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Freshwater Native Fish in Northland

Conservation status, critical habitat requirements and recommendations for management

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Executive Summary

Thirty-five fish species were recorded in the waterways of Northland between 1995 and 2015. Of these, 21 are native freshwater species, twelve are either 'marine wanderers' or introduced species and two are pest fish. According to the New Zealand conservation threat status for native fish, nine species are at risk and declining, dune lake Galaxias is at risk because it is naturally uncommon and three species are threatened and nationally vulnerable (lamprey, shortjaw kōkopu and Northland mudfish). Across Northland, 62% of all recorded native freshwater fish species have an 'at risk' or 'threatened' status, threatened species are concentrated in the Northern half of the region, excluding the Aupouri Peninsula.

Nationally, 78% of native freshwater fish have an assigned conservation threat status, this proportion has increased significantly over the last ten years. The majority of threatened fish in New Zealand are kōkopu species and mudfish. The leading causes of national patterns of decline in native fish have been identified as introduced fish species, declining water quality, water abstraction, loss of habitat via land-use change and land-use activities, and river modification. Such rapid declines at the national level have prompted fish experts to caution that:

> "*more serious effort is now required to reverse the decline in native freshwater fishes and to manage the instrumental causes of their decline that are ongoing, and in some cases increasing, if the extinction of further freshwater fish is to be prevented*."

Internationally, the Northland mudfish is considered critically endangered and the black mudfish and shortjaw kōkopu, both of which have population strongholds in Northland, are classified as endangered.

Threats to native fish in Northland include:

1. Threats are largely associated with loss of habitat, particularly wetlands and streams formerly surrounded by indigenous forest or riparian margins
2. Barriers to the migration of diadromous species significantly affect the sustainability of populations of a number of at risk and threatened fish
3. Declining water and habitat quality, in conjunction with predation and competition from pest fish (and trout in the Kai Iwi Lakes), are also significant threats
4. Deposited and suspended sediment are the key water quality problems in Northland likely to impact on native fish
5. Commercial harvesting of eels and whitebaiting reduces already declining populations
6. Management of the critical habitat requirements of threatened and at risk species across the full range of regulatory and non-regulatory mechanisms available is recommended
7. Migration and spawning times are critical periods requiring additional consideration as part of any management approach

This report contains ten recommendations for the management of activities that negatively impact on native fish communities in Northland and methods to define significant sites for native fish that can be used in policy, plans and consenting.

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1 Introduction

The Catalyst Group was contracted by Northland Regional Council to undertake an assessment of the state, conservation status and critical habitat requirements of freshwater native fish in Northland, with a view to identifying sites of significance for native fish across the region. Northland Regional Council are currently undertaking a review of their current regional plans with the intention of drafting new plans for the management of soil, water air and coast. This follows a review of the Regional Policy statement for Northland, which is currently under appeal following Environment Court mediation and contains criteria for determining the significance of indigenous vegetation or habitat(s) of indigenous fauna.

Understanding the conservation status, threats and critical habitat requirements of native fish in Northland assists the Regional Council to meet a number of statutory responsibilities as well as providing important context for aspects of the freshwater and coastal sections of the new Regional Plan. Section 6(c) of the Resource Management Act ("RMA") requires as a matter of national importance "the recognition and provision for protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna". Determining significant sites for native fish allows for the recognition and provision for 6(c) matters in the freshwater environment.

Many native fish are considered taonga by tāngata whenua. Although this report does not consider the taonga status of particular freshwater species to Northland iwi or hapū, the information within this report may be relevant to the taonga species aspect of section 6(e) of the RMA.

The Conservation Act (1987) also has requirements for the protection of freshwater fish. Section 6(ab) of the Act requires the Department of Conservation to preserve so far as is practicable all indigenous freshwater fisheries, and protect recreational freshwater fisheries and freshwater fish habitats. Thus, the protection of native fish is a responsibility across multiple legislation and agencies.

This report details the process undertaken to:

- compile a comprehensive dataset of freshwater fish records for Northland;
- assess the conservation threat status of native fish;
- identify critical habitat requirements;
- assess appropriate significance criteria;
- recommend management approaches to provide for at risk and threatened native fish; and
- map and list potential sites of significance for native fish.

2 Native fish in Northland

There were 4008 observations of fish in the New Zealand Freshwater Fish Database (NZFFD) for rivers, streams, wetlands and lakes in the Northland Region as at 5 June 2015. These entries included observations between 1915 and 2013. Only data from 1995 onwards was used in this report as some of the species of interest (e.g. shortjaw kōkopu, giant kōkopu, kōaro, lamprey and longfin eel) are long-lived (i.e. greater than 10-20 years). The data collected since 1995 comprised 2708 observations. Records that identify threatened or at-risk species (according to the 2013 DOC Threat Classification of Goodman et al. (2014)) numbered 782 observations over 515 individual surveys. There is a lag in records being checked and uploaded onto the NZFFD, administered by NIWA. Consequently some data collected since early 2013 is not accessible through the database.

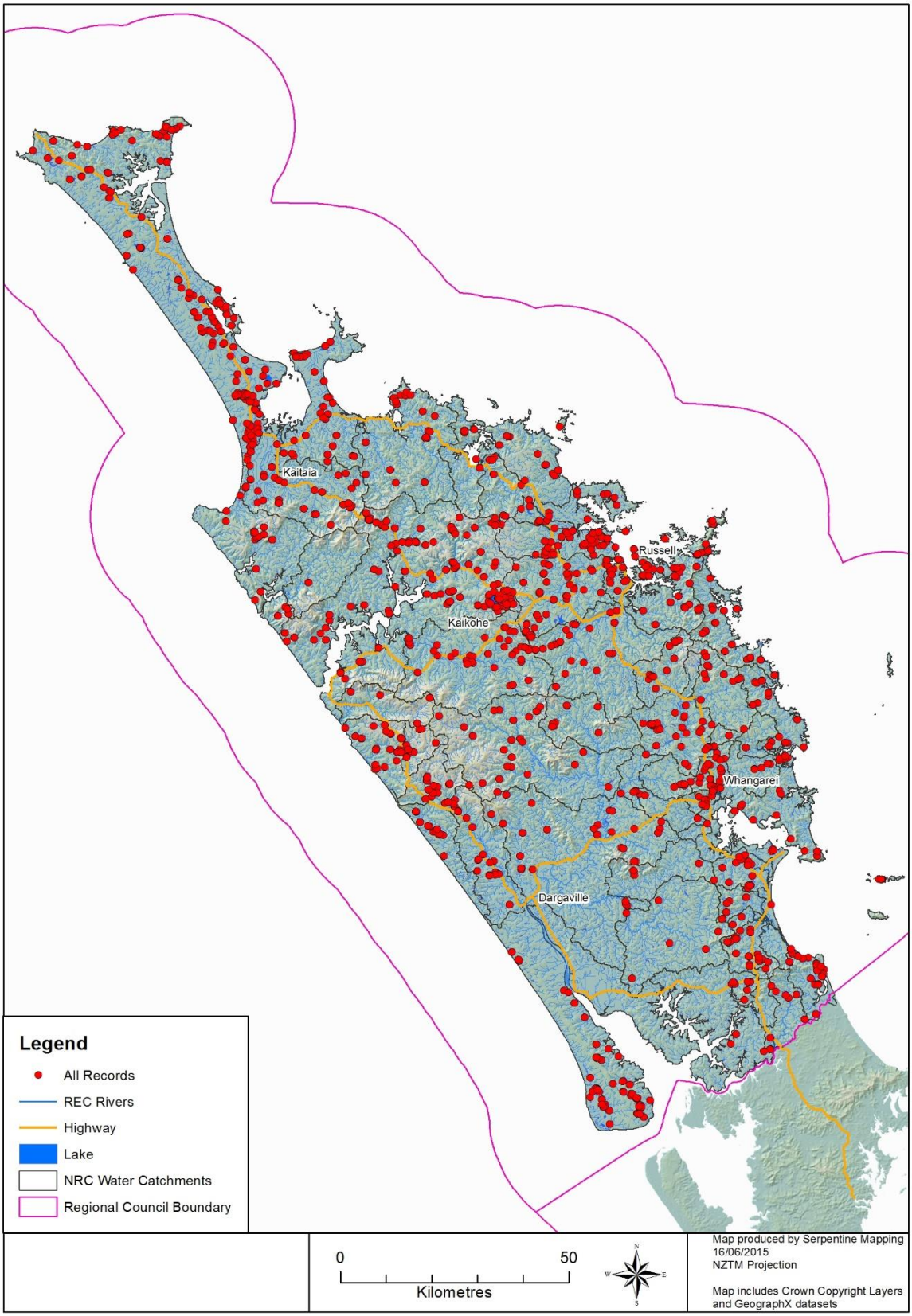
Data collected since 2013 by Northland Regional Council ("NRC") and the Department of Conservation ("DOC") was provided separately and collated along with NZFFD records to create the dataset used for this report. The additional records from NRC and DOC brought the total number of records up to 4054 and added an additional 37 surveys of threatened species to the dataset. This dataset constitutes the fullest and most up-to-date record of freshwater fish observations in Northland as at June 2015 and has been used for the mapping and analyses within this report.

Because of the broad range of species present and the variability of habitats those species inhabit, all methods of survey (e.g. electrofishing, spot-lighting, trapping and netting) were considered equally informative and have been utilised in this report. All abundance data was converted to presence/absence information because of variability in the quality of abundance data within the NZFFD. No account was made of the number of fish or the size class of the fish recorded at a particular site.

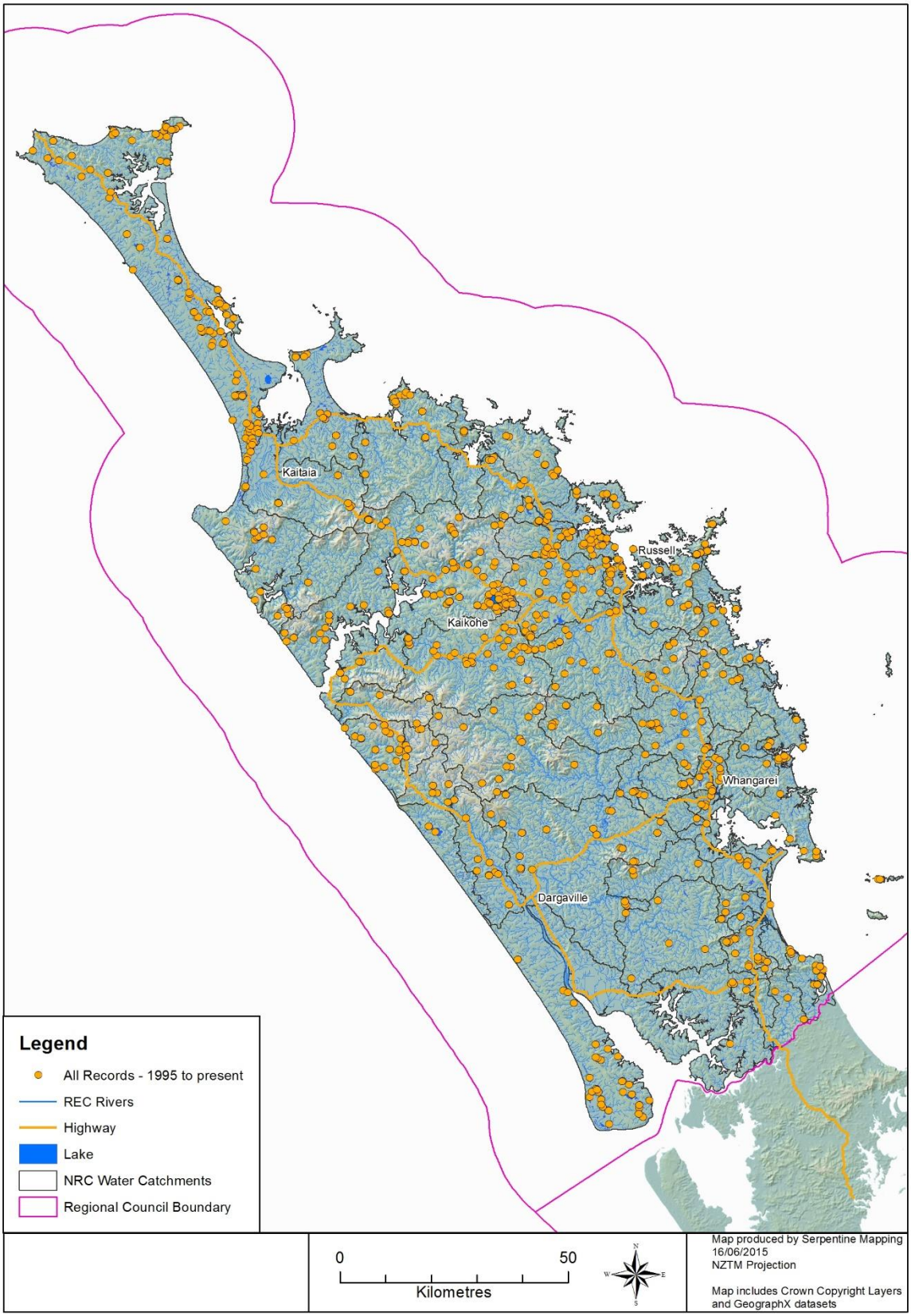
Work is ongoing between a number of agencies and Northland Regional Council to collate additional fish records that have not made their way into the NZFFD. However, the distribution of the current record of fish surveys across Northland is good (Map 1); few catchments contained large data gaps, even when data collected prior to 1995 was excluded (Map 2).

Thirty-five fish taxa were recorded in the waterways of Northland between 1995 and 2015 (Table 1). Of these, 21 are native freshwater species[1], with the rest being either 'marine wanderers' or introduced species, some of which are considered pest fish (e.g. *Gambusia affinis* and rudd).

[1] For the purposes of this report dune lake Galaxias and dwarf īnanga are treated as separate taxa, although recent work on their taxonomy and that of the parent īnanga group (*Galaxias maculatus*) suggests they are of the same species with phylogenetic separation between the three groups (White et el. 2014). The taxa are identified in the NZ Threat Classification system as ecologically significant units ("ESU"s) and the distribution of each ESU is distinct, allowing differentiation of survey records by ESU grouping.



Map 1: All recorded freshwater fish observations across the Northland Region (1915-2015)



Map 2: All recorded freshwater fish observations across the Northland Region (1995-2015)

Table 1: Fish taxa recorded in the Northland region between 1995 and 2015. Records compiled from the New Zealand Freshwater Fish Database, Department of Conservation and Northland Regional Council. * = native freshwater fish species.

Common name	Scientific name
Yelloweye mullet	*Aldrichetta forsteri*
Brown bullhead catfish	*Ameiurus nebulosus*
Shortfin eel*	*Anguilla australis*
Longfin eel*	*Anguilla dieffenbachii*
Goldfish	*Carassius auratus*
Torrentfish*	*Cheimarrichthys fosteri*
Grass carp	*Ctenopharyngodon idella*
European carp	*Cyprinus carpio*
Giant kōkopu*	*Galaxias argenteus*
Kōaro*	*Galaxias brevipinnis*
Banded kōkopu*	*Galaxias fasciatus*
Dune lakes galaxias*	*Galaxias "dune lakes"*
Dwarf īnanga*	*Galaxias gracilis*
Īnanga*	*Galaxias maculatus*
Shortjaw kōkopu*	*Galaxias postvectis*
Gambusia	*Gambusia affinis*
Lamprey*	*Geotria australis*
Cran's bully*	*Gobiomorphus basalis*
Common bully*	*Gobiomorphus cotidianus*
Giant bully*	*Gobiomorphus gobioides*
Bluegill bully*	*Gobiomorphus hubbsi*
Redfin bully*	*Gobiomorphus huttoni*
Cockabully	*Grahamina nigripenne*
Silver carp	*Hypophthalmichthys molitrix*
Grey mullet	*Mugil cephalus*
Black mudfish*	*Neochanna diversus*
Northland mudfish*	*Neochanna heleios*
Rainbow trout	*Oncorhynchus mykiss*
Koura/Freshwater crayfish+	*Paranephrops planifrons*
Dart goby	*Parioglossus marginalis*
Perch	*Perca fluviatilis*
Common smelt*	*Retropinna retropinna*
Black flounder*	*Rhombosolea retiaria*
Brown trout	*Salmo trutta*
Rudd	*Scardinius erythrophthalmus*
Tench	*Tinca tinca*

+ = a freshwater crustacean, but treated as an 'honorary fish' in NZFFD records.

3 Conservation status of freshwater fish in Northland

Applying the conservation threat status from the latest New Zealand threat classification for freshwater fish (Goodman et al. 2014) to the records for Northland, nine species are at risk and declining, one species (dune lake Galaxias) is at risk because it is naturally uncommon and three species are threatened and nationally vulnerable (Table 2). Freshwater species not listed in Table 2 are considered not threatened. Across Northland, 62% of all recorded native freshwater fish species have an 'at risk' or 'threatened' status. This is similar to the proportions of threatened fish in most other regions of New Zealand, with the exception of Otago and Canterbury.

At risk taxa are well distributed throughout most catchments across the region (Map 3). However, threatened species are concentrated in the Northern half of the region, excluding the Aupouri Peninsula. The only taxa in the at risk – naturally uncommon class is the *Galaxias* "dune lakes" which is only found in the Kai iwi Lakes on the West Coast of Northland (see taxa details below).

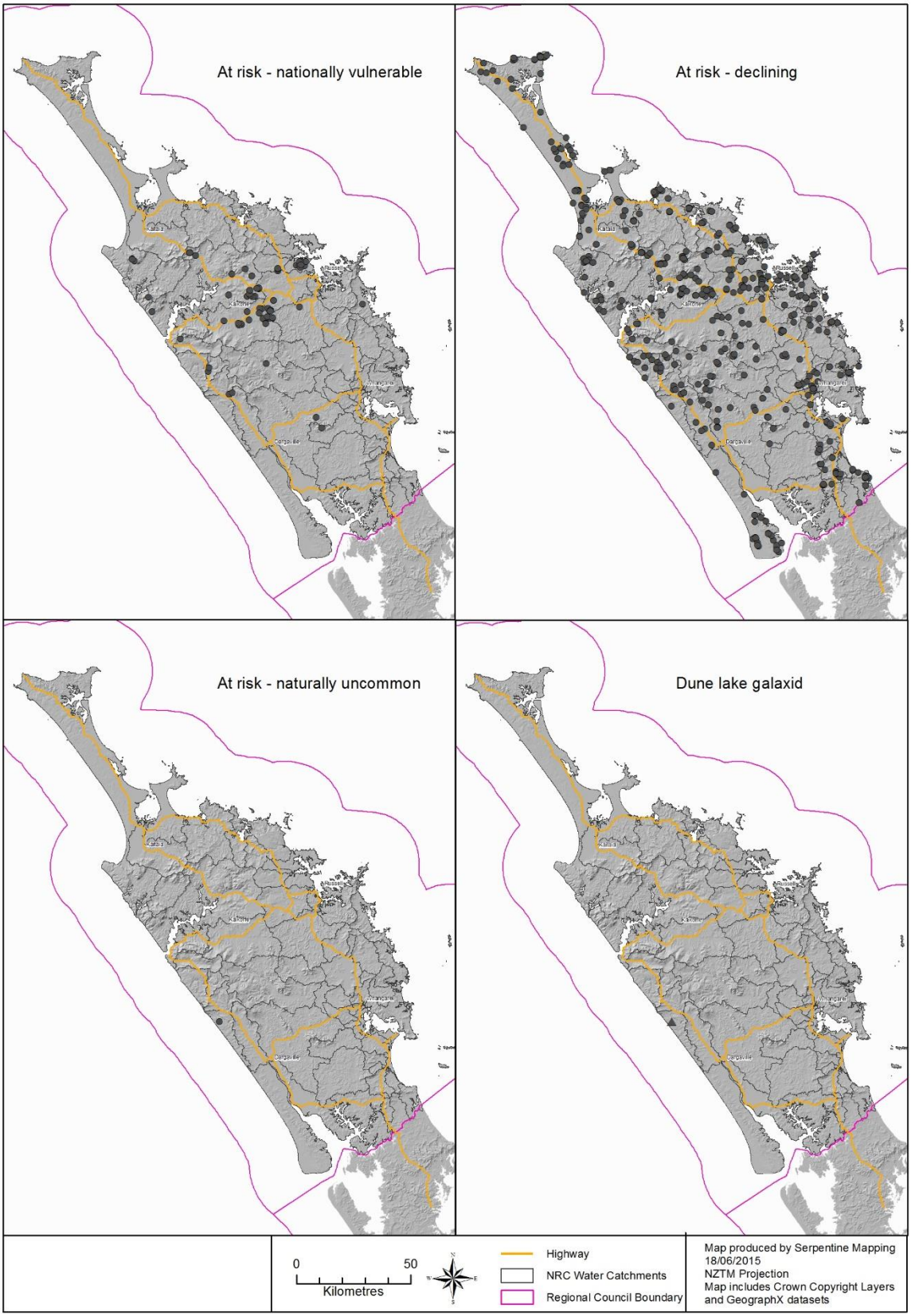
Table 2: Conservation status, criteria and qualifiers of at risk and threatened fish in Northland

Common Name	Threat Status	National threat status criteria and qualifiers
Lamprey	Threatened – Nationally Vulnerable	10-50% declining trend, worsening threat status since 2009, total area of occupancy ≤100 ha (1 km^2)
Shortjaw kōkopu	Threatened – Nationally Vulnerable	10-50% declining trend, worsening threat status, 5,000 – 20,000 mature individuals
Northland mudfish	Threatened – Nationally Vulnerable	30-70% declining trend, threat status unchanged, total area of occupancy ≤1000 ha, range restricted
Dune lake Galaxias	At risk – Naturally Uncommon	Range restricted, extreme fluctuation in population, no change in threat status
Longfin eel	At Risk – Declining	10-70% declining trend, threat status unchanged, conservation dependent
Torrentfish	At Risk – Declining	10-70% declining trend, threat status unchanged, >100,000 mature individuals
Bluegill bully	At Risk – Declining	10-70% declining trend, threat status unchanged, >100,000 mature individuals
Redfin bully	At Risk – Declining	10-70% declining trend, threat status unchanged, >100,000 mature individuals, partial decline
Giant kōkopu	At Risk – Declining	10-50% declining trend, threat status unchanged, 20,000-100,000 mature individuals, partial decline
Kōaro	At Risk – Declining	10-70% declining trend, threat status unchanged, >100,000 mature individuals, partial decline
Dwarf īnanga	At Risk – Declining	10-30% declining trend, worsening threat status, range restricted, extreme fluctuation in population, total area of occupancy ≤1000 ha (10 km^2)

Cont/…

Common Name	Threat Status	National threat status criteria and qualifiers
Īnanga	At Risk – Declining	10-70% declining trend, threat status unchanged, >100,000 mature individuals, conservation dependent
Black mudfish	At Risk – Declining	10-30% declining trend, worsening threat status, total area of occupancy >10,000 ha (100 km^2)

Townsend et al. (2008): ***Conservation dependent =*** *the taxon is likely to move to a higher threat category if management ceases.* ***Extreme fluctuation =*** *the taxon experiences extreme unnatural population fluctuations, or natural fluctuations overlaying human-induced declines, increasing the threat of extinction. The lowest number of mature individuals should be used to define population size.* ***Partial decline*** *= taxa are declining over most of their range, but with one or more secure populations.* ***Range restricted*** *= taxa are confined to specific substrates, habitats or geographic areas of less than 1000 km^2 (100,000 ha). This qualifier can apply to all 'threatened' and 'at risk' taxa regardless of whether their restricted distribution is natural or human-induced, but is redundant if a taxon is confined to 'One Location'. Areas of occupancy and numbers of mature individuals are national figures.*



Map 3: Distribution of at risk and threatened freshwater fish records (and Galaxias "dune lakes") across the Northland Region (1995-2015). Threat classification as per Goodman et al. (2014).

Nationally, 78% of native freshwater fish have an assigned conservation threat status[2]. This is an increase from the last reported threat classification for native fish in 2009 where 67% were identified as threatened or at risk[3] and the 2005 classification which described 53% as threatened or at risk (Hitchmough et al. 2007). Increases in the proportion of threatened or at risk species is a result of changes in taxonomic resolution for some species, changes in threat classification method between the 2007 and 2010 classifications, and continued national decline in native fish populations. The majority of threatened taxa classified as threatened or at risk in 2009 and 2013 belong to the *Galaxias* genus and all species from the *Neochanna* (mudfish) genus are ranked as threatened or at risk. The leading causes of national patterns of decline in native fish have been identified as introduced fish species, declining water quality, water abstraction, loss of habitat via land-use change and land-use activities, and river modification (Allibone et al. 2010).

The conservation threat status criteria and qualifiers for each species are detailed in Table 2. The three species identified as 'threatened' are all estimated to have substantial, nationally declining population trends, in combination with small total areas of occupancy or very low total numbers of mature fish. Both lamprey and shortjaw kōkopu have had their threat status elevated to nationally vulnerable since the last freshwater fish classification. Percentage population declines in Table 2 were estimated over ten-years or the timespan of three generations, whichever period was longer, depending on the species.

Of the species identified as 'at risk' all have substantial, nationally declining population trends (with the exception of the dune lake *Galaxias* which is noted for extreme population fluctuations and is restricted to only two Kai iwi Lakes with no recent survey records[4]). Black mudfish and dwarf īnanga have both had their threat status elevated since the last classification. The conservation dependent qualifier for longfin eel means the species is likely to move to a higher threat category if direct conservation management does not occur at a national level. The single record for giant kōkopu[5] suggests that Northland is not one of the areas where giant kōkopu have secure populations and this species should be considered as declining (and quite probably rare) regionally. Kaipara appears to be the current northern limit for giant kōkopu in New Zealand.

Genetic diversity

An often over-looked aspect of biodiversity is genetic diversity. This is a consideration for species that are range restricted or have very small numbers of mature adults available for breeding. Additionally, species that have undergone biogeographical separation of populations over time can result in genetically distinct populations. This has occurred in īnanga ESU through separate founding events establishing lake-locked populations in different dune lakes over geological time. Maintaining these genetically distinct and unique populations is important to maintaining the genetic diversity in īnanga in Northland.

[2] A number of rare non-migratory Galaxias taxa found only in parts of Canterbury or Otago are included in the calculation of this proportion, many of which have a nationally endangered or nationally critical conservation threat status.

[3] Allibone R, David B, Hitchmough R, Jellyman D, Ling N, Ravenscroft P, Waters J, 2010. Conservation status of New Zealand freshwater fish, 2009. *New Zealand Journal of Marine and Freshwater Research 44:4,* 271-287.

[4] Only one survey record was found for the Kai iwi Lakes since 1995: Lake Waikere in 2001.

[5] Giant kōkopu were last found at Lake Karaka in 2006.

3.1 IUCN Red List

The International Union for the Conservation of Nature ("IUCN") Red List provides conservation status information on a range of organisms that have been evaluated using globally applied criteria to determine their relative risk of extinction (Table 3 and Figure 1). Because the criteria used in the assessment are different from the NZ Conservation Threat status criteria there are differences between the two assessment methods and their results. However, the information provided by both assessments is relevant to understanding the threat status and significance of each species at the national and international levels respectively.

Table 3: The IUCN Red List classification for threatened freshwater fish found in Northland

Common Name	Scientific Name	IUCN Redlist Threat Status
Lamprey	*Aldrichetta fosteri*	Data deficient
Longfin eel	*Anguilla dieffenbachii*	Not assessed
Torrentfish	*Cheimarrichthys fosteri*	Vulnerable
Bluegill bully	*Gobiomorphus hubbsi*	Vulnerable
Redfin bully	*Gobiomorphus huttoni*	Near Threatened
Giant kōkopu	*Galaxias argenteus*	Vulnerable
Kōaro	*Galaxias brevipinnis*	Least concern
Dune lakes *Galaxias*/Dwarf īnanga	*Galaxias gracilis*	Vulnerable
Īnanga	*Galaxias maculatus*	Least Concern
Shortjaw kōkopu	*Galaxias postvectis*	Endangered
Black mudfish	*Neochanna diversus*	Endangered
Northland mudfish	*Neochanna heleios*	Critically Endangered

There is commonality between the elevated threat status in both the IUCN Red List and the New Zealand Threat Classification with respect to Northland mudfish (critically endangered) and shortjaw kōkopu (endangered). The IUCN Red List also considers the black mudfish as endangered and identifies torrentfish, bluegill bully, giant kōkopu and dwarf īnanga/Galaxias "dune lakes" as threatened and vulnerable to extinction. Redfin bully are considered near threatened due to declining populations and the least concern status of īnanga and kōaro largely reflects the presence of these species outside of New Zealand (although they are native to New Zealand they are not found only here i.e. not endemic). There is not enough data to classify lamprey using the IUCN criteria, despite their nationally vulnerable classification in New Zealand and longfin eel have yet to be evaluated by the IUCN for the Red List. Further information on species assessed as threatened under the IUCN status is included as Appendix 1.

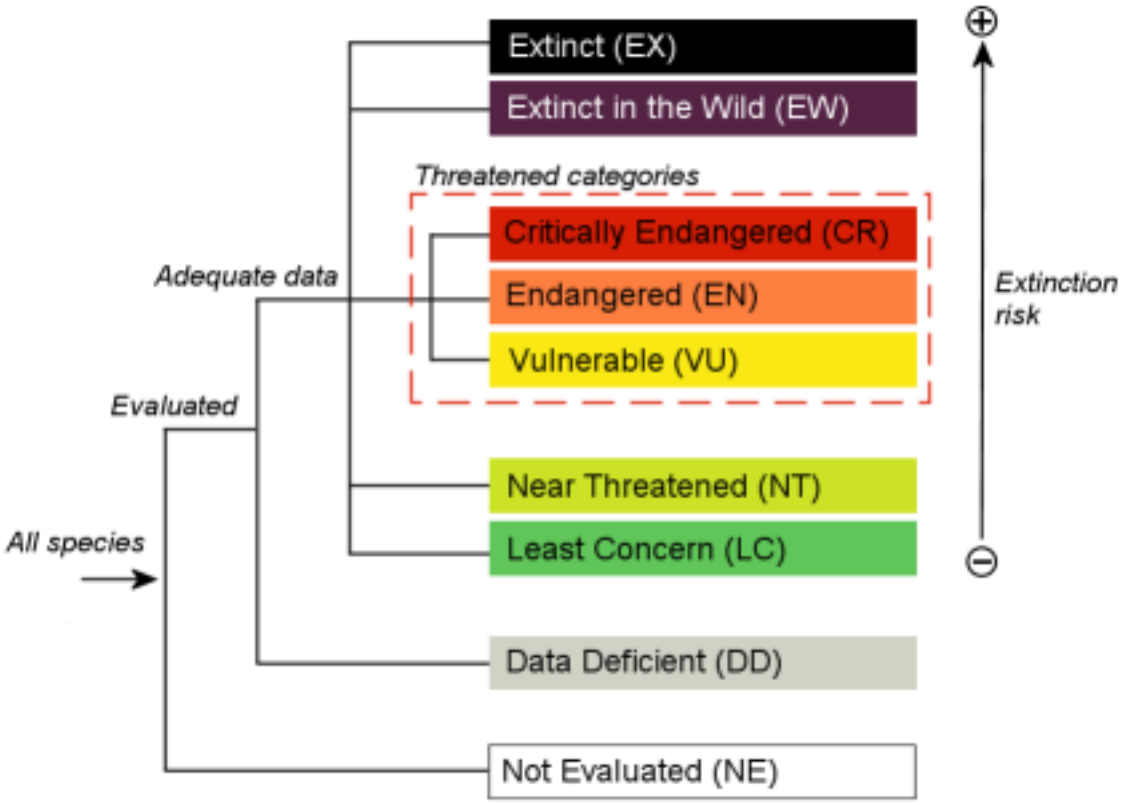


Figure 1: IUCN Red List Classifications

In summary, Northland contains a number of significant and threatened native fish species. General proportions of threatened species are similar to other regions. However, Northland mudfish, dwarf īnanga and dune lake Galaxias are only found in Northland, therefore declines in these species affect regional, national and international freshwater fish diversity. Giant kōkopu are also identified as a species with extremely restricted range in Northland. Further work is required to determine if range restriction is natural or induced through human impacts and loss of access or habitat.

3.2 Threat processes and patterns of decline

Allibone et al. (2010) identified a number of important threat processes affecting freshwater fish. Threats include land-use change, particularly agricultural and forestry effects, predation and competition by introduced fish and other native fish, and water abstraction. Concerns over declining freshwater quality and quantity, often associated with land use change, have been increasingly identified in recent years (PCE 2015) and culminated in the National Policy Statement for Freshwater Management ("NPS-FM") being released in 2011 and subsequently amended to provide for Ecosystem Health as a compulsory value at the national level in 2014. Despite an increasing concern for better management of freshwater and elevated recognition and acknowledgement of impacts, little has been done to provide specifically for freshwater fish and many taxa have continued to decline.

Stressors contributing to declines in native fish are often cumulative. Non-migratory species are particularly susceptible to impacts because they lack the ability to recolonise or disperse into unaffected areas following invasion from exotic species or degradation of habitat or water quality. This substantially reduces resilience to human induced impacts and leaves populations more vulnerable to

natural perturbations (e.g. floods and droughts). For species with very restricted range (either naturally or through habitat loss over time) like dune lake Galaxias, dwarf īnanga and Northland mudfish, this leaves them highly vulnerable to extinction.

There is evidence that migratory species are also declining rapidly and are now less widespread (Joy 2009; Allibone et al. 2010; Goodman et al. 2014). Allibone et al. (2010) suggest this may be the result of a 'source and sink' effect whereby 'sinks' occur in relatively poor habitat that does not provide the critical requirements for successful breeding, recruitment or long-term survival. The risk of source and sink affected populations is that rapid population decline (either regionally or nationally) is possible once recruitment source areas are depleted or destroyed. Such declines are now indicated in species that were once common. Allibone at el. (2010) warn that:

> "*more serious effort is now required to reverse the decline in native freshwater fishes and to manage the instrumental causes of their decline that are ongoing, and in some cases increasing, if the extinction of further freshwater fish is to be prevented*."

In a report to the Ministry for the Environment, Joy (2009) found a general decline in fish abundance and diversity in areas of agricultural and urban areas as habitat is degraded and sensitive species are lost. Joy (2009) analysed presence/absence fish data from more than 22,000 NZFFD records over 37 years and found:

- IBI score[6] had significantly decreased over the last 37 years, particularly over the last decade;
- Sites in native vegetation had significantly higher IBI scores than sites in urban or pastoral land cover. Sites in tussock had the lowest scores as these were generally at highest elevation and furthest from the sea;
- The biggest declines in IBI were at urban, pasture and tussock sites over the last decade with significant increases in IBI at native forest and scrub sites;
- Sites in exotic forestry are often considered to have less impact on aquatic ecosystems due to long periods between disturbance events caused by harvesting. However, exotic forestry sites had lower than expected IBI scores and declines were consistent with a period of national intensive harvesting in the 1990's.

Joy's (2009) findings indicate that freshwater ecosystem condition and native fish biodiversity has declined nationally over the last 37 years, particularly over the last decade. The strong association between land use and fish IBI shows the influence that land use and land use change has on native freshwater ecosystems. These results should be considered conservative, as species will decline in abundance for some time before becoming permanently extirpated (locally extinct) at a site as the result of source and sink effects described above.

[6] IBI is the Index of Biotic Integrity developed for New Zealand by Joy and Death (2004) to examine changes in freshwater fish diversity whilst accounting for the natural variation in native fish communities associated with the high degree of diadromy in the national fish fauna.

Summary of conservation status and threats: Northland's native fish

1. Threats are largely associated with loss of habitat, particularly wetlands and streams formerly surrounded by indigenous forest or riparian margins

2. Barriers to the migration of diadromous species significantly affect the sustainability of populations of a number of at risk and threatened fish

3. Declining water and habitat quality, in conjunction with predation and competition from pest fish (and trout in the Kai Iwi Lakes) are also significant threats

4. Deposited and suspended sediment are the key water quality problems in Northland likely to impact on native fish

5. Commercial harvesting of eels and whitebaiting reduces already declining populations

6. Management of the critical habitat requirements of threatened and at risk species across the full range of regulatory and non-regulatory mechanisms available is recommended

7. Migration and spawning times are critical periods requiring additional consideration as part of any management approach

4 Habitat requirements and life cycle summaries of the at risk and threatened fish of Northland

4.1 Longfin eel

Longfin eels can be found throughout New Zealand and records are well-distributed across Northland (Map 4). They live mainly in rivers and inland lakes but are found in almost all types of waters, usually penetrating further inland from the coast than the shortfin eel. They are legendary climbers and have made their way well inland in most river systems, even those with substantial natural barriers. Elvers (young eels) swimming up-river climb waterfalls and even dams 30 metres high and will also leave the water and wriggle over damp ground to transfer into other waterways. Small longfin eels living amongst river gravels feed on aquatic macroinvertebrates. When larger, they feed on fish, koura (freshwater crayfish) and small birds and mammals (e.g. ducklings and mice). During the day, eels are cryptic, hiding under logs and boulders or undercut riverbanks. They are most active at night when feeding.

Photo: Longfin eel, Mike Joy, Massey University

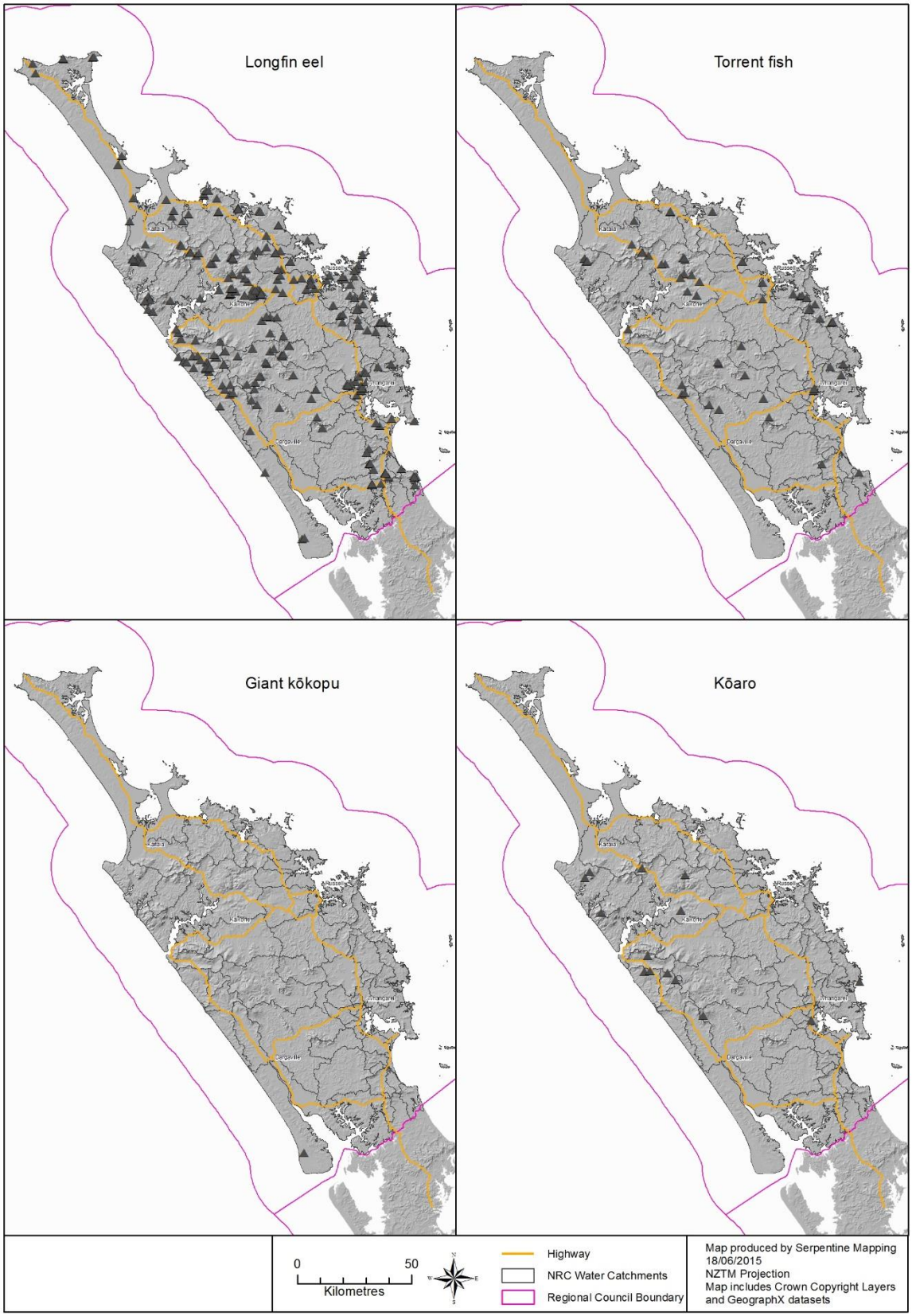
Longfin eels breed only once, at the end of their lives, following a downstream migration to the sea during autumn. Adult eels then swim ~5000 kilometres into the tropical South-Pacific to spawn, probably in deep ocean trenches near Tonga. Eels take many years to mature, the typical age of a migrating longfin eel is ~25 years for a male and >40 years for females. Large adult females may live for longer than 80 years. Upon reaching their destination, females lay millions of eggs that are fertilised by the male. Adult eels die after spawning and leptocephalus (transparent, flat, leaf-shaped larvae) return to New Zealand by drifting on ocean currents.

Before entering fresh water, the leptocephalus change into a more familiar eel shape, remaining transparent for up to a week after leaving the sea. These "glass" eels enter fresh water between July and November, often in very large numbers. Jellyman et al. (2009) found peak glass eel migration into the Waikato River occurred within a few hours of the peak of the high tide and between two and four days following the spring tide. Cooler water temperatures and river discharge were negatively correlated with numbers of glass eel migrants.

The minimum number of eels required to reach the spawning grounds for successful spawning and recruitment is unknown. If the minimum number of eels migrating is not reached in any year, eels may not encounter each other at oceanic spawning sites. There is a risk that if the number of eels spawning declines below a critical level, then Allee effects[7] will rapidly increase the rate of decline of the species (Allibone et al. 2010).

Larger eels are often targeted for commercial, cultural and recreational harvest. Jellyman (2012) has expressed concerns over the survival of female eels in freshwater because they need to grow larger to mature and thereby risk being harvested for longer periods. Commercial harvest is likely to be the greatest threat to large eels, particularly in the North Island where populations appear to be declining more rapidly than in the South Island. Mortality at hydro turbines (during downstream migration) is also a threat to larger female eels and equates to 10-20% of the commercial harvest annually.

[7] Allee effects are broadly defined as a decline in individual fitness at low population size or density that can result in critical thresholds below which populations crash to extinction.



Map 4: Distribution of longfin eel, torrentfish, giant kōkopu and kōaro freshwater fish records across the Northland Region (1995-2015).

4.1.2 Torrentfish

Torrentfish are the only member of the genus *Cheimarrichthys,* making them extremely important in terms of their biodiversity value. They are diadromous migrants that move long distances up and down rivers throughout their lives. Due to their swift-water swimming ability they tend to inhabit the mid to upper reaches of fast-flowing rivers and streams and are able to negotiate their way upstream through large rapids. As their name suggests they are often found in rapids or 'torrents' and their distribution is closely associated with swift-flowing, open rivers with gravel, cobble or bouldery substrate. Their diet largely consists of macroinvertebrates, which are at their highest densities in riffle habitats.

Adult torrentfish spawning habitat is unknown but is likely to be in substrate gravels. Males generally occur in the lower reaches of rivers and females dominate upstream populations (although some evidence has been found of overlap of the sexes in the lower reaches of North Island streams). Given the general segregation of habitats a spawning migration within the river channel is likely required for at least one of the sexes. However, there is evidence of spawning in upper and lower reaches of streams in the Waikato catchment. Spawning can occur over protracted periods from late spring to early winter, peaking in late summer to early autumn. Larvae are washed downstream after hatching and develop over several months in near coastal waters, returning to rivers to migrate upstream in spring and autumn.

Photo: Torrentfish, Stella McQueen

4.1.3 Giant kōkopu

Giant kōkopu are diadromous fish that don't have good climbing ability or inland penetration and tend to inhabit lowland, slow-flowing streams, lakes and wetlands. They are the largest species of the *Galaxias* genus. Despite this they are seldom seen due to their cryptic and nocturnal nature.

Growth is slow and giant kokopu are long-lived, taking several years to reach maturity. Spawning is not well studied but it is thought to occur in the margins of adult habitat in late autumn to early winter and probably requires inundation of riparian vegetation and detritus. Juveniles are washed out to sea and return late in the whitebait run (early November; McDowall, 2006). In the west of New Zealand giant kōkopu make up a large proportion of the whitebait catch (after īnanga and kōaro). Because they are large, fecund fish their reproductive potential per fish is high.

Photo: Giant kōkopu, Stephen Moore, Landcare Research

Giant kōkopu have stronghold populations on the West Coast of the South Island, however, populations are declining throughout most of the rest of the country. The single giant kōkopu record for Lake Karaka on the North Kaipara Heads is the only observation of this species collected in Northland. McDowall (2001) notes they are rare in Northland, so the Kaipara Heads may be the Northern limit of their distribution either naturally or through population contraction as a result of habitat loss following European colonisation.

4.1.4 Kōaro

Kōaro have the best climbing ability of all the Galaxid taxa. They penetrate well inland and inhabit steep gully streams, particularly those with indigenous forested margins. Kōaro are almost exclusively found on the West Coast in Northland. Nationally, they are the second most common species in the whitebait catch, although this has not been verified for Northland.

The critical habitat requirements of kōaro are cold, clear, high velocity, heavily vegetated, upland streams with good instream cover and bouldery substrate. Spawning occurs in autumn to early winter, in the marginal gravels and riparian detritus of adult habitat during fresh events. Juveniles are washed out to sea, returning early in the whitebait run through September and October. Instream whitebait migration occurs on the tail of freshes while the water is still turbid.

Photo: Kōaro, Stella McQueen

4.1.5 Īnanga

Photo: Īnanga, Stella McQueen

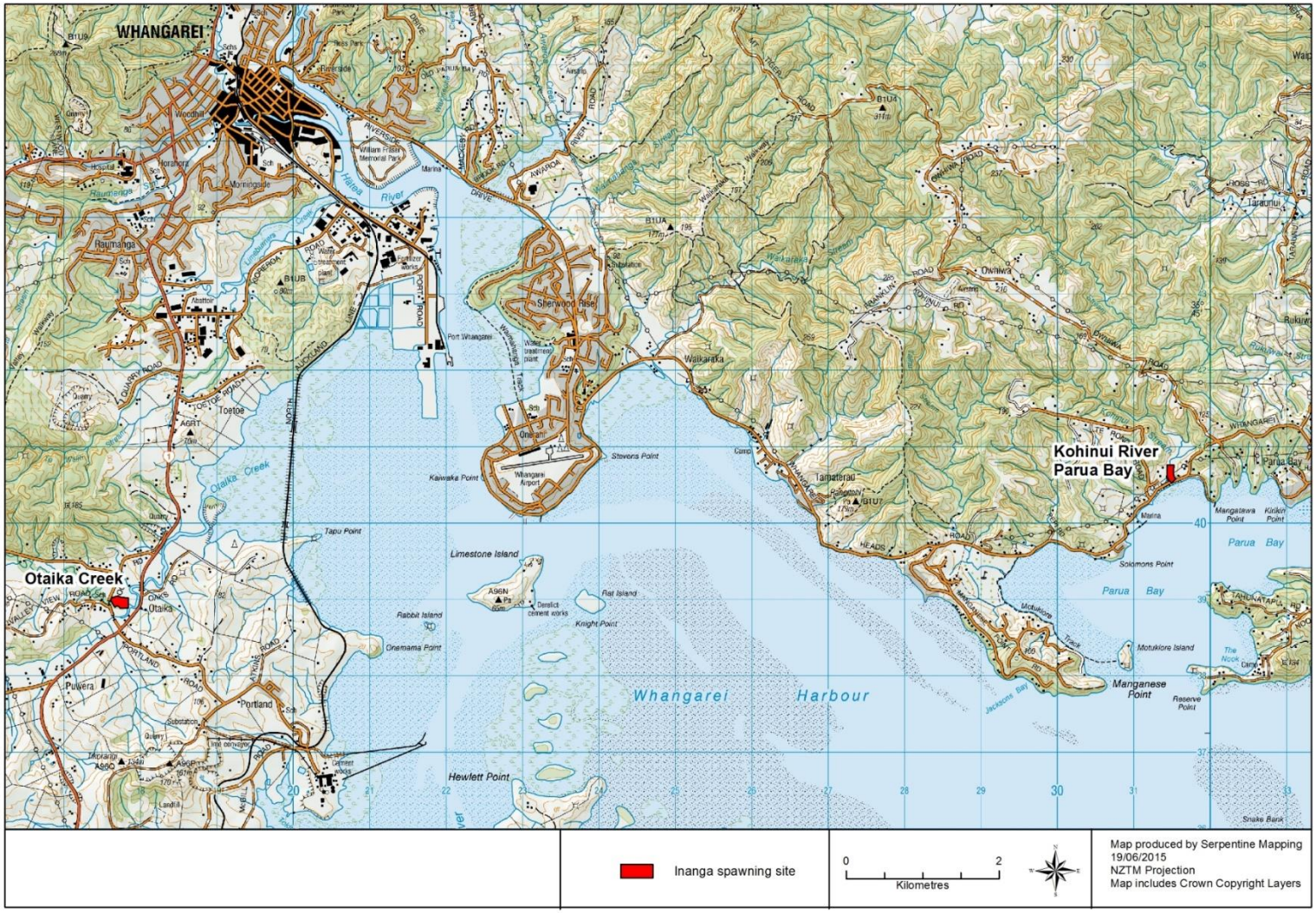
Īnanga are found in a wide variety of habitats around Northland (Map 6), from tiny creeks, to coastal rivers, lowland streams, lakes and wetlands, generally at low elevation (<20m above sea level) and within 10km of the coast, although in low elevation areas free from barriers they will penetrate further inland. Predominantly diadromous, they do occur as land-locked populations in Northland wetlands and lakes. North of Kaitaia there are land-locked populations that have their own status as ESUs due to the long period of time they have been genetically separated from diadromous īnanga populations (White et al. 2014). Īnanga are diverse bottom, mid-water and surface feeders, feeding on aquatic and terrestrial invertebrates. They are one of the few native fish with a shoaling habit and are often found in groups as juveniles, near the coast. During this life stage they are susceptible to predation by wading birds.

Īnanga make up the greatest proportion of the whitebait catch nationally and the continuation of a whitebait fishery in New Zealand is contingent upon īnanga populations remaining stable or increasing. Unfortunately, their 'at risk' conservation status, declining population trend and their dependency on good management of estuarine habitat means that without direct intervention, īnanga populations are likely to decline further. Continued whitebaiting puts additional strain on declining populations and īnanga are predated by larger exotic and native fish.

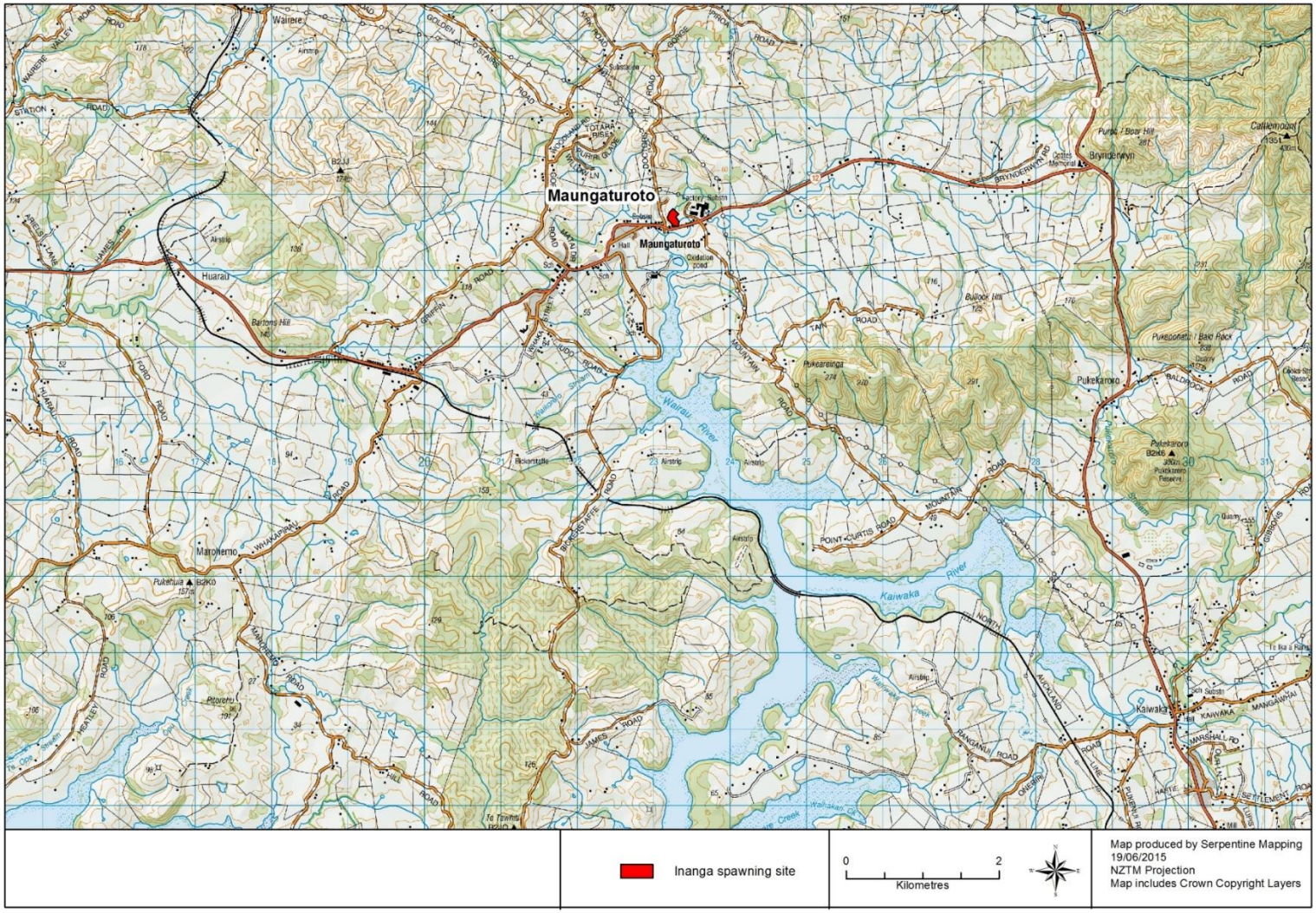
4.1.6 Īnanga spawning sites

Mature īnanga migrate to estuaries in autumn to spawn in marginal estuarine vegetation during spring high tides. Eggs develop in humid air, hatching when inundated during the following spring tide. Larvae migrate to sea for 21-23 weeks, returning in the spring as part of the whitebait run. Īnanga spawning sites are generally small in extent, often only tens of metres in length, where the salt-wedge inundates vegetation on the banks of coastal stream mouths during high spring tides. Eggs are susceptible to desiccation, stock trampling or disturbance from mowing and spraying of bankside vegetation and can also be predated by mice or rats.

The obligate estuarine spawning life history of īnanga is a risk to the sustainability of the species in New Zealand in the long-term as estuaries become increasingly degraded by the effects of rural and urban land use, or reclaimed for development. Surveys to confirm īnanga spawning have been undertaken at a limited number of locations around Northland (Maps 5 a-c). Further work is needed to better identify this critical habitat for protection.

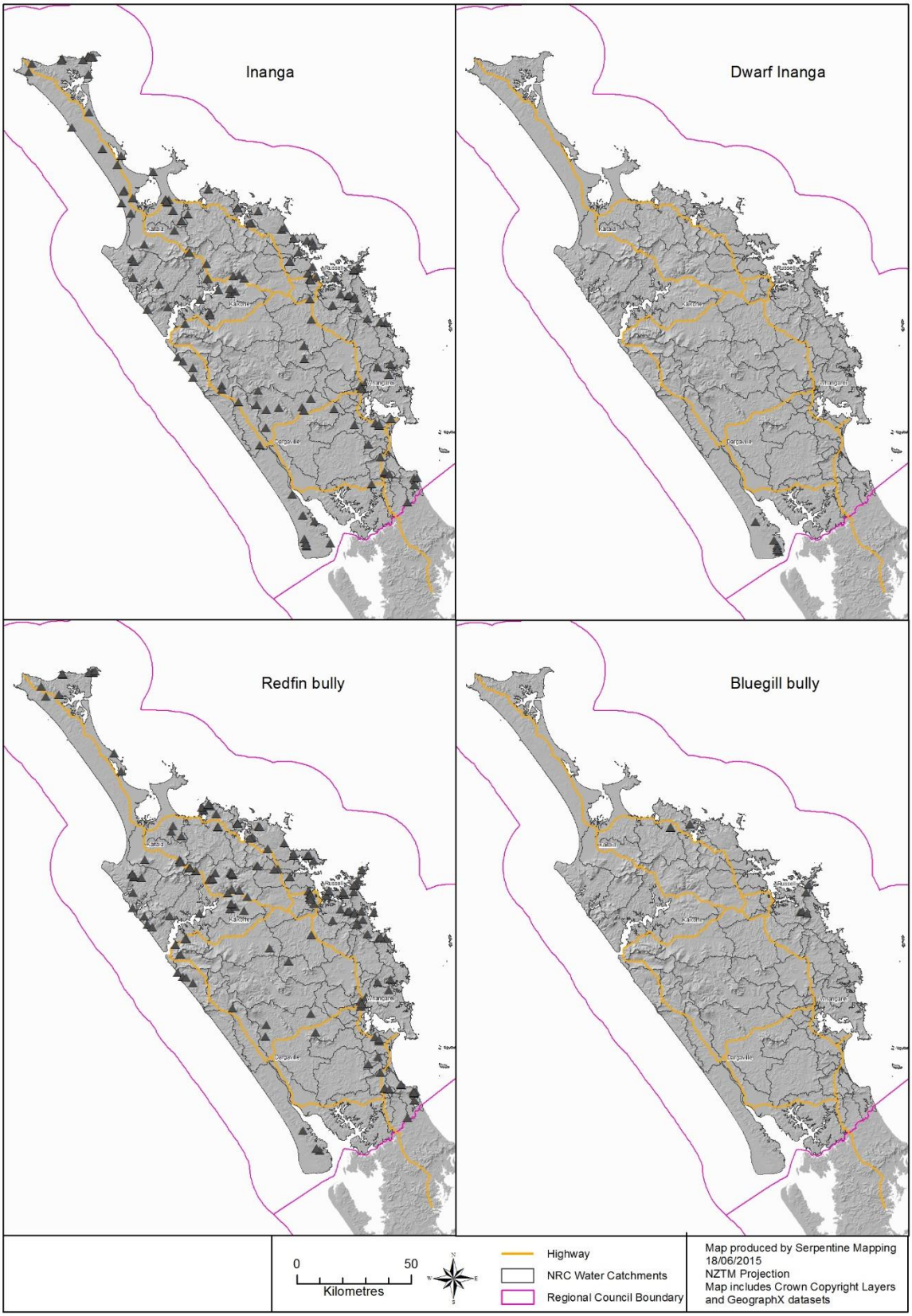


Map 5a: Confirmed īnanga spawning sites, Whāngārei.



Map 5b: Confirmed īnanga spawning site, Maungaturoto.

Map 5c: Confirmed īnanga spawning site, Tangatapu Wetland, Rāwhiti.



Map 6: Distribution of īnanga, dwarf īnanga, redfin bully and bluegill bully freshwater fish records across the Northland Region (1995-2015).

4.1.7 Dwarf īnanga / dune lake Galaxias

Dwarf īnanga (*Galaxias gracilis* McDowall 1967) were first described as a distinct species (from *Galaxias maculatus*, īnanga) from eleven dune lakes on the Poutu Peninsula around the North Kaipara Heads on the west coast of Northland. They have also been introduced as a forage food for trout in Lake Ototoa on the South Kaipara Head and into Lake Te Riu for conservation management purposes. Because of the restricted range of the group and its lack of any current gene flow with other īnanga groups it remains a conservation priority. Three distinct populations of dwarf īnanga have been recognised: 1) the Poutu lakes ESU, 2) Lake Rototuna ESU and 3) Kai iwi lakes ESU. The differences between these groups likely relates to three separate founding events for each lake complex over geological time. The three ESU require separate management because of distinct phylogenetic differences within the species, the Kai iwi Lakes ESU being the most genetically distinct (*Galaxias* "dune lakes"; White et al. 2014).

Lake-locked īnanga in the far North dune lakes also have phylogenetic differences resulting from isolation over geologic time scales and constitute another distinct īnanga ESU. Far North landlocked īnanga, dwarf īnanga and Galaxias "dune Lakes" are more genetically similar to diadromous *G. maculatus* than they are to each other (White et al. 2014).

Photo: Galaxias "dune lakes", Lake Taharoa, Stella McQueen

Dune lake Galaxias is thought to be extinct from Lake Kai iwi, remaining only in lakes Waikere and Taharoa. Dwarf īnanga are also no longer found in Lake Rototuna, remaining only in the Poutu lakes further to the south. These changes in population have resulted in an upgrading of the threat status of dwarf īnanga to 'declining' from their previous threat ranking of 'naturally uncommon'[8]. Key threats to the dwarf īnanga ESUs are invasive weeds and introduced fish, and degrading lake water and habitat quality. Trout introductions to Lake Waikere also constitute a threat to the viability of populations there.

Young adult dune lakes *Galaxias* prefer open water and lake margins. Large adults live in deep water by day, moving into the shallows for feeding at night amongst emergent aquatic vegetation. The adult diet comprises crustaceans, aquatic insects, snails, and terrestrial insects.

The spawning habitat and timing of dune lakes *Galaxias* are unknown, although it is thought spawning possibly occurs from summer to autumn. Larvae are pelagic in lakes and shoal in large groups as juveniles.

[8] Although the Kai iwi ESU (Galaxias "dune lakes") still has a 'naturally uncommon' threat classification.

4.1.8 Redfin bully

Redfin bullies are a strictly migratory fish generally found at lower elevations (<150 m above sea level) but also occasionally further inland. They have good climbing capability over some barriers as high as 5m. Nationally, redfin bullies are declining due to habitat loss and water quality degradation (McDowall 1990), and they are particularly susceptible to sedimentation and migrating juveniles are negatively affected by suspended sediment coming from upstream areas. Redfins take refuge around instream debris and woody material within gravel bed channels. They tend to inhabit pools and runs and are said to prefer smaller streams, although they have been found in the mainstem of large gravel rivers such as the Manawatū River (personal observation).

Photo: Redfin bully habitat, Koturetawhenua Stream, Carol Nicholson

Spawning occurs between July and November on the underside of large rocks in the upstream areas of adult habitat; male fish defend nest sites. Hatching is stimulated by high flow events and juveniles are washed downstream to the sea returning to freshwater throughout the summer (from November). Maturity to adult fish takes two years from return to freshwater. Large invertebrates comprise the diet of adult fish. Sedimentation has negative effects on food availability and feeding success.

Photo: Redfin bully (male), Stella McQueen

4.1.9 Bluegill bully

Bluegill bullies are a migratory fish generally found within 100km of the coast but also occasionally further inland and at altitudes <500m above sea level. The bluegill bully is the smallest of the New Zealand bullies and like most native fish is cryptic and seldom seen. Typical habitats are swift-flowing rivers with gravel substrate, with a preference for larger braided channels over smaller streams. Bluegills often co-occur with torrentfish but are overall less commonly represented than torrentfish in the New Zealand fauna.

Bluegills feed mainly on benthic invertebrates in rapids and riffles, particularly mayfly larvae. Males are larger than females and larger fish tend to inhabit upper reaches of habitat, resulting in some sexual habitat separation. Actual spawning habitat is unknown but because of the potential for habitat separation, fish may have to migrate within river channels to spawn. Fish passage throughout bluegill bully habitat may therefore be essential for successful reproduction and recruitment (D. Rowe, NIWA *pers. comm*.).

Newly hatched larvae are washed out to sea. Juvenile bluegill bullies are known to migrate into freshwaters during spring and autumn, suggesting a dual or protracted spawning season (McDowall, 1990).

Photo: Bluegill bully (male), Stella McQueen

4.1.10 Black mudfish

Black mudfish are widespread from the Mokau River system north. Found mostly in shallow pools in swamplands in the far north, small overgrown creeks and drains, and wetlands with associated forest floor pools and detritus.

Black mudfish are non-migratory, with spawning taking place near adult habitat after the dry season (from autumn through to spring). Larvae are often seen around wetland margins from autumn onwards. They feed on small aquatic crustacea, midge larvae and earthworms. Their key threats are invasion by Gambusia, and wetland drainage. Gambusia directly predate on mudfish fry and have a similar distribution pattern.

Photo: Black mudfish, Stella McQueen

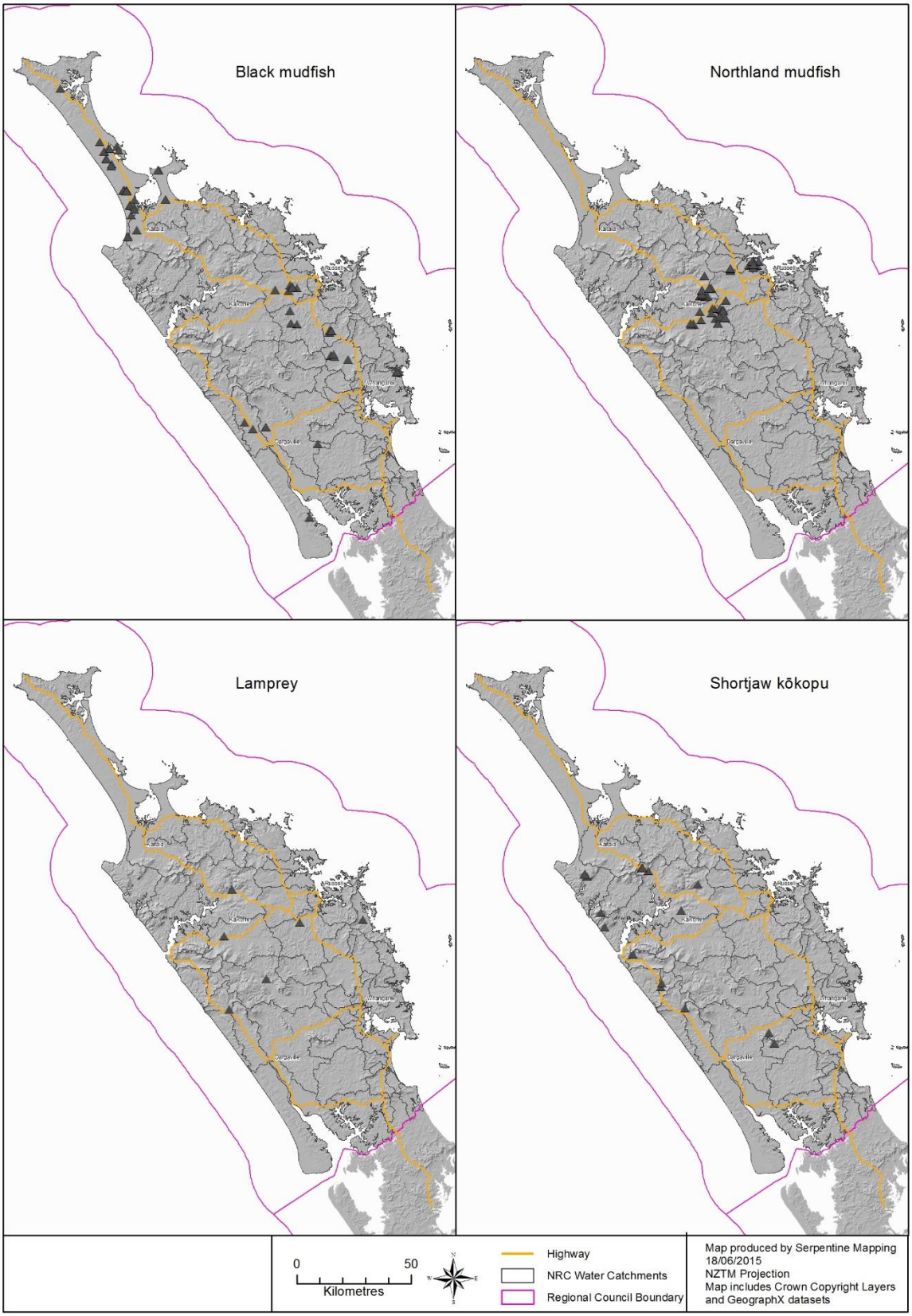
4.1.11 Northland mudfish

Northland mudfish are only found in low-fertility wetlands, confined to an approximately 30km radius around Lake Omapere, with an additional cluster of sites within 15km of Kerikeri (Map 7). Their distribution range overlaps with black mudfish, although the two species do not seem to co-occur.

Northland mudfish are generally found in still or very gently flowing water in gumland and peat bog wetlands. The water is often tea coloured due to the presence of peat soils, and tends to be surrounded by dense indigenous vegetation.

Photo: Northland mudfish, Stella McQueen

Northland mudfish are non-migratory, and little is known about their spawning habitat and range, although it is expected to be similar to the black mudfish i.e. spawning is likely to occur near adult habitat, following autumnal rains through to spring (and possibly early summer if conditions are favourable). Their diet is unstudied, but is assumed to be similar to that of other mudfish.



Map 7: Distribution of black mudfish, Northland mudfish, lamprey and shortjaw kōkopu freshwater fish records across the Northland Region (1995-2015).

4.1.12 Lamprey

Lamprey are migratory fish that are long-lived and very secretive. They have particular significance as a food source for Māori in many parts of New Zealand. Lamprey can penetrate far inland and have a reasonable ability to negotiate barriers. At times, when the ground cover is wet they are able to leave the water to move across land in a similar manner to eels.

Photo: Lamprey, Mike Joy, Massey University

Adult lamprey spawn in forested headwater streams and larval ammocoetes spend 4-5 years before metamorphosis into macrophthalmia which then migrate to the sea where they live and mature for 3-4 years. During the ammocoete stage they are filter feeders, consuming aquatic microorganisms and inhabiting shallow muddy or sandy backwaters along river margins. They migrate to sea from late winter to early spring in the early hours of the night, mid-river, during freshes.

Having matured at sea, macrophthalmia return to freshwater from late winter to early spring as adult lamprey. Inward migration is greatest at times of elevated flow and turbidity. This is the time lamprey are commonly harvested. Adults do not feed as they slowly migrate for up to 16 months into small upland streams to spawn. These migrations occur at night during dark phases of the moon. During the day adult lamprey hide beneath overhanging banks and in holes. Spawning occurs in shallow nests in streambed gravels. It is likely adults die after spawning.

4.1.13 Shortjaw kōkopu

Shortjaw kōkopu are diadromous galaxid fish with good climbing capability and an ability to penetrate far inland. They are generally restricted to streams with native forest vegetation. Shortjaws are nocturnal and generally inhabit small streams in pools with thick over-hanging riparian vegetation, good instream cover and often with large boulder substrate. They feed on a mixture of benthic and terrestrial invertebrates (McDowall, 2006). Spawning occurs on riparian margins with good overhead cover, in gravels, debris and leaf litter. Spawning habitat is found alongside pools and backwaters in adult habitat, during bank-full freshes. Egg development occurs in damp spaces amongst the riparian litter and debris and may take 2-3 weeks (though eggs can remain viable in damp terrestrial environments for up to two months; Charteris et al. 2003). Larvae are washed out to sea, returning in whitebait runs in the spring.

Because the shortjaw requires indigenous forested habitat with good hydrologic connection to intact riparian margins for spawning their habitat has been in decline along with forest clearance. They are the rarest of the Galaxias fauna and have one of the highest threat classifications (nationally vulnerable) of all of the migratory Galaxids, with low estimated populations of adult fish remaining (5,000 – 20,000 fish nationally).

Photo: Shortjaw kōkopu, Stella McQueen

5 Criteria to determine site significance

Appendix 5 of the proposed Regional Policy Statement ("RPS") for Northland defines a habitat of indigenous fauna as being significant if it meets one or more of the following criteria:

1. Representativeness;
2. Rarity/distinctiveness;
3. Diversity and pattern; or
4. Ecological context.

Determining ecological significance for native fish populations using aquatic habitats is problematic because the distribution, diversity and abundance of native fish communities is heavily influenced by factors such as distance from the sea, altitude, presence of barriers to migration, and the mobile nature of many native fish. Difficulties are exacerbated by incomplete or non-existent information on the state of aquatic habitats regionally and nationally.

These issues mean that approaches used to define the significance of terrestrial habitats are not always directly applicable to defining significant freshwater habitats for native fish. In many cases, the recorded presence of species is the only or best indicator for whether a site, reach, wetland or lake is a significant habitat. The main disadvantages to taking a species-based approach in determining significance are: not everywhere can be sampled and areas of high significance may be missed; sampling is biased towards accessible sites and sites that are more likely to contain native fish; presence of fish during surveys may be affected by season or life-cycle stage; fish that are sampled may be 'on the move' between critical or significant habitats; or the presence of fish does not indicate health of the population or recruitment success over time (see comments on source and sink effects above).

A number of predictive fish models have been developed for much of New Zealand but these models rely on good information about migration barriers and other human impacts and are not always able to predict the presence of rare or non-migratory species with much accuracy (Carol Nicholson, Northland Regional Council *pers. comm.*). For use in a regulatory framework a high degree of evidential confidence is needed if limits on activities are to be applied to sites determined to be significant.

Given the high proportion of threatened species in the national and regional fish fauna, the highly uncertain nature of the habitat and fish survey data, and the difficulties associated with accurate prediction of significant fish habitats; a presence/absence approach, based on NZFFD survey records is recommended as the first step in providing for significant native fish sites in Northland. Further development of a secondary tier of protection using predictive tools is recommended for future research and policy investigation.

Applying a presence/absence criterion, based on at risk and threatened fish species fits with the proposed RPS criteria in the following ways:

1. Rarity/distinctiveness: "*b) Indigenous vegetation or* ***habitat of indigenous fauna that supports one or more indigenous taxa that are threatened, at risk, data deficient or uncommon, either nationally*** *or at the relevant ecological scale. (c) The ecological site contains indigenous*

vegetation or an indigenous taxon that is: (i) ***endemic to the Northland-Auckland region****;*" [emphasis added]

The collated fish survey records for Northland over the last 20 years contain a large number of sites that fit the 'rarity/distinctiveness' significance criteria because they have records of one or more nationally threatened or at risk species (Table 4). In many cases these sites also contain species that are endemic to Northland, in particular the dwarf īnanga and dune lake *Galaxias* ESUs and Northland mudfish (Table 5).

Table 4: Number of at risk or threatened species per record for freshwater fish surveys in Northland

No. of at risk or threatened species/survey record	No. of surveys at which this occurs*
6	1: Tapapa Stream
5	4: Papakauri Stream x2, Rangihika Stream, Tapapa Stream
4	22 surveys
3	58 surveys
2	97 surveys
1	360 surveys

* N.B. sites can have multiple survey records within the dataset.

Table 5: Number of freshwater fish survey records containing species endemic to Northland

	Northland mudfish	Dwarf īnanga	Dune Lake *Galaxias*
No. of survey records	69	6	1

2. Ecological context: "*c) The ecological site is an important habitat for critical life history stages of indigenous fauna including breeding /* ***spawning****, roosting, nesting, resting, feeding, moulting, refugia or migration staging point (as used seasonally, temporarily or permanently).*" [emphasis added]

The aspects of the 'ecological context' criterion that are most immediately relevant to freshwater fish is the importance of sites for critical life-history stages such as spawning. Spawning sites for īnanga are identified by surveys of eggs during the spawning period, or through predictions of spring tide inundation areas with suitable estuarine vegetation (see critical habitat requirements for īnanga). Few sites have been surveyed or confirmed for īnanga egg presence in Northland. There are currently four confirmed sites recorded (Maps 5 a-c) and work is underway by community organisations and Northland Regional Council to identify more spawning sites through egg surveys. Northland Regional Council are also looking to build a GIS inundation layer that could be used in combination with LiDAR information to predict potential areas of īnanga spawning, although this work is not yet underway.

Spawning habitats for other at risk or threatened species are also relevant with respect to this criterion. For many *Galaxid* (kōkopu and kōaro) and *Gobiomorphus* (bully) species, spawning occurs within adult habitats. Therefore spawning sites are likely to be captured within surveyed site records for adult fish. For some species spawning sites are relatively unknown (e.g. torrentfish and bluegill bully) but occur within the channel of the river where adult fish are found. For longfin eel, access to the sea to migrate to spawning grounds in the South Pacific is a critical life history stage and downstream access of adult eels should be a key consideration for regulating any activities that may create instream barriers.

For species that have spawning habitats on the riparian margins of rivers, streams and wetlands, maintaining the quality of these margins is an important consideration for the maintenance of habitats critical to their ecological context. Disturbance within riparian margins (including vegetation clearance, cultivation, stock access, bank protection works, earthworks or gravel extraction) requires regulation in areas significant for native fish in order to maintain the riparian habitats that contribute to their critical life history stages (i.e. spawning, refugia and feeding) and in many cases water and habitat quality as well.

3. Representativeness: "*a) (iii) Is represented by faunal assemblages in most of the guilds[9] expected for the habitat type;*"

4. Diversity and pattern: "*a) Indigenous vegetation or habitat of indigenous fauna that contains a high diversity of… …(ii) indigenous taxa;*"

Further work is recommended to apply a model such as the fish IBI (Joy and Death 2004) possibly in combination with a national scale predictive model to determine sites that would fit both the representativeness and diversity and pattern criteria above. An analysis across the surveyed sites in the collated dataset for Northland as well as predictive modelling of each fish species for the region could yield additional sites/reaches for protection where there are known or predicted to be sites with intact faunal assemblages or fish diversity 'hot spots', relative to the distance from the sea (which is a key driver of natural abundance and diversity in native fish due to the large proportion of diadromous species in the New Zealand fauna).

[9] A guild (or ecological guild) is any group of species that exploit the same resources, often in related ways. It does not follow that the species within a guild occupy the same, or even similar, ecological niches.

6 Summary of critical habitat requirements for significant native fish species in Northland

A number of activities regulated by the Regional Council are likely to have adverse impacts on the habitat and populations of at risk and threatened native fish in Northland. There are a number of regulatory mechanisms that can be used to manage threats to native fish (Figure 2).

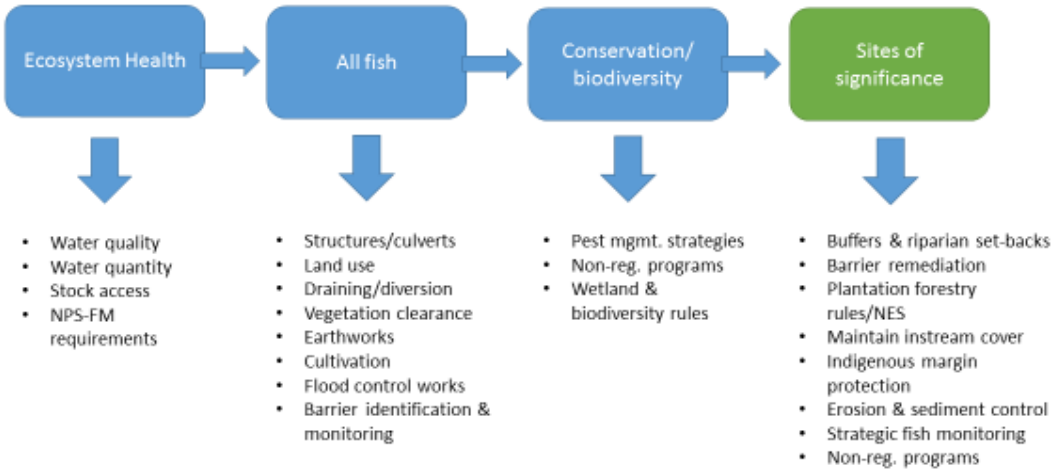


Figure 2: Regional Council mechanisms to provide for significant native fish populations and habitats

General Council provisions relating to Ecosystem Health values, fish-friendly planning and policy, conservation management and biodiversity programmes will provide a baseline level of protection for significant native fish sites, and for a number of the critical habitat requirements of threatened species. However, because populations continue to decline throughout New Zealand despite these general protections, additional protection is needed through rules and methods to ensure that all remaining critical habitat requirements for the species at each site are provided for. Management of additional threats needs to be undertaken where applicable depending on the role and function of regional councils and other key stakeholders (e.g. DOC) in relation to the threat.

7 Recommended Management Approaches

Barriers are a key factor controlling access for migratory native fish into habitats and for the maintenance of sustainable and resilient populations of fish. Barriers require consideration across three management areas to provide for native fish generally: 1) control and monitoring of new/proposed barriers, 2) identification and registration of existing barriers, and 3) remediation of existing barriers.

The abundance of instream cover is another critical factor for most native fish taxa due to their cryptic and nocturnal nature. Instream cover also provides refuge from predators such as trout, pest fish and birds. Removal of woody debris that is not causing a substantial flood hazard or instream barriers is detrimental to fish communities within sites of significance.

Maintaining and improving riparian margins provides for a numbers of critical habitat requirements across a range of species. Woody riparian vegetation provides invertebrate food inputs, shade and instream woody debris for cover. For species that spawn on riparian margins (i.e. lamprey, large Galaxids and īnanga), intact and undisturbed riparian margins are an essential habitat to complete their life-histories. Connectivity between streams and natural inundation of riparian margins during spawning periods is also a critical factor to the effective functioning of riparian margins for spawning.

Adequate riparian set-backs and control of riparian disturbance (e.g. vegetation clearance, stock access, cultivation, earthworks, sediment discharge, bank protection and instream structures) within those set-backs are key to providing spawning habitat for riparian spawning species. Fish need trees! A minimum setback of 20m is recommended for all reaches, wetlands and lakes where sites of significance for native fish have been identified.

Water quality and quantity are considerations at the Ecosystem Health level and are requirements under the NPS-FM (2014). Additionally, the physical aspects of taking water (i.e. intake and diversion screens and velocity management at water intakes) are particularly important for sites of significance to ensure any water takes do not cause mortality to adult or juvenile fish. From a water quality perspective, control of sediment and erosion is important, especially for species that spawn on instream rocks and gravels (i.e. bully species) and those with identified avoidance of sediment (e.g. kōaro, redfin bully) at various life-stages.

Intermittent or headwater streams are important to all native fish and are of critical importance to a number of at risk and threatened species. Often these first and second order streams are written out of rule and policy approaches to managing freshwater habitat and quality. However, they are critical to maintaining habitat quality, invertebrate food sources, spawning habitats, juvenile refugia and buffering catchment water quality and temperature. Species that are particularly affected by loss of upland streams include kōaro, lamprey and shortjaw kōkopu. Consideration of extending habitat protection upstream into first order reaches should be undertaken. Often, difficulties in identifying these stream channels is cited as a reason to exclude them from management. However, many first order stream channels are readily identifiable on topographic maps and using the River Environment Classification ("REC"). The inclusion of intermittent streams in any methods to provide for significant sites and fish values generally is recommended.

Existing and proposed wetland and lake provisions may provide additional protection of significant native fish sites. It is recommended to overlay significant sites for native fish where these intersect with lakes and wetlands to ensure provisions adequately capture all critical habitat requirements for the fish inhabiting these areas.

Successful īnanga spawning is associated with a number of well-identified critical habitat requirements. It is recommended that stringent controls are placed on the construction/installation of barriers to fish passage between adult īnanga habitat and īnanga spawning habitat. Any potential barrier will need to demonstrate that īnanga can pass it, and be monitored to ensure it remains in a fish-passable state throughout its life. Activities with the potential to physically impact on īnanga spawning sites should be carefully managed and regulated, including land use, vegetation clearance, stock-access, spraying and drain clearance, earthworks and structures, including flood or tide gates. Ideally, physical disturbance of īnanga spawning sites should be avoided from 1 January-30 July to provide sufficient time for habitat recovery for spawning suitability following any disturbance. To protect īnanga spawning, egg development, and fry hatching, only suitable grass species are to be used in plantings as part of remediating īnanga spawning sites following physical disturbance. Stock access to īnanga spawning sites should be avoided entirely during the period 1 January to 30 July.

Threats to each fish species are summarised in Table 6 below.

Summary of threats to Northland's native fish

1. Threats are largely associated with loss of habitat, particularly wetlands and streams formerly surrounded by indigenous forest or riparian margins

2. Barriers to the migration of diadromous species significantly affect the sustainability of populations of a number of at risk and threatened fish

3. Declining water and habitat quality, in conjunction with predation and competition from pest fish (and trout in the Kai Iwi Lakes) are also significant threats

4. Deposited and suspended sediment are the key water quality problems in Northland likely to impact on native fish

5. Commercial harvest of eels and whitebaiting reduces declining populations

6. Management of the critical habitat requirements of threatened and at risk species across the full range of regulatory mechanisms available is recommended

7. Migration and spawning times are critical periods that require additional consideration

Table 6: Summary of key threats to at risk and threatened native fish species of Northland

Species	Adult habitat & migration threats	Spawning and juvenile threats
Lamprey	• Loss of riparian and instream cover – upland streams • Loss of undercut bank habitat • Disturbance of sandy shallow backwaters	• Loss of forested riparian margins • Barriers
Longfin eel	• Large dams • Loss of instream cover • Commercial harvest	• Large Instream barriers • Loss of instream cover • High water temperatures
Torrentfish	• Water quality degradation • Barriers • Loss of habitat variability • Loss of high flow areas	• Bed disturbance • Sedimentation - suspended and on spawning substrate • Instream disturbance or embedding of cobble spawning substrates
Bluegill bully	• Water quality degradation • Loss of high quality aquatic invertebrates • Loss of habitat variability • Loss of high flow areas	• Barriers • Instream disturbance or embedding of cobble spawning substrates • Sedimentation - suspended and on spawning substrate
Redfin bully	• Water quality degradation • Loss of high quality aquatic invertebrates • Loss of habitat variability	• Bed disturbance • Sedimentation - suspended and on spawning substrate

Species	Adult habitat & migration threats	Spawning and juvenile threats
Giant kōkopu	• Water quality degradation • Barriers • Loss of forested riparian margin • Loss of slow flowing/pool habitat in lowland waterways • Channel straightening • Disconnection/loss of forested wetland habitat • Loss of instream woody debris • Whitebaiting	• Margin disturbance in adult habitat • Regulation/loss of overbank flows during autumn freshes
Kōaro	• Water quality degradation • Indigenous forest clearance – upland streams • Disturbance of substrate • Loss of flow in upland streams • Whitebaiting	• Riparian and instream disturbance • Loss of cobble/boulder substrate on river margins • Perched culverts
Dune lakes galaxias/Dwarf īnanga	• Drainage and drought • Loss of lake extent • Water quality degradation	• Pest fish and trout • Aquatic weeds
Īnanga	• Loss of lowland lakes, wetlands and streams • Tide and flood gates • Predation from trout • Barriers • Aquatic weeds • Whitebaiting	• Barriers • Predation from trout and pest fish (Gambusia) • Loss of estuarine and lower river riparian vegetation • Loss of riparian inundation on high tides • Aquatic weeds

Species	Adult habitat & migration threats	Spawning and juvenile threats
Shortjaw kōkopu	• Water quality degradation • Loss of podocarp/broadleaf forest and over-hanging cover • Loss of instream woody debris • Loss of pool/backwater habitat • Loss of high quality aquatic invertebrates • Whitebaiting	• Perched culverts • Instream and riparian vegetation disturbance in adult habitat – particularly adjacent to backwaters and pools • Regulation/loss of overbank flows during autumn freshes
Black mudfish	• Wetland and forest swamp drainage • Drain clearance, spraying and road grading • Lowered water table • Predation by pest fish (Gambusia)	• Drain clearance and spraying • Loss of cover in drains during spawning • Lowering of water table during/post spawning • Prolonged drought • Predation by pest fish (Gambusia)
Northland mudfish	• Water quality degradation • Wetland and forest swamp drainage • Drain clearance, spraying and road grading • Lowered water table	• Drain clearance and spraying • Loss of cover in drains during spawning • Lowering of water table during/post spawning • Prolonged drought • Predation by pest fish (Gambusia)

Table 7: Migration calendar for at risk and threatened native fish species of Northland. Modified from Smith (2014)

Functional Group	Species	Conservation status	Migration direction	Life stage	Summer			Autumn			Winter			Spring		
					D	J	F	M	A	M	J	J	A	S	O	N
Bullies & Torrentfish	Bluegill bully	●	upstream	juvenile												
			down	larvae												
	Redfin bully	●	upstream	juvenile												
			down	larvae												
	Torrentfish	●	upstream	juvenile												
			down	larvae*												
Eels	Longfin eel	●	to estuary	glass eel												
			upstream	juvenile												
			down	adult												
Īnanga & smelt	Īnanga	●	upstream	juvenile												
			down	larvae*												
Lamprey	Lamprey	+	upstream	juvenile												
			down	larvae												
Large Galaxiids	Giant kōkopu	●	upstream	juvenile												
			down	larvae												
	Kōaro	●	upstream	juvenile												
			down	larvae												
	Shortjaw kōkopu	+	upstream	juvenile												
			down	larvae												

Key	
●	At Risk - declining
+	Threatened - nationally vulnerable
	Peak
	Range

Table 8: Spawning calendar for at risk and threatened native fish species of Northland. Modified from Smith (2014)

Functional Group	Species	Conservation status	Summer			Autumn			Winter			Spring		
			D	J	F	M	A	M	J	J	A	S	O	N
Bullies & Torrentfish	Bluegill bully	●												
	Redfin bully	●												
	Torrentfish	●												
Eels	Longfin eel	●												
Īnanga & smelt	Īnanga	●												
Lamprey	Lamprey	+												
Large Galaxiids	Giant kōkopu	●												
	Kōaro	●												
	Shortjaw kōkopu	+												
Mudfish	Black mudfish	●												
	Northland mudfish	+												
Non-migratory Galaxiids	Dune lakes galaxias/Dwarf īnanga	●												

Key	
●	At Risk - declining
+	Threatened - nationally vulnerable
	Peak
	Range
	Larvae/Fry/Juveniles present

8 Recommended management of significant sites for native fish in Northland

The first step in increasing the protection for significant habitats of native freshwater fish is to define the sites these fish are known to inhabit and then to provide protection of these sites through regulation of activities that have the potential to threaten the critical habitat requirements of the species outlined in Table 6, including avoiding impacts on critical migration and spawning times (Tables 7 and 8). This is a 'stop-gap' measure to ensure significant habitats and populations are maintained and further declines halted. Proactive management across agencies, mechanisms and legislation is needed to reverse declining trends and improve the status of native fish populations and habitats in Northland. Recommendations for defining significant sites are as follows:

Recommendation 1: All sites in Northland with records of at risk or threatened native fish since 1995 should be considered Sites of Significance for native fish (Map 8 – regional overview; Maps 9-15 local scale sites with species data) – Rarity/distinctiveness criteria (1b).

Recommendation 2: An upstream and downstream buffer should be applied to each site to include immediately adjacent habitat/reaches. In larger rivers (order 5 or greater) this buffer should extend 2km upstream and downstream of the recorded site point. In smaller rivers and streams (< order 5) the buffer should extend 1km upstream and downstream of the recorded point.

Recommendation 3: For wetlands and lakes the entire extent of that wetland or lake should be included as the boundary of the site. Overlap of protections between significant terrestrial/wetland and native fish habitats is desirable as terrestrial and wetland protection may not always adequately link to the critical habitat, spawning and timing requirements of native fish – Ecological context criteria (2c).

Recommendation 4: Where sites are within the public conservation estate the boundary of the site should extend to the boundary of the conservation estate downstream of the recorded site point and upstream to the extent of the waterway and any tributaries within the conservation estate, if necessary to the source/headwaters of the waterway.

Recommendation 5: Where the edge of site buffers are within or near 2km of each other, sites should be combined to create contiguous significant habitat. Where contiguous habitat reaches to within 3km of the coast and migratory fish are present, consideration should be given to extend the downstream buffer of the site to the coast.

Recommendation 6: Confirmed īnanga spawning sites require buffers that extend 200m upstream and downstream to allow for natural variability in tidal inundation from year to year and landward buffers that include the extent of the inundation area. In the absence of information a landward buffer of 50m from the bank is recommended – Ecological context criteria (2c).

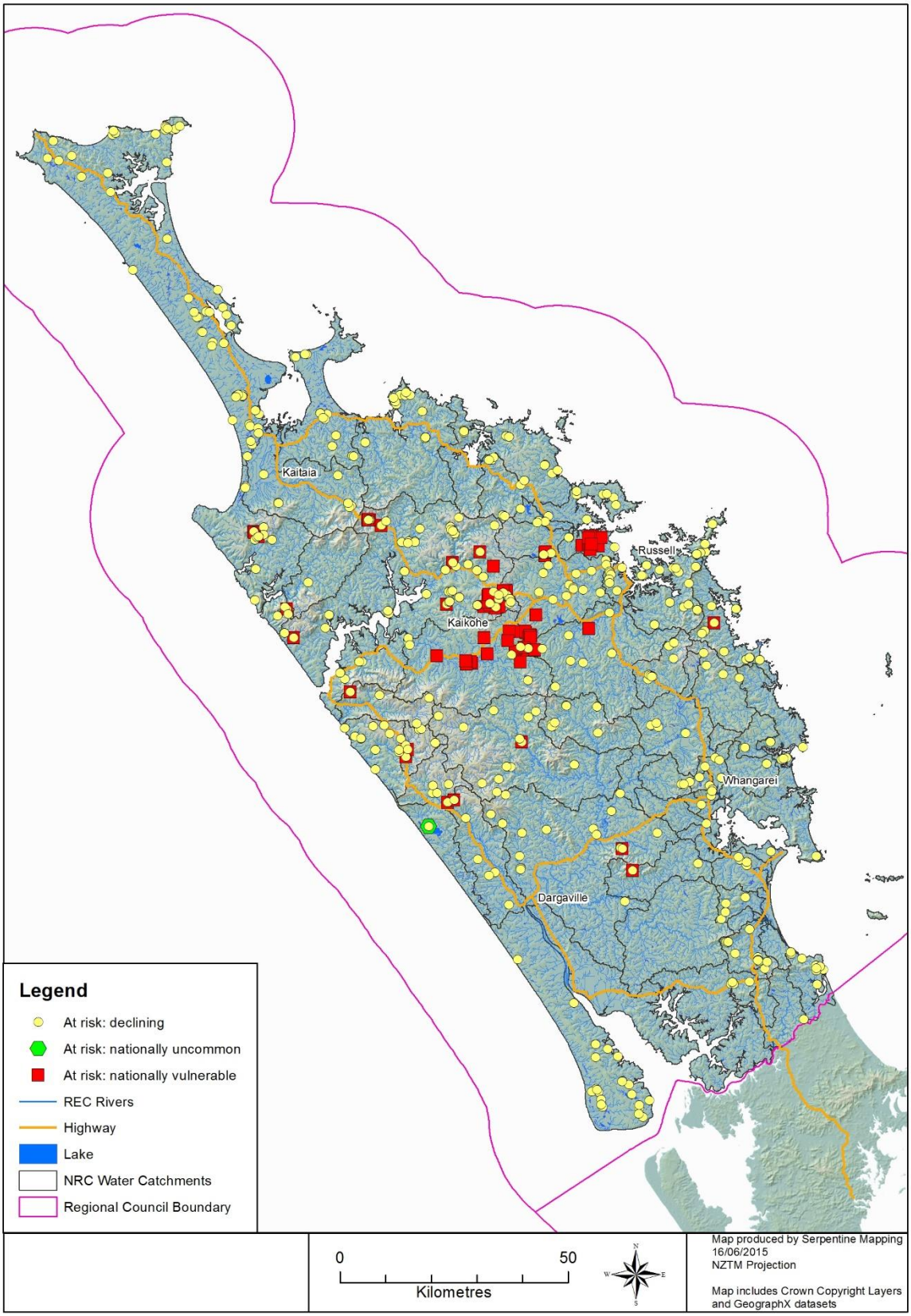
Recommendation 7: Physical disturbance of īnanga spawning sites should be avoided from 1 January to 30 July to provide for habitat recovery for spawning suitability. Stock access to īnanga spawning sites should be avoided during the period 1 January to 30 July.

Recommendation 8: Riparian buffers of 10m landward from the bank edge on both sides of a site of significance are recommended. Where the riparian buffer is comprised of indigenous woody vegetation that buffer should be extended to 20m landward from each bank.

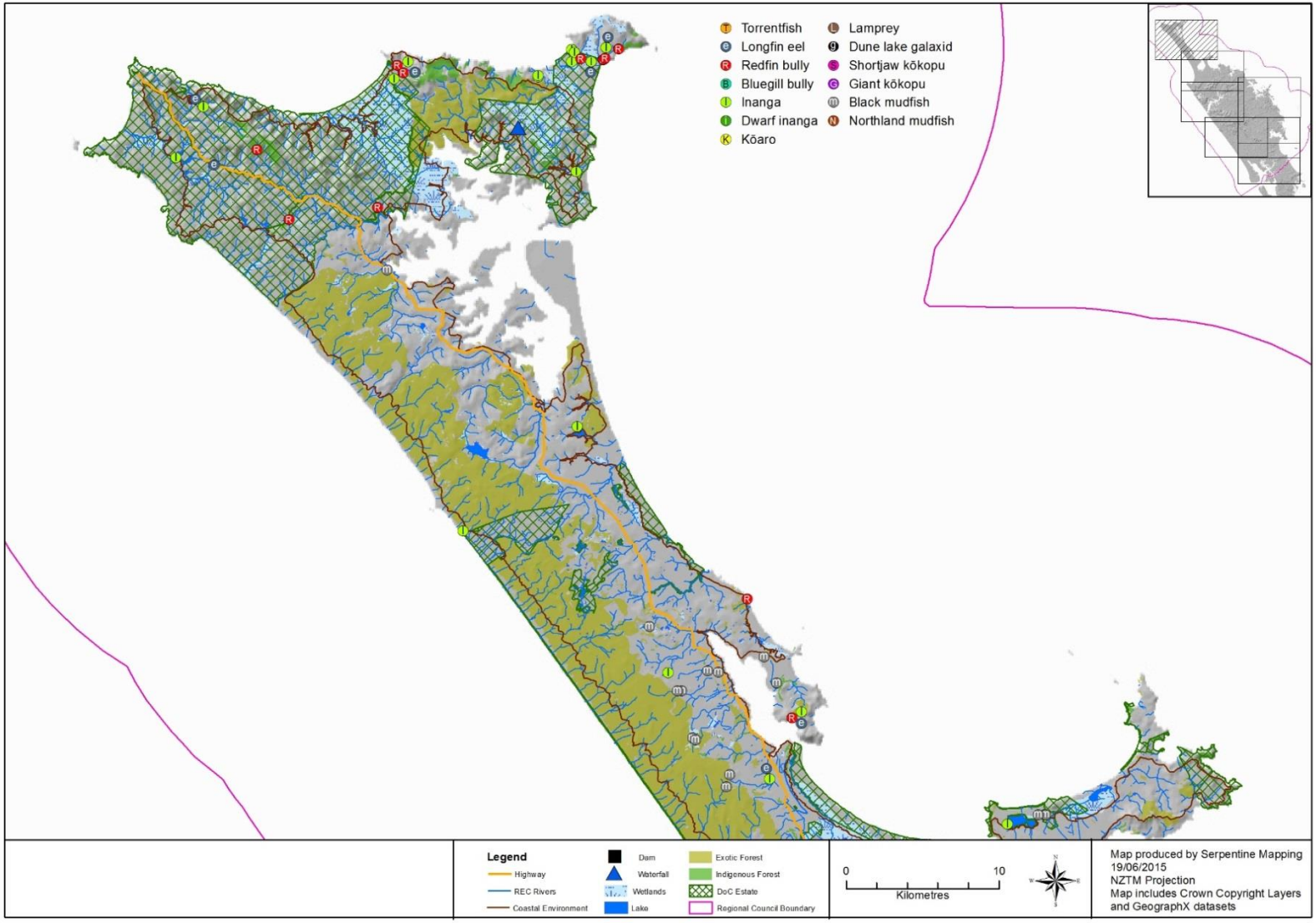
Recommendation 9: Water take infrastructure (i.e. intake pipes and diversions) requires fish screening and velocity management at intake points within sites of significance (defined above) to avoid fish mortality and/or entrainment.

Recommendation 10: Control of instream barriers is needed region-wide for unimpeded fish passage. In particular: 1) avoiding fish passage issues from new/proposed barriers, 2) identification and registration of existing barriers, and 3) remediation of existing barriers.

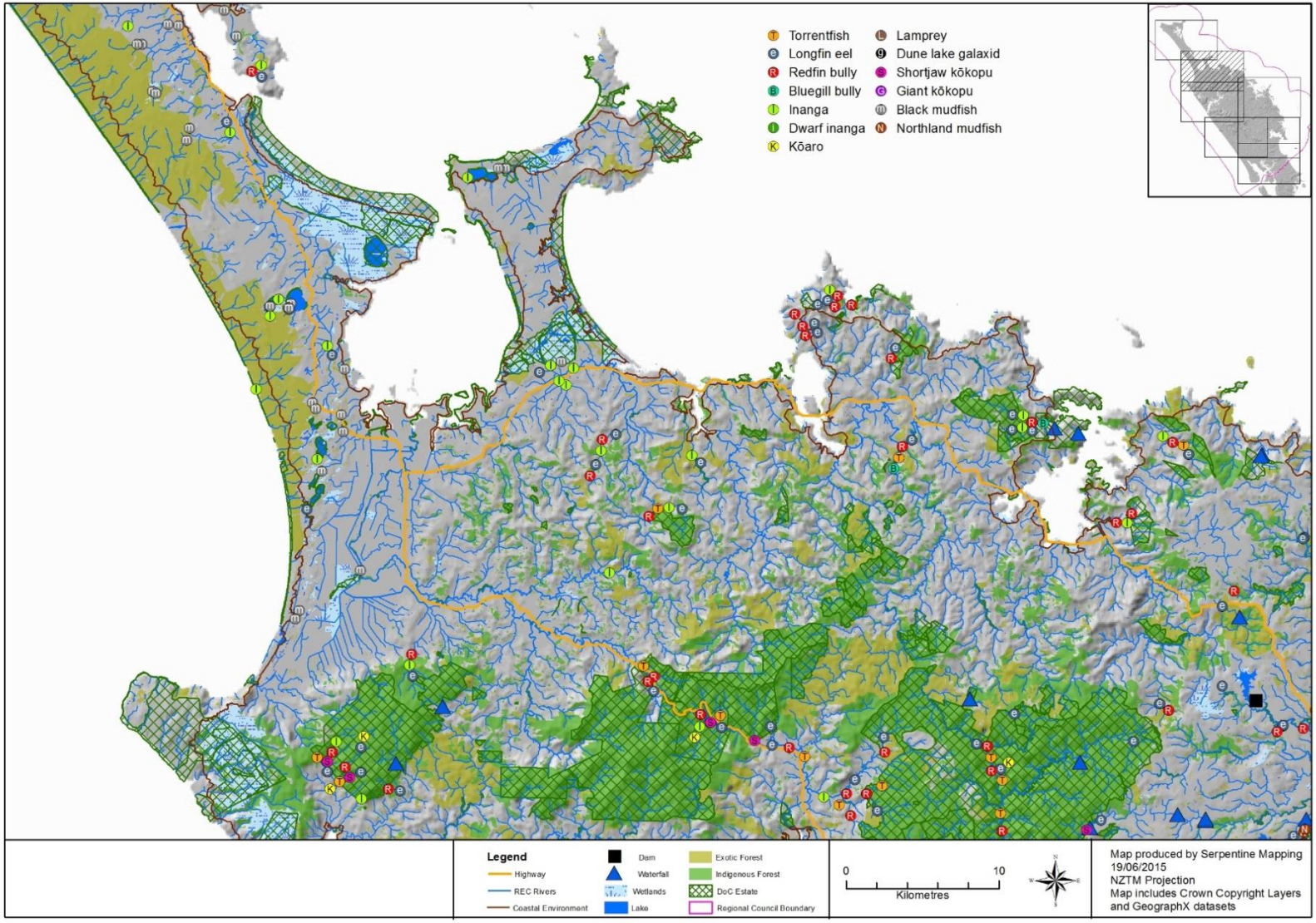
Further work to determine elevated significance criteria (at the request of Northland Regional Council Policy staff) is included as Appendix 2 to this report.



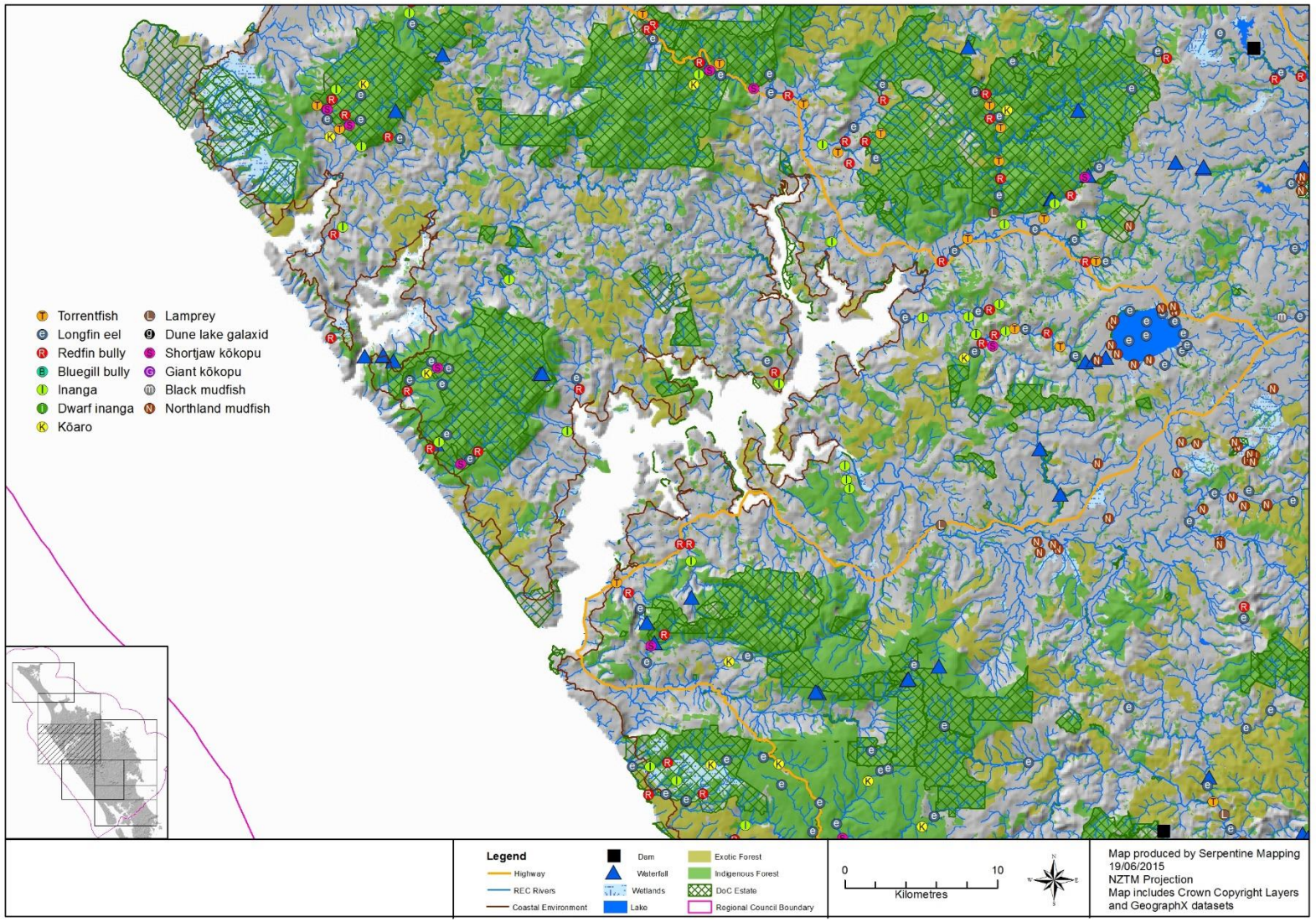
Map 8: Regional distribution of at risk and threatened native freshwater fish records (1995-2015)



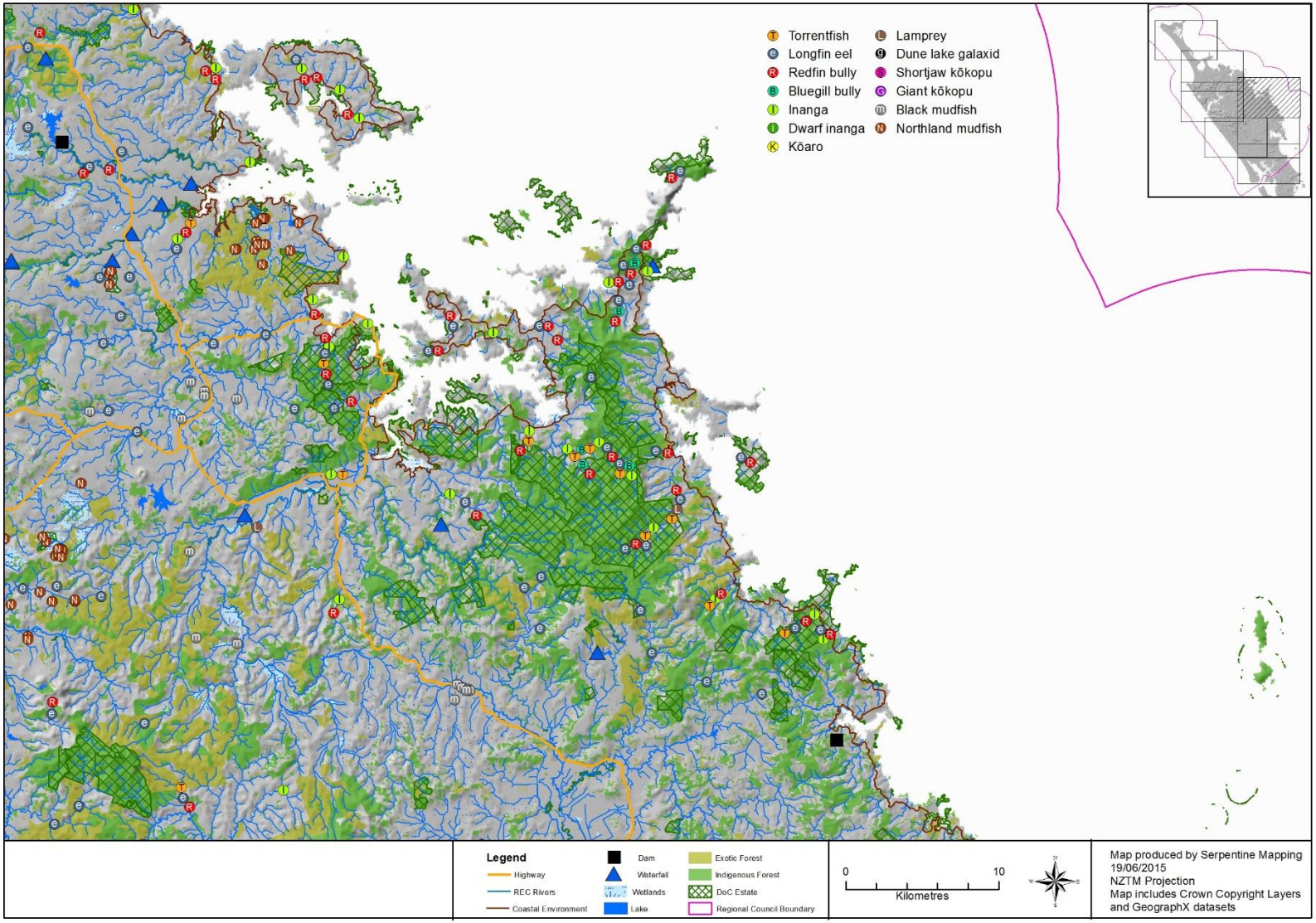
Map 9: Sub-regional distribution of at risk and threatened native fish in relation to exotic and native forest cover, Aupouri Peninsula



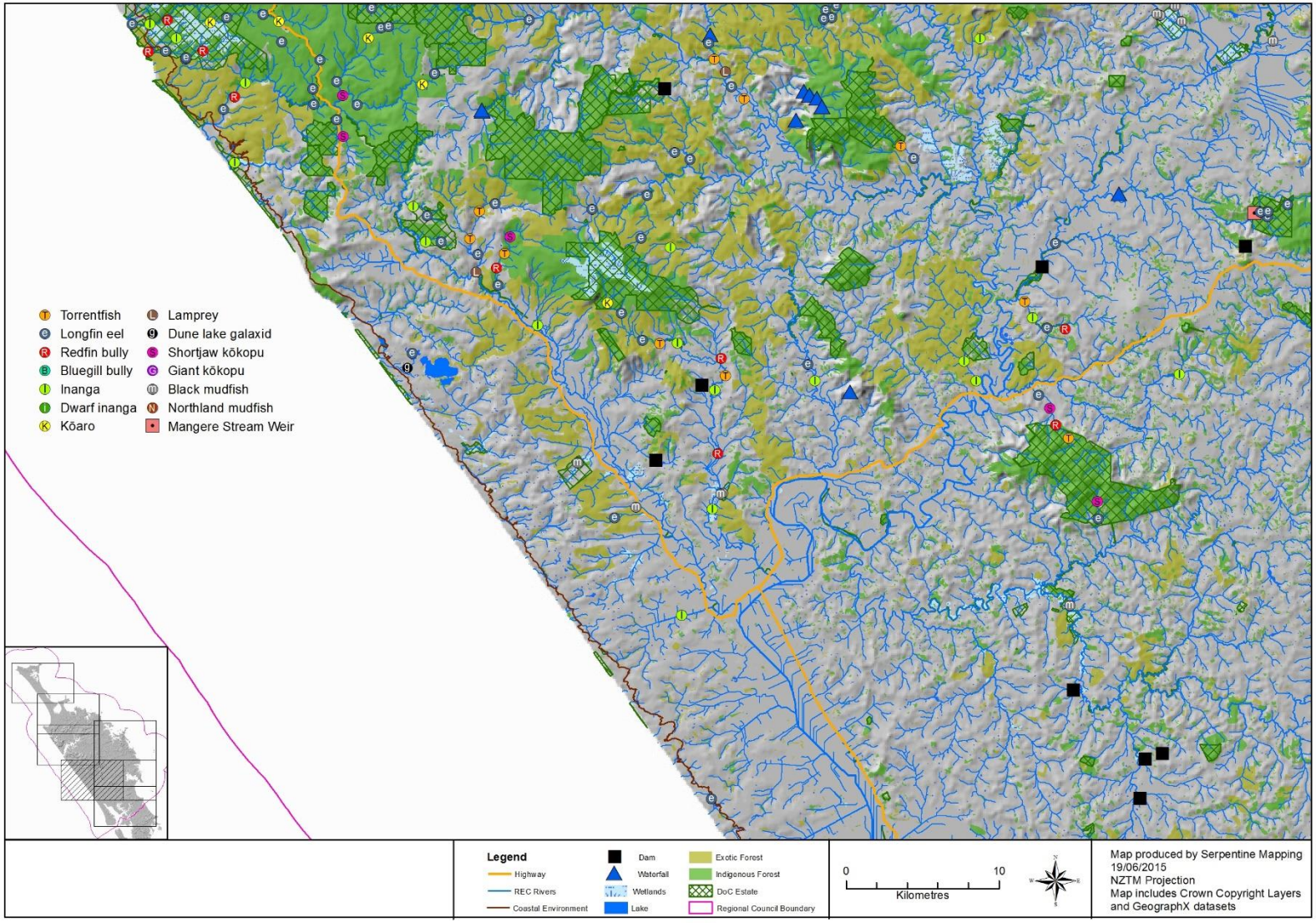
Map 10: Sub-regional distribution of at risk and threatened native fish in relation to exotic and native forest cover, Far North



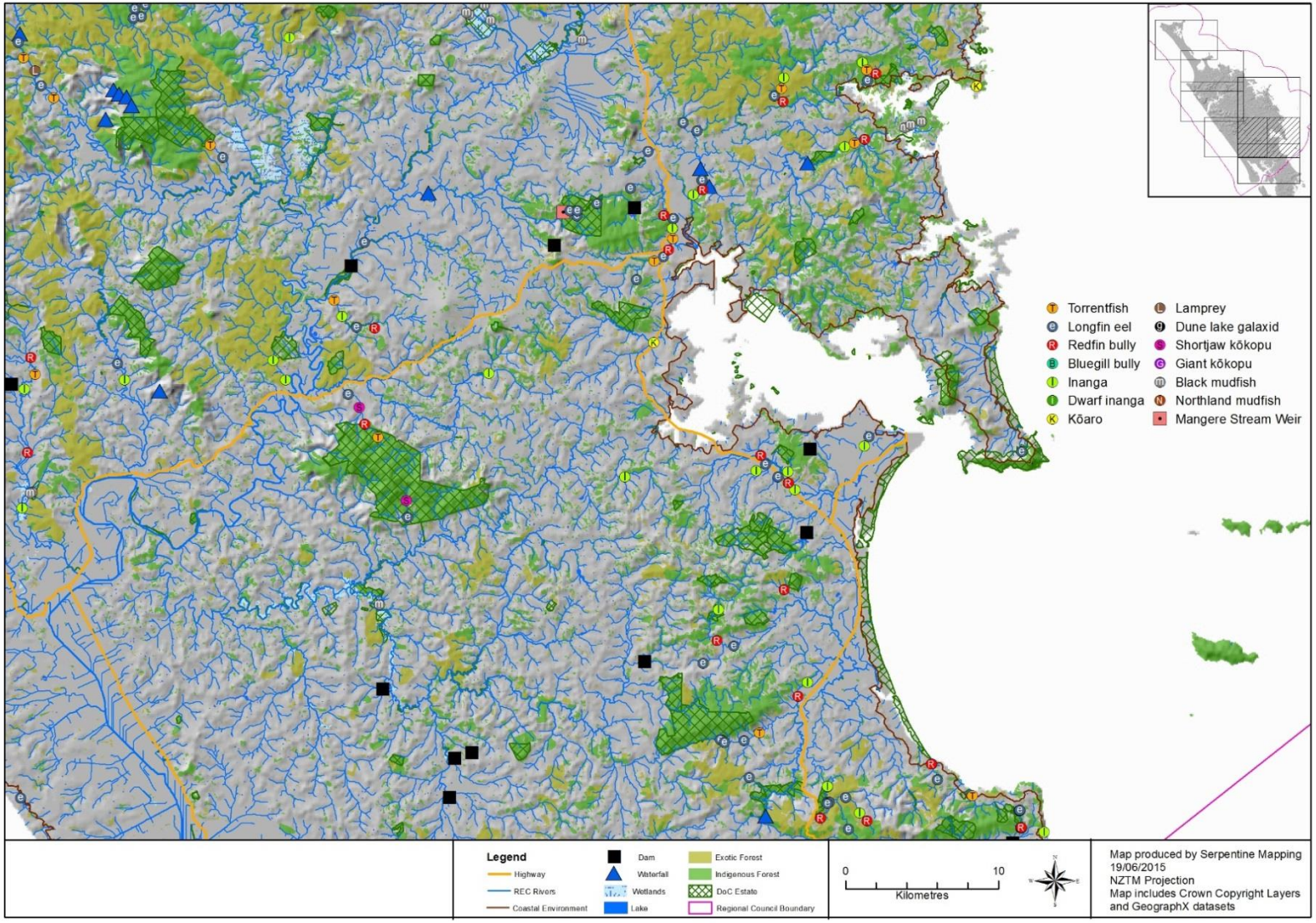
Map 11: Sub-regional distribution of at risk and threatened native fish in relation to exotic and native forest cover, Hokianga/Omapere



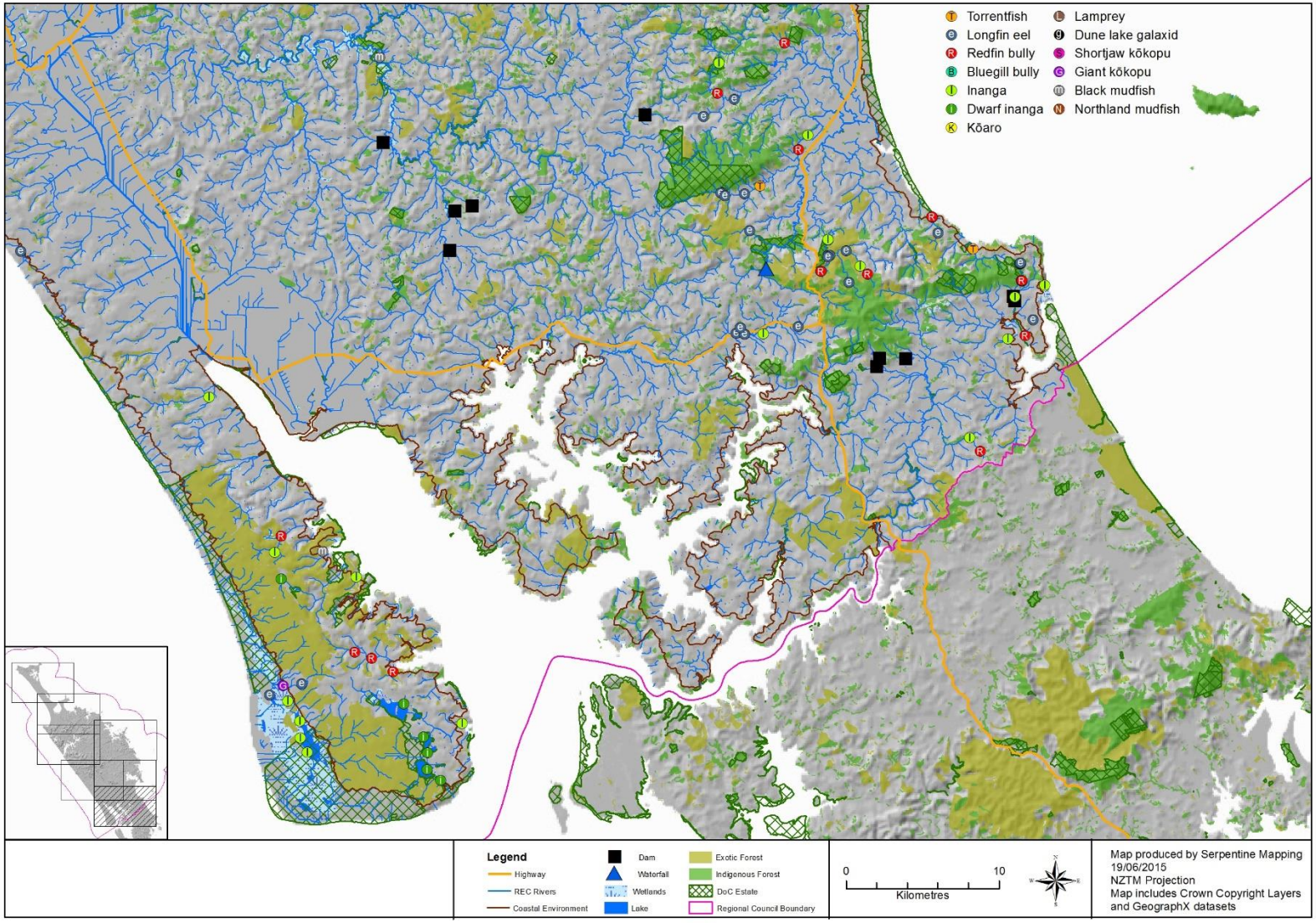
Map 12: Sub-regional distribution of at risk and threatened native fish in relation to exotic and native forest cover, Bay of Islands



Map 13: Sub-regional distribution of at risk and threatened native fish in relation to exotic and native forest cover, Kai Iwi Lakes/Dargaville



Map 14: Sub-regional distribution of at risk and threatened native fish in relation to exotic and native forest cover, Whāngārei



Map 15: Sub-regional distribution of at risk and threatened native fish in relation to exotic and native forest cover, Kaipara

9 Implications of the Proposed National Environmental Standard for Plantation Forestry

The Ministry for Primary Industries ("MPI") released a revised proposed National Environmental Standard ("NES") for Plantation Forestry in June 2015. The NES has implications for the identification of sites of significance in relation to a variety of production forestry related activities and the potential rule structure that the Regional Council may impose on those activities in significant sites to manage adverse effects on threatened native fish in the Northland Region.

The Proposed NES for Production Forestry general conditions for permitted activities use maps containing NZFFD records from 1915 to November 2014 for a small number of fish species found in Northland (redfin bully, giant kōkopu and kōaro) to determine when and where forestry activities that disturb the bed of a river or stream may require regulation in relation to the spawning periods of these species. An additional trigger for consent to disturb the bed during fish spawning periods uses a predictive fish model, based on the River Environment Classification (2014 version) where the probability of these species being found is greater than 50%.

Kōaro and redfin bully records in the NZFFD (between 1995 and 2015) have been used to determine sites of significance for Northland in section 8 of this report, as well as an additional ten at risk or threatened fish species found in the region. A number of forestry activities that disturb the bed of streams and rivers are likely to negatively impact on significant habitats of native fish beyond the three species identified for Northland in the proposed NES maps, and thus the NES will not provide an adequate level of protection for significant sites. Giant kōkopu are at their Northern extent at Kaipara and are not useful as a management species on which to determine impacts to native fish in Northland.

Intermittent and headwater streams, which are valuable habitat for all native fish and freshwater ecosystem health more generally are also be at risk of forestry activities impacting them in an unregulated manner as they are excluded from consideration within the NES for Plantation Forestry.

With respect to sites that are mapped in Regional Plans as "significant habitats of indigenous fauna" (a definition which the sites of significance for native fish detailed in this report would meet), the Regional Council will have the discretion to apply an activity status and rules more stringent than the NES-PF. If these sites are mapped and listed within the Regional Plan, the Council will have adequate ability to manage any adverse effects of production forestry activities on the habitat of at risk and threatened native fish in Northland.

Further policies and methods (rules and potentially non-regulatory methods as well) are likely to be required for a number of plantation forestry activities in significant sites identified through this report but not captured within the NES process. The details of the final NES will determine whether there is scope for Northland Regional Council to apply more stringent rules than the NES on an activity by activity basis. The proposed version of the NES suggests this will need to occur via a Plan Change process.

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Appendix 1:

IUCN Red List threat classification for the threatened native freshwater fish of Northland

Torrentfish

Red List category: Vulnerable

Torrentfish (*Cheimarrichthys fosteri*) are endemic to New Zealand where they are found in areas of suitable habitat in both the North and South Island. This species is considered obligately amphidromous and is found in fast flowing rivers with gravel substrate, often occupying the fastest flowing areas particularly in riffles, rapids and torrents. The maximum lifespan for this species is 8 years, with a maximum total length of up to 200 mm. The estimated generation time is 2-3 years. Although no complete population information is available for *Cheimarricthys fosteri*, it is considered that there has been a significant population decline of this species over the past ten years. Presence/absence records from the national New Zealand Freshwater Fish Database (NZFFD) for the decades 1960-69, 1970-79, 1980-89, 1990-99 were assessed. A second analysis was carried out to eliminate method bias, using only electric fishing records to remove any effect of an increase in use of spotlighting, trapping or netting. A third analysis of the data was aimed at reducing the effect of inland distance and altitude and removed all records over 100m and using just electric fishing records. All three analyses showed exactly the same trend that the decade from 2000-09 had 50% less *C. fosteri* than that of any of the preceding four decades. Additionally, data collected from the Manawatu River show that the number of sites where this species occurs has declined by about 50% and the number of specimens caught at these sites has also declined. The area fished is not available for all sites, but from the sites that do have these data available, it appears that the average area fished is the same for during the 1990s and 2000s, or has increased even as the catch rate has dropped.

According to the New Zealand Department of Conservation's threat classification system, this species is nationally assessed as 'At risk - declining - C(1/1)', which is based on a large population but with an ongoing or predicated decline of 10-70%. The primary threats to this species include barriers to upstream migration, habitat loss through water abstraction and land use changes causing habitat degradation throughout much of this species range. Additionally, considering long-term climate trends and water abstraction pressures, the availability of fast-flowing water for this very habitat specific species will likely to continue to decline.

Considering analysis of data from the New Zealand Freshwater Fish Database and findings of long-term site-specific research, it is considered reasonable to infer there has been at least a 30% population decline over the last ten years, with a continuing reduction in area of occupancy (AOO), extent of occurrence (EOO) and habitat quality, therefore this species has been assessed as Vulnerable. This is considered a reserved assessment and it is suspected that if actual population trend data were available, it may reveal a greater rate of decline, quite likely to exceed 50% over the past ten years, which would justify this species being assessed as Endangered.

Redfin bully

Red List category: Near Threatened

The redfin bully (*Gobiomorphus huttoni*) is endemic to New Zealand where it is widespread throughout the North and South Islands (however they are rare in the Canterbury region of the South Island's east-coast). It is also present on Chatham, Stewart and offshore islands. This species is considered obligately amphidromous. It is primarily distributed close to the coast and does not establish land-locked populations. This species has the best climbing ability of all the *Gobiomorphus* species (which is best at the juvenile stage), however they generally do not penetrate very far inland. It predominately occurs in the transitional zones of streams with meandering low gradient reaches. Adults are thought to spawn once a year in the spring. Larvae rear at sea and small juveniles return to freshwater after less than a year at sea. The lifespan of this species is 3-4 years and the estimated generation time is 1-2 years. Habitat loss and alteration are the primary causes of threat to this species. Loss of riparian vegetation and increased sedimentation is likely to change the water temperature and reduce feeding success. Artificial barriers to migration, particularly undercut culverts and hydro dams, disrupt river connectivity and access to adult habitats. Additionally, there is a potential threat from predation and competition by introduced salmonids, primarily Brown Trout (*Salmo trutta*).

The population is thought to have been slowly declining over the past 20 years. This species is nationally assessed as 'At risk - declining', based on on-going or predicted population declines according to the New Zealand Department of Conservation's threat classification system. The national New Zealand Freshwater Fish Database presence/absence data show a decline of 30% in records of this species over the past 10 years and it is considered reasonable to suspect that this species has therefore experienced population declines of at least 20-25% over this same time period. This species is therefore assessed as Near Threatened and the population should be monitored to provide a clearer picture of population trends over time.

Giant kōkopu

Red List category: Vulnerable

The giant kōkopu (*Galaxias argenteus*) is the largest of the galaxiid species and is endemic to New Zealand. It is primarily a coastal species that does not usually penetrate very far inland and is mainly found in low altitude areas close to the south and west coasts of both main islands. *G. argenteus* is migratory, but it can form land-locked populations and therefore has the capacity for both diadromous and non-diadromous recruitment. This species has undergone significant population declines since European settlement times and it has been locally extirpated in parts of its former range. Loss and degradation of habitat through activities such as drainage of wetlands and straightening of river channel systems are the biggest threat to this species.

Current and historic land-use change and intensification has resulted in an incremental loss of habitat. Around 85% to 90% of New Zealand's wetlands have been lost in the last 100 years and this species is now essentially absent from most of New Zealand's intensively utilised lowland plains. There is a continuing expansion of dairy farming and associated drain management practices in

stronghold areas for this species. The mechanical clearance of drains causes direct mortality through the removal and stranding of fish on banks. Drain clearing occurs extensively in the Waikato and Southland and is increasingly occurring on the West Coast, as land use changes to more intensive dairy farming. Here, the impacts on the *G. argenteus* are expected to be severe.

Although specific data on the rates of population decline are unavailable, it is reasonable to assume on the basis of past and on-going habitat loss and human pressures that the population has experienced at least a 25% decline over the past 20 years (2 generations). Furthermore, a confounding aspect of this species' life history is that large, old fecund specimens could be sustaining the population in the face of habitat loss and drain clearing mortalities and a 10-20 year lag may be weakening the current observations of a decline. It is therefore reasonable to suspect that that the population will experience further declines of at least 5% over the next 10 years (1 generation). Based on these suspected population decline rates in the past and the predicted future population declines, this species has been assessed as Vulnerable, where the cause of declines are due to a decline in the area of occupancy, extent of occurrence and habitat quality.

Shortjaw kōkopu

Red List category: Endangered

The Shortjaw kōkopu (*Galaxias postvectis*) is a large, nocturnal migratory galaxiid species, endemic to New Zealand. It is considered that it was probably once widespread, but has been regarded as very uncommon for some time and is considered to be the rarest of the whitebait galaxiids. The area of occupancy (AOO) is calculated at 18.5 km^2 and extent of occurrence (EOO) as 7,077 km^2. The population of this species is sparsely distributed and concentrated at a few sites of suitable adult habitat in many areas. It is notably absent from most of the east coasts of both the North and South Islands. Although this species penetrates well inland in many catchments, it appears to be restricted to specific habitats with fast flowing streams located in native forest catchments, featuring pools and large boulder substrates with large interstitial spaces. It is known to have become locally extirpated at specific sites. Sometimes the species may not be found in neighbouring habitats, even though they appear to be very similar. *G. postvectis* lives to at least 15 years, maturing at about 2-3 years with a generation time of about 10 years. The number of mature individuals is estimated to be 500-10,000.

The population is considered to be declining and although there are few presence/absence records of this species in the national New Zealand Freshwater Fish Database, the small numbers of records have indicated declines over a prolonged period (more than 20 years), despite more targeted and efficient sampling effort in their preferred habitats over this time. The population of this species is sparsely distributed but concentrated in suitable adult habitat. The majority of records are of low numbers of large adults and the predominance of large, old adults and the lack of juveniles is of concern. The high proportion of adults and evidence of poor recruitment at many sites also suggests that the current population is declining and that it is severely fragmented.

According to the New Zealand Department of Conservation's national threat classification system, this species is assessed as Threatened - Nationally Vulnerable, based on a moderate to high ongoing

or predicted population decline. Of the large galaxiids, this species has the most specific habitat requirements and is least adaptable to habitat modification. Historical rapid and extensive deforestation is considered to have been the biggest threat to this species and is likely to have significantly reduced and fragmented its distribution and abundance. Most remaining suitable adult habitat exists in protected high county locations, however some suitable habitat at lower altitudes is susceptible to further development for agriculture and forestry. Evidence of poor recruitment suggests migratory juveniles are particularly susceptible to impacts within the lower catchment and/or are limited by a sparse, highly fragmented adult population. Impacts on the population resulting from the harvest of whitebait are possible, but unquantified.

This species is assessed as Endangered based on a suspected population decline of at least 50% over the past 30 years (3 generations) based on observed, but un-quantified declines at known sites and ongoing declines in area of occupancy, extent of occurrence and habitat quality caused by deforestation and development in lowland areas where suitable habitat currently still exists. If specific trend data were available, it is suspected that the actual rates of decline could be higher than this and the species may qualify as Critically Endangered. Additionally, the area of occupancy (AOO) for this species is less than 500 km^2. The population is suspected to be severely fragmented and there is a continual decline in area, extent and quality of habitat and the number of mature individuals, meaning this species also meets the Endangered category under the geographic range criteria.

Dune lakes galaxias/Dwarf īnanga

Red List Category: Vulnerable

The dwarf īnanga (*Galaxias gracilis*) is endemic to North Island, New Zealand, where it is restricted to two groups of lakes in eight distinct locations on North Kaipara Head, Northland. It is a non-migratory species that lives throughout the pelagic and littoral areas of multiple landlocked coastal dune lakes. The estimated area of occupancy (AOO) and extent of occurrence (EOO) are both 2.9km^2. Populations in most of the lakes in which this species occurs have undergone significant declines over the past 30 years and the species has disappeared from some lakes where it was formerly known. Currently, the population fluctuates naturally due to variable recruitment success; however there is still an overall decline in population trend, although specific data are not available. Population declines have been primarily attributed to the introduction of exotic fish species, a decline in water quality and a reduction in water levels due to plantation and forestry land use. Mosquito fish (*Gambusia affinis*) pose a significant threat to this species through competition for food and space in the summer and diet studies indicate that predation by rainbow trout (*Oncorhynchus mykiss*) is common and is likely to have contributed to the extirpation of *G. gracilis* in proximal areas.

This species is assessed as Vulnerable based on a restricted area of occupancy of less than 20km^2 and the plausible threat posed particularly by the potential for illegal introductions of other introduced fish, particularly European perch (*Perca fluviatillis*).

Black Mudfish

Red List category: Endangered

The black mudfish (*Neochanna diversus*) is endemic to the northern North Island of New Zealand, where it is found from the Mokau River catchment in the south to north of Kaitaia in the north. There has been an overall loss of approximately 85-90% of wetlands in New Zealand and this species has disappeared from many areas, especially lower Waikato and the Hauraki Plains. It now occupies less than 10% of its former range prior to human colonization of New Zealand. This species occurs in swamps and wetlands, where they are found in low nutrient acid wetlands with low summer water levels. This species has undergone significant population declines in the past. The species can be locally abundant in areas of suitable habitat in Northland and the Waikato region, however the population is severely fragmented and there are a large number of small relict populations. *N. diversus* are sensitive to a wide range of environmental impacts such as habitat loss, pollution and sedimentation.

Wetland drainage is the most significant threat to this species; however the rate of habitat loss has slowed compared to that of historic levels as not much wetland habitat remains. These fish are also threatened by the presence of mosquito fish (*Gambusia affinis*) an aggressive and prolific introduced fish, which has a similar distribution pattern to this species. Observations of their behaviour in tanks showed that large mosquito fish would readily eat *N. diversus* fry, and that they chased and nipped juveniles. Adults were not affected, but are impacted by competition.

This species is assessed as Endangered based an area of occupancy (AOO) of 261km^2 with a severely fragmented population. Although the geographic range declines have slowed significantly compared to historic levels, they are ongoing.

Northland/Burgundy mudfish

Red List category: Critically Endangered

The Northland mudfish (*Neochanna heleios*) is endemic to the North Island of New Zealand, where it occupies a relatively small area of central Northland and is known from only 30 localities. There has been an overall loss of approximately 85-90% of wetlands in New Zealand. Extensive survey work documenting the present distribution has indicated that this species may be one of New Zealand's rarest mudfish species. The main threats to this species are habitat degradation and loss through nutrient enrichment and draining of wetlands for agriculture. Two major man-made fires occurred at key sites between 2006 and 2011, which also destroyed critical habitat.

The population of this species is highly fragmented and is now estimated to occupy just 2% of its probable historic range. The current estimated area of occupancy (AOO) for this species is 9.5km^2. Actual mudfish occupancy continues to contract within current wetland sites due to water quality declines, hydrological alterations and exotic weed and fish invasions. This species has therefore been assessed as Critically Endangered.

Appendix 2:

Consideration of elevated significance criteria for native fish sites in Northland

Following a review of a draft version of this report and the recommendations contained in section 8, Northland Regional Council policy staff requested The Catalyst Group provide additional advice on criteria that could be applied to define sites with elevated ecological significance. The recommendations below align closely with the Diversity and Pattern criteria (4aii) contained in the Proposed RPS for Northland, but are less inclusive than the broader criteria applied in the recommendations above.

Notwithstanding the recommendations in section 8 of this report, additional criteria to define sites with elevated significance were determined as follows:

1. All sites with three or more at risk or threatened fish species surveyed between 1995 and 2015; and
2. Any site with a species defined as 'nationally vulnerable' using the current conservation threat classification (Northland mudfish, lamprey and shortjaw kōkopu); and
3. Any sites with a range-restricted īnanga ESU[10] present (i.e. dwarf Galaxias, dune-lake Galaxias, far-north lake-locked īnanga); and
4. All wetland habitats within a 30km radius of Lake Omapere and a 15km radius of Kerikeri for the protection of habitat likely to contain Northland mudfish (whether confirmed by survey or not).

A spreadsheet of sites determined using the elevated significance criteria were provided to Northland Regional Council along with the final version of this report. Decisions on policy approaches for native fish protection through a site of significance framework ultimately rests with the Council.

[10] ESU: Ecologically Significant Unit of īnanga according to White et al. (2014).