi had been present for at least 10 years and that they had found 5 dead in the summer of 2016. The respondent assumed shags had introduced the carp.

Survey



NIWA Database



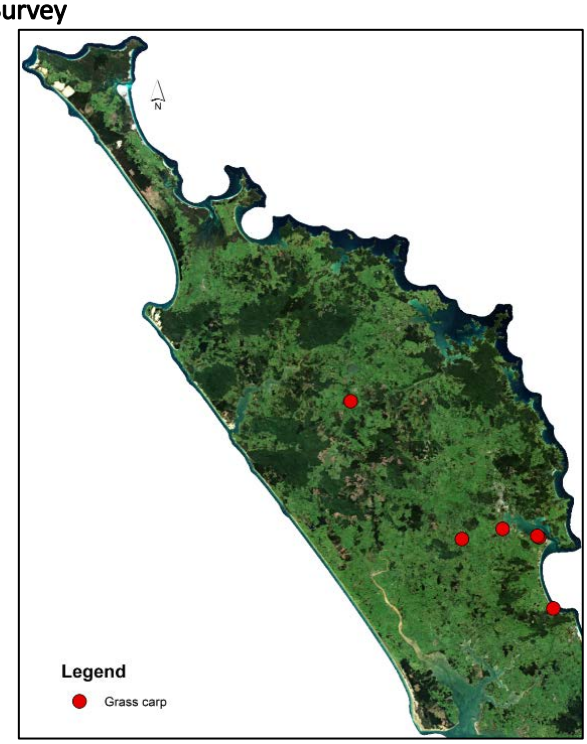


Grass carp (*Ctenopharyngodon idella*)

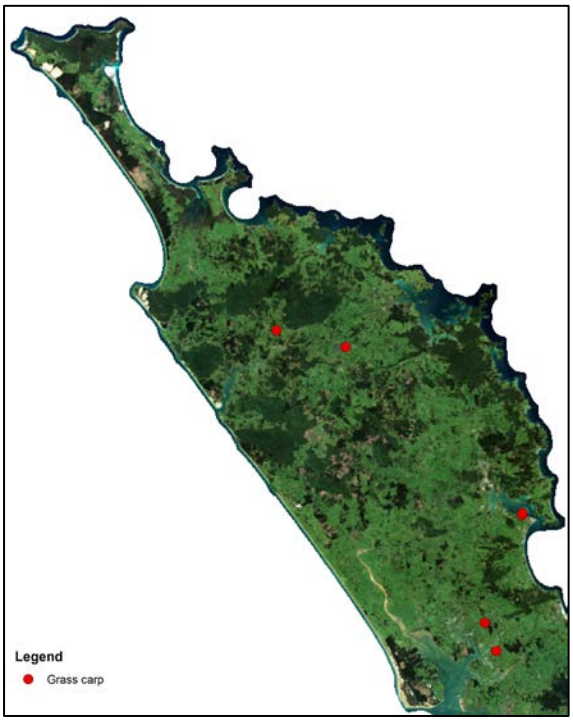
Five respondents indicated grass carp were present in their waterbodies. One of these responses may not be accurate as the respondent also stated they had a thick mat of weed, which would likely not be the case if grass carp were present.

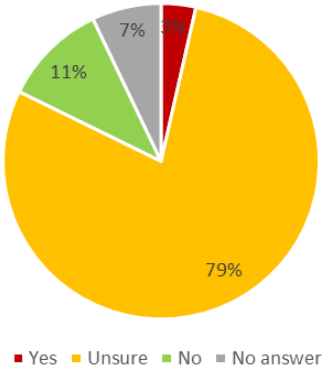
One respondent indicated grass carp had been released about one year ago. One property had farmed grass carp since 1992 and another since 1999 (both under permit).

Survey



NIWA Database

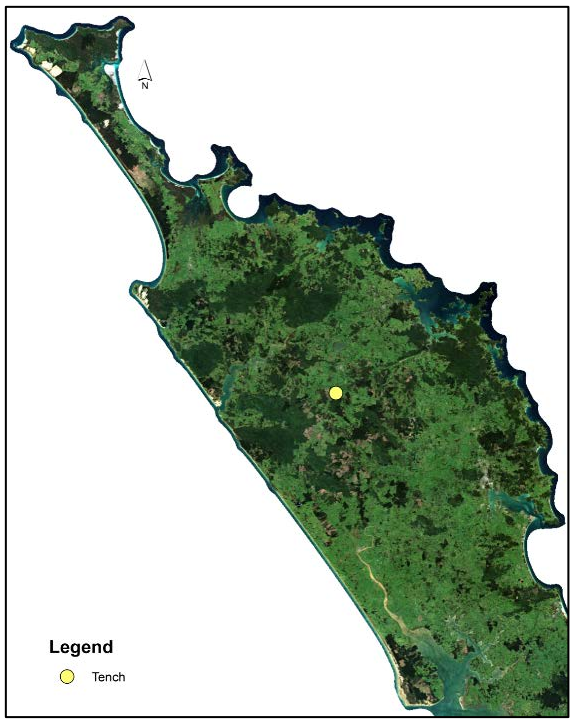




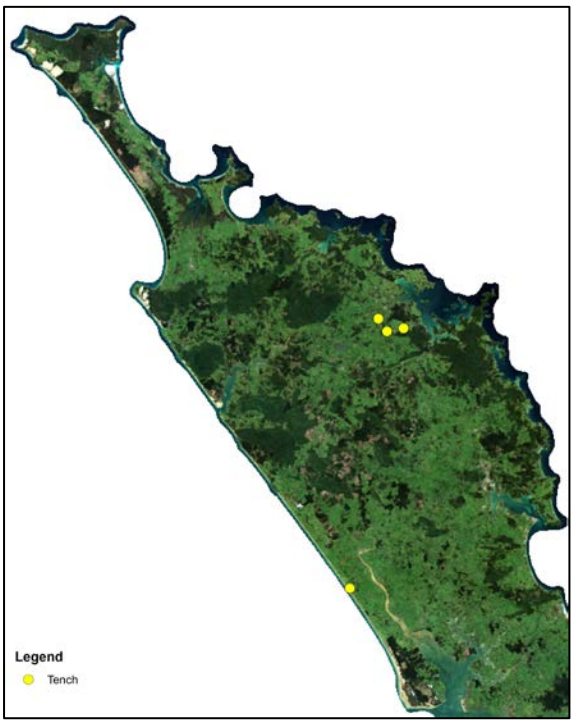
Tench (*Tinca tinca*)

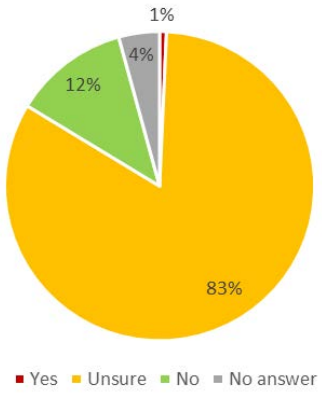
Only one record of tench was obtained via this survey. The respondent indicated tench had possibly arrived via flooding from the nearby Huehue Stream but did not indicate how long the fish had been present.

Survey



NIWA Database



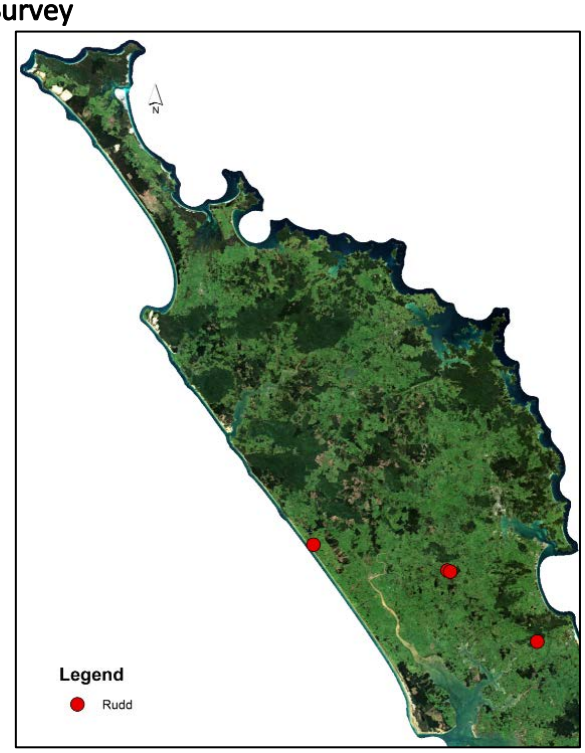


Rudd (*Scardinius erythrophthalmus*)

Rudd were the second most common fish to be commented on in this survey with 7 respondents indicating they were present in their waterbodies. Interestingly, four out of nine landowners from one lake responded to this survey and all noted rudd were present. Only one of these landowners commented on how long the fish had been present (since before 2003) and another commented that the rudd population appears to be regulated well by a flock of shags.

One landowner returned two surveys for two separate waterbodies on their land and indicated that both waterbodies contained rudd. This respondent noted rudd had been present for 30 – 40 years and arrived via shags.

Survey



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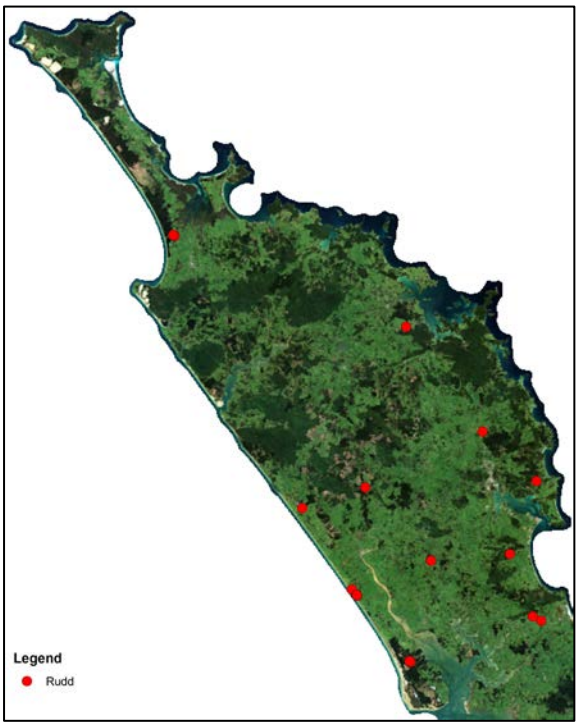
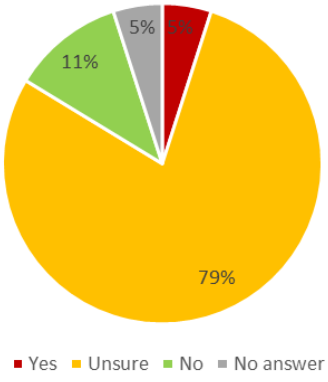
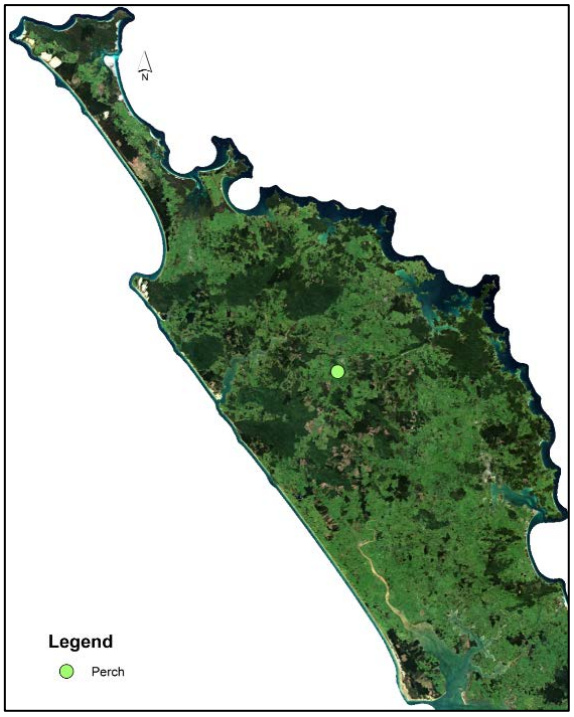




Perch (*Perca fluviatilis*)

Only one respondent indicated perch were present in their waterbody, while 116 said perch were not present. The single respondent did not indicate how long the fish had been present or how they got there.

Survey



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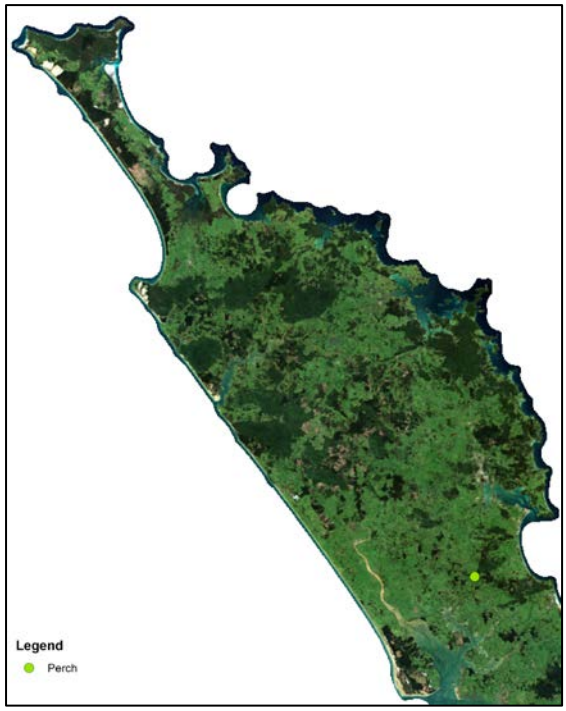
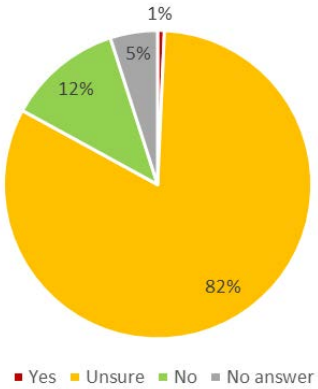
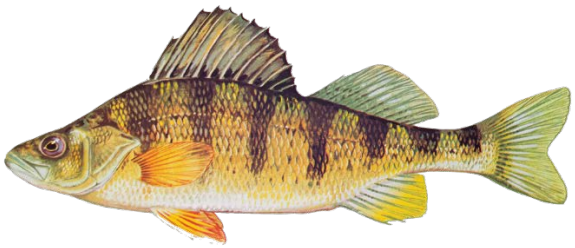




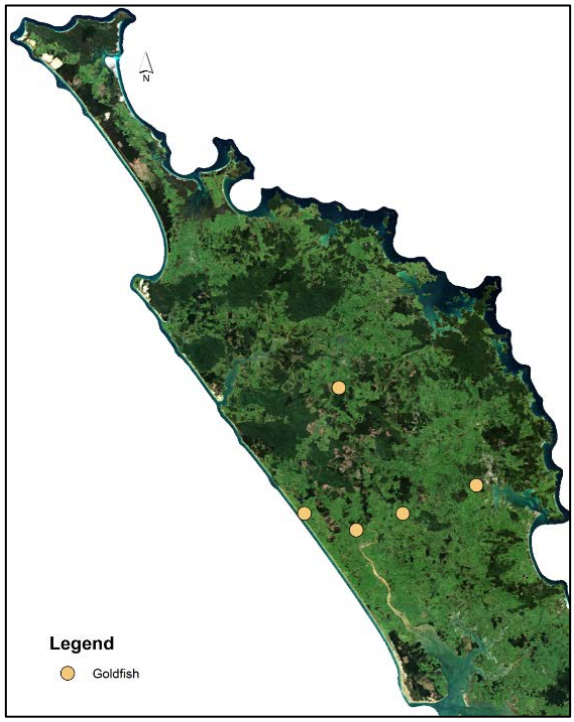


Goldfish (*Carassius auratus*)

Only 5 respondents indicated goldfish were present in their waterbody, while 111 indicated they were not present. One of these responses stated they had deliberately released goldfish into the waterbody three years ago. The earliest record given for goldfish was prior to the 1980s, while the latest appearance was the deliberate release 3 years ago. Other respondents noted the fish may have come from flooding via the Wairua River and Huehue Stream.

In the comments section, three others said goldfish were present but did not circle 'yes' when answering the questions.

Survey



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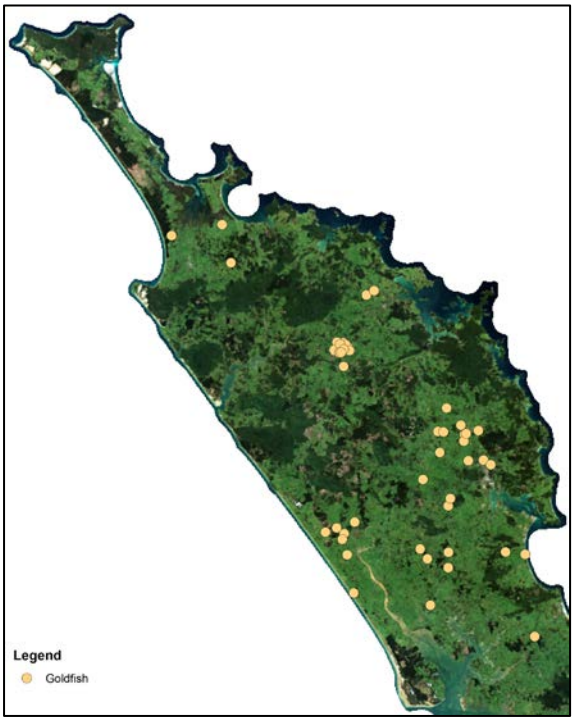
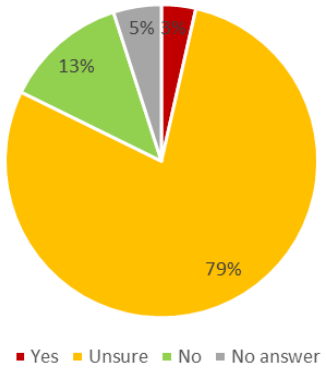
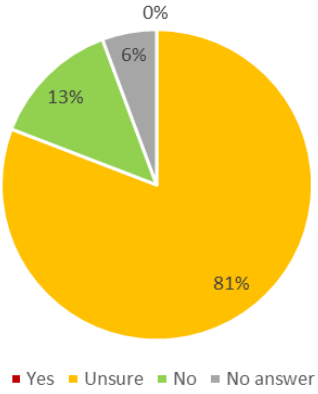




Brown bullhead catfish (*Ameiurus nebulosus*)

No respondents indicated catfish were present. Catfish are widespread throughout Northland and are particularly prevalent in the Kaipara Harbour catchment. The lack of catfish records from this survey was surprising, however the bottom-dwelling nature of catfish means these fish are not seen often and could explain the lack of responses.

Survey



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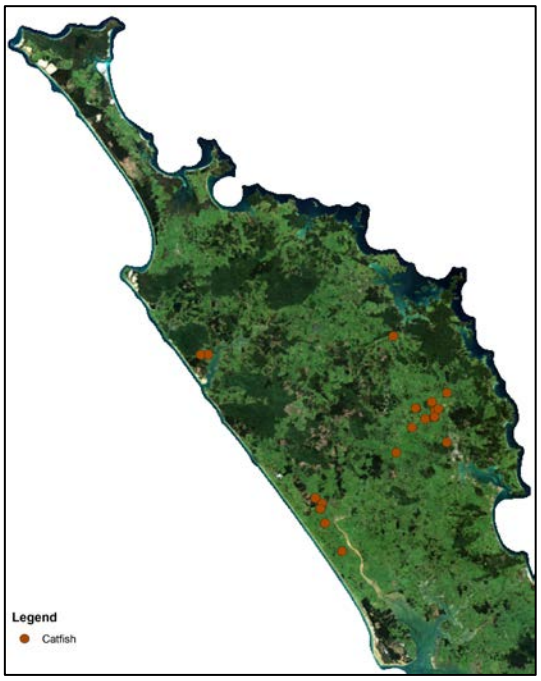

Orfe (*Leuciscus idus*)

No respondents indicated orfe were present. These fish are assumed to be eradicated from New Zealand but records of their presence exist.

Inflows/outflows - Nga ara ki roto, nga ara ki waho

Five respondents indicated their waterbody only had inflows, 18 indicated outflows only, and 54 indicated their waterbody had both inflows and outflows. When compared to NRC's ArcGIS records, most of these responses appeared correct.

These records will be key when prioritising waterbodies for exotic weed and fish removal or control as connected waterbodies likely pose a greater risk of promoting the movement of exotic, invasive species than stand-alone waterbodies.

Names of lakes - Ngā ingoa a roto

There was a general lack of names of waterbodies during this survey. Many appeared to be names the landowner had given the waterbody themselves. In most cases, it may be that the waterbody was somewhat unimportant and does not need a name (e.g. highly degraded ponds at the back of farms, small waterbodies shifting to wetlands, etc.).

Waterbody names are important in obtaining historic information such as events that may have occurred in or around the waterbody or what vegetation was once dominant there, and ensuring we are dealing with the right property when we can confirm names with our current records. From this survey, 49 respondents, regarding 23 waterbodies, gave a name for their lake, pond or dam. The project will be working with mana whenua iwi towards recovering traditional cultural place names and restoring them, where possible.

Deliberate introductions - Whakaaro i tuku

Out of all respondents, only seven indicated they, or the previous landowner, had deliberately introduced the exotic species. Three landowners indicated grass carp were released, two under permit, one not. Goldfish were released by one landowner three years ago, after they intentionally purchased the fish for this purpose. The purpose of this survey is not compliance action and the NRC appreciates the honesty of all respondents.

NRC Biosecurity Officers were already aware of all grass carp records we received during this survey and illegal releases without permits are currently under investigation (independent of this survey). The single koi carp and tench records we received are also being investigated.

Other information - Ētahi atu mōhiohio

Many respondents were eager to provide further information than what we asked in the questions, often writing at length the end of the survey in the field provided for this. Many stated they had fenced off the waterway or planted riparian zones. Respondents were often keen for NRC to visit their property to identify aquatic weeds and fish and to provide advice on their control. This will be important if and when the time comes to deal with the exotic, invasive species present on their properties.

The selection process for control/eradication operations - Ko te tukanga whiriwhiri mo nga mahi whakahaere / whakakorenga

The FIF Dune Lakes project required NRC to select up to 21 waterbodies for fish control or eradication. The selection process considered factors such as access to the waterbody, whether a lake is already ecologically monitored, if non-monitored waterbodies are a potential threat to Outstanding or High-ranking waterbodies, recreational activities conducted in/around the waterbody, and the invasiveness score of the fish present in the waterbody (Figure 3 and Table 5). From a strategic point of view, locations where invasive fish occur that could potentially spread to other waters were prioritised over those that were more isolated and thus posed less of a threat.

	COMMON NAME	SCIENTIFIC NAME	LEGAL STATUS
	Koi carp	*Cyprinus carpio*	Noxious fish Unwanted organism
	Perch	*Perca fluviatilis*	Sports fish
	Brown bullhead catfish	*Ameiurus nebulosus*	No legal status
	Gambusia	*Gambusia affinis*	Unwanted organism
	Orfe	*Leuciscus idus*	No legal status
	Rudd	*Scardinius erythrophthalmus*	Noxious fish*
	Tench	*Tinca tinca*	Sports fish
	Goldfish	*Carassius auratus*	No legal status

Figure 3. *Exotic fish species addressed in our mail survey in order of their risk assessment score by Rowe & Wilding (2012).*
**excludes the Auckland/Waikato Fish & Game regions where rudd are a sports fish under the Freshwater Fisheries Regulations 1983*

As this FIF project is limited to dune lake water-quality, most other waterbodies (such as man-made dams, volcanic lakes, alluvial lakes, reservoirs) are excluded. There were, however, two exceptions – waterbodies 173 and 198 from the mail survey. The two waterbodies were deemed a high priority for fish removal due to their close proximity to Outstanding and High-ranking lakes on the west coast of Northland. These sites may also pose a considerable threat as potential source-populations for new fish invasions.

Table 5. *The 8 lakes and waterbodies selected for exotic fish removal.*

Priority	Lake name	Species present	Invasiveness score
1	Ngatu	Perch (?)	9
		Gambusia	8
		Goldfish	7
		Rudd	7
2	Parawanui	Koi carp	8
		Goldfish	7
		Rudd	7
		Orfe (?)	6
3	Kapoai	Goldfish	7
		Rudd	7
		Tench	5
4	198 – privately owned	Perch	9
		Goldfish	7
5	Waiparera	Gambusia	8
		Rudd	7
6	Rototuna	Gambusia	8
		Rudd	7
7	Ngakapua	Gambusia	8
		Goldfish	7
8	173 – privately owned	Goldfish	7
		Rudd	7

Many waterbodies were excluded from consideration for pest fish removal due to their distance from significant lakes and/or high connectivity with other water systems. For example, Lake 311 is a waterbody that surveys were sent to adjacent landowners for, but from which we did not receive any responses. However, this waterbody contains tench (according to the NIWA Freshwater Fish Database) and has an outflow where tench have also been recorded downstream. Tench could potentially be removed from this waterbody and barriers installed to prevent their reinvasion. However, as the waterbody is not a dune lake, and the stream system is not connected to a dune lake, the fish work falls outside of the FIF Dune Lake project. This could be a site for consideration by the NRC's Biosecurity team in the future.

Similarly, Lake 242 in Kaiwaka contains rudd but is connected to other waterways that also contain koi carp. It is important to note here that rudd are considered a noxious fish in Northland, but a sports fish in the Auckland and Waikato Fish & Game regions. The removal of rudd is probably not an effective means of remediation here as rudd are likely to reinvade from downstream, along with koi carp. Another option could be to install a barrier downstream and remove all exotic fish from the upper reaches, however this is likely to be out of the scope of the FIF Dune Lakes project; 1) because the system is not connected to a dune lake, and 2) there are limited funds and resources to undertake the research into a suitable barrier followed by its construction.

The following maps show the distribution of the eight lakes chosen (from north to south)

Lakes Waiparera, Ngakapua and Ngatu in the Sweetwater area.

Waterbody 173 from the mail survey. Note its proximity to the Kai Iwi Lakes.

Lakes Kapoai and Parawanui, and waterbody 198 from the mail survey.

Lake Rototuna on the Poutō Peninsula.

Conclusions and recommendations - Ngā whakatau me ngā tohutohu

NRC would like to thank the respondents who completed our Exotic Fish & Water-Weed mail survey. We appreciate the time and effort as these results will be important in steering future management options for exotic, invasive weeds and fish. From the survey, we have identified some key conclusions and recommendations:

Conclusions - Ngā whakataunga

- A total of 372 lakes, ponds or dams, larger than half a hectare, were selected for the survey. This excluded around 100 lakes which NRC and NIWA ecologically monitor on a 5-10 yearly rotational basis and for which there is good biological data.

- A total of 141 responses were received (36.72%) from 121 individual landowners, covering 143 waterbodies.

- Egeria was the most commonly reported weed, while gambusia, followed by rudd, were the most common fish reported in waterbodies.

- Duck hunting was the most common lake use, with 42.25% of respondents indicating duck hunting was previously, or currently, an activity conducted at their waterbody. The use of pumps, hoses and tanks in or around waterbodies was the next common use (41.30%), then kayaks, canoes and dinghies (25.36%) and eel fishing (24.64%).

- Lake use varied when correlated with fish or weed occurrences. Where weeds were present in waterbodies, duck hunting (24.24%), kayaks, canoes and dinghies (24.24%) and pumps, tanks and hoses (18.18%) were the most common lake uses. However, where exotic fish were present, kayaks, canoes and dinghies (54.55%), duck hunters (45.45%) and eel fishers (36.36%) were the most common lake uses. These results will be important in the future with the implementation of a Freshwater Pests Pathways Management Plan.

- New records of invasive fish are being investigated, although this is limited to three responses. All other invasive fish records were known by either NRC, DOC or Fish & Game staff.

- Many of Northland's dune lakes are classed as ecologically Outstanding, High or High-Medium in rank. Eight lakes that contain exotic fish and/or are near to one or more Outstanding or High-ranking lake have been prioritised for fish removal within the Freshwater Improvement Fund Dune Lakes project.

Recommendations - Ngā tohutohu

- Undertake control or eradication of invasive fish in the eight lakes identified as high priority. Measure the effects of these eradications on water quality using baseline and post-operation LakeSPI (Submerged Plant Index).

- Undertake fish surveys at key sites identified in this survey to verify the presence of reported species and determine their risk of spread from these locations.

- Create a Freshwater Pests Pathways Management Plan for invasive fish and water-weeds.

- Work through the FIF project's Kaiwhakahaere to identify community interests in managing invasive fish. This may include training of kaimahi in the Te Hiku Lakes project.

- Finalise a communications plan, with the project's Technical Advisory Group, for keeping the public informed of the FIF Dune Lakes Project work on invasive fish control and how they can help avoid further spread. Public awareness and education will influence the introduction of exotic fish to waterways becoming socially unacceptable due to the impact on native ecosystems.

- Institute a Pest-Free Warrant for lake users who display knowledge of good biosecurity practice. This system will generate self-policing in sector groups and it will become increasingly unfashionable not to display a warrant sticker on boats and trailers. This system is adapted from the successful Treasure Islands/Pest-Free Warrant programme in the Hauraki Gulf which protects pest-free islands from re-invasion. (www.doc.govt.nz/parks-and-recreation/places-to-go/auckland/hauraki-gulf-marine-park/know-before-you-go/pest-free-hauraki-gulf/).

- Start a training program with interested landowners with waterbodies affected by invasive fish, providing gear and training to allow them to continue fishing and recording catch per unit effort to track progress.

- Develop a Memorandum of Understanding with DOC, MPI and the Fish & Game Councils around their respective permissions systems for possession of the species covered in this survey to avoid unnecessary new fish or weed introductions without very sound reasons.

- Continue annual 'Check, Clean, Dry' initiative with Ministry of Primary Industries.

- Erect temporary signage at lakes showing what invasive fish and weeds are specifically present in each lake and how to avoid spreading them

- Work with key freshwater use-sectors towards Codes of Practice (eel fishers, duck hunters, recreational boaties, waka ama, coarse fishers) to reduce risk of fish and weed spread.

- Develop novel educational tools for school students in conjunction with Enviroschools and Te Aho Tū Roa.

- Create online biological keys for ease of identification of invasive fish and macrophytes (including weeds).

Northland
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