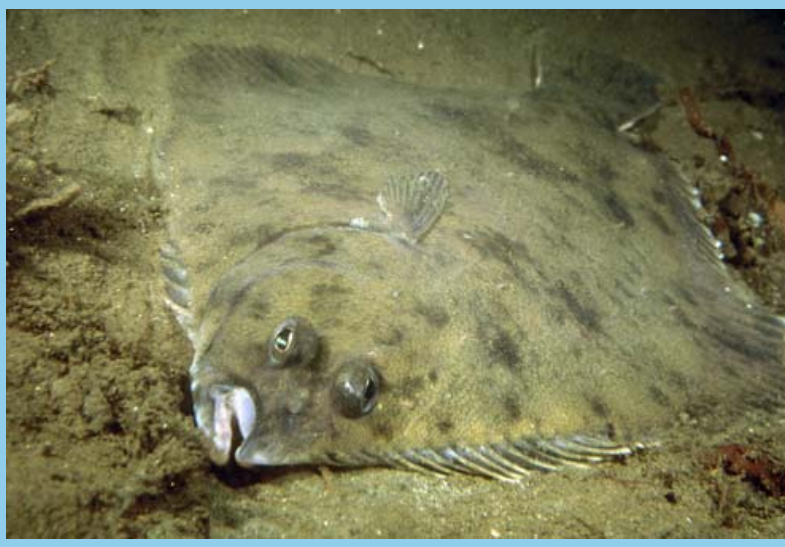
Native Fish in Hawke's Bay: Development and Application of the River Values Assessment System (RiVAS and RiVAS+)



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LEaP Research Paper No. 18
August 2012

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Land Environment & People

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Executive Summary

The second application of the River Values Assessment System (RiVAS and RiVAS+) for native fisheries value was made in the Hawke's Bay Region. Of 16 rivers or river clusters evaluated, four were considered of national significance, namely the Tukituki, Ngaruroro, Tutaekuri, and Wairoa; the remainder, except the Napier Coast cluster which is 'local', are of regional significance. 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. The RiVAS+ methodology was also applied to assess future potential value. Of the 16 rivers or clusters, eight altered their sum total score, all in a positive direction. The Tukituki, Karamu and Napier Coast all shifted most but still remained in their same importance categories. The interventions most frequently identified for enhancing native fishlife value (with the number of times it was identified across all rivers given in brackets) were: Enhance Water Quality – remove/fence out stock (6) (but noting this intervention for Hawke's Bay is mostly around protecting Inanga spawning sites), and Enhance Water Quality – reduce sediment input (3).

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Chapter 1
Introduction

1.1 Purpose

This report[1] presents the development, and an application, of the River Values Assessment System for existing value (RiVAS) and for potential value (RiVAS+) to native fisheries in rivers of the Hawke's Bay Region, undertaken in August 2012. The first full application was made in Gisborne (Clapcott et al., 2012) in March 2012. This Hawke's Bay Region native fisheries report needs to be read in conjunction with that report and with the overall method report (see Hughey et al., 2010).

1.2 Preparatory step: Establish a regional expert panel

Joanne Clapcott and Eric Goodwin (Cawthron Institute), aided by Fiona Cameron, assembled the raw data for Hawke's Bay.

The Regional Expert Panel (EP) was Ken Hughey (facilitator, Lincoln University), Helen Jonas (DoC), John Cheyne (Fish and Game, Hawke's Bay), Hans Rook (DoC), Fiona Cameron (HBRC), Iain Maxwell (HBRC) and Tim Sharp (HBRC).

The Regional EP met on 20th August 2012 in Napier 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.

1 The authors wish to acknowledge the earlier work and inputs made by Dr Mike Joy from Massey University to thinking about how to rank the native fisheries value. Subsequent peer reviews by Shelley McMurtrie from EOS Ecology and John Leathwick of NIWA led ultimately to the revised approach presented in this report.

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 fishlife in Hawke's Bay Region

The freshwater fish fauna of Hawke's Bay is few with only 16 of the 35 (46%) of the national native taxa represented. One coloniser, a recent arrival to New Zealand is the Australian Longfin eel which has been recorded for the first time in 2011 in the Tutaekuri River.

Table 1
Native fish taxa found in Hawke's Bay

Species	Threat Status	Migration
Longfin eel	Declining	Catadromous
Short finned eel	Not threatened	Catadromous
Koaro	Declining	Diadromous
Banded kokopu	Not threatened	Diadromous
Torrentfish	Declining	Diadromous
Redfin bully	Declining	Diadromous
Common bully	Not threatened	Diadromous
Bluegill bully	Declining	Diadromous
Inanga	Declining	Diadromous
Common smelt	Not threatened	Anadromous
Upland bully	Not threatened	Non-migratory
Crans bully	Not threatened	Non-migratory
Black flounder	Not threatened	Catadromous
Dwarf galaxiid	Declining	Non-migratory
Giant bully	Not threatened	Diadromous
Lamprey	Declining	Anadromous
Australian Longfin eel	Coloniser	Catadromous

The Hawke's Bay fish fauna is characterised by the dominance of migratory species. Volcanism in the Central North Island has contributed to the diminished non-migratory taxa present. Only three non-migratory species persist in the Hawke's Bay region. These are Upland and Crans bully (which require very similar habitats) and the Dwarf galaxiid which has stronghold populations in the Tukituki and Ngaruroro catchments.

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 Hawke's Bay rising to 8 taxa. This is especially important in Hawke's Bay

where the total number of species present in the region is considerably lower than in other regions around New Zealand. Of special note are the Torrentfish, Koaro, Bluegill bully and Redfin bully which once were abundant throughout the Hawke's Bay area but are showing significant declines nationally, which is likely to be reflected regionally. Banded kokopu are present in the region, although their distribution is low and localised to the headwater streams of Lake Tutira as well as the smaller, more vegetated coastal streams, i.e., Pakuratahi Stream.

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 Hawke's Bay Region where 15 of the 16 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 Hawke's Bay 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.

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 of 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/).

Initially, 15 management units (individual rivers or river clusters) were identified for Hawke's Bay. However, these did not give 100% regional coverage and so at the EP workshop a 16th cluster, Northern Coastal, was added. The 16 management units for the Hawke's Bay included the major individual rivers each on their own, e.g., Tukituki and Wairoa, and clusters of like rivers and streams, e.g., Napier Coastal. The list of management units (apart from Northern Coastal), ordered geographically from north to south (Figure 1), was taken by

Cawthron Institute and populated with raw data for EP consideration. The EP used its own knowledge to populate all 10 indicators for Northern Coastal.

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. The Hawke's Bay Region rivers and streams have approximately 860 records (Cameron, pers. comm., August 2012). The distribution of sampling sites shows good coverage of the region with most rivers and streams types represented.

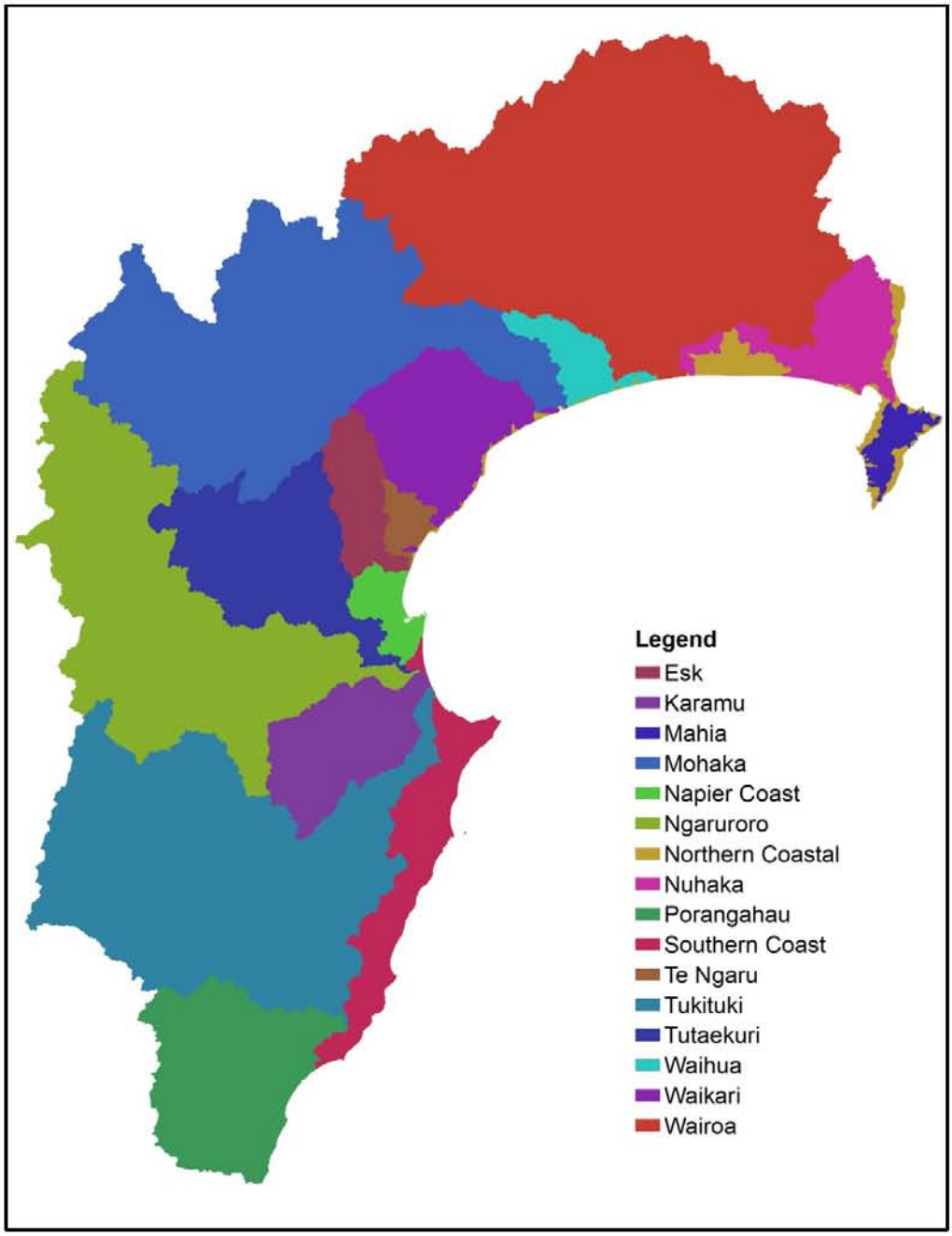
Comparing and ranking of rivers using only NZFFD data, where some rivers have many records and some rivers have none, is therefore not appropriate as they cannot be objectively assessed and there will always be a bias towards rivers and streams that have been sampled more frequently (i.e., there is more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

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 clusters for native fish in Hawke's Bay Region



Other Considerations

When applying this method in the Hawke's Bay Region, it was not considered appropriate to treat migratory and non-migratory species separately, however, in some regions it might be, especially when the non-migratory species have extremely high conservation interest (e.g., much of the east coast of the South Island). However, at this stage, 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 the Hawke's Bay Region 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.

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 the sub-catchment scale in the case of large rivers.

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 Hawke's Bay (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.

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. The original pre-EP data set is shown in Appendix 3A.

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. The spreadsheet for the selection of management units is set out in 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

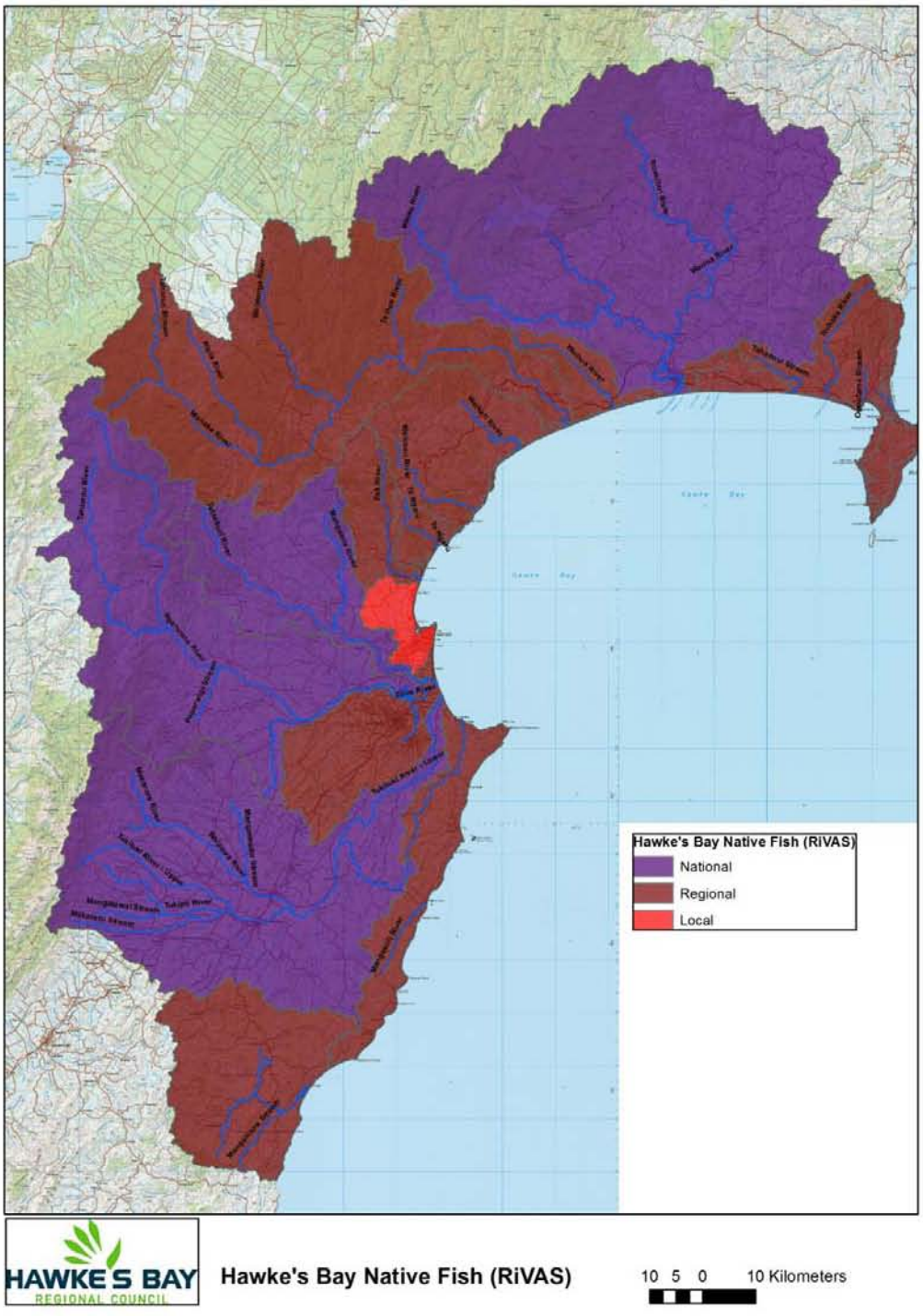
Using the list from Step 8a, the Expert Panel examined the rivers, and their attribute scores. The following criteria were applied:

National significance:
Criterion 1: Total score of all indicator columns is 24 or more; or
Criterion 2: Declining species score 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 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 16 rivers or clusters thereof were considered: 4 were deemed to be of national significance, namely the Tukituki, Ngaruroro, Tutaekuri, and Wairoa; 11 of regional and 1 of local significance. These findings are mapped in Figure 2.

Figure 2
Hawkes Bay native fish rivers/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.

Chapter 3
Application of the RiVAS+ Methodology

Step 10: Identify rivers and interventions

Rivers for potential state assessment

The 16 river clusters identified in the RiVAS assessment (see Appendix 3) were used as the basis for the RiVAS+ analysis.

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 1.

Table 2
Potential interventions to enhance river values

1. Enhance access		
	a. Helicopter access	
	b. Vehicle access	
	c. Boat access	
	d. 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	
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)	
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 Hawke's Bay Region river sections 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).

Sometimes discussion slipped into consideration of protecting current value or avoiding its degradation. It was reinforced that the RiVAS provides information to assist decision-makers with those policy questions, and the Panel was steered back to addressing potential future value.

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 16 rivers or river clusters were considered for RiVAS+ those with the lowest scores were given the most attention. Of the 16 rivers or clusters, eight altered their sum total score, all in a positive direction. The Tukituki, Karamu and Napier Coast all shifted most (by +3 points) but still remained in their same importance categories – the latter two of these rivers would gain most by the removal of barriers to native fish movement (Intervention 4a). The interventions most frequently identified for enhancing native fishlife value (with the number of times it was identified across all rivers given in brackets) were: Enhance Water Quality – remove/fence out stock (6) (but noting this intervention for Hawke's Bay is mostly around protecting Inanga spawning sites), and Enhance Water Quality – reduce sediment input (3).

In total, eight rivers were identified as having potential to improve river conditions in a way that would enhance native fishlife value. The interventions most frequently identified for enhancing native fishlife value (with the number of times it was identified across all rivers given in brackets) were:

1. 7a, Enhance Water Quality – remove/fence out stock (6), bus as above noting this is mainly for Inanga spawning site protection
2. 7d, Enhance Water Quality – reduce sediment input (3)
3. 4a, Remove or mitigate fish barriers – (a) culverts (2) (including in HBRC also better management of small weirs and pump stations in the Karamu and Napier Coastal rivers.

Appendix 5 provides a list of rivers ranked by their potential increase in value for native fishlife, with possible interventions identified for each river.

Step 14: Review assessment process and identify future information requirements

Additional survey work, especially around lamprey could well be justified in the region.

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Appendix 1
Credentials of the Expert Panel members

The Expert Panel comprised six members. Their credentials are:

Helen Jonas has been a Ranger for the Department of Conservation in Wairoa since 1990. In that time she has worked on numerous projects, including many involving native fish. In recent years, Helen's work has focussed on the monitoring and management of whitebait (inanga) spawning habitat areas.

Hans Rook is a biodiversity ranger for the Department of Conservation. Hans has spent 40 years working on conservation around New Zealand first with the NZ Wildlife Service and then, the Department of Conservation. Based in Hawke's Bay for the last 30 years, Hans has spent a considerable part of this time working to restore spawning sites for whitebait, breeding grounds for the nationally endangered Australasian bittern and leading the way in marine mammal conservation.

Tim Sharp is a Strategic Policy Advisor for the Hawke's Bay Regional Council where he coordinates the RiVAS programme for Council. He has an environmental management background, specialising in resource management to assess and support community values.

John Cheyne has spent 44 years working on conservation matters for the NZ Wildlife Service, Department of Conservation and Fish and Game Hawke's Bay. John has been based in Hawke's Bay for the last 24 years. A significant part of this time has been spent working on improving the management of wetland and rivers. He has much experience and knowledge concerning native fish.

Fiona Cameron is a Senior Resource Analyst for the Hawke's Bay Regional Council working within the Water Quality and Ecology team. Fiona has been working for HBRC for 5 years, managing the regional wetland monitoring programme and specialises in river and wetland monitoring.

Iain Maxwell leads the Resource Management Group of HBRC motivating a group that spans scientists and staff involved in implementing the RMA. He has 21 years experience as a freshwater ecologist in a career that spans time with the Department of Conservation, Fish and Game New Zealand and the Cawthron Institute. He has specialist skills in in-stream habitat requirements for freshwater fish and has spent 11 years of his career involved in natural resource management in the Hawke's Bay. He has had experience in using RIVAS for recreational fisheries in the Hawke's Bay.

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).

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. (Note expert panel adjustment possible – record why)	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 • 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	Continuous variable (sum probability of occurrence) for each 3rd order catchment	3= relatively high probability of occurrence 2= moderate probability	FENZ (Obj.) and then to EP for reconsideration. Predictive feature. Specifically: • Use national analysis [use sum of the probability of

ATTRIBUTE CLUSTERS	ATTRIBUTE (primary attributes in bold)	DESCRIPTION OF PRIMARY ATTRIBUTES	INDICATORS	INDICATOR SIGNIFICANCE THRESHOLDS	DATA SOURCES and SPECIFIC APPLICATION to HBRC (and reliability)
		species will occur in particular locations/reaches. This data can be used to capture diversity, richness etc	(length-based aggregation), and natural breaks at national scale to inform scores	of occurrence 1= relatively low probability of occurrence	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
	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 at risk' species in New Zealand. Multiple criteria used in recovery plans including scientific, so make it EP Same list as above.	Named species and relative regional or national proportions of populations thought to be there in 5% classes. Populations key to the ongoing 'survival' of the species. Get EP to consider: 1. If basically only region with the fish then 5 sites 2. Max 3 otherwise	3 = One (or more) population(s) considered to be of national importance; 2 = More than one population(s) considered to be of regional importance; 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	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 = 2+ populations of regional importance, 3 = 1+ population of national importance • REPORT: 1. Number of sites AND 2. Defined score 0,1,2,3

ATTRIBUTE CLUSTERS	ATTRIBUTE (primary attributes in bold)	DESCRIPTION OF PRIMARY ATTRIBUTES	INDICATORS	INDICATOR SIGNIFICANCE THRESHOLDS	DATA SOURCES and SPECIFIC APPLICATION to HBRC (and reliability)
				recorded in the catchment.	
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 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.	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. 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 consider	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; if 3 passed = 3, best	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. sum(score*length)/sum(length)) at HBRC15 level

ATTRIBUTE CLUSTERS	ATTRIBUTE (primary attributes in bold)	DESCRIPTION OF PRIMARY ATTRIBUTES	INDICATORS	INDICATOR SIGNIFICANCE THRESHOLDS	DATA SOURCES and SPECIFIC APPLICATION to HBRC (and reliability)
		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	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)		• 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 breaks to inform score; area average to inform regional score Same as attribute 3	3 = little or no presence or impact from introduced flora and fauna ; 2 = moderate level presence of introduced 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.	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] • 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 = 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);	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

ATTRIBUTE CLUSTERS	ATTRIBUTE (primary attributes in bold)	DESCRIPTION OF PRIMARY ATTRIBUTES	INDICATORS	INDICATOR SIGNIFICANCE THRESHOLDS	DATA SOURCES and SPECIFIC APPLICATION to HBRC (and reliability)
			==3	1 = barrier(s) having some impact on the fish fauna (e.g., >20% of stream length 20km to coast above a barrier).	>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-river channel condition which is a driver of habitat condition for native fish.	Proportion of river length within 20km of coast with an immediate (i.e., adjacent) embankment/ channelization effect.	3= <5%; virtually no artificial structures or 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.	Embankment feature (Obj)
	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 Hawke's Bay (Steps 1 and 5-8)

Hawke's Bay management units	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	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	RiVAS Sum	Importance	Comments
Porangahau	122002	2	4	3	1.92	2	3	1	I,	1	2.90	3	3.20	2	2.97	3	0.00	3	0.45	2	22	Regional	Updated spawning data - DoC; Sewage treatment issue
SouthCoast	25403	1	0	0	1.91	2	5	2		0	2.69	2	3.31	1	2.65	2	0.00	3	0.49	2	15	Regional	
Tukituki	198740	3	2	3	1.42	1	8	3	I, L,K, DG	2	2.66	1	3.11	2	2.86	2	0.00	3	0.47	2	22	National	Updated spawning data - DoC
Karamu	51074	1	1	2	2.02	2	4	2		0	2.42	1	3.34	1	2.58	2	0.96	1	0.19	1	13	Regional	Regional because declining species score is 2
Ngaruroro	120040	2	1	2	1.01	1	8	3	LFE, I, BK, L, K, DG	2	2.82	1	3.95	3	2.57	2	0.11	3	0.60	3	22	National	There are barriers but amount of upstream network affected is not significant
Tutaekuri	92209	2	1	2	1.50	1	7	3	I, L, K,	2	2.79	2	3.80	3	2.70	2	0.39	2	0.60	3	22	National	
Napier Coast	3794	1	0	0	2.50	3	3	1		0	2.75	2	3.50	1	2.55	2	0.84	1	0.15	1	12	Local	Huge reduction in riparian protection estimate
Esk	25212	1	1	2	1.85	2	4	2		0	2.89	2	3.58	2	2.94	2	0.00	3	0.56	2	18	Regional	
TeNgaru	14541	1	1	2	2.52	3	6	2		0	2.91	3	3.40	2	2.44	2	0.40	1	0.55	2	18	Regional	
Waikari	59078	1	0	0	1.84	2	6	2	BGB, BK,	2	2.91	3	3.49	2	2.89	2	0.00	3	0.53	2	19	Regional	
Mohaka	40305	1	1	2	0.93	1	6	2	LFE, K,	2	2.92	3	4.38	3	2.38	2	0.00	3	0.66	3	22	Regional	Natural barriers limit diversity etc
Waihua	1640	1	0	0	2.56	3	2	1		0	2.96	3	3.52	2	2.64	3	0.00	3	0.52	2	18	Regional	
Wairoa	269879	3	2	3	1.34	1	7	3	LFE, I, K	2	2.92	3	3.94	3	2.64	2	0.00	3	0.60	3	26	National	There are barriers (dams) but amount of upstream network affected is not significant
Nuhaka	53022	1	1	2	2.50	3	6	2	I,	1	2.90	3	3.51	2	2.77	3	0.00	3	0.53	2	22	Regional	
Mahia	20480	1	0	0	2.56	3	4	2		0	2.87	3	3.69	2	2.22	3	0.00	3	0.45	2	19	Regional	No known Gambusia; check for BK abundance over time
Northern HB Coast	ep	1	0	0	ep	3	4	2		0	ep	3	ep	1	ep	2	ep	2	0.15	1	15	Regional	Regional because declining species score is 2

Sp. Codes GK = Giant Kokupu; SJK = Short Jawed Kokupu; BK = Banded Kokupu; LFE = Long Finned Eel; K= Koaro; DG= Dwarf Galaxid; TF= Torrentfish; L= Lamprey; RFB=Red fin bully; BGB= Blue gill bully; I= Inanga

* declining species list

									Number
Porangahau	Longfin eel	Inanga	Redfin bully						3
SouthCoast	Longfin eel	Inanga	Redfin bully	Bluegill bully		Torrentfish			5

Tukituki	Longfin eel	Inanga	Redfin bully	Bluegill bully	Lamprey	Torrentfish	Koaro	Dwarf galaxid	8
Karamu	Longfin eel	Inanga	Redfin bully		Lamprey	Torrentfish		Dwarf galaxid	4
Ngaruroro	Longfin eel	Inanga	Redfin bully	Bluegill bully	Lamprey	Torrentfish	Koaro	Dwarf galaxid	8
Tutaekuri	Longfin eel	Inanga	Redfin bully	Bluegill bully	Lamprey	Torrentfish	Koaro		7
NapierCoast	Longfin eel	Inanga				Torrentfish			3
Esk	Longfin eel	Inanga		Bluegill bully		Torrentfish			4
TeNgaru	Longfin eel	Inanga	Redfin bully	Bluegill bully		Torrentfish	Koaro		6
Waikaro	Longfin eel	Inanga	Redfin bully	Bluegill bully		Torrentfish	Koaro		6
Mohaka	Longfin eel	Inanga	Redfin bully	Bluegill bully		Torrentfish	Koaro		6
Waihua	Longfin eel	Inanga							2
Wairoa	Longfin eel	Inanga	Redfin bull	Bluegill bully	Lamprey	Torrentfish	Koaro		7
Nuhaka	Longfin eel	Inanga	Redfin bull	Bluegill bully		Torrentfish	Koaro		6
Mahia	Longfin eel	Inanga	Redfin bull			Torrentfish			4
HB Coast	Longfin eel	Inanga	Redfin bully				Koaro		4

Significance thresholds (highlighted columns)

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

Misc (highlighted rivers)

Pink	Rivers overlap with neighbouring council

Data reliability (font colour)

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

Appendix 3a
Significance assessment calculations for native fishlife in Hawke's Bay (Steps 1 and 5-8) – original data – pre EP consideration

Hawke's Bay 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		
	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
Porangahau	122002	2	2	3	1.92	2	3	1			2.90	3	3.20	1	2.97	3	0.00	3	0.45	2	20
SouthCoast	25403	1	0	0	1.91	2	5	2			2.69	2	3.31	1	2.65	2	0.00	3	0.49	2	15
Tukituki	198740	3	1	2	1.42	1	8	3			2.66	2	3.11	1	2.86	3	0.00	3	0.47	2	20
Karamu	51074	1	1	2	2.02	2	4	2			2.42	2	3.34	1	2.58	2	0.96	1	0.59	2	15
Ngaruroro	120040	2	1	2	1.01	1	8	3			2.82	3	3.95	3	2.57	2	0.11	2	0.57	2	20
Tutaekuri	92209	2	1	2	1.50	1	6	2			2.79	2	3.80	3	2.70	2	0.39	1	0.59	2	17
NapierCoast	3794	1	0	0	2.50	3	3	1			2.75	2	3.50	2	2.55	2	0.84	1	0.65	3	15
Esk	25212	1	1	2	1.85	2	4	2			2.89	3	3.58	2	2.94	3	0.00	3	0.56	2	20
TeNgaru	14541	1	1	2	2.52	3	6	2			2.91	3	3.40	2	2.44	1	0.40	1	0.55	2	17
Waikaro	59078	1	0	0	1.84	2	6	2			2.91	3	3.49	2	2.89	3	0.00	3	0.53	2	18
Mohaka	40305	1	1	2	0.93	1	6	2			2.92	3	4.38	3	2.38	1	0.00	3	0.66	3	19
Waihua	1640	1	0	0	2.56	3	1	1			2.96	3	3.52	2	2.64	2	0.00	3	0.52	2	17
Wairoa	269879	3	1	2	1.34	1	7	3			2.92	3	3.94	3	2.64	2	0.00	3	0.55	2	22
Nuhaka	53022	1	1	2	2.50	3	6	2			2.90	3	3.51	2	2.77	3	0.00	3	0.53	2	21
Mahia	20480	1	0	0	2.56	3	3	1			2.87	3	3.69	2	2.22	1	0.00	3	0.61	3	17

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
Porangahau	7c	122002	2	4	3	1.92	2	3	1	I,	1	2.90	3	3.20	2 (+0.5)	2.97	3	0.00	3	0.45	2	22	Regional	22.5	Regional
South Coast		25403	1	0	0	1.91	2	5	2		0	2.69	2	3.31	1	2.65	2	0.00	3	0.49	2	15	Regional		Regional
Tukituki	2a, 7b	198740	3	2	3	1.42	1	8	3	I, L,K, DG	2	2.66	1 (+2)	3.11	2 (+1)	2.86	2	0.00	3	0.47	2	22	National	25	National
Karamu	4a, 7d	51074	1	1	2	2.02	2	4	2		0	2.42	1	3.34	1 (+1)	2.58	2	0.96	1 (+2)	0.19	1	13	Regional	16	Regional
Ngaruroro		120040	2	1	2	1.01	1	8	3	LFE, I, BK, L, K, DG	2	2.82	1	3.95	3	2.57	2	0.11	3	0.60	3	22	National		National
Tutaekuri		92209	2	1	2	1.50	1	7	3	I, L, K,	2	2.79	2	3.80	3	2.70	2	0.39	2	0.60	3	22	National		National
Napier Coast	4a, 7c	3794	1	0	0	2.50	3	3	1		0	2.75	2	3.50	1 (+1)	2.55	2	0.84	1 (+2)	0.15	1	12	Local	15	Local
Esk		25212	1	1	2	1.85	2	4	2		0	2.89	2	3.58	2	2.94	2	0.00	3	0.56	2	18	Regional		Regional
TeNgaru		14541	1	1	2	2.52	3	6	2		0	2.91	3	3.40	2	2.44	2	0.40	1	0.55	2	18	Regional		Regional
Waikari		59078	1	0	0	1.84	2	6	2	BGB, BK,	2	2.91	3	3.49	2	2.89	2	0.00	3	0.53	2	19	Regional		Regional
Mohaka	7a	40305	1	1	2 (+0.5)	0.93	1	6	2	LFE, K,	2	2.92	3	4.38	3	2.38	2	0.00	3	0.66	3	22	Regional	22.5	Regional
Waihua	7a	1640	1	1	2	2.56	3	2	1		0	2.96	3	3.52	2	2.64	3	0.00	3	0.52	2	18	Regional		Regional
Wairoa	7c	269879	3	2	3	1.34	1	7	3	LFE, I, K	2	2.92	3	3.94	3 (+0.5)	2.64	2	0.00	3	0.60	3	26	National	26.5	National
Nuhaka	7a	53022	1	2	3	2.50	3	6	2	I,	1	2.90	3	3.51	2	2.77	3	0.00	3	0.53	2	22	Regional		Regional
Mahia	7a, 6c	20480	1	1	2	2.56	3	4	2		0	2.87	3	3.69	2 (+0.5)	2.22	3	0.00	3	0.45	2 (+0.5)	19	Regional	20	Regional
Northern HB Coast	7a	ep	1	1	2 (+2)	ep	3	4	2		0	ep	3	ep	1	ep	2	ep	2	0.15	1	15	Regional	17	Regional

Sp. Codes: GK = Giant Kokupu; SJK = Short Jawed Kokupu; BK = Banded Kokupu; LFE = Long Finned Eel; K= Koaro; DG= Dwarf Galaxid; TF= torrentfish; L= Lamprey; RFB=Red fin bully; BGB= Blue gill bully; I= Inanga

	Declining species present								Number
Porangahau	Longfin eel	inanga	redfin bully						3
SouthCoast	Longfin eel	inanga	redfin bully	bluegill bully		torrentfish			5
Tukituki	Longfin eel	inanga	redfin bully	bluegill bully	lamprey	torrentfish	koaro	dwarf galaxid	8
Karamu	Longfin eel	inanga			lamprey			dwarf galaxid	4

Ngarururoro	Longfin eel	inanga	redfin bully	bluegill bully	lamprey	torrentfish	koaro	dwarf galaxid	8
Tutaekuri	Longfin eel	inanga	redfin bully	bluegill bully	lamprey	torrentfish	koaro		7
NapierCoast	Longfin eel	inanga				torrentfish			3
Esk	Longfin eel	inanga		bluegill bully		torrentfish			4
TeNgaru	Longfin eel	inanga	redfin bully	bluegill bully		torrentfish	koaro		6
Waikaro	Longfin eel	inanga	redfin bully	bluegill bully		torrentfish	koaro		6
Mohaka	Longfin eel	inanga	redfin bully	bluegill bully		torrentfish	koaro		6
Waihua	Longfin eel	Inanga							2
Wairoa	Longfin eel	inanga	redfin bull	bluegill bully	lamprey	torrentfish	koaro		7
Nuhaka	Longfin eel	inanga	redfin bull	bluegill bully		torrentfish	koaro		6
Mahia	Longfin eel	inanga	redfin bull			torrentfish			4
HB Coast	Longfin eel	inanga	redfin bull				koaro		4

Significance thresholds (highlighted columns)

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

Misc (highlighted rivers)

Pink	Rivers overlap with neighbouring council

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+)