Native Fish in Northland:

Application of the River Values Assessment System (RiVAS and RiVAS+)

Kenneth F.D. Hughey
Eric Goodwin
Nathan Burkepile
Natalie Glover
Bruce Griffin
Keith Hawkins
Kim Jones
Mike McGlynn
Carol Nicholson
Mark Poynter

LEaP Research Paper No. 20
July 2013

Land Environment & People

Centre for Land Environment & People
A Lincoln University Research Centre.
New Zealand's specialist land-based university.

Lincoln University
Te Whare Wānaka o Aoraki
CHRISTCHURCH•NEW ZEALAND
New Zealand's specialist land-based university

Native Fish in Northland:

Application of the River Values Assessment System (RiVAS and RiVAS+)

Kenneth F.D. Hughey
Nathan Burkepile
Natalie Glover
Eric Goodwin
Bruce Griffin
Keith Hawkins
Kim Jones
Mike McGlynn
Carol Nicholson
Mark Poynter

Land Environment and People Research Paper No. 20

July 2013

ISSN 2230-4207 (online)
ISBN 978-0-86476-334-1 (online)

Lincoln University, Canterbury, New Zealand

Cover photo: Redfin Bully. Source: Kim Jones

Acknowledgements

This work was funded by Northland Regional Council and we gratefully acknowledge their support. Thanks to Andrew Macdonald (GIS Officer, Northland Regional Council) who provided GIS support.

Contacts - email: leap@lincoln.ac.nz
web: http://www.lincoln.ac.nz/leap

Series URL: http://hdl.handle.net/10182/3410

Executive Summary

The fourth application of the River Values Assessment System (RiVAS and RiVAS+) for native fisheries value was made in the Northland region. Data for nine out of ten indicators were provided from modelling undertaken by Cawthron Institute using a variety of databases including the NZFFD and FENZ. The expert panel then checked the modelling results and adjusted where appropriate based on local knowledge, and it populated the Population Stronghold indicator. Of 27 river catchment/clusters evaluated, nine were considered of national significance, namely the Bay of Islands North, Bay of Islands South, East Coast, Herekino, Hokianga, Mangamuka, Waihou, Waipoua and Wairoa. The Wairoa scored very poorly for all attributes other than presence of many at risk species. The remaining 18 are of regional significance. No river catchment/clusters were identified as being of local significance. The RIVAS+ identified work that can be done to reduce the inference on migratory fish movements caused by a barrier on the Waipoua River.

Contents

List of Tables

List of Figures

Chapter 1
Introduction

1.1 Purpose

This report presents the application of the River Values Assessment System for existing value (RiVAS) and for potential value (RiVAS+) to native fisheries in rivers of the Northland Region, undertaken in May 2013. The first full application to native fish was made in Gisborne (Clapcott et al., 2012) in March 2012. This Northland native fisheries report needs to be read in conjunction with that report and with the overall RiVAS method report (see Hughey et al., 2010).

1.2 Preparatory step: Establish a regional expert panel

Eric Goodwin (Cawthron Institute) used the methodology tested on the earlier native fish reports (see for example Clapcott et al. 2012) assembled the raw data for Northland.

The Northland regional Expert Panel (EP) was Ken Hughey (facilitator, Lincoln University), Nathan Burkepile, Natalie Glover, Bruce Griffin, Keith Hawkins, Kim Jones, Mike McGlynn, Carol Nicholson and Mark Poynter.

The EP met on 24th May 2013 to ‘refine’ the raw data in RiVAS in light of local knowledge, and to undertake the RiVAS+ part of the process.

Credentials of the Expert Panel are provided in Appendix 1.

Chapter 2
Application of the method

There are two parts of the River Values Assessment System: RiVAS is applied to existing value in steps 1-9 and RiVAS+ to potential value in steps 10-14.

Step 1: Define river value categories, river segments/catchments and fish distribution information

River value context for native fish fauna in Northland

The freshwater fish fauna of Northland is relatively rich with 22 of the 35 national native taxa represented (Table 1). Although it is characterised by the dominance of migratory species, two important non-migratory species, namely the Black mudfish and the Northland mudfish also occur in the region. While not present in rivers, Dune lakes galaxid and Dwarf inanga are also important non-migratory Northland fish fauna.

Table 1: Native fish taxa found in Northland: conservation and migration status

Species	Scientific name	Threat Status	Migration
Shortfin eel	Anguiilla australis	Not threatened	Catadromous
Longfin eel	Anguilla dieffenbachii	Declining	Catadromous
Torrentfish	Cheimarrichthys fosteri	Declining	Diadromous
Giant kokopu	Galaxias argenteus	Declining	Diadromous
Koaro	Galaxias brevipinnis	Declining	Diadromous
Banded kokopu	Galaxias fasciatus	Not threatened	Diadromous
Dwarf inanga	Galaxias gracilis	Naturally uncommon	Diadromous
Inanga	Gal. maculatus	Declining	Diadromous
Shortjaw kokopu	Gal. postvectis	Declining	Diadromous
Lamprey	Geotria australis	Declining	Anadromous
Cran’s bully	Gobiomorphus basalis	Not threatened	Non-migratory
Common bully	Gobiomorphus cotidianus	Not threatened	Diadromous
Giant bully	Gobiomorphus gobioides	Not threatened	Diadromous
Bluegill bully	Gobiomorphus hubbsi	Declining	Diadromous
Redfin bully	Gobiomorphus huttoni	Declining	Diadromous
Triplefin	Grahamina spp		
Grey mullet	Mugil cephalus	Not threatened	
Black mudfish	Neochanna diversus	Relictual	Non-migratory
Northland mudfish	Neochanna heleios	Nationally vulnerable	Non-migratory
Dart goby	Parioglossus marginalis	Coloniser	
Common smelt	Retropinna retropinna	Not threatened	Anadromous
Flounder species	Rhombosolea spp		

The freshwater fish ranking process determined a threat ranking for all described species of freshwater fish in New Zealand and included an additional 11 indeterminate taxa and 20 introduced taxa (Allibone et al., 2010). Results from the report show the number of species classified as “threatened” has increased, with the number of threatened species with a declining trend in Northland rising to 12 taxa. Of particular note in Northland are the two species of mudfish which, while mostly resident in and relying on swampy wetlands, also inhabit some slow flowing streams and are thus included in this evaluation. While Lamprey are present in the region their populations are thought to have declined hugely (Expert Panel assessment 24 May 2013) and relatively little is known about current distribution and population size.

River value categories

There are two distinct categories of native fish in New Zealand's rivers and streams; migratory (i.e., diadromous) and non-migratory species. New Zealand's native fish fauna is predominantly migratory and this is true for the Northland Region where the vast majority of native freshwater species migrate between fresh water and the sea to complete part of their lifecycle.

Due to differences in the lifecycles of migratory and non-migratory species, the distribution of these two categories of native fish can respond differently to both natural gradients and anthropogenic impacts. For example, because migratory species typically require access to the sea, their diversity and abundance is strongly influenced by elevation and distance inland (Jowett & Richardson 1996). For non-migratory species that do not require access to the sea, elevation and distance are far less likely to have an impact on the diversity and abundance of these species. Instream barriers (both natural and man-made, physical and chemical) that stop fish from migrating to and from the sea can also have a significant impact on the distribution of migratory species and yet may have a minimal impact on the distribution of non-migratory species.

Despite these differences the expert panel decided that a different approach to migratory and non-migratory species in the overall assessment will not usually be needed. This is because the fish fauna of the Northland Region is dominated by migratory species - both migratory and non-migratory species can be found at the same locations and potential in-stream barriers can also limit the dispersal of non-migratory species (although in the case of Northland this is unlikely to be significant for the two mudfish species present).

River segments/catchments

Although the adult habitat of many native fish species occur in particular river segments (e.g., lowland or upper reaches), native fish habitat in rivers is usually driven by catchment scale characteristics (e.g., elevation, distance inland, proportion of indigenous forest cover); therefore a catchment-scale approach is warranted. The predominance of migratory fish in New Zealand also warrant the use of a catchment-scale approach rather than river segments in isolation as many fish species require access both up and downstream in the entire catchment. We have developed the method so that it can be applied at multiple scales, essentially built around the concept of catchment order, complemented by data sourced from a range of different applications but especially from the Freshwater Ecosystems of New Zealand (see http://www.doc.govt.nz/conservation/land-and-freshwater/freshwater/freshwater-ecosystems-of-new-zealand/).

Twenty-seven river catchment/clusters were used for this assessment drawing on the FENZ database (Figure 1). FENZ identifies over 1,300 whole river catchments for Northland that drain into the sea. Nine FENZ catchments were considered large or distinctive enough not to be amalgamated – Awanui, Kawakawa, Mangamuka, Waihou, Waima, Wairoa[1], Waitangi, Whangapae and Utakura. The remaining FENZ catchments were amalgamated into 18 river clusters based on location of the

1 The Expert Panel considered the Wairoa carefully. Its large size and naturally existing (waterfall) barriers make it challenging to consider as a whole. On the other hand it is a single FENZ catchment and previous RiVAS applications have considered large catchments each as a single entity. An alternative approach considered could be to consider the Wairoa as a whole (as per this assessment) but then also consider 2 or more sub catchments and score these solely on the basis of EP assessments. This latter approach has not been attempted but could easily be done.

endpoint, i.e., harbour, estuary or open sea, and the FENZ classification of the catchment. For example, catchments in the Aupouri peninsula were divided into Aupouri East and Aupouri West depending on whether the catchments flowed into either the Pacific Ocean or Tasman Sea, while catchments within the Te Paki cluster were separated off due to their relatively high FENZ ranking.

Nine of the river clusters (Aupouri East, Bay of Islands North, Bay of Islands South, Dargaville Coast, Herekino, Hokianga, Kaipara Harbour, North Coast and Rangaunu) are non-contiguous, i.e., they contain FENZ catchments that do not border with other FENZ catchments within the cluster. This is because they were recognised as being more like other catchments in their respective clusters in terms of location of the endpoint or FENZ classification than their immediate neighbouring catchment.

The 27 catchment/clusters cover almost 100% of the region – the tiny exceptions being very narrow coastal areas with little to no permanently flowing water. The list of river catchment/clusters was taken by Cawthron Institute and populated with raw data for EP consideration (Appendix 3).

Fish distribution information

The New Zealand Freshwater Fish Database (NZFFD) provides a wealth of information on the presence and distribution of freshwater fish in New Zealand's rivers and streams with approximately 32,000 records. Northland rivers and streams have 3216 records (E Goodwin, Cawthron Institute, pers. comm., 23 May 2013). The distribution of sampling sites shows good coverage of most of the region with most rivers and streams types represented. However, some of the information is relatively old and inconsistent methodologies were used to obtain the data .

Comparing and ranking of rivers using only NZFFD data, where some rivers have many records and some rivers have none, is therefore not appropriate as they cannot be objectively assessed and there will always be a bias towards rivers and streams that have been sampled more frequently (i.e., there is more chance of recording a threatened species in a river that has been fished than a river that has not).

To help overcome the spatial variability of fish information, and to complement existing data in the NZFFD, source data from the FENZ and other databases was incorporated into this assessment process. The predictive modelling effectively fills in the gaps for rivers where there are few or no fishing records in the NZFFD. The model provides accurate probabilities of the occurrence for each fish species in all of the region's rivers and streams and can be used to give an objective, consistent and accurate assessment of where fish will be present. The accuracy of the prediction decreases with the rarity of the fish species.

An additional threatened species score for each river was calculated from the NZFFD presence per catchment, by applying a weighting to each threatened species based on their threat status listed in Allibone et al. (2009).

Existing data in the NZFFD, along with data from FENZ and threatened species scores, were used to evaluate and rank the fish communities for the different river catchments in the region.

Figure 1: River catchment/clusters for native fish in Northland

Other Considerations

When applying this method in Northland, it was not considered appropriate to treat migratory and non-migratory species separately. In some regions it might be appropriate, especially when the non-migratory species have extremely high conservation interest (e.g., much of the east coast of the South Island, and of course Northland with the two mudfish species). However, it was considered that rivers with these species would gain recognition by attributes that also take into account the threatened status of a species.

Records in the NZFFD span a significant period of time (e.g., in Northland there are records from the 1960s). NZFFD records older than 10-20 years may no longer represent the actual fish communities in the river fished. A cut-off time period was discussed by the Expert Panel but it decided to use Expert Panel discretion in determining whether older NZFFD records were still relevant (i.e., compare them to more recent NZFFD records if available and/or consider the effects of any land use changes over time). If older NZFFD records were not considered to be still relevant they were not used in this process.

Lakes, wetlands and estuaries can all have significant native fish values, and while in many cases they are intricately linked with river and stream ecosystems, differences in habitat and some differences in the species likely to occur within that habitat (e.g., estuaries are often populated by a mixture of both freshwater and marine species) mean that it would be inappropriate to assess these habitat types alongside rivers. Therefore a separate evaluation for each different habitat (e.g., lakes, wetlands and estuaries) is required. Having said this it has been noted already that both mudfish species are included in this evaluation even though they are mostly linked to swamp-type wetlands – this was justified because there is a link with small slow flowing streams where these species have been recorded.

Outcomes

Treat all native freshwater fish the same (no separate categories for migratory and non-migratory species).

Assess freshwater fish communities at the whole catchment scale or cluster scale.

Use NZFFD data, along with FENZ and threatened species scores, to evaluate and rank the fish communities in the different river catchments.

Step 2: Identify attributes

The same list of attributes and indicators used for the Gisborne application (Clapcott et al. 2012) were used for Northland (See Appendix 2).

Step 3: Select and describe primary attributes

Appendix 2 identifies the 10 primary attributes (in bold) and descriptions for each.

Step 4: Identify indicators

Indicators linked to each of the 10 primary attributes are listed in Appendix 2.

Step 5: Determine indicator thresholds

Thresholds are applied to each indicator to determine high, medium and low relative significance. Thresholds for each indicator were defined by real data for virtually all indicators of Primary Attributes, or largely by Expert Panel judgment (e.g., Primary Attribute 5: Key population of threatened species ('Stronghold')).

In most cases thresholds were determined to allow for three (and occasionally a fourth) different thresholds (high (3), medium (2), low (1) and occasionally no importance (0)).

The thresholds are identified in Appendix 2 and are the same as those applied in other native fish applications.

Step 6: Apply indicators and indicator thresholds

Most indicators were assessed using objective data and in these cases data were kept in their original format (e.g., Primary Attribute 4: Number of Declining Species) to assist the Expert Panel when evaluating the data, and to help achieve a transparent process.

Some indicators (for Primary Attribute 5: Key population of threatened species ('Stronghold')) were assessed by Expert Panel opinion due to a lack of available hard data. While this was a subjective process and is not ideal, this indicator and attribute was deemed important enough that a subjective assessment was better than no assessment at all.

Applications of the thresholds are given in Appendix 3.

Step 7: Weight the primary attributes

The 10 primary attributes were considered to make an equal contribution to native fish life as a whole, weightings are therefore equal.

Step 8: Determine river significance

Step 8a: Rank rivers

A spreadsheet was used to sum the indicator threshold scores for each river catchment/cluster (Appendix 3). Since we had chosen to equally weight the primary attributes, we did not have to first multiply the threshold scores by the weights.

Step 8b: Identify river significance

Using the list from Step 8a, the Expert Panel examined the river catchment/clusters, and their attribute scores. The following criteria were applied:

National significance:
Criterion 1: Total score of all indicator columns is 24 or more; or
Criterion 2: Declining species score of 3.
Regional significance:
Rivers that are not of local or of national significance.
Local significance:
Criterion 1: Total score of all indicator columns is 15 or less, and
Criterion 2: Declining species score is 1 or less then local.
Translation of these functions to rivers is shown in Appendix 3 through a list of rivers identified as significant at the national, regional and local level.

Using this assessment system, 27 river catchment/clusters were considered:

- 9 were deemed to be of national significance, namely the
    - Bay of Islands North,
    - Bay of Islands South,

  - East Coast,
  - Herekino,
  - Hokianga,
  - Mangamuka,
  - Waihou,
  - Waipoua and
  - Wairoa
- 18 of regional significance and
- None of only local significance.

Of the nine river catchment/clusters considered nationally important, only the Bay of Islands South and Mangamuka clusters achieved both criteria, i.e., a total score of 24 or more and a declining species score of 3 indicating a number of threatened species present. Conversely, six river catchment/clusters – Bay of Islands North, East Coast, Herekino, Hokianga, Waipoua and Wairoa – ranked as nationally important based on Criterion 2 alone, i.e., a declining species score of 3. All six had total scores that would have identified then as being of regional significance (i.e. between 16 and 23) with the exception of the Wairoa which would have ranked as locally significant based on a total score of 15. The Wairoa had the highest number of threatened species present, probably reflecting size and diversity of the catchment. However, it was not considered either a national or regional stronghold for any of these species. Similarly, the Awanui and Waima were ranked as being of regional significance rather than local significance because, although their total score was 15 or less, they both had a declining species score of 2.

These findings are mapped in Figure 2.

Figure 2: Northland native fish river catchment/clusters mapped by significance level

Step 9: Outline other factors relevant to the assessment of significance

Where necessary we used EP knowledge to complement existing data on freshwater fish distribution with data from predictive models and use subjective indicators where no hard data is available.

The EP faced some challenges in Northland, but all were addressed, as follows.

1. There is little to no Inanga spawning information. However, because Inanga are present in almost all clusters it was considered that spawning too would occur in most, if not all; scores were adjusted accordingly but to the lowest presumed spawning level score.

2. The NZFFD is lacking in some areas and more contemporary Northland data needs including. There is a particular lack of contemporary data for Lamprey and this needs addressing as it is an important species in its own right, but also important for the tangata whenua. When this issue is then placed in the context of the predictive ability of FENZ there are always going to be occasions when the EP will have more up to date information which will lead to adjustments in indicator date and threshold scores. Threatened species data for Northland was no exception and Table 2 shows EP final data for this evaluation.

   There is a likelihood that Torrentfish and Koaro are to be found in the Utakura and Waima river catchments but these have not been added in at this stage. The presence of these two species in Waima would result in a threatened species indicator score of 3 rather than 2 currently, raising it from a river catchment of regional importance to one of national importance.

   The information gaps highlighted in points 1 and 2 suggest that further work could be undertaken by relevant agencies such as Northland Regional Council and the Department of Conservation to rectify this situation. In particular Northland Regional Council should consider implementing a fish monitoring programme, particularly in light of new national protocols enabling consistent and repeatable sampling for distribution/density/trends.

3. Considerable work was required of the Expert Panel in terms of defining species strongholds – these were defined following considerable discussion amongst the experts present, with the results of these discussions recorded in Table 3.

4. Some adjustment was needed regarding invasive species, especially concerning the pervasive threat posed by Gambusia. A decision rule was introduced that where Gambusia and mudfish overlapped then by default a middle range score (2) would be given. The EP modified the list of invasive species as shown in Table 4.

5. Water Quality is a challenging issue in Northland. While the base level modelling was useful some adjustments were required for sandy soils in particular, but also where erosion was considered more of an issue. Changes in water quality scores are shown in Appendix 3.

6. There is no comprehensive database of barriers to native fish movement in Northland. This is a significant shortcoming and one that NRC and DoC should seek to resolve in the short term.

None of the adjustments made as a result of the above significantly affected overall scores and were confirmed by the EP.

Table 2: Threatened native fish in Northland (Empty purple cells show records removed by EP; purple cells with white text are records added by the EP)

River catchment/ cluster	Longfin eel	Torrentfish	Giant kokopu	Koaro	Dwarf galaxid	Inanga	Shortjaw kokopu	Bluegill bully	Redfin bully	Lamprey	Black mudfish	Northland mudfish
Aupouri East	Longfin eel					Inanga			Redfin bully		Black mudfish	
Aupouri West												
Awanui	Longfin eel	Torrentfish				Inanga			Redfin bully		Black mudfish	
BOI North	Longfin eel	Torrentfish				Inanga		Bluegill bully	Redfin bully		Black mudfish	Northland mudfish
BOI South	Longfin eel	Torrentfish				Inanga		Bluegill bully	Redfin bully		Black mudfish	Northland mudfish
Dargaville Coast	Longfin eel					Inanga						
Doubtless Bay	Longfin eel	Torrentfish				Inanga		Bluegill bully	Redfin bully		Black mudfish	
East Coast	Longfin eel	Torrentfish				Inanga		Bluegill bully	Redfin bully	Lamprey	Black mudfish	
Herekino	Longfin eel	Torrentfish		Koaro		Inanga	Shortjaw kokopu		Redfin bully		Black mudfish	
Hokianga	Longfin eel	Torrentfish		Koaro		Inanga	Shortjaw kokopu		Redfin bully	Lamprey	Black mudfish	Northland mudfish
Kaipara	Longfin eel					Inanga			Redfin bully		Black mudfish	
Kawakawa	Longfin eel	Torrentfish				Inanga			Redfin bully	Lamprey	Black mudfish	
Mangamuka	Longfin eel	Torrentfish		Koaro		Inanga	Shortjaw kokopu		Redfin bully			

North Coast	Longfin eel	Torrent fish				Inanga			Redfin bully		Black mudfish	
Pouto	Longfin eel											
Rangaunu	Longfin eel					Inanga					Black mudfish	
South Coast	Longfin eel	Torrentfish				Inanga	Shortjaw kokopu		Redfin bully		Black mudfish	
Te Paki	Longfin eel					Inanga			Redfin bully			
Utakura[2]	Longfin eel					Inanga			Redfin bully			Northland mudfish
Waihou	Longfin eel	Torrentfish		Koaro		Inanga	Shortjaw kokopu		Redfin bully	Lamprey		Northland mudfish
Waima[3]	Longfin eel					Inanga			Redfin bully	Lamprey		Northland mudfish
Waipoua	Longfin eel			Koaro		Inanga	Shortjaw kokopu		Redfin bully	Lamprey		Northland mudfish
Wairoa	Longfin eel	Torrentfish		Koaro		Inanga	Shortjaw kokopu		Redfin bully	Lamprey	Black mudfish	
Waitangi	Longfin eel					Inanga			Redfin bully		Black mudfish	Northland mudfish
Whangape	Longfin eel					Inanga			Redfin bully			
Whangarei	Longfin eel	Torrentfish				Inanga			Redfin bully			
Whangaroa	Longfin eel					Inanga		Bluegill bully	Redfin bully	Lamprey	Black mudfish	

2 There is a likelihood that Torrentfish and Koaro are present in the Utakura River catchment but these have not been included at this time.
3 There is a likelihood that Torrentfish and Koaro are present in the Waima River catchment but these have not been included at this time.

Table 3: Threatened species strongholds

	Shortjaw kokopu	Black mudfish	Northland mudfish	Longfin eel	Torrentfish	Giant kokopu	Koaro	Dwarf inanga	Inanga	Bluegill bully	Redfin bully	Lamprey
Aupouri East		Black mudfish		Longfin eel					Inanga		Redfin bully	
Aupouri West												
Awanui		Black mudfish		Longfin eel	Torrentfish				Inanga		Redfin bully	
BOI North		Black mudfish	Northland mudfish	Longfin eel	Torrentfish				Inanga	Bluegill bully	Redfin bully	
BOI South		Black mudfish	Northland mudfish	Longfin eel	Torrentfish				Inanga	Bluegill bully	Redfin bully	
Dargaville Coast				Longfin eel					Inanga			
Doubtless Bay		Black mudfish		Longfin eel	Torrentfish				Inanga	Bluegill bully	Redfin bully	
East Coast		Black mudfish		Longfin eel	Torrentfish				Inanga	Bluegill bully	Redfin bully	Lamprey
Herekino	Shortjaw kokopu	Black mudfish		Longfin eel	Torrentfish		Koaro		Inanga		Redfin bully	
Hokianga	Shortjaw kokopu	Black mudfish	Northland mudfish	Longfin eel	Torrentfish		Koaro		Inanga		Redfin bully	Lamprey
Kaipara		Black mudfish		Longfin eel					Inanga		Redfin bully	
Kawakawa		Black mudfish		Longfin eel	Torrentfish				Inanga		Redfin bully	Lamprey
Mangamuka	Shortjaw kokopu			Longfin eel	Torrentfish		Koaro		Inanga		Redfin bully	
North Coast		Black mudfish		Longfin eel					Inanga		Redfin bully	
Pouto				Longfin eel								

Rangaunu		Black mudfish		Longfin eel					Inanga			
South Coast	Shortjaw kokopu	Black mudfish		Longfin eel	Torrentfish				Inanga		Redfin bully	
Te Paki				Longfin eel					Inanga		Redfin bully	
Utakura			Northland mudfish	Longfin eel					Inanga		Redfin bully	
Waihou	Shortjaw kokopu		Northland mudfish	Longfin eel	Torrentfish		Koaro		inanga		Redfin bully	Lamprey
Waima			Northland mudfish	Longfin eel					inanga		Redfin bully	Lamprey
Waipoua	Shortjaw kokopu		Northland mudfish	Longfin eel			Koaro		inanga		Redfin bully	Lamprey
Wairoa	Shortjaw kokopu	Black mudfish		Longfin eel	Torrentfish		Koaro		inanga		Redfin bully	Lamprey
Waitangi		Black mudfish	Northland mudfish	Longfin eel					inanga		Redfin bully	
Whangape				Longfin eel					inanga		Redfin bully	
Whangarei				Longfin eel	Torrentfish				inanga		Redfin bully	
Whangaroa		Black mudfish		longfin eel					inanga	Bluegill bully	Redfin bully	Lamprey

Key:		Regionally significant stronghold
		Indicates catchment contains more than 5% of national fish species population

Table 4: Invasive fish in Northland (Empty purple cells show records removed by EP; purple cells with white text are records added by the EP)

River catchment/ cluster	Catfish	Goldfish	Grass carp	Koi carp	Gambusia	Silver carp	Rainbow trout	Chinook salmon	Perch	Brown trout	Rudd	Tench
Aupouri East					Gambusia							
Aupouri West					Gambusia							
Awanui		Goldfish			Gambusia		Rainbow trout					
BOI North		Goldfish			Gambusia		Rrainbow trout					
BOI South					Gambusia							
Dargaville Coast					Gambusia						Rudd	
Doubtless Bay		Goldfish		Koi carp	Gambusia							
East Coast		Goldfish									Rudd	
Herekino					Gambusia							
Hokianga	Catfish		Grass carp	Koi carp	Gambusia							
Kaipara			Grass carp	Koi carp	Gambusia						Rudd	
Kawakawa	Catfish				Gambusia		Rainbow trout					
Mangamuka												
North Coast					Gambusia							
Pouto												
Rangaunu		Goldfish		Koi carp	Gambusia						Rudd	
South Coast				Koi carp	Gambusia		Rainbow trout			Brown trout		
Te Paki												
Utakura		Goldfish	Grass carp		Gambusia	Silver carp						

Waihou				Koi carp	Gambusia		Rainbow trout					
Waima		Goldfish			Gambusia							
Waipoua					Gambusia							
Wairua	Catfish	Goldfish			Gambusia		Rainbow trout			Brown trout	Rudd	
Waitangi		Goldfish			Gambusia		Rainbow trout				Rudd	Tench
Whangape												
Whangarei		Goldfish		Koi carp	Gambusia		Rainbow trout					
Whangaroa					Gambusia							

Chapter 3
Application of the RiVAS+ Methodology

Step 10: Identify rivers and interventions

Rivers for potential state assessment

The 27 river catchment/clusters identified in the RiVAS assessment (Appendix 3) were used as the basis for the RiVAS+ analysis. Insufficient time was available at the workshop to properly consider this part of the evaluation – the principal author advised that he would review the information provided in terms of RiVAS and assess whether any logical candidates for RiVAS+ stood out, with a particular emphasis on Waipoua cluster where there is a multi pipe ford which is a major fish barrier, yet one that could be easily managed.

It was suggested that a low gradient wetted face could be constructed at both ends of the causeway. An alternative would be to lower the upstream ponded area by embedding some of the pipes into the substrate. While more detailed analysis is required to assess the financial costs and freshwater ecosystem impacts of both options, the first option is probably the least damaging, and most promising in terms of remedying the barrier effect.

No new river reaches were added that represent rivers with potential value for native fishlife but hold little current value.

Potential interventions

Means (via interventions) by which river conditions may be enhanced are listed in Table 4.

Table 5: Potential interventions to enhance river values

1. Manage access		
	a. Enhance access	
		i. Helicopter access
		ii. Vehicle access
		iii. Boat access
		iv. Foot access
	b. Control access	
		i. Helicopter access
		ii. Vehicle access
		iii. Boat access
		iv. Foot access
2. Enhance flow		
	a. Increase minimum	
	b. Stabilise (around targeted specific flow)	
	c. More natural variability	
	d. Restore flood flows	
	e. Transfer water between catchments	
3. Improve bed & in-stream habitat		
	a. Maintain channel works (e.g. groynes, other structures) that enhance worth	
	b. Remove channel works (groynes, stop banks etc) that detract from worth	
	c. Control weeds (in-stream, including active river bed) to enhance worth	
	d. Remove hazards (e.g., wire, trees, old structures, forestry slash)	
	e. Leave woody debris in river that enhance worth	
	f. Improve timing of management within flood control area, including root raking	
	g. Remove woody debris to enhance worth	

4. Remove or mitigate fish barriers		
	a. Culverts (or similar – includes small weirs and pump stations)	
	b. Dams	
	c. Flood gates	
	d. Chemical	
5. Set back stopbanks		
6. Improve riparian habitat		
	a. Weed control	
	b. Pest control	
	c. Native revegetation	
	d. Remove litter	
7. Enhance water quality		
	a. Remove/fence out stock	
	b. Reduce non-point source nutrient pollution (e.g., farm nutrient budgets)	
	c. Reduce point source pollution (e.g., mining waste, storm water in urban environments)	
	d. Reduce sediment input (e.g., forest management practices)	
8. Stock with fish		
9. Provide amenities		
	a. Boat launching facilities	
	b. Car parking	
	c. Toilets	
	d. Storage facilities (for kayaks etc)	
	e. Artificial hydraulic feature (for kayakers, swimmers, anglers)	
		i) Slalom course
		ii) Play wave
		iii) Swimming hole
	f. Interpretive signage	
	g. Riverside track (for access)	
	h. Camping	
	i. Picnic tables	
	j. Location signage	
	k. Swimmers' jetty (get in)	
10. Construct water storage		
	a. In-river	
	b. Out-of-river	
11. Develop a run-of-the-river diversion		
12. Provide telemetered flow monitoring (& communicate readings)		

Appendix 4 lists the Northland Region clusters used for the RiVAS+ assessment and records the potential interventions.

Step 11: Apply indicators and indicator thresholds for potential value

Taking each river in turn, the Expert Panel considered which interventions were relevant to that river. These were recorded in Appendix 4.

The Panel then considered the net effect of these interventions upon the value of the river to native fishlife. The degree or extent of intervention was discussed. The RiVAS+ methodology calls for the panel to select the two most important interventions for each river, and for these to be practical and feasible rather than ideal.

The effect of the potential interventions was assessed for each indicator by considering the current score (from RiVAS) and identifying whether the score would change as a result of the interventions.

By definition, there are no raw data for native fishlife based on potential future conditions of a river, so the Panel focused primarily on the scores. Occasionally, the Panel considered whether interventions would be likely to shift the raw data over the relevant threshold value to a higher score.

The new scores were recorded. Where the Panel believed the interventions were likely to enhance (or degrade) river conditions for native fishlife, but that the score itself would not change, ‘+’ or ‘-‘ was recorded, indicating a positive or negative shift respectively. Where no change was thought likely, the RIVAS score was not altered (cells were left blank for convenience).

Step 12: Weight the primary attributes for potential value

Because no attributes or indicators were altered for the RIVAS+ exercise, weightings were not revisited (i.e., an equal weighting regime was automatically applied to the RIVAS+ exercise).

Step 13: Determine river potential value

The scores were summed for each river. A score of 0.5 was given to each ‘+’ and ‘-‘ (i.e., +0.5 or -0.5).

While all 27 rivers or river clusters were considered for RiVAS+ those with the lowest scores were given the most attention. The Waipoua was considered first – it would improve significantly if the multi pipe ford was ‘fixed’, something the EP noted had been planned but never undertaken.

While there are known other issues for native fish in Northland, the lack of a comprehensive barriers database meant going further with RiVAS+ at this point was not warranted.

Step 14: Review assessment process and identify future information requirements

Additional survey work, especially around lamprey could well be justified in the region. A database of barriers to native fish, designed and managed jointly between NRC and DoC would be very beneficial to native fish management.

References

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

Clapcott, J., West, D., Goodman, J., Goodwin, E., Lander, R., Lucas, J., Crone, D., Murphy, P., Palmer, M., Hughey, K.F.D. 2012. Native Fish: Development and Application of the River Values Assessment System (RiVAS and RiVAS+) Method to the Gisborne District Council Region. Land Environment and People Research Paper No. 10, Lincoln University, Canterbury.

Hughey, K., Booth, K., and Baker, M. 2010. River Values Assessment System (RiVAS) – The method. Pp. 43-64 in: Hughey, K.F.D., Baker, M-A. (eds). (2010a). The River Values Assessment System: Volume 1: Overview of the Method, Guidelines for Use and Application to Recreational Values. LEaP Report No.24A, Lincoln University, New Zealand.

Jowett, I,G., and Richardson, J. 1996. Distribution and abundance of freshwater fish in New Zealand Rivers. New Zealand Journal of Marine and Freshwater Research 30: 239-255.

Leathwick, J.R., Julian, K., Elith, J., and Rowe, D. 2008. Predicting the distribution of freshwater fish species for all New Zealand's rivers and streams. NIWA Client Report HAM2008-005, National Institute of Water and Atmospheric Research.

Appendix 1
Credentials of the Expert Panel members

The Expert Panel comprised nine members. Their credentials are:

Ken Hughey is Professor of Environmental Management, Lincoln University. Ken was formerly employed by the Department of Conservation and one area of responsibility was native fisheries management in Canterbury and on the Chatham Islands. Ken has been largely responsible for managing the development of the River Values Assessment System (RiVAS).

Nathan Burkepile is the Field Officer for Northland Fish & Game. He has a B.Sc. in Wildlife Management and a M.Sc. in Wildlife and Range Sciences. He has over 20 years' experience working in wildlife and fisheries conservation and over 8 years' experience in stream, floodplain and wetland restoration both in the United States and New Zealand.

Natalie Glover is a Policy Specialist – Water with the Northland Regional Council. She is project managing Waiora Northland Water, Northland Regional Council's implementation of the National Policy Statement for Freshwater Management.

Bruce Griffin is Estuary Management Advisor, Land and Rivers, for Northland Regional Council.

Keith Hawkins is Programme Manager, Biodiversity, Department of Conservation, Whangarei.

Kim Jones is the National and Northland Regional Coordinator for the Whitebait Connection programme. Part of this work involves leading and developing instream native fish and macroinvertebrate monitoring workshops and resources with communities around Northland and New Zealand.

Mike McGlynn was formerly employed by the Department of Conservation and is now a self-employed consultant specialising in freshwater fish issues for various Government agencies and environmental organisations. He has 22 years of freshwater fish survey experience throughout Northland.

Carol Nicholson is an Environmental Monitoring Officer with Northland Regional Council. She was previously employed as Freshwater Ecologist – Biodiversity for Horizons Regional Council where she developed and implemented the fish monitoring programme..

Mark Poynter is an Ecologist with Poynter & Associates Environmental, Whangarei. He has more than 20 years of freshwater ecological experience in Northland, particularly in relation to fisheries, water quality and flow management.

Appendix 2
Assessment criteria for native fish (Steps 2-4)

ATTRIBUTE CLUSTERS	ATTRIBUTE (primary attributes in bold)	DESCRIPTION OF PRIMARY ATTRIBUTES	INDICATORS	INDICATOR SIGNIFICANCE THRESHOLDS	DATA SOURCES and SPECIFIC APPLICATION to HBRC (and reliability)
Step 2: Identify attributes Step 3: Select and describe primary attributes		Step 3: Select and describe primary attributes	Step 4: Identify indicators	Step 5: Determine significance thresholds	
Numbers	**1. Abundance of fish (Fish)**	Compilation of the named species using the reach rated by relative abundance	Continuous variable (estimated total fish abundance) for each area – natural breaks in data at a regional scale to inform scores	3 = high estimated abundance of native species; 2 = moderate estimated abundance of native species; 1 = low estimated abundance of native species	NZFFD for species diversity and then expert input on relative abundance of each. Note that for some areas there is a limited number of records. Specifically, based on the average abundance of native fish (22 species): • use "native abundance" spread sheet in HBRC NZFFD data.xls • Range in values: min = 0, max = 236, mean = 31 • For each HBRC15 sum (total spp/total reach length sampled) • REPORT: 1. Average number native fish AND 2. Regional score 1,2,3
	2. Inanga spawning site (Spawning)	Known or surmised areas of whitebait spawning	Raw data	Raw number of spawning sites per river: 3 = 2+ known sites; 2= 1 spawning sites; 1= likely but not known; 0 = unlikely.	Expert Panel opinion (Subj.). Specifically: DOC local knowledge • Score 0 = no known spawning sites, 1 = likely spawning but not known (expert panel to assess whether 0 or 1), 2 = 1 spawning sites, 3 = 2+ spawning sites

ATTRIBUTE CLUSTERS	ATTRIBUTE (primary attributes in bold)	DESCRIPTION OF PRIMARY ATTRIBUTES	INDICATORS	INDICATOR SIGNIFICANCE THRESHOLDS	DATA SOURCES and SPECIFIC APPLICATION to HBRC (and reliability)
				(Note expert panel adjustment possible – record why)	• REPORT: 1. Number of sites AND 2. Defined score 0,1,2,3
Scarcity, Diversity, Benefits	Fish community	Biogeographic and/or regional recruitment contexts. Expected fish species diversity vs. found show healthy fish communities. Consider guilds.	Unknown		Mined from other attributes (Obj.) plus expert opinion (Subj.)
	3. Diadromous predictions (Diadromous)	FENZ provides the ability to predict which diadromous species will occur in particular locations/reaches. This data can be used to capture diversity, richness etc	Continuous variable (sum probability of occurrence) for each 3rd order catchment (length-based aggregation), and natural breaks at national scale to inform scores	3= relatively high probability of occurrence 2= moderate probability of occurrence 1= relatively low probability of occurrence	FENZ (Obj.) and then to EP for reconsideration. Predictive feature. Specifically: • Use national analysis [use sum of the probability of occurrence of 15 spp length weighted at the 3rd order group should be viewed at the national scale to inform natural breaks and assign 1,2,3] • Length weighted aggregation (e.g. sum (probability)/total stream length) to inform HBRC15 score • REPORT: 1. Average national score AND 2. Regional score 1,2,3

ATTRIBUTE CLUSTERS	ATTRIBUTE (primary attributes in bold)	DESCRIPTION OF PRIMARY ATTRIBUTES	INDICATORS	INDICATOR SIGNIFICANCE THRESHOLDS	DATA SOURCES and SPECIFIC APPLICATION to HBRC (and reliability)
	4. Number of Critical, Endangered or Vulnerable fish spp. (Declining species)	Provides a snapshot of the importance of the river for species 'at risk' (includes declining, recovering, relict, naturally uncommon – for NZ = 17 described species; Allibone et al 2010)	Named species and their conservation status	3= 7 (or more) declining or 1 or more nationally endangered spp; 2= 4 (or more) declining or 1 or more nationally vulnerable; 1 = 1 (or more) declining spp; 0 = No Threatened or At risk-declining spp.	NZFFD (Obj.). EP to consider as yet undescribed species, and related issues. Specifically: • use '"native abundance" spread sheet in HBRC NZFFD data.xls. This is the sum number of unique species labelled as declining (n = 9; NO critical, endangered or vulnerable in HBRC) • Score 0 = none declining, 1 = 1 or more declining, 2 = 4 or more declining and/or 1+ vulnerable, 3 = 7 or more declining and/or 1+ vulnerable • REPORT: 1. Number declining species AND 2. Defined score 0, 1,2,3
	Number of Declining fish species	Similar to above	Named species 5 spp.	Similar to birdlife and related to defined conservation status	NZFFD & FENZ Predicted (Obj.)
	5. Key population Threatened species (Stronghold)	Provides a measure of relative importance of rivers as strongholds for populations of 'threatened or	Named species and relative regional or national proportions of populations thought to be there in 5% classes. Populations key to the ongoing 'survival' of	3 = One (or more) population(s) considered to be of national importance; 2 = More than one population(s) considered to be of regional importance;	NZFFD (and recovery Plans (Obj.) and Expert Opinion (Subj.). Use NZFFD. Scan and rank order by species. Specifically: • Plot location of sites (DoC) • Score cluster 0 = no strongholds, 1 = at least 1 population stronghold at risk of regional importance, 2 =

ATTRIBUTE CLUSTERS	ATTRIBUTE (primary attributes in bold)	DESCRIPTION OF PRIMARY ATTRIBUTES	INDICATORS	INDICATOR SIGNIFICANCE THRESHOLDS	DATA SOURCES and SPECIFIC APPLICATION to HBRC (and reliability)
		at risk' species in New Zealand. Multiple criteria used in recovery plans including scientific, so make it EP Same list as above.	the species. Get EP to consider: 1. If basically only region with the fish then 5 sites 2. Max 3 otherwise	1 = At least one population of an at risk species of regional stronghold importance recorded in the catchment; 0 = No stronghold populations of threatened species recorded in the catchment.	2+ populations of regional importance, 3 = 1+ population of national importance • REPORT: 1. Number of sites AND 2. Defined score 0,1,2,3
Water quantity & quality)	**6. Flow regime integrity (Flow)**	Water abstraction is one pressure that affects the integrity of natural flow regimes. The greater the abstraction the lesser the integrity. This is just one indicator of integrity.	Continuous variable and 1-3 score for each 3rd order catchment (score first then aggregate – length based); natural breaks at national level to inform average regional scores Water allocation pressure spatial layer based on data up to and including 2006 which looks at the proportion of	3 = relatively no water abstraction pressure; 2 = moderate water abstraction pressure; 1 = relatively high water abstraction pressure.	RC abstraction database (Obj.). Proposed National Environmental Standards on Ecological Flows: a. For all NZREACH segments where SegFlow <= 5 cumecsWhen SegProLowFlow = 1 score 3 When SegProLowFlow >0.9 score 2 >>>0 records When SegProLowFlow <0.9 score 1 >>>677 records b. For all NZREACH segments where SegFlow > 5 cumecs When SegProLowFlow = 1 score 3 When SegProLowFlow >0.8 score 2 >>>0 records When SegProLowFlow <0.8 score 1 >>> 669 records [When SegProLowFlow = 1 >>>20583 records] c. Averaged values for 3rd order catchment Complemented by EP – existing use, timing of use, length of use.

ATTRIBUTE CLUSTERS	ATTRIBUTE (primary attributes in bold)	DESCRIPTION OF PRIMARY ATTRIBUTES	INDICATORS	INDICATOR SIGNIFICANCE THRESHOLDS	DATA SOURCES and SPECIFIC APPLICATION to HBRC (and reliability)
			consented water takes in relation to mean annual low flow (most recent layer not used because calculations based on mean flow); scores based on adherence to Proposed National Environmental Standards on Ecological Flows. Note – EP to update to evaluate whether takes are active.		Specifically: • Use national analysis [Using water allocation scores (SegPFlw123). Proportion of low flow remaining after allocated takes is viewed in relation to proposed NEF standards. For example, score 1 when flow <= 5 cumecs and flow remaining is <0.9 low flow. Assign NES standards to national data set. View length-weighted aggregation at 3rd order group and assign scores based on natural breaks] • Length weighted aggregation (e.g. sum (probability)/total stream length) to inform HBRC15 score • REPORT: 1. Mean national score AND 2. Regional score 1,2,3
	7. Water Quality (WQ)	Water quality can be measured in multiple ways and not all parameters can be included in an evaluation index. To this end it was decided to	Adopted a 'minimum operator' approach a. If sediment cover <20% = pass; if nitrate < 1.7 = pass; if MCI > 100 = pass b. If 0 or 1 components passed = 1, worst water quality; if 2 passed = 2, average water quality;	3 = best water quality; 2 = average water quality; 1= worst water quality.	a. Fine sediment cover spatial layer and sediment guidelines; b. nitrate spatial layer and nitrate toxicity guidelines; c. MCI spatial layer and MCI recommended guidelines Specifically: • Using water quality score (wq2). Includes assessment of predicted MCI, nitrate and sediment values viewed in relation to 'healthy water' guidelines. For example, score 3 = MCI > 100, sediment < 20% and nitrate < 1.7 ppm • Length-weighted aggregation (e.g.

ATTRIBUTE CLUSTERS	ATTRIBUTE (primary attributes in bold)	DESCRIPTION OF PRIMARY ATTRIBUTES	INDICATORS	INDICATOR SIGNIFICANCE THRESHOLDS	DATA SOURCES and SPECIFIC APPLICATION to HBRC (and reliability)
		consider sediment, N toxicity and MCI and to use a decision support tool to determine indicator significance. Temperature was not included because all streams have less than 20°C in the predicted mean summer temperature spatial layer in FENZ	if 3 passed = 3, best water quality Ultimately a continuous variable and 1-3 score for each 3rd order catchment (score first then aggregate – length based); regional breaks to inform scores then aggregated to area (length-based)		sum(score*length)/sum(length)) at HBRC15 level • REPORT: 1. Average regional score AND 2. Regional score 1,2,3
Natural environment	**8. Introduced fauna (Fauna)**	Presence of introduced fauna (introduced fish)	Maximum probability of **9** introduced fish species for a given segment, then length-weighted aggregation: then national natural	3 = little or no presence or impact from introduced flora and fauna ; 2 = moderate level presence of introduced	FENZ base layer exotic, informed by Expert Panel opinion (Subj.). Specifically: • Use national 3PLU analysis [Sum of regional probabilities length weighted to 3rd order, viewed at a national scale using natural breaks to inform scores]

ATTRIBUTE CLUSTERS	ATTRIBUTE (primary attributes in bold)	DESCRIPTION OF PRIMARY ATTRIBUTES	INDICATORS	INDICATOR SIGNIFICANCE THRESHOLDS	DATA SOURCES and SPECIFIC APPLICATION to HBRC (and reliability)
			breaks to inform score; area average to inform regional score Same as attribute 3	flora and fauna likely having a moderate, but survivable, population level impact on native fish; 1 = Dominating presence of life threatening introduced flora and fauna having/or likely to be having a severe population level impact on native fish.	• Length weighted aggregation (e.g. sum (probability)/total stream length) to inform HBRC15 score • REPORT: 1. Average national score AND 2. Regional score 1,2,3
	9. Physical Barriers	'Human made' structures that fully or partially prevent up- and/or down-stream fish movements	Location of barrier and calculated proportion of stream length within 20km of coast affected by barrier. 20% and <20km = 1; <20% and >20km = 2; ==3	3 = no barriers known; 2 = barrier(s) present but having minimal impact on the fish fauna (e.g., <20% of stream length 20km to coast above a barrier); 1 = barrier(s) having some impact on the fish fauna (e.g., >20% of stream length 20km to coast above a barrier).	Regional Council databases. FENZ base layers (Obj.). EP local knowledge. Specifically: • Plot location of 88 barriers –use supplied HB_fish barriers.shp • Plot nz-mainland-dam-centreline • Spatial analysis to inform scores 1 = barriers effect >20% of stream length within 20km of coastline (stream length), 2 = barriers effect <20% stream length within 20km of coastline, 3 = no barriers • REPORT: 1. Proportion of zone affected AND 2. Defined score 1,2,3
	Channelisation	Acts as descriptor of in-	Proportion of river length within 20km of	3= <5%; virtually no artificial structures or	Embankment feature (Obj)

ATTRIBUTE CLUSTERS	ATTRIBUTE (primary attributes in bold)	DESCRIPTION OF PRIMARY ATTRIBUTES	INDICATORS	INDICATOR SIGNIFICANCE THRESHOLDS	DATA SOURCES and SPECIFIC APPLICATION to HBRC (and reliability)
		river channel condition which is a driver of habitat condition for native fish.	coast with an immediate (i.e., adjacent) embankment/ channelization effect.	channelization; 2= 5-30%; a moderate level of channelisation etc; 1= >30%; a small proportion remains in a natural channel form; 0= Totally channelised, isolated etc.	
	10. Functioning riparian zone (Riparian shading)	An evaluation of the value of the riparian margin contribution to native fish habitat	Riparian shade in FENZ reflects riparian vegetation composition (potential food source and habitat availability for fish) and shading of channel (temperature control of habitat). Continuous shade variable aggregated (length based) then scored.	3= High shade (>60%) maintains temperature and provides food sources; 2= 20%-60% shade provides some structure and function; 1= <20% shade suggests poor fish habitat.	FENZ base layer (Obj.), informed then by EP (Subj.). Specifically: • Use SegRipShade • Length-weighted aggregation (e.g. Sum (SegRipShade * stream length)/ Sum(stream length)) at HBRC15 level • Score 1 = <20%, 2 = 20-60%, 3 =>60% • REPORT: 1. Average riparian cover AND 2. Defined score 1,2,3

Appendix 3
Significance assessment calculations for native fishlife in Northland (Steps 1 and 5-8)

NRC clusters	1 Fish Score		2 Spawning Score		3 Diadromous Score		4 Declining Species Score		5 Stronghold Score		6 Flow Score			7 WQ Score			8 Introduced Fauna Score			9 Physical Barrier Score		10 Riparian Shading Score				
	Average number native fish	Regional score	Number of whitebait sites	Defined score	Average national score	Regional score	Declining species	Defined score	Number of stronghold sites	Expert panel score	Average national score	Regional score	Expert panel score	Average regional score	Regional score	Expert panel score	Average national score	Regional score	Expert panel score	Proportion of zone affected	Defined score	Average riparian cover	Defined score	Sum	Importance	Comments
Kaipara Harbour	3,020.9	3	Expert panel	1	2.5	1	LFE, I, RFB, NM	2	Expert panel	0	2.8	2	2	3.1	1	1	0.77	1	2	0.045	2	0.51	2	16	Regional	WQ score raised as sand country with little runoff; Introd. fauna score increased due to influence of gambusia on mudfish
Kawakawa	77.8	1	Expert panel	1	3.7	3	LFE, TF, I, RFB, LR, BM	2	Expert panel	0	2.9	2	2	3.4	2	2	0.32	3	2	0.000	3	0.55	2	18	Regional	WQ score raised as sand country with little runoff;
Mangamuka	234.3	1	Expert panel	1	4.1	3	LFE, TF, K, I, SJK, RFB	2	Expert panel	3	2.9	3	3	4	3	3	0.42	3	3	0.000	3	0.61	3	25	National	Introd. fauna score increased due to influence of gambusia on mudfish; Physical barrier score lowered because of presence of flood gates; Rip. Shading - significant drainage scheme on the Awanui River portion - score is higher because of tributaries, e.g. Victoria and Takahue.
North Coast	328.2	1	Expert panel	1	4.0	3	LFE, TF, I, RFB, BM	2	Expert panel	0	2.8	2	2	3.5	2	2	0.65	2	2	0.000	3	0.55	2	18	Regional	WQ score raised as NRC own data suggests mid range;
Pouto	987.2	3		0	1.4	1	LFE	1	Expert panel	0	3	3	3	2.8	1	2	0.79	1	3	0.000	3	0.70	3	19	Regional	
Rangaunu	970.9	3	Expert panel	1	3.3	2	LFE, I, BM	1	Expert panel	0	2.9	2	2	3.2	2	2	1.33	1	2	0.000	3	0.52	2	18	Regional	WQ score raised as sand country with little runoff
South Coast	3,622.6	3	Expert panel	1	3.5	2	LFE, TF, I, SJK, RFB, BM	2	Expert panel	0	2.7	1	1	3.3	2	2	0.57	2	2	0.046	2	0.52	2	17	Regional	
Te Paki	885.4	2	Expert panel	1	4.8	3	LFE, I, RFB	1	Expert panel	0	2.9	3	3	3.8	3	3	0.74	1	3	0.000	3	0.73	3	22	Regional	
Utakura	41.4	1	Expert panel	1	3.2	2	LFE, I, RFB, NM	2	Expert panel	3	2.6	1	2	3.5	2	2	0.52	3	2	0.000	3	0.45	2	20	Regional	Rip. shading score high due to P. radiata shading - benefits though unclear
Waihou	640.2	2	Expert panel	1	3.6	2	LFE, TF, K, I, SJK, RFB, LR, NM	3	Expert panel	3	2.9	3	2	3.9	3	2	0.30	3	2	0.000	3	0.62	3	23	National	Rip. shading score high due to P. radiata shading - benefits though unclear
Waima	92.6	1	Expert panel	1	3.1	1	LFE, I, RFB, LR, NM	2	Expert panel	0	2.7	1	1	3.4	2	2	0.33	3	2	0.000	3	0.50	2	15	Regional	Introd. fauna score increased due to influence of gambusia on mudfish
Waipoua	601.0	2	Expert panel	1	3.4	2	LFE, K, I, SJK, RFB, LR, NM	3	Expert panel	3	2.9	3	3	4.3	3	3	0.37	3	2	0.000	1	0.65	3	23	National	Introd. fauna score lowered due to influence of gambusia on mudfish
Wairoa	1,822.5	3	Expert panel	1	2.0	1	LFE, TF, K, I, SJK, RFB, LR, BM, NM	3	Expert panel	0	2.7	1	1	3.1	1	1	0.44	3	2	0.332	1	0.45	2	15	National	
Waitangi	114.9	1	Expert panel	1	2.9	1	LFE, I, RFB, BM, NM	2	Expert panel	3	2.5	1	1	3	1	1	0.36	3	2	0.000	2	0.45	2	16	Regional	
Whangape	2.1	1	Expert panel	1	3.1	2	LFE, I, RFB	1	Expert panel	0	2.7	2	2	3.7	3	2	0.39	3	3	0.000	3	0.54	2	17	Regional	WQ score raised as sand country with little runoff; Rip. shading score high due to P. radiata shading - benefits though unclear
Whangarei	367.9	1	1	2	3.9	3	LFE, TF, I, RFB	2	Expert panel	0	2.5	1	1	3.4	2	2	0.63	2	2	0.066	2	0.54	2	17	Regional	Introd. fauna score increased due to influence of gambusia on mudfish
Whangaroa	538.6	2	Expert panel	1	5.2	3	LFE, I, BGB, RFB, LR, BM	2	Expert panel	0	2.9	2	2	3.8	3	2	0.56	2	2	0.000	3	0.58	2	19	Regional	
Kaipara Harbour	3,020.9	3	Expert panel	1	2.5	1	LFE, I, RFB, NM	2	Expert panel	0	2.8	2	2	3.1	1	1	0.77	1	2	0.045	2	0.51	2	16	Regional	Rip. shading score high due to P. radiata shading - benefits though unclear
Kawakawa	77.8	1	Expert panel	1	3.7	3	LFE, TF, I, RFB, LR, BM	2	Expert panel	0	2.9	2	2	3.4	2	2	0.32	3	2	0.000	3	0.55	2	18	Regional	Introd. fauna score lowered due to influence of gambusia on mudfish

Mangamuka	234.3	1	Expert panel	1	4.1	3	LFE, TF, K, I, SJK, RFB	2	Expert panel	3	2.9	3	3	4	3	3	0.42	3	3	0.000	3	0.61	3	25	National	Introd. fauna score lowered due to influence of gambusia on mudfish
North Coast	328.2	1	Expert panel	1	4.0	3	LFE, TF, I, RFB, BM	2	Expert panel	0	2.8	2	2	3.5	2	2	0.65	2	2	0.000	3	0.55	2	18	Regional	Introd. fauna score lowered due to influence of gambusia on mudfish; Rip. shading score high due to P. radiata shading - benefits though unclear
Pouto	987.2	3		0	1.4	1	LFE	1	Expert panel	0	3	3	3	2.8	1	2	0.79	1	3	0.000	3	0.70	3	19	Regional	Introd. fauna score lowered due to influence of gambusia on mudfish
Rangaunu	970.9	3	Expert panel	1	3.3	2	LFE, I, BM	1	Expert panel	0	2.9	2	2	3.2	2	2	1.33	1	2	0.000	3	0.52	2	18	Regional	Introd. fauna score lowered due to influence of gambusia on mudfish; Rip. shading score high due to P. radiata shading - benefits though unclear
South Coast	3,622.6	3	Expert panel	1	3.5	2	LFE, TF, I, SJK, RFB, BM	2	Expert panel	0	2.7	1	1	3.3	2	2	0.57	2	2	0.046	2	0.52	2	17	Regional	Introd. fauna score lowered due to influence of gambusia on mudfish; Barrier score raised due to irrigation intake structures
Te Paki	885.4	2	Expert panel	1	4.8	3	LFE, I, RFB	1	Expert panel	0	2.9	3	3	3.8	3	3	0.74	1	3	0.000	3	0.73	3	22	Regional	WQ score lowered due to erosion/sedimentation
Utakura	41.4	1	Expert panel	1	3.2	2	LFE, I, RFB, NM	2	Expert panel	3	2.6	1	2	3.5	2	2	0.52	3	2	0.000	3	0.45	2	20	Regional	Rip. shading score high due to P. radiata shading - benefits though unclear
Waihou	640.2	2	Expert panel	1	3.6	2	LFE, TF, K, I, SJK, RFB, LR, NM	3	Expert panel	3	2.9	3	2	3.9	3	2	0.30	3	2	0.000	3	0.62	3	23	National	WQ score lowered due to sediment input

Significance thresholds (highlighted columns)		
Green	High = National	
Blue	Medium = Regional	
Yellow	Low = Local	

	Data reliability (font colour)
Black	Reliable data
Red	Data checked by Expert Panel and has been adjusted

Appendix 4
Potential significance assessment calculations for native fishlife (RiVAS+) (Steps 10-13)

HB zones		1 Fish Score		2 Spawning Score		3 Diadromous Score		4 Declining Species Score		5 Stronghold Score		6 Flow Score		7 WQ Score		8 Introduced Fauna Score		9 Physical Barrier Score		10 Riparian Shading Score					
	Intervention	Average number native fish	Regional score	Number of whitebait sites	Defined score	Average national score	Regional score	Number declining species	Defined score	Number of stronghold sites	Defined score	Average national score	Regional score	Average regional score	Regional score	Average national score	Regional score	Proportion of zone affected	Defined score	Average riparian cover	Defined score	Sum of RiVAS	Importance	Sum of RiVAS+	Importance
Aupouri East		1,186.6	3	Expert panel	1	3.1	1	LFE, I, RFB, BM	2	Expert panel	3	2.9	2	3.1	2	1.20	2	0.000	3	0.58	2	20	Regional		
Aupouri West		563.5	2		0	2.4	1		0	Expert panel	0	2.9	3	3	2	1.10	2	0.000	3	0.77	3	14	Regional		
Awanui		980.5	3	Expert panel	1	2.9	1	LFE, TF, I, RFB, BM	2	Expert panel	0	2.7	1	3.1	1	0.70	2	0.000	1	0.42	2	15	Regional		
BOI North		598.1	2	Expert panel	1	3.6	2	LFE, TF, I, BGB, RFB, BM, NM	3	Expert panel	3	2.5	1	2.9	2	0.65	2	0.091	2	0.44	2	20	National		
BOI South		942.1	3	Expert panel	1	4.6	3	LFE, TF, I, BGB, RFB, BM, NM	3	Expert panel	0	2.9	3	4.1	3	0.64	2	0.000	3	0.70	3	22	National		
Dargaville Coast		721.1	2	Expert panel	1	2.5	1	LFE, I	1	Expert panel	0	2.9	3	3.1	2	0.79	2	0.000	3	0.54	2	15	Regional		
Doubtless Bay		403.8	1	Expert panel	1	4.7	3	LFE, TF, I, BGB, RFB, BM	2	Expert panel	3	2.9	2	3.5	2	0.62	2	0.000	3	0.52	2	21	Regional		
East Coast		1,697.3	3	Expert panel	1	4.4	3	LFE, TF, BGB, RFB, LR, BM, NM	3	Expert panel	1	2.8	2	3.6	2	0.59	3	0.006	2	0.59	2	22	National		
Herekino		493.8	2	Expert panel	1	3.6	2	LFE, TF, K, I, SJK, RFB, BM	3	Expert panel	1	2.9	3	3.9	3	0.67	2	0.000	3	0.63	3	21	National		
Hokianga		554.9	2	Expert panel	1	3.6	2	LFE, TF, K, I, SJK, RFB, BM, NM	3	Expert panel	0	2.8	2	3.7	2	0.78	1	0.000	3	0.60	2	18	National		
Kaipara		3,020.9	3	Expert panel	1	2.5	1	LFE, I, RFB, NM	2	Expert panel	0	2.8	2	3.1	1	0.77	2	0.045	2	0.51	2	16	Regional		
Kawakawa		77.8	1	Expert panel	1	3.7	3	LFE, TF, I, RFB, LR, BM	2	Expert panel	0	2.9	2	3.4	2	0.32	2	0.000	3	0.55	2	17	Regional		
Mangamuka		234.3	1	Expert panel	1	4.1	3	LFE, TF, K, I, SJK, RFB	2	Expert panel	3	2.9	3	4	3	0.42	3	0.000	3	0.61	3	23	National		
North Coast		328.2	1	Expert panel	1	4.0	3	LFE, I, RFB, BM	2	Expert panel	0	2.8	2	3.5	2	0.65	2	0.000	3	0.55	2	18	Regional		
Pouto		987.2	3		0	1.4	1	LFE	1	Expert panel	0	3	3	2.8	2	0.79	3	0.000	3	0.70	3	17	Regional		
Rangaunu		970.9	3	Expert panel	1	3.3	2	LFE, I, BM	1	Expert panel	0	2.9	2	3.2	2	1.33	2	0.000	3	0.52	2	17	Regional		
South Coast		3,622.6	3	Expert panel	1	3.5	2	LFE, TF, I, SJK, RFB, BM	2	Expert panel	0	2.7	1	3.3	2	0.57	2	0.046	2	0.52	2	17	Regional		
Te Paki		885.4	2	Expert panel	1	4.8	3	LFE, I, RFB	1	Expert panel	0	2.9	3	3.8	3	0.74	3	0.000	3	0.73	3	20	Regional		

Utakura		41.4	1	Expert panel	1	3.2	2	LFE, I, RFB, NM	2	Expert panel	3	2.6	1	3.5	2	0.52	2	0.000	3	0.45	2	20	Regional		
Waihou		640.2	2	Expert panel	1	3.6	2	LFE, TF, K, I, SJK, RFB, LR, NM	3	Expert panel	3	2.9	3	3.9	2	0.30	2	0.000	3	0.62	3	23	National		
Waima		92.6	1	Expert panel	1	3.1	1	LFE, I, RFB, LR, NM	2	Expert panel	0	2.7	1	3.4	2	0.33	2	0.000	3	0.50	2	15	Regional		
Waipoua	4a	601.0	2 (+0.5)	Expert panel	1	3.4	2	LFE, K, I, SJK, RFB, LR, NM	3	Expert panel	3 (+0.5)	2.9	3	4.3	3	0.37	2	0.000	1 (+2)	0.65	3	23	National	26	National
Wairoa		1,822.5	3	Expert panel	1	2.0	1	LFE, TF, K, I, SJK, RFB, LR, BM, NM	3	Expert panel	0	2.7	1	3.1	1	0.44	2	0.332	1	0.45	2	16	National		
Waitangi		114.9	1	Expert panel	1	2.9	1	LFE, I, RFB, BM, NM	2	Expert panel	3	2.5	1	3	1	0.36	2	0.000	2	0.45	2	17	Regional		
Whangape		2.1	1	Expert panel	1	3.1	2	LFE, I, RFB	1	Expert panel	0	2.7		3.7	2	0.39	3	0.000	3	0.54	2	17	Regional		
Whangarei		367.9	1	1	2	3.9	3	LFE, TF, I, RFB	2	Expert panel	0	2.5	1	3.4	2	0.63	2	0.066	2	0.54	2	17	Regional		
Whangaroa		538.6	2	Expert panel	1	5.2	3	LFE, I, BGB, RFB, LR, BM	2	Expert panel	0	2.9	2	3.8	2	0.56	2	0.000	3	0.58	2	19	Regional		

Significance thresholds (highlighted columns)

Green	High = National
Blue	Medium = Regional
Yellow	Low = Local

Data reliability (font colour)

Black	Reliable data
Blue/Purple	Less reliable data
Red	Data checked by Expert Panel and has been adjusted

RiVAS+ (highlighted rows)

Blue	Also assessed for potential future state (RiVAS+)
Orange	Score changed by proposed interventions (RiVAS+)
Green	Positive influence on attribute but not enough to shift value - counted as an increase of 0.5 (RiVAS+)