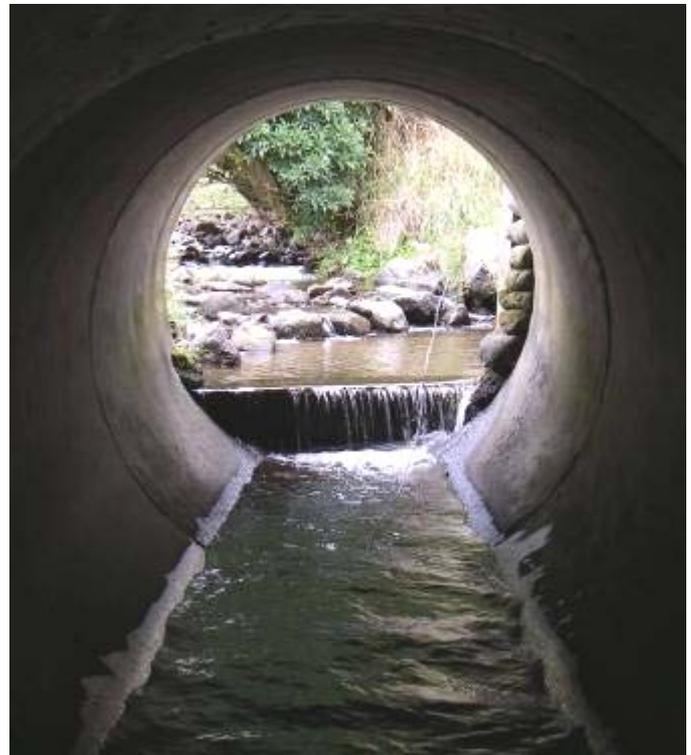


A preliminary assessment of potential barriers to fish migration in the Manawatu River catchment, North Island, New Zealand



A report prepared for Horizons Regional Council, June 2008

Dr Alex James and Dr Mike Joy



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Executive summary

- Many New Zealand native fish are diadromous, meaning they require access between the ocean and their preferred freshwater habitat. Artificial in-stream structures including culverts, fords and weirs can prevent fish migration.
- We assessed 91 in-stream structures in the Manawatu River catchment for their potential to impede the passage of native fish. Predictive modelling and the River Environment Classification (REC) were used to estimate the length of suitable habitat upstream of structures for a number of fish species.
- Based on the available habitat upstream, the presence of other barriers and the ease of repair, structures were ranked for their remediation priority.
- The structures were mostly box and pipe culverts constructed from concrete. Around two-thirds of the structures were perched to some degree. For most structures the height of this perch was less than 0.4 m. Only a few structures had existing fish passes and none of these appeared functional.
- Of the 91 structures, 15 were ranked as high priority for remediation. Thirteen of these may be simple to fix (i.e. emplacement of gravel). Of the other two, one has an existing fish pass that requires repair whilst the other requires a full assessment before any costly remediation occurs.
- In-stream structures are legally required to provide for fish passage or have written dispensation. Horizons must continue to ensure the designers and installers of new in-stream structures are aware of their legal obligations regarding fish passage.

1. Introduction

1.1 Diadromous fish and their ability to traverse obstacles

New Zealand has around 35 native and 21 introduced freshwater fish species (McDowall, 1990). About half of the native species are diadromous meaning they must spend part of their lifecycle in the sea. Twelve native diadromous species are found in the Manawatu River catchment (Table 1) although some are very uncommon (e.g. giant kokopu).

Table 1: Habitat requirements and details of diadromous species present in the Manawatu River catchment. (Adapted from ARC 2004, information from McDowall 2000)

Species	Larvae	Adult habitat	Spawning
Lamprey (<i>Geotria australis</i>)	Freshwater (fine sediment deposits)	Ocean	Small, forested streams
Longfin eel (<i>Anguilla dieffenbachii</i>)	Ocean	Varied – streams, rivers, wetlands and lakes. Higher elevations	Ocean
Shortfin eel (<i>Anguilla australis</i>)	Ocean	Varied – streams, rivers, wetlands and lakes. Lower elevations	Ocean
Shortjaw kokopu (<i>Galaxias postvectis</i>)	Ocean	Small, stable, bouldery, densely forested streams with good in-stream cover	Amongst marginal gravels and litter during elevated stream flows in adult habitat
Giant kokopu (<i>Galaxias argenteus</i>) - very rare in Manawatu catchment.	Ocean	Small to medium, gently flowing, overgrown, weedy/boggy streams, swampy lagoons and lakes.	Unknown, maybe a downstream spawning migration.
Banded kokopu (<i>Galaxias fasciatus</i>)	Ocean	Small pools in bouldery/rocky, forested streams	Amongst marginal gravels and litter during elevated stream flows in adult habitat
Koaro (<i>Galaxias brevipinnis</i>)	Ocean (unless landlocked)	Swift, clear, boulder-cobble, small to moderate sized, forested streams	Amongst marginal gravels and litter during elevated stream flows in adult habitat
Inanga (<i>Galaxias maculatus</i>)	Ocean	Slow and still waters, mostly in lowlands	In upper estuaries amongst marginal vegetation when covered during spring tides
Torrentfish (<i>Cheimarrichthys fosteri</i>)	Probably ocean	Gravel/cobble rivers in swiftest riffles	Possibly estuary

Redfin bully (<i>Gobiomorphus huttoni</i>)	Ocean	Cobble/bouldery streams in moderately swift flows	Under large rock in adult habitat
Common bully (<i>Gobiomorphus cotidianus</i>)	Ocean (unless landlocked)	Varied – small streams, river margins, lake and wetland margins	Large rock or amongst aquatic vegetation in adult habitat
Common smelt (<i>Retropinna retropinna</i>)	Ocean (unless landlocked)	Estuaries, lowland rivers, lakes. Prefers still or gently flowing water.	Lower reaches of rivers

These species require access to the ocean in order to complete their lifecycles. In-stream barriers, both natural (e.g. falls) and artificial (e.g. dams, culverts) can affect the ability of such species to colonise and persist in some areas of otherwise suitable habitat. This can lead to a decline in adult stocks or reduced biodiversity (Baker 2003).

Diadromous fish have varying abilities to traverse in-stream structures and this is reviewed by Boubée *et al.* (1999). Some species such as longfin and shortfin eels can slither through interstices in rocks or vegetation both in and out of the water and can absorb atmospheric oxygen provided their skin remains damp. Other species or life stages (e.g. lamprey, elvers, juvenile kokopu, koaro) are able to climb the wet margins of spillways, waterfalls and rapids by adhering to the substrate using surface tension and/or roughened sucker like pectoral and pelvic fins (Boubée *et al.*, 1999). Lampreys use their sucking mouth to climb seemingly impossible obstacles. Species such as salmonids are able to use the waves at waterfalls and rapids to jump past obstructions. On a small scale, inanga can do the same. Other species, including inanga can swim around obstacles, using short bursts of speed to get through high velocity areas and relying on low velocity zones to rest (Boubée *et al.*, 1999). Despite these morphological and behavioural adaptations, many species are unable to get past

in-stream barriers that are perched, undercut, lack wetted margins or create sustained high velocity flows (Boubee *et al.*, 1999).

There is limited detailed information on the actual heights, slopes and velocities that New Zealand native freshwater fish can or cannot traverse. Baker (2003) investigated the impact of fall height and weir notch shape on the upstream passage of two relatively poor climbers - common bully and inanga. Fall height was the greatest factor influencing passage, with common bully and juvenile inanga restricted by falls of only 10 cm. The passage of adult inanga was restricted by falls of 20 cm indicating body size has an influence for this species. Baker & Boubee (2006) investigated the affect of fish ramp substrate and slope on the passage of inanga and redfin bully. They found that slope was the main factor influencing passage and a gradient of 15° provided the highest success for inanga and redfin bullies. A high slope of 45° was only traversed by redfin bullies capable of climbing (mostly juveniles). They recommended that to maximise passage for these species, structure slope should not be >15° and a wetted margin is essential for climbing species. Apart from these studies and some information on swimming speed in Boubee *et al.* (1999), there are few actual measurements of a structure that can be related to the specific swimming and climbing abilities of New Zealand species.

1.2 Manawatu catchment and fish habitat

With the clearance of native vegetation, conversion to farmland and construction of flood control and drainage schemes, resident adult populations of sensitive native fish species have disappeared from the lower Manawatu catchment. Most of the remaining suitable habitat for these fish species is in the upper Manawatu River catchment, where native vegetation cover remains. Since many of these species need access to the

ocean to complete their lifecycles, they require free access through the lower parts of the catchment. Fortunately, the Manawatu River catchment lacks large dams and there are minimal physical barriers for fish to access most of the larger tributaries of the Manawatu River. However, as these tributaries break into lower order streams the potential for artificial in-stream barriers to be present increases. This is because where small streams are crossed by roads, culverts are usually installed. Larger waterways usually require the building of bridges which span the waterway and leave the streambed unaltered.

1.3 Legislative provisions

In New Zealand the provision of fish passage for in-stream structures has been a legislative requirement since the Freshwater Fisheries Regulations (1983) required the written approval of the Director-General of Conservation for anyone to build a structure that impedes fish passage. More recently the Resource Management Act (1991) has several provisions that relate to fish passage such as protecting the intrinsic value of ecosystems (see Appendix 1). In Horizons' Proposed One Plan, any activities (which include structures in the beds of rivers and streams) are required to provide for the safe passage of fish both upstream and downstream. The same intent is in the existing Bed of Rivers and Lakes Regional Plan. The Department of Conservation has the legal mandate for policing the Freshwater Fisheries Regulations while regional councils must use the Resource Management Act. It should also be noted that other regulations allow local government entities to perform legal actions that in some circumstances may prevent the free passage of fish (e.g. Local Government Act).

No data on the age of, or consent information for these structures was collected. It is quite possible that any of the structures assessed as having a likely

severity of barrier higher than “none/minimal” are impeding the passage of fish in contravention to the Freshwater Fisheries Regulations and Horizons’ rules on structures in the beds of rivers. Further investigations are needed to determine if the structures have regional council consent or the required dispensation from the Department of Conservation.

1.4 Rationale and aim of this report

A state of the environment report investigating the native fish fauna of the Manawatu-Wanganui Region concluded that while there were some areas with “high-value fish communities”, overall native fish communities in the region are in a poor state (Horizons Regional Council, 2002). This report was an assessment of the state of the fish communities in the region’s waterways based on the presence or absence of native fish species and was not intended to identify reasons why particular species are absent but did highlight some priority areas for future research. One of these was the “Identification of potential fish barriers throughout the region, including physical, chemical and sediment barriers”. There is a lack of knowledge about chemical and sediment barriers, making them difficult to assess. Thus, in order to understand the distribution of diadromous fish in the region, an obvious starting point is the identification of potential physical barriers to fish migration.

Despite some initial assessment of physical barriers in the region during summer 2002, no serious consideration or reporting on potential fish barriers has occurred to date. In 2007, an EnviroLink grant was obtained by Horizons to investigate and report on potential fish barriers in the Manawatu River catchment. Dr Mike Joy of Massey University was then engaged to complete the assessment, with

the actual fieldwork and report production being done by recent Massey graduate, Dr Alex James.

The overall aim of this report is to provide a preliminary assessment of potential barriers to the free passage of freshwater fish in the Manawatu River catchment. Some other regional authorities have completed similar assessments for parts of their regions (e.g. Environment Waikato, 2007; Auckland Regional Council, 2004). While these reports attempt to prioritise sites for remediation, this report is the first published use of the predictive fish model developed by Dr Joy (Joy & Death, 2002; Joy & Death, 2004) to give a better idea of the amount of species specific fish habitat upstream of the structures identified.

2. Methods

2.1 Site selection

Initially, structures previously assessed by Horizons in summer 2002 were visited and reassessed. Potential new structures were identified using topographic maps (NZMS 260 series). Some were found whilst travelling to previously known structures. The structures assessed were located where streams intersected public roads excepting a series of forestry road structures in the upper Kahuterawa Stream catchment (Palmerston North City Council's Gordon Kear Forest). Horizons also provided a list of lower Manawatu flood scheme-related structures from their asset management system. Most of these were culverts. Upon visiting some of these it was clear that many were capped pipes that could be opened or closed by landowners to facilitate drainage and prevent backwash during floods. It is often hard to know if these pipes are installed on artificially formed drainage channels or small natural streams.

Whatever the case, these channels draining the Manawatu Plain are heavily degraded

or modified and lack adult habitat for many native fish species. They are probably not important as barriers to the migration of sensitive native fish.

We attempted to search most of the upper Manawatu catchment for barriers. Between late January and April 2008, a total of 91 structures were assessed (Fig. 1). No barriers were located in some areas such as the Tiraumea River and upper Oroua catchments despite extensive searching. Because of the soft geology of the Tiraumea area, any streams of significant size were deeply incised and crossed by bridges rather than culverts. None of the sites were in the tidal reaches so the tidal state did not influence any assessments.

The weather over the period of assessment was a particularly dry spell, thus the streams were at low flows and some measurements (e.g. water depths) are likely about as low as they ever get and this must be kept in mind.

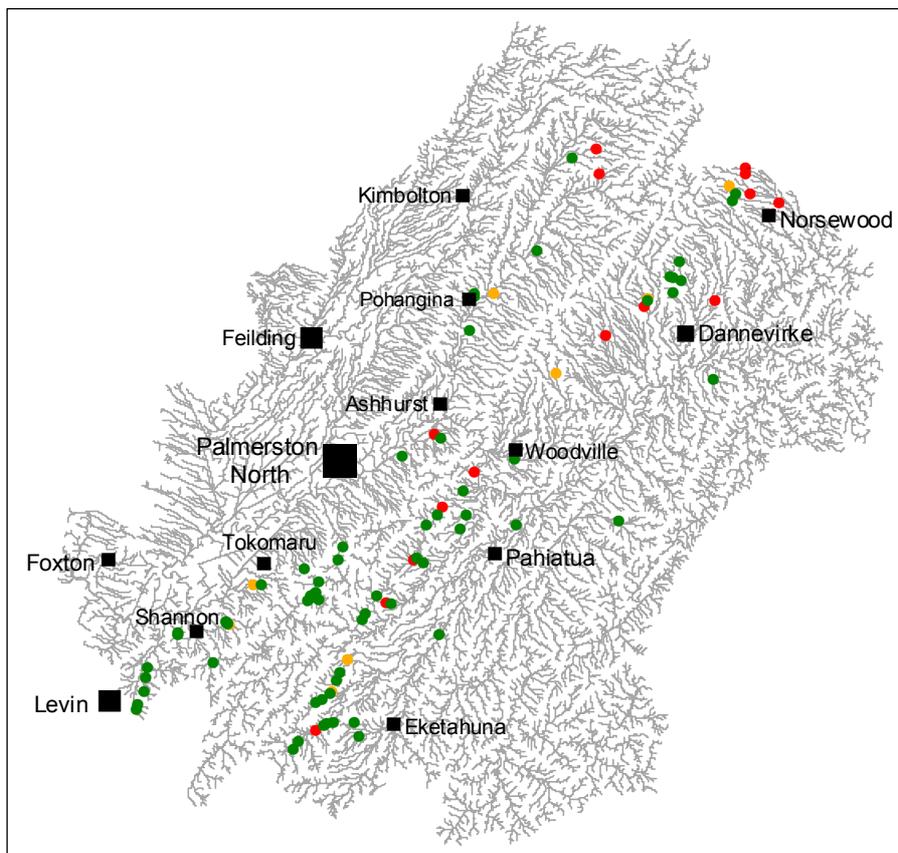


Figure 1. The distribution of structures assessed in the Manawatu River catchment. The colour of the points indicate the priority for remediation (Green = low, Orange = medium, Red = high).

2.2 Field protocol

At each site a record sheet adapted from that used by Environment Waikato (2007) was completed (see Appendix 2). A tape measure, 3 m extendable surveyor's staff and foldable 1 m ruler were used to make a series of measurements including length, width, water depth and undercut length, and perch height where applicable. Initially it was attempted to measure water velocity through the structures using a timed float but this was abandoned as the water depth in most structures was too shallow. Site coordinates according to the New Zealand Map Grid were obtained with a Garmin Etrex Vista handheld GPS unit. A digital camera was used to take inlet and outlet photos. Each site was numbered using the NZMS 260 map number and coordinates (e.g. T24:433900). In the photos this identification number was written on a whiteboard or directly with chalk on the structure. On site, structures were assigned to one of four categories following Environment Waikato (2001) (Fig. 2):

- **None/minimal**, where the structure poses no significant barrier to the upstream or downstream passage of fish likely to be found in the stream under normal flow conditions.
- **Low flow**, where the structure is a significant barrier to fish passage, but only during periods of low flows.
- **High flow**, where the structure is a significant barrier to fish passage, but only during periods of high flow.
- **Most flow**, where the structure is a significant barrier to fish passage during most flow conditions.



Figure 2. **A.** Culvert that may restrict fish passage at high flows. It has a smooth base, fairly deep water at low flow and would likely cause a velocity barrier at high flows. **B.** Culvert that may be a barrier to fish under low flow conditions because of the shallow water depth. **C.** Culvert that is unlikely to restrict fish passage. This culvert has a rough base and is a similar width to the stream channel. **D.** Culvert that impedes fish passage under most flows due to a perched outlet structure with a vertical wall.

2.3 Data analysis

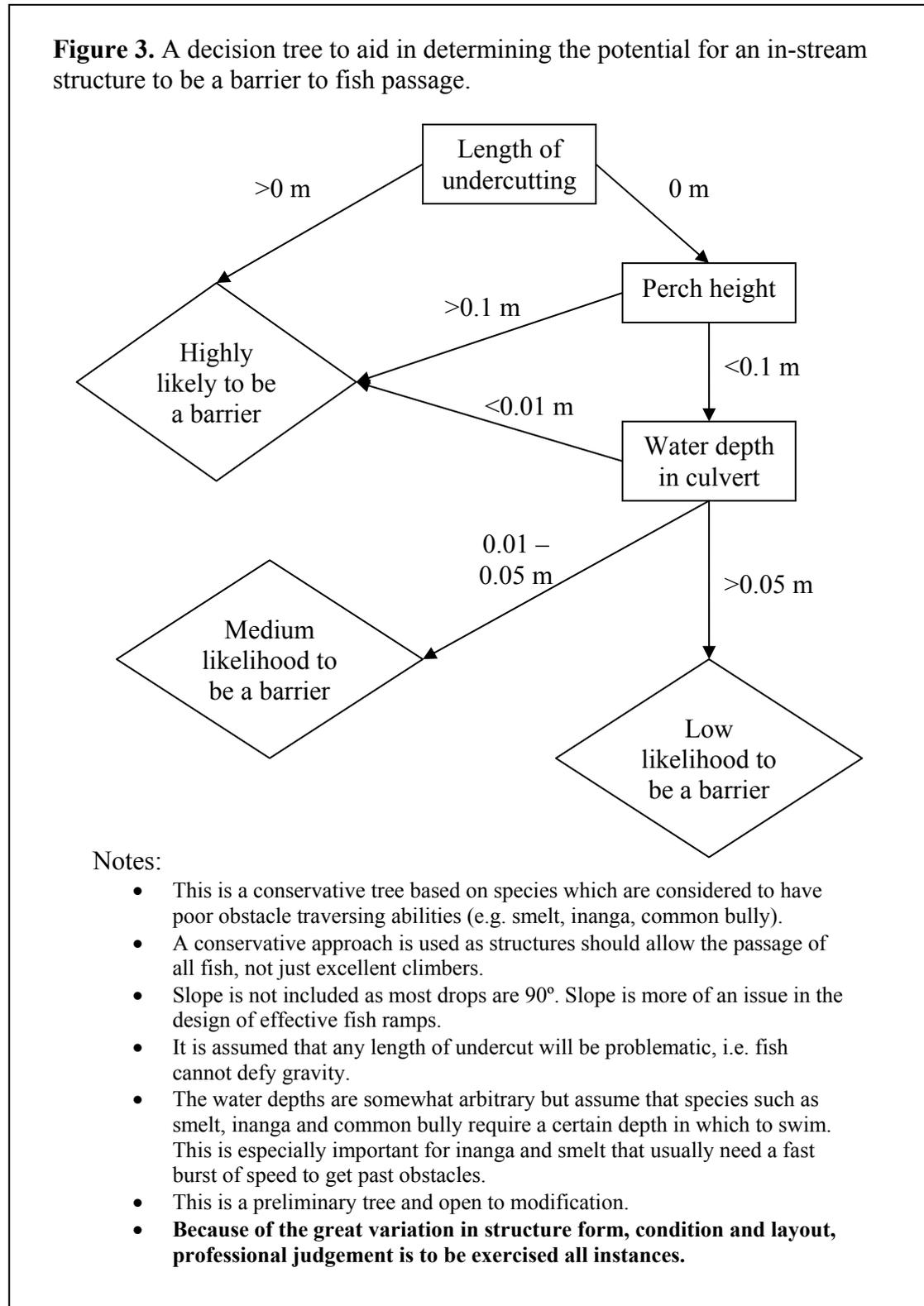
Structure locations were plotted in ArcView GIS 3.3 (ESRI, 2002). Each point was georeferenced to ensure they plotted on the correct reach of the watershed layer of the River Environment Classification (REC) (Snelder *et al.*, 2002). The characteristics of the individual REC stream segments upstream of the site were obtained using the ‘Tracer Tool’ supplied with the REC. The REC New Zealand reach numbers for these segments were then used to select each segment’s probabilities of occurrence of various fish species derived from the predictive modelling of Joy & Death (2004). The probability of occurrence of each species was then multiplied by segment length to give a predicted length of suitable habitat for each segment. These were then summed for all segments upstream of the structure to give both an idea of the potential fish habitat upstream of the structure and an indication of what fish species may be present in the stream.

For each site, the New Zealand Freshwater Fish Database (NZFFDB) was searched for any records that were from either upstream, not too far downstream (within ~ 8 km) or from the site itself. It was hoped that for at least some streams there would be some actual data on the fish species present.

The structures physical characteristics (e.g. perch height, undercut length) were used to give each site a ‘potential as migratory barrier’ designation of either:

- **Low** – the structure does not provide any barrier to the free passage of fish and/or there is limited suitable fish habitat upstream of the structure.
- **Medium** – the structure may prevent some species from freely moving to and from suitable habitat upstream of the structure.
- **High** – the structure likely prevents most if not all free movement of fish to and from suitable habitat upstream.

Given the range of climbing abilities of diadromous fish, poorer climbers such as common bully and inanga were in mind when assigning these designations. Figure 3 is a decision tree to assist in the assessment of structures in the future.

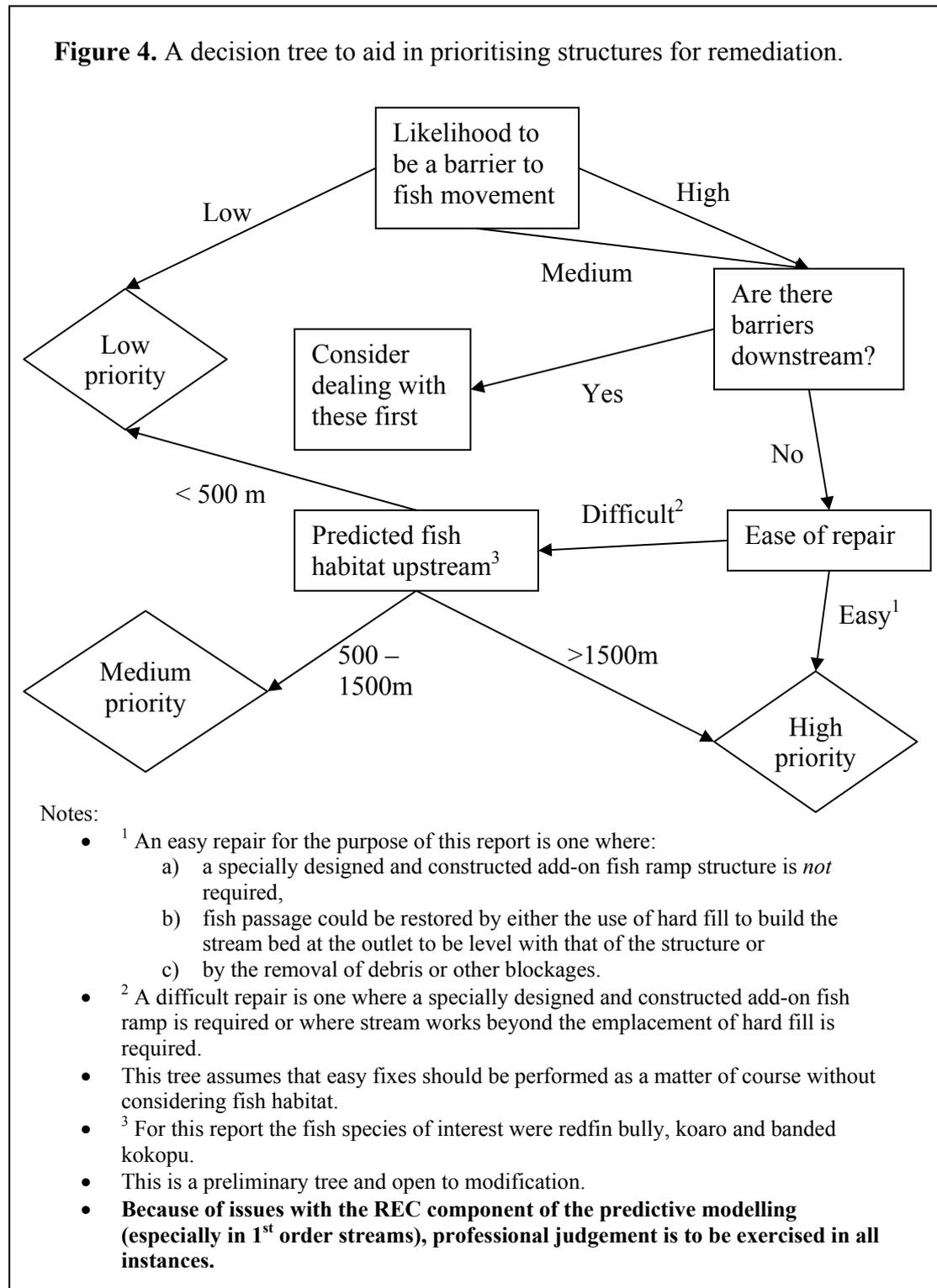


Given the heterogeneity of the structure forms encountered there was and will always be an element on professional judgement in making such decisions. However, Table 2 gives an idea of some structure parameters that may be relevant to assessing the ability of various diadromous fish species to get past.

Table 2. The ability of various diadromous fish species to cope with structure parameters important to the passage of fish. Derived from Boubee *et al.* (1999), McDowall (2000), Baker (2003) and Baker & Boubee (2006).

Species	Perch height (assuming minimal undercut)	Water depth	Slope
Lamprey (<i>Geotria australis</i>)	At least 14 m	0	90°
Longfin eel (<i>Anguilla dieffenbachii</i>)	Elvers (<120 mm): skilled climber of high and steep falls	0 (wetted margins, cutaneous respiration)	Steep
Shortfin eel (<i>Anguilla australis</i>)	Elvers (<120 mm): skilled climber of high and steep falls	0 (wetted margins, cutaneous respiration)	Steep
Shortjaw kokopu (<i>Galaxias postvectis</i>)	Strong climber	0 (wetted margins, cutaneous respiration)	Steep
Banded kokopu (<i>Galaxias fasciatus</i>)	Juveniles are strong climbers	0 (wetted margins, cutaneous respiration)	Steep
Koaro (<i>Galaxias brevipinnis</i>)	Very strong climber getting past seemingly impassable falls.	0 (wetted margins, cutaneous respiration)	Steep
Inanga (<i>Galaxias maculatus</i>)	Juveniles: up to 10 cm Adults: up to 20 cm	Deep enough to swim	15°
Torrentfish (<i>Cheimarrichthys fosteri</i>)	Body form suggests a reasonable climbing ability	Must remain submerged	Moderate?
Redfin bully (<i>Gobiomorphus huttoni</i>)	Can climb significant barriers	0 (wetted margins)	Juveniles: up to 45°
Common bully (<i>Gobiomorphus cotidianus</i>)	Not known as a vigorous climber. Up to 10 cm	Must remain submerged?	Minimal
Common smelt (<i>Retropinna retropinna</i>)	Possibly can jump small obstacles (2 - 5 cm)	Deep enough to swim	Minimal

Each structure was ranked high, medium or low for remedial works based on the ‘potential as a migratory barrier’ rating, the ease of repair, the predicted length of fish habitat upstream for the more sensitive native fish taxa (e.g. redfin bully, banded kokopu, koaro) and the presence of other known barriers up/downstream (see Fig. 4).



However, an element of professional judgement was used since for some sites the predicted length of upstream habitat were clearly unlikely given the nature of the stream at the assessment location (e.g. tiny, pastoral streams with little or no forested upstream catchment). This is related to the REC not being a true representation of some streams and potentially overestimating or underestimating the length of first order streams. Some small streams do not even exist according to the REC so some caution on its outputs must be applied. Some sites were also rated as high for remediation because the problem was relatively easy to repair (see Fig. 4).

2.4 Limitations and difficulties

There are a number of difficulties and limitations in any assessment of potential fish barriers. Of the 91 sites visited, the predictive model procedure was unable to be used for eight. These streams were either not present or incorrectly plotted on the REC watershed layer. We did, however, still rate the fish barrier potential of these sites. Another issue with the REC is that the smallest unit is the segment between forks in the waterway. Usually a potential barrier is somewhere in the middle of a REC segment thus the calculation of predictive model probabilities of occurrence are often an overestimate of the length of the available upstream habitat. This overestimate is potentially greater for those sites with minimal stream length upstream which are also sites that are unlikely to be important barriers because of a lack of habitat upstream. For sites with a number of stream segments upstream and thus more likely to be important migration barriers, this overestimate is minimal. Therefore this source of error is unlikely to greatly affect the designation of potential barrier sites.

Given the lack of empirical information on the abilities of most native species to traverse in-stream obstacles and the great heterogeneity in structure form and

condition, there are a number of variables and designations that are subjective. The onsite designation of structures as either being barriers at high flow, low flows, most flow or none/minimal (see pg. 12) is highly subjective. While some sites are obviously ‘most flow’ or ‘none/minimal’, many are difficult to sensibly designate. For example, where the outflow drops over and through a boulder pile it is difficult to judge exactly how difficult it is for fish to get past. At such outlets it is difficult to measure perch height. While the depth of the water in the culvert is easy to measure, attempting to predict how a fish may respond to say very shallow water is largely subjective.

The characteristics of some structures are likely to change after floods, maintenance and at varying levels of flow. For example, the formation and clearing of debris jams at the inlet and sediment scour and infill may influence the barrier potential of some structures. It must be acknowledged that any assessment is only 100% reliable on the date it is completed.

Finally, this preliminary assessment only involves relatively easily accessible physical barriers not other potential barriers that may affect the choices migrating fish make (e.g. chemical, sediment). Additionally, there are almost certainly numerous physical barriers on private land (Fig. 5) many of which are very difficult to find.



Figure 5. Unassessed culvert on private land near Levin. Note the ineffective fish ramp on the right.

3. Results

3.1 Structure characteristics

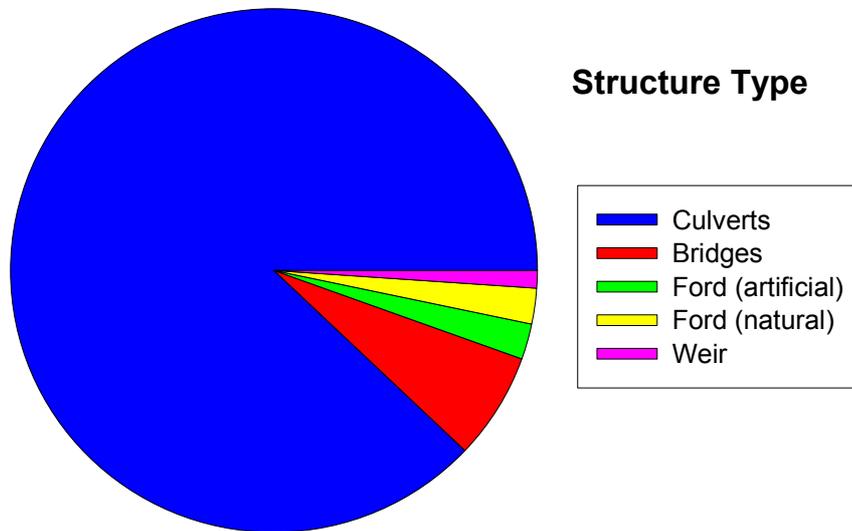


Figure 6. The proportion of each type of structure assessed.

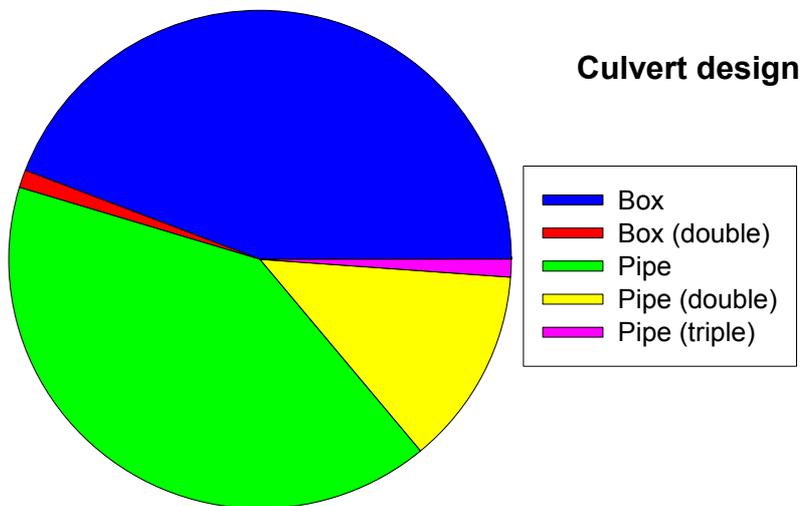


Figure 7. The proportion of each culvert design assessed.

Most of the structures assessed were road culverts (Fig 6.). A few bridges with concrete lined streambed, some fords and one weir structure were also assessed.

Of the culverts there was an even split between pipes and box designs. Most culverts were single barrel (Fig. 7). The most common construction material was concrete (Fig. 8).

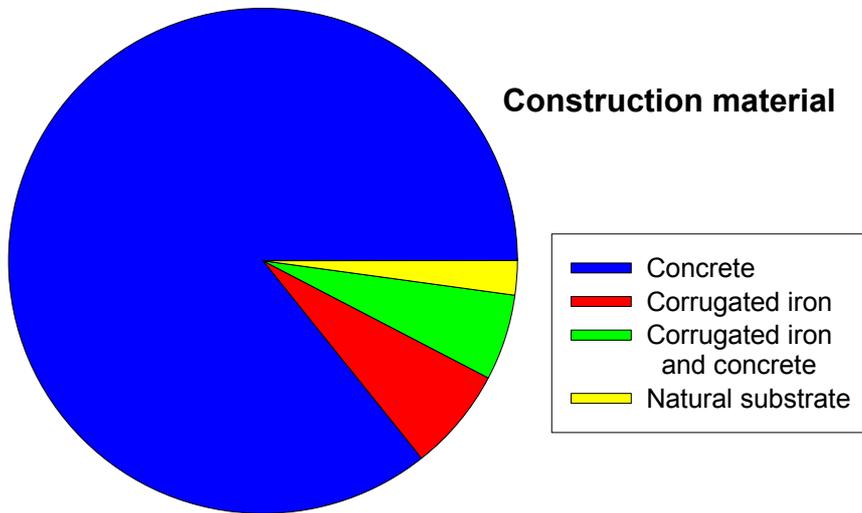


Figure 8. The proportion of construction materials of the structures assessed.

3.2 Structure features relevant to fish passage

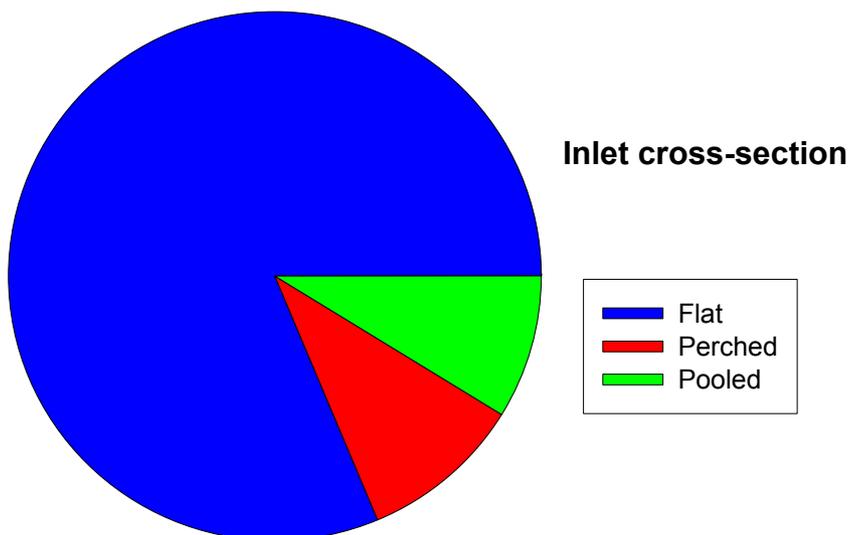


Figure 9. The proportion of inlet types of the structures assessed.

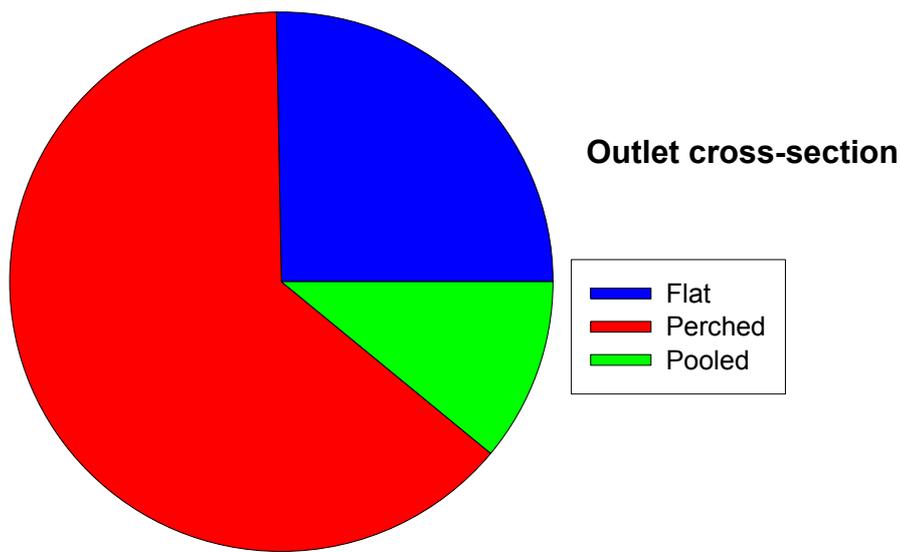


Figure 10. The proportion of outlet types of the structures assessed.

Most structure inlets were flat and pose little problem for the free movement of fish (Fig. 9). Around 66% of the structures assessed had outlets that were perched to some degree (Fig. 10).

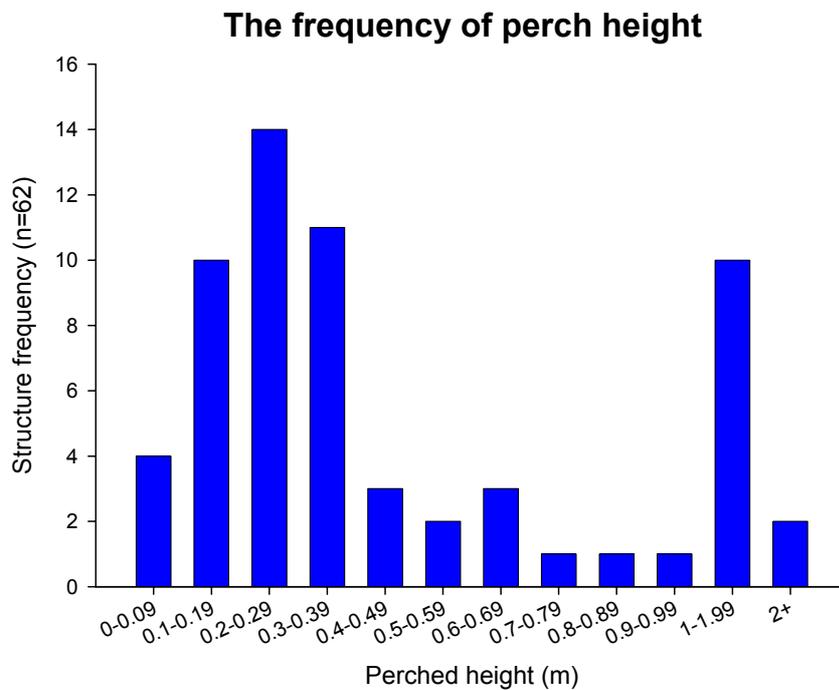


Figure 11. The frequency of structure perch height. Perched inlets and outlets are combined for this graph.

The frequency of undercut length for perched structures

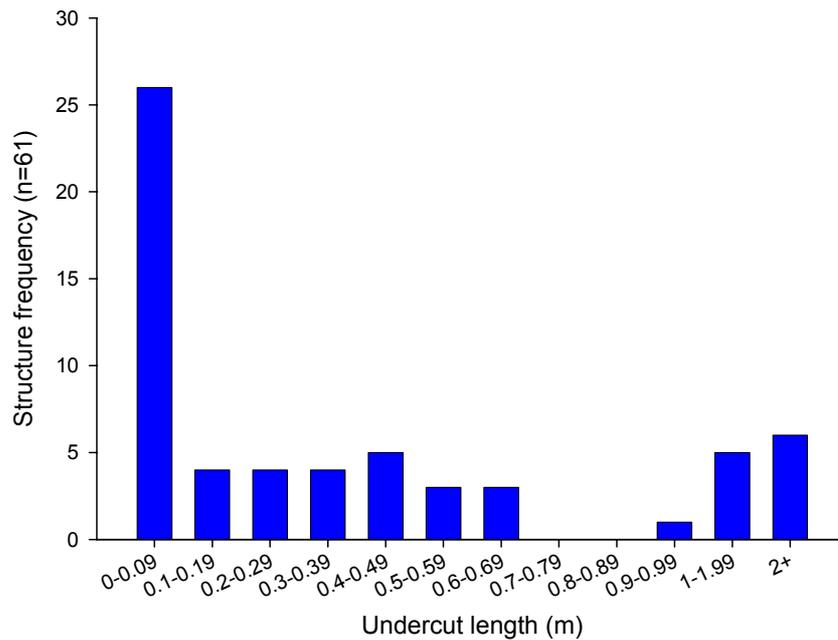


Figure 12. The frequency of undercut length for those structures that have perched inlets and/or outlets.

Of the perched structures, the height of the perch for most was equal to or less than 0.39 m. However, there were 12 structures with perch heights of equal to or greater than 1 metre (Fig. 11). Around 25% of perched structures had undercutting of equal to or less than 0.09 m. The rest were mostly spread evenly between 0.10 and 0.69 m (Fig. 12). There was a cluster of sites with undercutting greater than a metre.

3.3 Existing fish pass structures

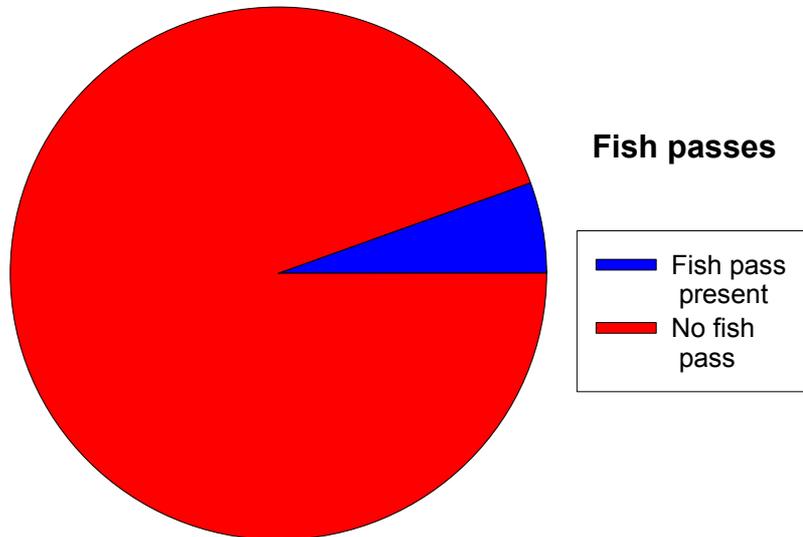


Figure 13. The proportion of sites assessed with evidence of fish pass structures.

The vast majority of sites visited had no evidence of any pre-existing fish pass structures (Fig. 13). Unfortunately, none of the fish passes encountered appeared functional as they either had a concreted-up inlet (Fig. 14A), were eroded and high out of the water (Fig. 14B), or were eroded, blocked by debris and had perch heights greater than the main structure (Fig. 14C).

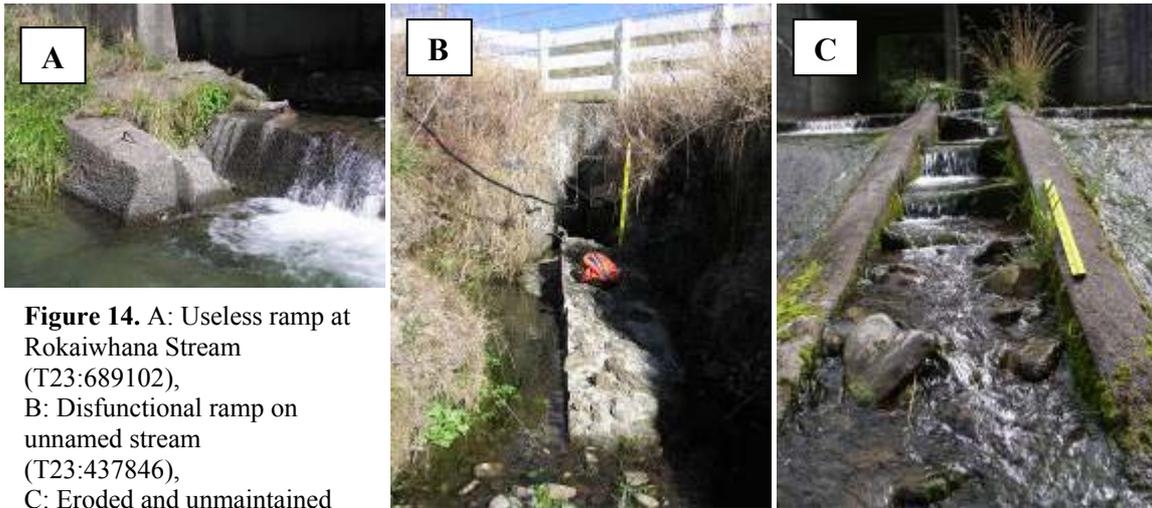


Figure 14. A: Useless ramp at Rokaiwhana Stream (T23:689102), B: Disfunctional ramp on unnamed stream (T23:437846), C: Eroded and unmaintained ramp on upper Manawatu River (U23:821241).

3.4 Other structures encountered

Some other structures were encountered which were not assessed either because they were dry at the time of visitation (Fig. 15) or they were complex structures with great difficulty in taking sensible measurements (Fig. 16). These included a new-looking weir with a 3 m vertical drop where Thorburn Rd crosses the upper Mangapuaka Stream (Fig. 15). A structure of this form which also has steep sides preventing the formation of wetted margins (required by climbing species) would likely prevent the passage of most fish with the possible exception of lamprey. Other structures include cable and boulder weir structures on the Mangatainoka River which may impede the movement of fish under some conditions (Fig. 16) especially low flows (Fig. 16A).



Figure 15. A: Massive structure on Mangapuaka Stream. B: The main drop is a 3 m vertical wall. C: Smaller weirs are present upstream. D: Desiccated koura at base of main drop.

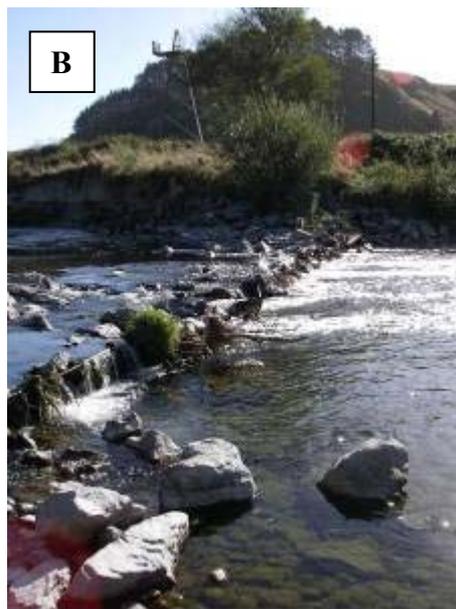


Figure 16. Two cable and boulder weir structures on the Mangatainoka River, A: below bridge on Bridge Rd and B: at the end of James Line.

3.5 Assessed structures

A page with key details (e.g. length, diameter, water depth, perched height, undercut length), inlet and outlet photos and barrier potential and remediation rankings was prepared for each site. In most of the photos a yellow unextended (1 m high) surveyor's staff is used to indicate scale. The NZFFDB was checked for records relevant to each site (i.e. upstream, at the site, or within ~ 8 km downstream) and where present, these are provided in Appendix 3.

Under some of the remediation rankings are brief comments giving the reasoning behind the decision:

- “Easy fix” or “difficult fix” (see Fig. 4 for explanation)
- “Limited area upstream” or “tiny stream” = it was obvious when on site that the stream was small and had minimal catchment upstream of structure. The length of the upstream catchment was also determined using NZMS260 1:50 000 topographic map overlays in ARCVIEW in conjunction with the REC.
- “Degraded upstream” = it was obvious when on site that the stream was in a degraded state (usually abundant fine sediment and mostly pastoral catchment). The nature of the upstream catchment was also determined using NZMS260 1:50 000 topographic map overlays in ARCVIEW.
- ”Existing pass” = an existing fish pass structure is present.
- “Forested upstream” = forested and likely high habitat quality reaches upstream.



Above: Inlet looking downstream.

Below: Perched inlet



Below: Outlet. Note the very shallow water on ramps and central eroded fish pass structure that has a series of perched steps.



Site no.: U23:821241	
Location: Manawatu River, Ellison Rd, near Norsewood	
Easting	2782140
Northing	6124191
Date assessed	26/03/2008
Structure	bridge
Type	double box
Construction	concrete
Length	~20 m
Diameter	3.04 m (each)
Water depth (inlet)	~0.05 m
Water depth (outlet)	~0.05 m
Inlet cross section	perched
Outlet cross section	perched
If perched (height)	Out: 0.15 m In: 0.30 m
If perched (undercut)	0 m
Likely severity of barrier	Most flows
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	11742 m
Shortfin eel	2951 m
Torrentfish	2219 m
Koaro	1817 m
Redfin bully	196 m
Brown trout	2794 m
Rainbow trout	7622 m

NZFFDB records for site	Yes (see Appendix 3)
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Potential as migratory barrier	High
Priority for remediation	High (existing pass, forested upstream)



Above: Double weir structure below bridge.

Below: High water velocity over the concrete block weir.



Below: Useless fish ramp on upper weir.



Site no.: T23:689102	
Location: Rokaiwhana Stream, Top Grass Rd	
Easting	2768985
Northing	6110261
Date assessed	7/03/2008
Structure	weir below bridge
Type	double weir
Construction	concrete
Length	-
Width	11.5/10.8 m
Water depth (inlet)	0.15/0.21 m
Water depth (outlet)	-
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	0.7/1.04 m
If perched (undercut)	0 m
Likely severity of barrier	Most flows
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	8319 m
Shortfin eel	1311 m
Torrentfish	80 m
Koaro	13266 m
Redfin bully	647 m
Brown trout	2646 m
Rainbow trout	5409 m

NZFFDB records for site	Yes (see Appendix 3)
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Potential as migratory barrier	High
Priority for remediation	High (forested upstream)



Above: Inlet.

Below: Outlet.



Site no.: U23:776110	
Location: Whakaruatapu Stream, Otanga Rd, near Dannevirke	
Easting	2777650
Northing	6111098
Date assessed	26/03/2008
Structure	culvert
Type	box
Construction	concrete
Length	23.3 m
Diameter	3.02 m
Water depth (inlet)	0.05 m
Water depth (outlet)	0.05 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	0.2 m
If perched (undercut)	0 m
Likely severity of barrier	Most flows
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	25213 m
Shortfin eel	11391 m
Torrentfish	89 m
Koaro	1300 m
Banded kokopu	1 m
Redfin bully	188 m
Brown trout	18169 m
Rainbow trout	1821 m

NZFFDB records for site	Yes (see Appendix 3)
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Potential as migratory barrier	High
Priority for remediation	High (easy fix)



Above: Perched inlet.

Below: Outlet.



Site no.: S25:290582	
Location: unnamed stream, Putara Rd, near Eketahuna	
Easting	2729057
Northing	6058228
Date assessed	18/02/2008
Structure	culvert
Type	pipe
Construction	concrete
Length	9.8 m
Diameter	1.8 m
Water depth (inlet)	0.11 m
Water depth (outlet)	0.32 m
Inlet cross section	perched
Outlet cross section	pooled
If perched (height)	0.36 m
If perched (undercut)	0.40 m
Likely severity of barrier	Most flows
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	2441 m
Shortfin eel	253 m
Torrentfish	16 m
Koaro	343 m
Redfin bully	220 m
Brown trout	559 m
Rainbow trout	93 m

NZFFDB records for site	No
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Potential as migratory barrier	High
Priority for remediation	High (easy fix)



Above: Perched inlet.



Below: Outlet.

Site no.: T23:632296	
Location: Piripiri Stream, Pohangina Valley East Rd, Umutoi	
Easting	2763207
Northing	6129687
Date assessed	27/03/2008
Structure	culvert
Type	pipe
Construction	concrete
Length	23.6 m
Diameter	1.79 m
Water depth (inlet)	0.01 m
Water depth (outlet)	0.03 m
Inlet cross section	perched
Outlet cross section	flat
If perched (height)	0.25 m
If perched (undercut)	0 m
Likely severity of barrier	Most flows
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	709 m
Shortfin eel	108 m
Banded kokopu	<1 m
Brown trout	4026 m
Rainbow trout	1229 m

NZFFDB records for site	No
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Potential as migratory barrier	High
Priority for remediation	High (easy fix)



Above: Inlet.



Below: Perched outlet.

Site no.: T23:635265	
Location: unnamed stream, Pohangina Valley East Rd	
Easting	2763575
Northing	6126553
Date assessed	27/03/2008
Structure	culvert
Type	double pipe
Construction	concrete
Length	14.6 m
Diameter	1.2 m
Water depth (inlet)	0.05 m
Water depth (outlet)	0.03 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	0.2 m
If perched (undercut)	0.2 m
Likely severity of barrier	Most flows
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	381 m
Shortfin eel	52 m
Koaro	13 m
Redfin bully	<1 m
Brown trout	3149 m
Rainbow trout	696 m

NZFFDB records for site	No
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Potential as migratory barrier	High
Priority for remediation	High (easy fix)



Above: Inlet



Below: Outlet

Site no.: T24:376736	
Location: Unnamed stream, Naenae Rd, near Marima	
Easting	2737665
Northing	6073855
Date assessed	1/02/2008
Structure	culvert
Type	box
Construction	concrete
Length	6.4 m
Diameter	2.4 m
Water depth (inlet)	0.04 m
Water depth (outlet)	0.04 m
Inlet cross section	pooled
Outlet cross section	perched
If perched (height)	0.20
If perched (undercut)	0
Likely severity of barrier	Low flows
Known barriers upstream	0
Known barriers downstream	1 (T24:381735)

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	1634 m
Shortfin eel	125 m
Torrentfish	< 1 m
Koaro	69 m
Banded kokopu	< 1 m
Redfin bully	24 m
Rainbow trout	< 1 m
Brown trout	482 m

NZFFDB records for site	None
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Potential as migratory barrier	Medium
Priority for remediation	High (easy fix)



Above: Inlet



Below: Outlet

Site no.: T23:644067	
Location: Otamarahu Stream, Top Grass Rd	
Easting	2764409
Northing	6106702
Date assessed	7/03/2008
Structure	culvert
Type	box
Construction	concrete
Length	10.1 m
Diameter	1.85 m
Water depth (inlet)	0.04 m
Water depth (outlet)	0.02 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	0.13 m
If perched (undercut)	0.09 m
Likely severity of barrier	Low flows
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	6237 m
Shortfin eel	666 m
Torrentfish	<1 m
Koaro	3424 m
Redfin bully	594 m
Brown trout	4901 m
Rainbow trout	305 m

NZFFDB records for site	None
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Potential as migratory barrier	Medium
Priority for remediation	High (easy fix)



Above: Inlet

Below: Outlet looking downstream. Rocks have recently been dumped in an effort to repair a perched outlet.



Below: Outlet showing how a dam has been created during low flow period.



Site no.: T24:410791	
Location: Unnamed stream, Inglis Rd	
Easting	2741052
Northing	6079111
Date assessed	18/03/2008
Structure	culvert
Type	box
Construction	concrete
Length	6.73 m
Diameter	3.1 m
Water depth (inlet)	0.12 m
Water depth (outlet)	0.05 m
Inlet cross section	flat
Outlet cross section	perched/ dammed
If perched (height)	-
If perched (undercut)	-
Likely severity of barrier	Low flows
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	6881 m
Shortfin eel	1823 m
Koaro	2051 m
Banded kokopu	9 m
Redfin bully	1580 m
Brown trout	5646 m
Rainbow trout	111 m

NZFFDB records for site	None
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Potential as migratory barrier	Medium
Priority for remediation	High (easy fix)



Above: Inlet

Below: Outlet



Site no.: T24:435946	
Location: Unnamed stream, Centre Rd (off Fitzherbert East Rd)	
Easting	2743501
Northing	6094671
Date assessed	7/04/2008
Structure	culvert
Type	box
Construction	concrete
Length	9.6 m
Diameter	2.5 m
Water depth (inlet)	0.05 m
Water depth (outlet)	0.02 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	0.04 m
If perched (undercut)	0 m
Likely severity of barrier	Low flows
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	2761 m
Shortfin eel	3021 m
Koaro	171 m
Banded kokopu	168 m
Redfin bully	357 m
Brown trout	2992 m

NZFFDB records for site	Yes (see Appendix 3)
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Potential as migratory barrier	Medium
Priority for remediation	High (easy fix)



Above: Log creating perched inlet but water flow beneath end of log at time of assessment.



Above: Inlet



Above: Outlet

Site no.: T24:483900	
Location: Unnamed stream, Gorge Rd, ~3 km south of Ballance Bridge	
Easting	2748364
Northing	6090041
Date assessed	18/03/2008
Structure	culvert
Type	box
Construction	concrete
Length	29.3 m
Diameter	2.4 m
Water depth (inlet)	0.03 m
Water depth (outlet)	0.13 m
Inlet cross section	Perched
Outlet cross section	Flat
If perched (height)	0.33
If perched (undercut)	0.20
Likely severity of barrier (visual assessment)	High flows
Known barriers upstream	0
Known barriers downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	4548 m
Shortfin eel	629 m
Koaro	566 m
Banded kokopu	365 m
Redfin bully	1491 m
Brown trout	4927 m
Rainbow trout	8 m

NZFFDB records for site	Yes (see Appendix 3)
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Potential as migratory barrier	Medium
Priority for remediation	High (easy fix)



Above: Inlet.

Site no.: T24:445855	
Location: unnamed stream, Ballance Valley Rd	
Easting	2744527
Northing	6085551
Date assessed	18/03/2008
Structure	culvert
Type	box
Construction	concrete
Length	7.95 m
Diameter	2.42 m
Water depth (inlet)	0.06 m
Water depth (outlet)	0.03 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	0.12 m
If perched (undercut)	~0.9 m
Likely severity of barrier	Most flows
Potential barriers known upstream	0
Potential barriers known downstream	0

Below: Perched outlet.



Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	2361 m
Shortfin eel	397 m
Koaro	904 m
Banded kokopu	91 m
Redfin bully	548 m
Brown trout	3069 m
Rainbow trout	1190 m

NZFFDB records for site	No
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Potential as migratory barrier	Medium
Priority for remediation	High (easy fix)



Above: Inlet.

Below: Perched outlet.



Site no.: U23:856230	
Location: Mangamokio Stream/Butchers Creek, SH2, north of Norsewood	
Easting	2785668
Northing	6123010
Date assessed	8/04/2008
Structure	culvert
Type	pipe
Construction	corrugated iron
Length	38.8 m
Diameter	5.94 m
Water depth (inlet)	0.18 m
Water depth (outlet)	0.08 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	0.2 m
If perched (undercut)	0 m
Likely severity of barrier	Most flows
Potential barriers known upstream	2 (U23:803241, U23:798232)
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	11375 m
Shortfin eel	2246 m
Torrentfish	1 m
Koaro	4370 m
Redfin bully	31 m
Brown trout	13448 m
Rainbow trout	3533 m

NZFFDB records for site	Yes (see Appendix 3)
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Potential as migratory barrier	Medium
Priority for remediation	High (easy fix, long length upstream)



Above: Inlet. Note that this culvert is incorrectly labeled in the photo.

Site no.: U23:815273	
Location: Mahuraiti Stream, Ellison Rd, near Norsewood	
Easting	2781515
Northing	6127367
Date assessed	8/04/2008
Structure	culvert
Type	box
Construction	concrete
Length	12.6 m
Diameter	1.44 m
Water depth (inlet)	0.04 m
Water depth (outlet)	0.04 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	0.1 m
If perched (undercut)	0 m
Likely severity of barrier	Most flows
Potential barriers known upstream	0
Potential barriers known downstream	0

Below: Perched outlet.



Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	1418 m
Shortfin eel	423 m
Koaro	1737 m
Brown trout	1701 m
Rainbow trout	354 m

NZFFDB records for site	No
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Potential as migratory barrier	Medium
Priority for remediation	High (easy fix)



Above: Inlet.

Below: Perched outlet with ramp and boulders that may reduce effect.



Site no.: U23:815266	
Location: Mahuraunui Stream/Stoney Creek, Ellison Rd, near Norsewood	
Easting	2781572
Northing	6126608
Date assessed	8/04/2008
Structure	culvert/bridge
Type	box
Construction	concrete
Length	14 m
Diameter	3.7 m
Water depth (inlet)	0.04 m
Water depth (outlet)	0.04 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	0.5 m
If perched (undercut)	0 m
Likely severity of barrier	Most flows
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	5695 m
Shortfin eel	871 m
Torrentfish	334 m
Koaro	183 m
Redfin bully	18 m
Brown trout	1599 m
Rainbow trout	2759 m

NZFFDB records for site	No
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Potential as migratory barrier	Medium
Priority for remediation	High (easy fix)



Above: Inlet.

Below: Perched and undercut outlet.



Site no.: T25:309628	
Location: unnamed stream, Mangaraupiu Rd, near Eketahuna	
Easting	2730941
Northing	6062854
Date assessed	26/02/2008
Structure	culvert
Type	double pipe
Construction	concrete
Length	7.3 m
Diameter	0.85 m
Water depth (inlet)	0.07/0.04 m
Water depth (outlet)	0.07/0.03 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	1.1 m
If perched (undercut)	1 m
Likely severity of barrier	Most flows
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	1826 m
Shortfin eel	112 m
Koaro	1315 m
Redfin bully	68 m
Brown trout	132 m
Rainbow trout	122 m

NZFFDB records for site	No
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Potential as migratory barrier	High
Priority for remediation	Medium (difficult fix, forested upstream)



Above: Inlet well above substrate surface.

Site no.: T25:330667	
Location: unnamed stream, Mangaraupiu Rd, near Eketahuna	
Easting	2733013
Northing	6066773
Date assessed	26/02/2008
Structure	culvert
Type	double pipe
Construction	concrete
Length	4.9 m
Diameter	0.6 m
Water depth (inlet)	0 m
Water depth (outlet)	0 m
Inlet cross section	perched
Outlet cross section	perched
If perched (height)	0.32 m
If perched (undercut)	0 m
Likely severity of barrier	Most flows
Potential barriers known upstream	0
Potential barriers known downstream	0

Below: Perched outlet.



Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	2757 m
Shortfin eel	100 m
Koaro	1555 m
Redfin bully	269 m
Brown trout	976 m
Rainbow trout	107 m

NZFFDB records for site	No
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Potential as migratory barrier	High
Priority for remediation	Medium (difficult fix, forested upstream)



Above: Inlet.

Below: Outlet.



Site no.: T23:695112	
Location: unnamed stream, Top Grass Rd	
Easting	2769592
Northing	6111250
Date assessed	7/03/2008
Structure	culvert
Type	box
Construction	concrete
Length	5.5 m
Diameter	1.8 m
Water depth (inlet)	0.03 m
Water depth (outlet)	0.03 m
Inlet cross section	pooled
Outlet cross section	perched
If perched (height)	0.27 m
If perched (undercut)	0.12 m
Likely severity of barrier	Most flows
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	4805 m
Shortfin eel	901 m
Torrentfish	<1 m
Koaro	57 m
Redfin bully	111 m
Brown trout	1683 m
Rainbow trout	73 m

NZFFDB records for site	No
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Potential as migratory barrier	High
Priority for remediation	Medium (easy fix , degraded upstream)



Above: Inlet.

Site no.: T23:584020	
Location: unnamed stream, Top Grass Rd	
Easting	2758414
Northing	6102089
Date assessed	7/03/2008
Structure	culvert
Type	box
Construction	concrete
Length	7 m
Diameter	2.45 m
Water depth (inlet)	0.03 m
Water depth (outlet)	0.04 m
Inlet cross section	pooled
Outlet cross section	perched
If perched (height)	0.37 m
If perched (undercut)	0 m
Likely severity of barrier	Most flows
Potential barriers known upstream	0
Potential barriers known downstream	0

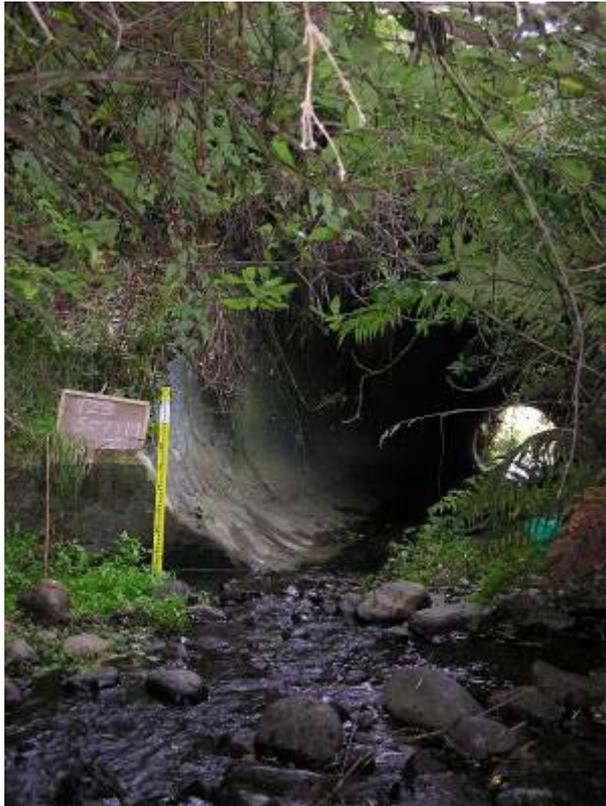
Below: Outlet.



Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	2653 m
Shortfin eel	290 m
Torrentfish	<1 m
Koaro	201 m
Banded kokopu	4 m
Redfin bully	275 m
Brown trout	1230 m
Rainbow trout	<1 m

NZFFDB records for site	No
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Potential as migratory barrier	High
Priority for remediation	Medium (degraded upstream)



Above: Inlet.

Site no.: T23:507119	
Location: unnamed stream, Pohangina Valley East Rd	
Easting	2750795
Northing	6111966
Date assessed	27/03/2008
Structure	culvert
Type	pipe
Construction	corrugated iron
Length	24.6 m
Diameter	2.4 m
Water depth (inlet)	0.05 m
Water depth (outlet)	0.02 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	0.23 m
If perched (undercut)	0 m
Likely severity of barrier	Most flows
Potential barriers known upstream	0
Potential barriers known downstream	0

Below: The outlet is difficult to access because of deep pool.



Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	2105 m
Shortfin eel	192 m
Koaro	579 m
Banded kokopu	124 m
Redfin bully	131 m
Brown trout	2301 m
Rainbow trout	2 m

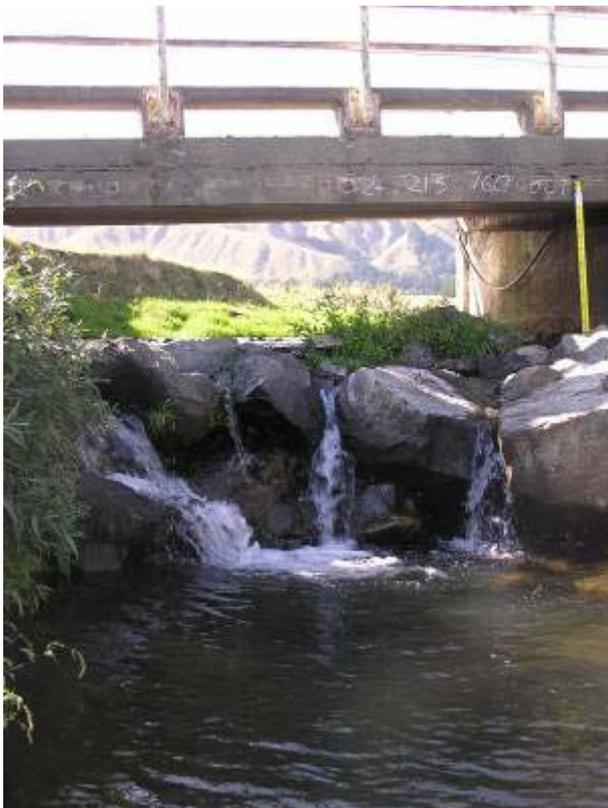
NZFFDB records for site	No
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Potential as migratory barrier	High
Priority for remediation	Medium (difficult fix)



Above: Inlet.

Below: Perched outlet.



Site no.: S24:213760	
Location: Waterfall Creek/Mangaharakeikei Stream, SH57, south of Tokomaru	
Easting	2721349
Northing	6076049
Date assessed	3/04/2008
Structure	bridge
Type	box
Construction	concrete
Length	9.5 m
Diameter	6.4 m
Water depth (inlet)	0.02 m
Water depth (outlet)	0.02 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	0.98 m
If perched (undercut)	0 m
Likely severity of barrier	Most flows
Potential barriers known upstream	1 (S24:222760)
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	4872 m
Shortfin eel	7138 m
Koaro	99 m
Banded kokopu	1046 m
Redfin bully	1959 m
Brown trout	5113 m
Rainbow trout	52 m

NZFFDB records for site	No
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Potential as migratory barrier	High
Priority for remediation	Medium (difficult fix)



Above: Inlet.

Below: Debris dam just upstream of inlet.



Site no.: U23:794252	
Location: Unnamed stream, Manawatu River Rd, near Norsewood	
Easting	2779437
Northing	6125256
Date assessed	8/04/2008
Structure	culvert
Type	box
Construction	concrete
Length	11.2 m
Diameter	1.44 m
Water depth (inlet)	0.04 m
Water depth (outlet)	0.08 m
Inlet cross section	perched
Outlet cross section	flat
If perched (height)	0.63 m
If perched (undercut)	0 m
Likely severity of barrier	Most flows
Potential barriers known upstream	0
Potential barriers known downstream	1 (U23:821241)

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	986 m
Shortfin eel	17 m
Koaro	22 m
Redfin bully	<1 m
Brown trout	191 m
Rainbow trout	272 m

NZFFDB records for site	No (but records for U23:821241 are within 4 km downstream)
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Potential as migratory barrier	High
Priority for remediation	Medium (easy fix, limited area upstream)

Left: Outlet.



Above: Inlet.

Below: Perched outlet.



Site no.: S24:183711	
Location: unnamed stream, Kingston Rd, north of Shannon	
Easting	2718383
Northing	6071185
Date assessed	3/04/2008
Structure	culvert
Type	pipe
Construction	concrete
Length	22.7 m
Diameter	1.5 m
Water depth (inlet)	0.08 m
Water depth (outlet)	0.06 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	0.70 m
If perched (undercut)	0.45 m
Likely severity of barrier	Most flows
Potential barriers known upstream	0
Potential barriers known downstream	0 (S24:182713, S24:182712)

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	3553 m
Shortfin eel	1715 m
Torrentfish	80 m
Koaro	168 m
Banded kokopu	835 m
Redfin bully	2474 m
Brown trout	543 m
Rainbow trout	2 m

NZFFDB records for site	No
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Potential as migratory barrier	High
Priority for remediation	Medium (difficult fix, degraded upstream)



Above: Inlet

Below: Outlet showing long defunct fish ramp



Site no.: T24:437846	
Location: Unnamed stream, Ballance Valley Rd	
Easting	2743794
Northing	6084684
Date assessed	18/03/2008
Structure	culvert
Type	pipe
Construction	concrete
Length	7.45 m
Diameter	0.72 m
Water depth (inlet)	0.10 m
Water depth (outlet)	0.17 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	0.17 m
If perched (undercut)	0 m
Likely severity of barrier	Low flows
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	596 m
Shortfin eel	24 m
Koaro	374 m
Banded kokopu	<1 m
Redfin bully	80 m
Brown trout	1365 m
Rainbow trout	<1 m

NZFFDB records for site	None
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Potential as migratory barrier	High
Priority for remediation	Low (degraded and limited upstream)



Above: Inlet that is above the level of water flow at low flows.

Below: Outlet



Site no.: T24:532912	
Location: Unnamed stream, SH2, just south of Woodville	
Easting	2753205
Northing	6091255
Date assessed	20/03/2008
Structure	culvert
Type	box
Construction	concrete
Length	10.8 m
Diameter	2.7 m
Water depth (inlet)	0 m
Water depth (outlet)	0.03 m
Inlet cross section	perched
Outlet cross section	flat
If perched (height)	0.3 m
If perched (undercut)	0 m
Likely severity of barrier	Low flows
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)
Incorrect plotting on REC watershed layer

NZFFDB records for site	None
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Potential as migratory barrier	High
Priority for remediation	Low (degraded upstream)



Above: Inlet.

Below: Perched outlet with remnants of a fish ramp.



Site no.: T24:422785	
Location: unnamed stream, Nikau Rd, near Pahiatua Track	
Easting	2742177
Northing	6078701
Date assessed	1/02/2008
Structure	culvert
Type	box
Construction	concrete
Length	6.7 m
Diameter	1.9 m
Water depth (inlet)	0.05 m
Water depth (outlet)	0.04 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	4 m
If perched (undercut)	1.5 - 2 m
Likely severity of barrier	Most flows
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	4013 m
Shortfin eel	2774 m
Torrentfish	2 m
Koaro	15 m
Redfin bully	101 m
Brown trout	1122 m
Rainbow trout	<1 m

NZFFDB records for site	No
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Potential as migratory barrier	High
Priority for remediation	Low (difficult fix, degraded upstream)



Above: Inlet concealed by debris.

Below: Perched outlet.



Site no.: T24:346715	
Location: Wahaoteika Stream, Kopikopiko Rd	
Easting	2734580
Northing	6071705
Date assessed	1/02/2008
Structure	culvert
Type	pipe
Construction	concrete
Length	>10 m
Diameter	0.91 m
Water depth (inlet)	no access
Water depth (outlet)	0.04 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	0.6 m
If perched (undercut)	0 m
Likely severity of barrier	Most flows
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	651m
Shortfin eel	30 m
Torrentfish	<1 m
Koaro	10 m
Redfin bully	50 m
Brown trout	480 m
Rainbow trout	<1 m

NZFFDB records for site	No
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Potential as migratory barrier	High
Priority for remediation	Low



Above: Inlet.

Below: Outlet with only a dribble going through pipe. Most flow was under the pipe.



Site no.: T24:364743	
Location: unnamed stream, Naenae Rd, near road end	
Easting	2736384
Northing	6074507
Date assessed	1/02/2008
Structure	culvert
Type	pipe
Construction	concrete
Length	4.7 m
Diameter	0.6 m
Water depth (inlet)	0.02 m
Water depth (outlet)	0.002 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	0.28 m
If perched (undercut)	0.25 m
Likely severity of barrier	Most flows
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)
Stream not on REC watershed layer or NZMS 260 map

NZFFDB records for site	No
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Potential as migratory barrier	High
Priority for remediation	Low (tiny stream, limited upstream)



Above: Inlet. Note that a fence and deep pool prevented full photo of inlet.

Below: Perched outlet. Note this photo is incorrectly labelled on whiteboard.



Site no.: T24:381735	
Location: unnamed stream, Kopikopiko Rd	
Easting	2738100
Northing	6073710
Date assessed	1/02/2008
Structure	culvert
Type	box
Construction	concrete
Length	9 m
Diameter	3.7 m
Water depth (inlet)	0.04 m
Water depth (outlet)	0.02 m
Inlet cross section	pooled
Outlet cross section	perched
If perched (height)	1.5 m
If perched (undercut)	2 m
Likely severity of barrier	Most flows
Potential barriers known upstream	1 (T24:376736)
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	2821 m
Shortfin eel	706 m
Koaro	94 m
Banded kokopu	<1 m
Redfin bully	48 m
Brown trout	808 m
Rainbow trout	1 m

NZFFDB records for site	No
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Potential as migratory barrier	High
Priority for remediation	Low (difficult fix, degraded upstream)



Above: Inlet.



Below: Outlet.

Site no.: T25:336593	
Location: unnamed stream, Priests Rd, near Eketahuna	
Easting	2733621
Northing	6059317
Date assessed	18/02/2008
Structure	culvert
Type	pipe
Construction	concrete
Length	8.55 m
Diameter	1.05 m
Water depth (inlet)	0.06 m
Water depth (outlet)	0.04 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	0.3 m
If perched (undercut)	0.35 m
Likely severity of barrier	Most flows
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	670 m
Shortfin eel	180 m
Koaro	163 m
Brown trout	1754 m
Rainbow trout	<1 m

NZFFDB records for site	No
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Potential as migratory barrier	High
Priority for remediation	Low (limited and degraded upstream)



Above: Inlet.



Below: Outlet.

Site no.: S25:261559	
Location: unnamed stream, Putara Rd, near Eketahuna	
Easting	2733621
Northing	6059317
Date assessed	18/02/2008
Structure	ford
Type	pipe
Construction	concrete
Length	6.05 m
Diameter	0.44 m
Water depth (inlet)	0.05 m
Water depth (outlet)	0.03 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	0.25 m
If perched (undercut)	>1 m
Likely severity of barrier	Most flows
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	239 m
Shortfin eel	<1 m
Koaro	222 m
Redfin bully	8 m
Brown trout	142 m
Rainbow trout	17 m

NZFFDB records for site	No
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Potential as migratory barrier	High
Priority for remediation	Low (difficult fix, limited upstream)



Above: Inlet. The left pipe is dry.

Below: Outlet.



Site no.: T25:310591	
Location: unnamed stream, Putara Rd, near Eketahuna	
Easting	2731052
Northing	6059173
Date assessed	18/02/2008
Structure	culvert
Type	double pipe
Construction	concrete
Length	12.3 m
Diameter	1.05 m
Water depth (inlet)	0.05 m
Water depth (outlet)	0.15 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	0.25 m
If perched (undercut)	0.13 m
Likely severity of barrier	Most flows
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	357 m
Shortfin eel	20 m
Torrentfish	<1 m
Koaro	2 m
Redfin bully	4 m
Brown trout	306 m
Rainbow trout	<1 m

NZFFDB records for site	No
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Potential as migratory barrier	High
Priority for remediation	Low (limited upstream)



Above: Inlet.

Below: Perched outlet.



Site no.: T25:303590	
Location: unnamed stream, Putara Rd, near Eketahuna	
Easting	2730351
Northing	6059048
Date assessed	18/02/2008
Structure	culvert
Type	pipe
Construction	concrete
Length	16.3 m
Diameter	1.08 m
Water depth (inlet)	0.05 m
Water depth (outlet)	0.05 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	1.15 m
If perched (undercut)	>2 m
Likely severity of barrier	Most flows
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	383 m
Shortfin eel	237 m
Koaro	17 m
Redfin bully	36 m
Brown trout	1073 m
Rainbow trout	1 m

NZFFDB records for site	No
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Potential as migratory barrier	High
Priority for remediation	Low (difficult fix, limited upstream)



Above: Inlet.

Below: Perched outlet.



Site no.: S25:298619	
Location: unnamed stream, Mangaroa Rd, near Eketahuna	
Easting	2729852
Northing	6061985
Date assessed	26/02/2008
Structure	culvert
Type	pipe
Construction	concrete
Length	7.5 m
Diameter	2.5 m
Water depth (inlet)	0.05 m
Water depth (outlet)	0.03 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	0.12 m
If perched (undercut)	0.38 m
Likely severity of barrier	Most flows
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	527 m
Shortfin eel	20 m
Koaro	18 m
Redfin bully	5 m
Brown trout	291 m
Rainbow trout	2 m

NZFFDB records for site	No
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Potential as migratory barrier	High
Priority for remediation	Low (limited upstream)



Above: Inlet facing upstream below iron boulder screen.
 Below: Inlet boulder screen from above.



Site no.: T24:317791	
Location: unnamed stream, Kahuterawa Rd	
Easting	2731759
Northing	6079104
Date assessed	11/03/2008
Structure	culvert
Type	pipe
Construction	corrugated iron
Length	8.1 m
Diameter	1.4 m
Water depth (inlet)	0.01 m
Water depth (outlet)	0.01 m
Inlet cross section	perched
Outlet cross section	perched
If perched (height)	0.35 m
If perched (undercut)	0 m
Likely severity of barrier	Most flows
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	1126 m
Shortfin eel	123 m
Koaro	4 m
Banded kokopu	<1 m
Redfin bully	2 m
Brown trout	1331 m
Rainbow trout	<4 m

NZFFDB records for site	No
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Potential as migratory barrier	High
Priority for remediation	Low (difficult fix and tiny stream)

Left: Outlet.



Above: Inlet with culvert totally buried by sediment.

Below: Outlet. The pipe is just to the left of the surveyor's staff.



Site no.: T24:323806	
Location: unnamed stream, Kahuterawa Rd	
Easting	2732311
Northing	6080625
Date assessed	11/03/2008
Structure	ford
Type	single culvert
Construction	concrete
Length	5.3 m
Diameter	0.23 m
Water depth (inlet)	0.01 m
Water depth (outlet)	0.005 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	1.17 m
If perched (undercut)	>1 m
Likely severity of barrier	Most flows
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	497 m
Shortfin eel	65 m
Koaro	13 m
Redfin bully	117 m
Brown trout	86 m
Rainbow trout	25 m

NZFFDB records for site	No
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Potential as migratory barrier	High
Priority for remediation	Low (difficult fix)



Above: Perched inlet.

Below: Perched outlet.



Site no.: T24:469875	
Location: unnamed stream, Ballance Valley Rd	
Easting	2746943
Northing	6087524
Date assessed	18/03/2008
Structure	culvert
Type	box
Construction	concrete
Length	3.9 m
Diameter	1 m
Water depth (inlet)	0.03 m
Water depth (outlet)	0.01 m
Inlet cross section	perched
Outlet cross section	perched
If perched (height)	In: 0.3 m, Out: 0.8 m
If perched (undercut)	In: 0.27 m, Out: 1.8 m
Likely severity of barrier	Most flows
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	4539 m
Shortfin eel	2122 m
Koaro	610 m
Banded kokopu	26 m
Redfin bully	2219 m
Brown trout	2085 m
Rainbow trout	<1 m

NZFFDB records for site	No
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Potential as migratory barrier	High
Priority for remediation	Low (difficult fix and minimal surface water)



Above: Inlet.

Below: Perched outlet.



Site no.: T24:534834	
Location: unnamed stream, Mangatainoka, near Brewery	
Easting	2753450
Northing	6083416
Date assessed	20/03/2008
Structure	culvert
Type	pipe
Construction	concrete
Length	10.1 m
Diameter	0.75 m
Water depth (inlet)	0.08 m
Water depth (outlet)	0.05 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	0.18 m
If perched (undercut)	0.3 m
Likely severity of barrier	Most flows
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Incorrect plotting on REC watershed layer	

NZFFDB records for site	No
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Potential as migratory barrier	High
Priority for remediation	Low (degraded upstream)



Above: Inlet.



Below: Perched outlet.

Site no.: U23:726138	
Location: unnamed stream, Umutaoroa Rd, near Dannevirke	
Easting	2772624
Northing	6113887
Date assessed	26/03/2008
Structure	culvert
Type	box
Construction	concrete
Length	6.32 m
Diameter	1.52 m
Water depth (inlet)	0.05 m
Water depth (outlet)	0.02 m
Inlet cross section	pooled
Outlet cross section	perched
If perched (height)	0.44 m
If perched (undercut)	0.45 m
Likely severity of barrier	Most flows
Potential barriers known upstream	1 (U23:722139)
Potential barriers known downstream	1 (U23:735133)

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	2245 m
Shortfin eel	525 m
Torrentfish	<1 m
Koaro	102 m
Banded kokopu	2 m
Redfin bully	1 m
Brown trout	635 m
Rainbow trout	30 m

NZFFDB records for site	No
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Potential as migratory barrier	High
Priority for remediation	Low (degraded upstream)



Above: Inlet.

Below: Perched outlet with damaged fish ramp.



Site no.: U23:722139	
Location: unnamed stream, Top Grass Rd (north end)	
Easting	2772282
Northing	6113951
Date assessed	26/03/2008
Structure	culvert
Type	box
Construction	concrete
Length	6.25 m
Diameter	1.05 m
Water depth (inlet)	0.04 m
Water depth (outlet)	0.03 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	0.28 m
If perched (undercut)	0.66 m
Likely severity of barrier	Most flows
Potential barriers known upstream	0
Potential barriers known downstream	2 (U23:735133, U23:726138)

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	1354 m
Shortfin eel	32 m
Koaro	6 m
Banded kokopu	2 m
Redfin bully	<1 m
Brown trout	212 m
Rainbow trout	1 m

NZFFDB records for site	No
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Potential as migratory barrier	High
Priority for remediation	Low (degraded upstream)



Above: Inlet.

Below: Perched outlet. Access to below culvert was difficult.



Site no.: U23:735133	
Location: unnamed stream, Dangen Rd, near Dannevirke	
Easting	2773578
Northing	6113398
Date assessed	26/03/2008
Structure	culvert
Type	box
Construction	concrete
Length	12.5 m
Diameter	2.42 m
Water depth (inlet)	0.05 m
Water depth (outlet)	0.02 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	1.45 m
If perched (undercut)	~0.5 m
Likely severity of barrier	Most flows
Potential barriers known upstream	2 (U23:735133, U23:726138)
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	6350 m
Shortfin eel	1094 m
Torrenfish	7 m
Koaro	150 m
Banded kokopu	3 m
Redfin bully	61 m
Brown trout	2073 m
Rainbow trout	108 m

NZFFDB records for site	No
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Potential as migratory barrier	High
Priority for remediation	Low (difficult fix, degraded upstream)



Above: Inlet.

Below: Extremely perched outlet.
Evidence of very recent erosion prevention works.



Site no.: T23:559171	
Location: unnamed stream, Pohangina Valley East Rd	
Easting	2755944
Northing	6117197
Date assessed	27/03/2008
Structure	culvert
Type	box
Construction	concrete
Length	26.5 m
Diameter	1.74 m
Water depth (inlet)	0.02 m
Water depth (outlet)	0.01 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	~3 m
If perched (undercut)	0 m
Likely severity of barrier	Most flows
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	857 m
Shortfin eel	67 m
Koaro	77 m
Banded kokopu	<1 m
Redfin bully	70 m
Brown trout	338 m

NZFFDB records for site	No
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Potential as migratory barrier	High
Priority for remediation	Low (difficult fix, limited upstream)



Above: Inlet.

Site no.: U23:775011	
Location: Kotarenu Stream, Weber Rd, near Dannevirke	
Easting	2777563
Northing	6101123
Date assessed	8/04/2008
Structure	culvert
Type	pipe
Construction	corrugated iron
Length	41 m
Diameter	2.4 m
Water depth (inlet)	0.09 m
Water depth (outlet)	0.10 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	1.36 m
If perched (undercut)	2 m+
Likely severity of barrier	Most flows
Potential barriers known upstream	0
Potential barriers known downstream	0

Below: Perched outlet.



Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	2812 m
Shortfin eel	224 m
Koaro	14 m
Banded kokopu	521 m
Redfin bully	195 m
Brown trout	2626 m

NZFFDB records for site	No
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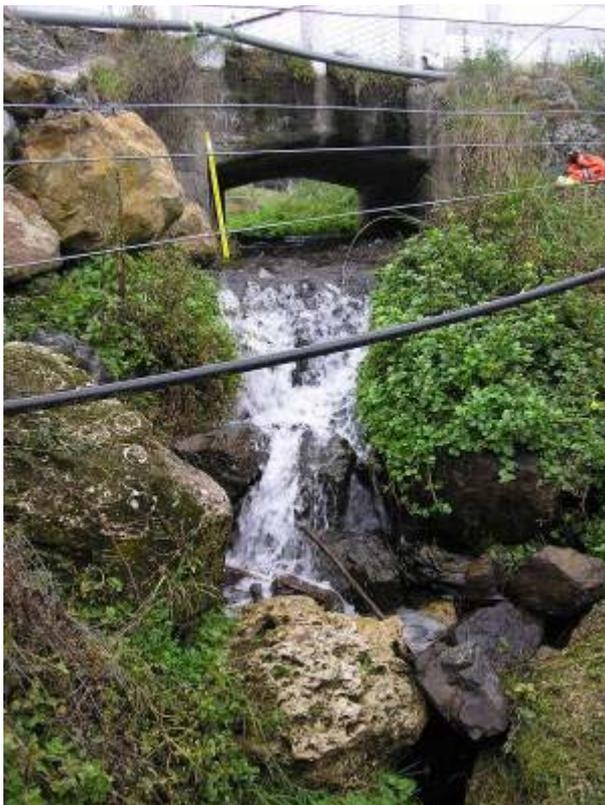
Potential as migratory barrier	High
Priority for remediation	Low (difficult fix, degraded upstream)



Above: Inlet.

Site no.: U23:798232	
Location: Unnamed stream, Ngamoko Rd, near Norsewood	
Easting	2779828
Northing	6123276
Date assessed	8/04/2008
Structure	culvert/bridge
Type	box
Construction	concrete
Length	12.6 m
Diameter	2.7 m
Water depth (inlet)	0.16 m
Water depth (outlet)	0.05 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	1.6 m
If perched (undercut)	0 m
Likely severity of barrier	Most flows
Potential barriers known upstream	0
Potential barriers known downstream	1 (U23:856230)

Below: Perched outlet.



Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	3584 m
Shortfin eel	180 m
Torrentfish	1 m
Koaro	3011 m
Redfin bully	1 m
Brown trout	4450 m
Rainbow trout	1781 m

NZFFDB records for site	No (but records for U23:856230 are within 7 km downstream)
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Potential as migratory barrier	High
Priority for remediation	Low (difficult fix, degraded upstream)



Above: Inlet.

Below: The outlet is at the top right with a perched drop around 3 m downstream.



Site no.: U23:803241	
Location: Unnamed stream, Manawatu River Rd, near Norsewood	
Easting	2780376
Northing	6124118
Date assessed	8/04/2008
Structure	culvert
Type	pipe
Construction	concrete
Length	19.66 m
Diameter	1.17 m
Water depth (inlet)	0.12 m
Water depth (outlet)	0.06 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	0.3 m
If perched (undercut)	0.5 m
Likely severity of barrier	Most flows
Potential barriers known upstream	0
Potential barriers known downstream	1 (U23:856230)

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	2099 m
Shortfin eel	400 m
Koaro	1098 m
Redfin bully	<1 m
Brown trout	551 m
Rainbow trout	283 m

NZFFDB records for site	No (but records for U23:856230 are within 7 km downstream)
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Potential as migratory barrier	High
Priority for remediation	Low (difficult fix, degraded upstream)



Above: Inlet.



Below: Perched outlet.

Site no.: S24:284745 (GPS coords from clearing 50m away)	
Location: Unnamed stream, Scotts Rd, Gordon Kear Forest	
Easting	2728433
Northing	6074540
Date assessed	20/04/2008
Structure	culvert
Type	double pipe
Construction	concrete
Length	7.7 m
Diameter	0.75 m
Water depth (inlet)	0.05/0.06 m
Water depth (outlet)	0.04/0.04 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	0.27 m
If perched (undercut)	0.55 m
Likely severity of barrier	Most flows
Potential barriers known upstream	3 (S24:284745, S24:282744, S24:280740)
Potential barriers known downstream	2 (S24:287748, S24:589749)

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	282 m
Shortfin eel	22 m
Koaro	1596 m
Banded kokopu	1 m
Brown trout	762 m
Rainbow trout	3548 m

NZFFDB records for site	Yes (see Appendix 3)
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Potential as migratory barrier	High
Priority for remediation	Low (difficult fix)



Above: Inlet.

Below: Perched outlet with drop over bedrock outcrop.



Site no.: S24:289750	
Location: Unnamed stream, Scotts Rd, Gordon Kear Forest	
Easting	2728947
Northing	6075044
Date assessed	20/04/2008
Structure	culvert
Type	double pipe
Construction	concrete
Length	10.5 m
Diameter	0.75 m
Water depth (inlet)	0.04/0.03 m
Water depth (outlet)	0.02/0.03 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	1.4 m
If perched (undercut)	0 m
Likely severity of barrier	Most flows
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	30 m
Shortfin eel	4 m
Koaro	40 m
Banded kokopu	<1 m
Brown trout	985 m
Rainbow trout	<1 m

NZFFDB records for site	Yes (see Appendix 3)
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Potential as migratory barrier	High
Priority for remediation	Low (difficult fix, limited upstream)



Above: Inlet.

Site no.: S24:294741	
Location: Unnamed stream, Scotts Rd, Gordon Kear Forest	
Easting	2729476
Northing	6074196
Date assessed	20/04/2008
Structure	culvert
Type	pipe
Construction	concrete
Length	7.35 m
Diameter	1.06 m
Water depth (inlet)	0.07 m
Water depth (outlet)	0.06 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	1 m
If perched (undercut)	2 m
Likely severity of barrier	Most flows
Potential barriers known upstream	0
Potential barriers known downstream	0

Below: Perched outlet with significant undercutting.



Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	70 m
Shortfin eel	<1 m
Koaro	497 m
Brown trout	2078 m
Rainbow trout	4 m

NZFFDB records for site	Yes (see Appendix 3)
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Potential as migratory barrier	High
Priority for remediation	Low (difficult fix, limited upstream)



Above: Inlet. No water flows through the righthand pipe.

Below: Perched outlet.



Site no.: S24:284745	
Location: Unnamed stream, Scotts Rd, Gordon Kear Forest	
Easting	2728418
Northing	6074540
Date assessed	20/04/2008
Structure	culvert
Type	double pipe
Construction	iron lined with concrete
Length	6.5 m
Diameter	0.46 m
Water depth (inlet)	0.05 m
Water depth (outlet)	0.03 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	0.17 m
If perched (undercut)	0.3 m
Likely severity of barrier	Most flows
Potential barriers known upstream	0
Potential barriers known downstream	3 (S24:284745 clearing, S24:287748, S24:289749)

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	29 m
Shortfin eel	<1 m
Koaro	80 m
Banded kokopu	<1 m
Brown trout	189 m
Rainbow trout	<1 m

NZFFDB records for site	Yes (see Appendix 3)
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Potential as migratory barrier	High
Priority for remediation	Low (difficult fix, limited upstream)



Above: Inlet.

Below: Perched outlet. There is flow outside of culvert here and the road is being undermined.



Site no.: S24:280740	
Location: Unnamed stream, Scotts Rd, Gordon Kear Forest	
Easting	2728065
Northing	6074041
Date assessed	20/04/2008
Structure	culvert
Type	pipe
Construction	iron lined with concrete
Length	6.1 m
Diameter	0.55 m
Water depth (inlet)	0.05 m
Water depth (outlet)	0.03 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	0.25 m
If perched (undercut)	6.1 m
Likely severity of barrier	Most flows
Potential barriers known upstream	0
Potential barriers known downstream	4 (S24:282744A, S24:284745 clearing, S24:287748, S24:289749)

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	68 m
Shortfin eel	14 m
Koaro	845 m
Banded kokopu	<1 m
Brown trout	1295 m
Rainbow trout	698 m

NZFFDB records for site	Yes (see Appendix 3)
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Potential as migratory barrier	High
Priority for remediation	Low (difficult fix, limited upstream)



Above: Inlet.

Below: Perched outlet. A deep (>1 m) plunge pool made access difficult.



Site no.: S24:282744A	
Location: Unnamed stream, Scotts Rd, Gordon Kear Forest	
Easting	2728297
Northing	6074435
Date assessed	20/04/2008
Structure	culvert
Type	pipe
Construction	iron lined with concrete
Length	7.6 m
Diameter	0.55 m
Water depth (inlet)	0.05 m
Water depth (outlet)	0.05 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	0.3 m
If perched (undercut)	could not access
Likely severity of barrier	Most flows
Potential barriers known upstream	1 (S24:280740)
Potential barriers known downstream	3 (S24:284745 clearing, S24:287748, S24:289749)

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	68 m
Shortfin eel	14 m
Koaro	845 m
Banded kokopu	<1 m
Brown trout	1295 m
Rainbow trout	698 m

NZFFDB records for site	Yes (see Appendix 3)
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Potential as migratory barrier	High
Priority for remediation	Low (difficult fix, limited upstream)



Above: Inlet.

Below: Perched outlet.



Site no.: S24:282744B	
Location: Unnamed stream, Scotts Rd, Gordon Kear Forest	
Easting	2728297
Northing	6074435
Date assessed	20/04/2008
Structure	culvert
Type	pipe
Construction	iron lined with concrete
Length	6 m
Diameter	0.55 m
Water depth (inlet)	0.03 m
Water depth (outlet)	0.02 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	0.55 m
If perched (undercut)	0.1 m
Likely severity of barrier	Most flows
Potential barriers known upstream	0
Potential barriers known downstream	3 (S24:284745 clearing, S24:287748, S24:289749)

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Stream not on REC watershed layer	

NZFFDB records for site	Yes (see Appendix 3)
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Potential as migratory barrier	High
Priority for remediation	Low (difficult fix, limited upstream)



Above: Inlet.



Below: Perched outlet.

Site no.: S25:073613	
Location: unnamed stream, Denton Rd, near Levin	
Easting	2707329
Northing	6061336
Date assessed	4/04/2008
Structure	culvert
Type	pipe
Construction	concrete
Length	12.3 m
Diameter	1.2 m
Water depth (inlet)	0.02 m
Water depth (outlet)	0.02 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	0.40 m
If perched (undercut)	0.43 m
Likely severity of barrier	Most flows
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	1273 m
Shortfin eel	1194 m
Torrentfish	35 m
Koaro	8 m
Banded kokopu	440 m
Redfin bully	992 m
Brown trout	39 m

NZFFDB records for site	No
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Potential as migratory barrier	High
Priority for remediation	Low (degraded upstream)



Above: Inlet.

Below: Perched outlet.



Left: Double perch due to broken pipe segment at outlet.

Site no.: S25:118700 road	
Location: unnamed stream, Buckley Shannon Rd	
Easting	2711813
Northing	6070032
Date assessed	3/04/2008
Structure	culvert
Type	pipe
Construction	concrete
Length	8.75 m
Diameter	1.2 m
Water depth (inlet)	0.12 m
Water depth (outlet)	0.03 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	0.27/0.10 m
If perched (undercut)	0.60/1.2 m
Likely severity of barrier	Most flows
Potential barriers known upstream	1 (S25:118700)
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	4026 m
Shortfin eel	5219 m
Koaro	2 m
Banded kokopu	1842 m
Redfin bully	1760 m
Brown trout	148 m

NZFFDB records for site	No
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Potential as migratory barrier	Medium
Priority for remediation	Low (degraded upstream)



Above: Inlet.

Below: Perched outlet.



Site no.: S25:080629	
Location: unnamed stream, McDonald Rd, near Levin	
Easting	2708027
Northing	6062934
Date assessed	4/04/2008
Structure	culvert
Type	pipe
Construction	concrete
Length	11.2 m
Diameter	1.2 m
Water depth (inlet)	0.10 m
Water depth (outlet)	0.04 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	0.37 m
If perched (undercut)	0.60 m
Likely severity of barrier	Most flows
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	2 m
Shortfin eel	1 m
Torrentfish	<1 m
Koaro	1 m
Banded kokopu	1 m
Redfin bully	1 m
Brown trout	<1 m

NZFFDB records for site	No
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Potential as migratory barrier	Medium
Priority for remediation	Low (degraded upstream)



Above: Inlet.

Below: The outlet with the entire flow beneath the concrete base of the culvert.



Site no.: S25:082646	
Location: unnamed stream, Wallace Rd, near Levin	
Easting	2708232
Northing	6064686
Date assessed	4/04/2008
Structure	culvert
Type	box
Construction	concrete
Length	4.7 m
Diameter	2.4 m
Water depth (inlet)	0.04 m
Water depth (outlet)	0.04 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	0.15 m
If perched (undercut)	4.7 m
Likely severity of barrier	Most flows
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	413 m
Shortfin eel	820 m
Banded kokopu	274 m
Redfin bully	7 m
Brown trout	5 m

NZFFDB records for site	No
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Potential as migratory barrier	Medium
Priority for remediation	Low (degraded and limited upstream)



Above: Inlet.



Below: Perched outlet.

Site no.: T24:443940	
Location: unnamed stream, Back Rd, off Fitzherbert East Rd	
Easting	2744320
Northing	6094000
Date assessed	7/04/2008
Structure	culvert
Type	box
Construction	concrete
Length	24.9 m
Diameter	In: 1.6 m, Out: 1.9 m
Water depth (inlet)	0.05 m
Water depth (outlet)	0.05 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	0.18 m
If perched (undercut)	0.15 m
Likely severity of barrier	Most flows
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	703 m
Shortfin eel	1126 m
Koaro	118 m
Redfin bully	67 m
Brown trout	5243 m
Rainbow trout	15 m

NZFFDB records for site	No
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Potential as migratory barrier	Medium
Priority for remediation	Low (degraded upstream)



Above: Inlet.

Site no.: T24:661838	
Location: unnamed stream, Makairo Rd	
Easting	2766129
Northing	6083806
Date assessed	20/03/2008
Structure	culvert
Type	box
Construction	concrete
Length	6.34 m
Diameter	1.9 m
Water depth (inlet)	0.002 m
Water depth (outlet)	0.002 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	0.12 m
If perched (undercut)	0 m
Likely severity of barrier	Most flows
Potential barriers known upstream	0
Potential barriers known downstream	1 (natural drop)

Below: Perched outlet.



Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	5 m
Shortfin eel	8 m
Koaro	105 m
Redfin bully	2 m
Brown trout	52 m

NZFFDB records for site	No
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Potential as migratory barrier	Medium
Priority for remediation	Low (30 m natural drop just downstream)



Above: Inlet.

Site no.: T24:425835	
Location: unnamed stream, Pahiatua Track	
Easting	2742561
Northing	6083552
Date assessed	18/03/2008
Structure	culvert
Type	box
Construction	concrete
Length	9.5 m
Diameter	3.1 m
Water depth (inlet)	0.04 m
Water depth (outlet)	0.02 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	0.6 m
If perched (undercut)	0 m
Likely severity of barrier	Most flows
Potential barriers known upstream	0
Potential barriers known downstream	0

Below: Outlet.



Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	2615 m
Shortfin eel	771 m
Torrentfish	<1 m
Koaro	245 m
Banded kokopu	1 m
Redfin bully	348 m
Brown trout	2966 m
Rainbow trout	1 m

NZFFDB records for site	No
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Potential as migratory barrier	Medium
Priority for remediation	Low (difficult fix, degraded upstream)



Above: Inlet.

Below: Outlet. This stream is barely moving at this site and smells anoxic.



Site no.: T24:396916	
Location: unnamed stream, Forest Hill Rd (off Fitzherbert East Rd)	
Easting	2739578
Northing	6091813
Date assessed	30/01/2008
Structure	culvert
Type	box
Construction	concrete
Length	5.6 m
Diameter	1.5 m
Water depth (inlet)	0.62 m
Water depth (outlet)	0.37 m
Inlet cross section	pooled
Outlet cross section	flat
If perched (height)	-
If perched (undercut)	-
Likely severity of barrier	None/minimal
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	2375 m
Shortfin eel	712 m
Torrentfish	4 m
Koaro	20 m
Banded kokopu	1974 m
Redfin bully	271 m
Brown trout	813 m

NZFFDB records for site	No
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Potential as migratory barrier	Low
Priority for remediation	Low



Above: Inlet.

Below: Outlet. This site was dry at the time of assessment.



Site no.: T23:477073	
Location: Waitokanui Stream, Awahou South Rd (off Pohangina Valley East Rd)	
Easting	2747731
Northing	6107388
Date assessed	30/01/2008
Structure	culvert
Type	box
Construction	concrete
Length	6 m
Diameter	2.5 m
Water depth (inlet)	0 m
Water depth (outlet)	0 m
Inlet cross section	flat
Outlet cross section	flat
If perched (height)	-
If perched (undercut)	-
Likely severity of barrier	None/minimal
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	1389 m
Shortfin eel	421 m
Torrentfish	<1 m
Koaro	110 m
Banded kokopu	49 m
Redfin bully	144 m
Brown trout	884 m
Rainbow trout	<1 m

NZFFDB records for site	Yes (see Appendix 3)
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Potential as migratory barrier	Low
Priority for remediation	Low



Above: Inlet.



Below: Outlet

Site no.: T24:350723	
Location: unnamed stream, Kopikopiko Rd	
Easting	2734981
Northing	6072477
Date assessed	1/02/2008
Structure	culvert
Type	double pipe
Construction	concrete
Length	5 m
Diameter	0.85 m
Water depth (inlet)	0.06 m
Water depth (outlet)	0.11 m
Inlet cross section	flat
Outlet cross section	pooled
If perched (height)	-
If perched (undercut)	-
Likely severity of barrier	None/minimal
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	2102 m
Shortfin eel	53 m
Torrentfish	5 m
Koaro	476 m
Redfin bully	183 m
Brown trout	556 m
Rainbow trout	1 m

NZFFDB records for site	No
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Potential as migratory barrier	Low
Priority for remediation	Low



Above: Inlet.



Below: Outlet.

Site no.: T25:441698	
Location: unnamed stream, Bourkes Rd (off SH2 north of Eketahuna)	
Easting	2744101
Northing	6069868
Date assessed	18/02/2008
Structure	culvert
Type	box
Construction	concrete
Length	5.25 m
Diameter	1.7 m
Water depth (inlet)	0.73 m
Water depth (outlet)	0.79 m
Inlet cross section	flat
Outlet cross section	flat
If perched (height)	-
If perched (undercut)	-
Likely severity of barrier	None/minimal
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)
Stream not on REC watershed layer

NZFFDB records for site	No
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Potential as migratory barrier	Low
Priority for remediation	Low



Above: Inlet.



Below: Outlet.

Site no.: S25:267569	
Location: unnamed stream, Putara Rd, Eketahuna	
Easting	2726778
Northing	6056948
Date assessed	18/02/2008
Structure	culvert
Type	double pipe
Construction	concrete
Length	8.6 m
Diameter	0.9 m
Water depth (inlet)	0.06/0.02 m
Water depth (outlet)	0.04/0.01 m
Inlet cross section	flat
Outlet cross section	flat
If perched (height)	-
If perched (undercut)	-
Likely severity of barrier	None/minimal
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	110 m
Shortfin eel	1 m
Koaro	<1 m
Redfin bully	<1 m
Brown trout	45 m
Rainbow trout	<1 m

NZFFDB records for site	No
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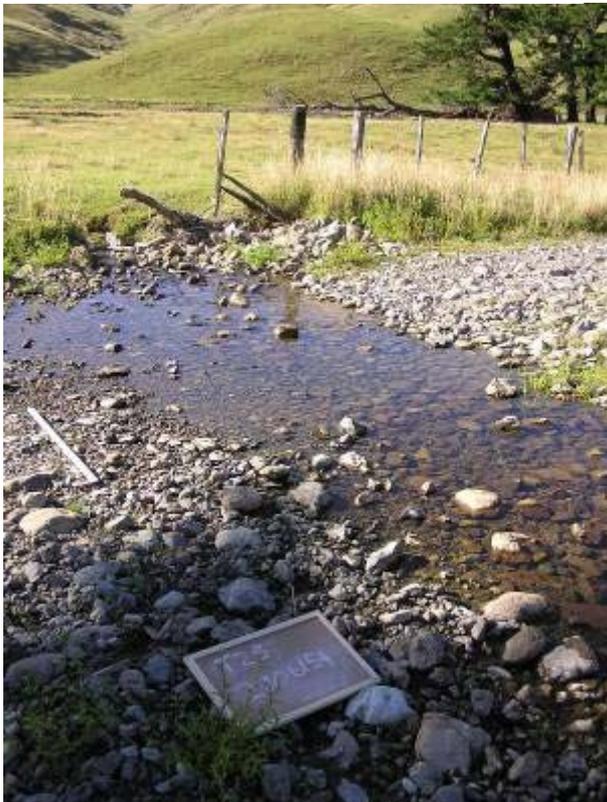
Potential as migratory barrier	Low
Priority for remediation	Low



Above: Inlet. Label should be S25 not T25.

Site no.: S25:290615	
Location: unnamed stream, Mangaroa Rd, Eketahuna	
Easting	2729019
Northing	6061542
Date assessed	26/02/2008
Structure	ford
Type	ford
Construction	natural substrate
Length	3.5 m
Diameter	2.3 m
Water depth (inlet)	0.04 m
Water depth (outlet)	0.08 m
Inlet cross section	flat
Outlet cross section	flat
If perched (height)	-
If perched (undercut)	-
Likely severity of barrier	None/minimal
Potential barriers known upstream	0
Potential barriers known downstream	0

Below: The ford.



Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	420 m
Shortfin eel	29 m
Torrentfish	<1 m
Koaro	4 m
Banded kokopu	<1 m
Redfin bully	12 m
Brown trout	8 m
Rainbow trout	4 m

NZFFDB records for site	No
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Potential as migratory barrier	Low
Priority for remediation	Low



Above: Inlet. This culvert was installed just before site visit.

Below: Outlet.



Site no.: T25:308626	
Location: unnamed stream, Mangaraupiu Rd, near Eketahuna	
Easting	2730809
Northing	6062667
Date assessed	26/02/2008
Structure	culvert
Type	pipe
Construction	concrete
Length	12.5 m
Diameter	0.75 m
Water depth (inlet)	0.03 m
Water depth (outlet)	0.04 m
Inlet cross section	flat
Outlet cross section	flat
If perched (height)	-
If perched (undercut)	-
Likely severity of barrier	None/minimal
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)
Stream not on REC watershed layer

NZFFDB records for site	No
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Potential as migratory barrier	Low
Priority for remediation	Low



Above: Inlet.

Below: Outlet.



Site no.: T25:316643	
Location: unnamed stream, Mangaraupiu Rd, near Eketahuna	
Easting	2731616
Northing	6064358
Date assessed	26/02/2008
Structure	culvert
Type	pipe
Construction	concrete
Length	12.5 m
Diameter	0.57 m
Water depth (inlet)	0.06 m
Water depth (outlet)	0.09 m
Inlet cross section	flat
Outlet cross section	pooled
If perched (height)	-
If perched (undercut)	-
Likely severity of barrier	None/minimal
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)
Stream not on REC watershed layer

NZFFDB records for site	No
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Potential as migratory barrier	Low
Priority for remediation	Low



Above: Inlet.

Below: Outlet



Site no.: T23:694111	
Location: unnamed stream, Top Grass Rd	
Easting	2769434
Northing	6111101
Date assessed	7/03/2008
Structure	culvert
Type	box
Construction	concrete
Length	8 m
Diameter	3.05 m
Water depth (inlet)	0.12 m
Water depth (outlet)	0.09 m
Inlet cross section	flat
Outlet cross section	flat
If perched (height)	-
If perched (undercut)	-
Likely severity of barrier	None/minimal
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	8795 m
Shortfin eel	492 m
Torrentfish	308 m
Koaro	31 m
Banded kokopu	<1 m
Redfin bully	581 m
Brown trout	3295 m
Rainbow trout	558 m

NZFFDB records for site	No
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Potential as migratory barrier	Low
Priority for remediation	Low



Above: Inlet. The label should show S24 not T24.

Below: Outlet



Site no.: S24:275780	
Location: unnamed stream, Scotts Rd	
Easting	2727568
Northing	6078083
Date assessed	11/03/2008
Structure	culvert
Type	pipe
Construction	corrugated iron
Length	15.3 m
Diameter	1.44 m
Water depth (inlet)	0.08 m
Water depth (outlet)	0.04 m
Inlet cross section	flat
Outlet cross section	flat
If perched (height)	-
If perched (undercut)	-
Likely severity of barrier	None/minimal
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	934 m
Shortfin eel	891 m
Koaro	13 m
Banded kokopu	<1 m
Redfin bully	284 m
Brown trout	66 m

NZFFDB records for site	No
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Potential as migratory barrier	Low
Priority for remediation	Low



Above: Inlet

Below: Outlet



Site no.: T24:474845	
Location: unnamed stream, Ballance Gorge Rd	
Easting	2747450
Northing	6084566
Date assessed	18/03/2008
Structure	culvert
Type	box
Construction	concrete
Length	7.3 m
Diameter	2.44 m
Water depth (inlet)	0.04 m
Water depth (outlet)	0.03 m
Inlet cross section	flat
Outlet cross section	flat
If perched (height)	-
If perched (undercut)	-
Likely severity of barrier	None/minimal
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	5287 m
Shortfin eel	4801 m
Torrentfish	<1 m
Koaro	13 m
Banded kokopu	209 m
Redfin bully	966 m
Brown trout	3156 m

NZFFDB records for site	No
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Potential as migratory barrier	Low
Priority for remediation	Low



Above: Inlet

Site no.: T24:465828	
Location: unnamed stream, Ballance Gorge Rd @ Tararua Rd	
Easting	2746566
Northing	6082838
Date assessed	18/03/2008
Structure	culvert
Type	pipe
Construction	concrete
Length	15.5 m
Diameter	1.7 m
Water depth (inlet)	0.18 m
Water depth (outlet)	0.18 m
Inlet cross section	flat
Outlet cross section	pooled
If perched (height)	-
If perched (undercut)	-
Likely severity of barrier	None/minimal
Potential barriers known upstream	0
Potential barriers known downstream	0

Below: Outlet.



Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	6842 m
Shortfin eel	2063 m
Torrentfish	<1 m
Koaro	14 m
Banded kokopu	98 m
Redfin bully	2002 m
Brown trout	1503 m
Rainbow trout	<1 m

NZFFDB records for site	Yes (see Appendix 3)
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Potential as migratory barrier	Low
Priority for remediation	Low



Above: Inlet

Below: Outlet.



Site no.: T24:412793	
Location: unnamed stream, Inglis Rd	
Easting	2741256
Northing	6079361
Date assessed	18/03/2008
Structure	culvert
Type	box
Construction	concrete
Length	5.47 m
Diameter	2.5 m
Water depth (inlet)	0.20 m
Water depth (outlet)	0.17 m
Inlet cross section	pooled
Outlet cross section	pooled
If perched (height)	-
If perched (undercut)	-
Likely severity of barrier	None/minimal
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	4211 m
Shortfin eel	2609 m
Koaro	961 m
Banded kokopu	<1 m
Redfin bully	1187 m
Brown trout	2603 m
Rainbow trout	16 m

NZFFDB records for site	No
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Potential as migratory barrier	Low
Priority for remediation	Low



Above: Inlet



Below: Outlet.

Site no.: U23:735157	
Location: unnamed stream, Te Kakapo Valley Rd	
Easting	2773526
Northing	6115798
Date assessed	26/03/2008
Structure	culvert
Type	box
Construction	concrete
Length	7.2 m
Diameter	1.23 m
Water depth (inlet)	0.04 m
Water depth (outlet)	0.04 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	0.01 m
If perched (undercut)	0 m
Likely severity of barrier	None/minimal
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	3657 m
Shortfin eel	116 m
Torrentfish	87 m
Koaro	4 m
Banded kokopu	<1 m
Redfin bully	99 m
Brown trout	512 m
Rainbow trout	112 m

NZFFDB records for site	No
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Potential as migratory barrier	Low
Priority for remediation	Low



Above: Inlet

Below: Outlet.



Site no.: U23:726120	
Location: unnamed stream, Armstrong Rd, near Dannevirke	
Easting	2772699
Northing	6112024
Date assessed	26/03/2008
Structure	culvert
Type	pipe
Construction	corrugated iron
Length	18.95 m
Diameter	1.8 m
Water depth (inlet)	0.09 m
Water depth (outlet)	0.26 m
Inlet cross section	flat
Outlet cross section	pooled
If perched (height)	-
If perched (undercut)	-
Likely severity of barrier	None/minimal
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	696 m
Shortfin eel	379 m
Koaro	17 m
Redfin bully	<1 m
Brown trout	204 m
Rainbow trout	1 m

NZFFDB records for site	No
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Potential as migratory barrier	Low
Priority for remediation	Low



Above: Inlet

Below: Outlet. The middle pipe is half filled with sediment.



Site no.: S24:182713	
Location: unnamed stream, Kingston Rd, north of Shannon	
Easting	2718224
Northing	6071346
Date assessed	3/04/2008
Structure	culvert
Type	triple pipe
Construction	concrete
Length	13.3 m
Diameter	1.78 m
Water depth (inlet)	0.1/0.15/0.25 m
Water depth (outlet)	0.06/blocked/0.15 m
Inlet cross section	flat
Outlet cross section	flat
If perched (height)	-
If perched (undercut)	-
Likely severity of barrier	None/minimal
Potential barriers known upstream	2 (S24:182712, S24: 183711)
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	3553 m
Shortfin eel	1715 m
Torrentfish	80 m
Koaro	168 m
Banded kokopu	835 m
Redfin bully	2474 m
Brown trout	543 m
Rainbow trout	2 m

NZFFDB records for site	No
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Potential as migratory barrier	Low
Priority for remediation	Low



Above: Inlet

Below: Outlet. The righthand pipe was well above the water level at the time of assessment. This dry pipe has a severely undercut and perched fish pass structure.



Site no.: S24:180715	
Location: Kara Stream, Kingston Rd, north of Shannon	
Easting	2718052
Northing	6071522
Date assessed	3/04/2008
Structure	culvert
Type	pipe
Construction	concrete
Length	13.4 m
Diameter	1.5 m
Water depth (inlet)	0.08 m
Water depth (outlet)	0.03 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	0.02 m
If perched (undercut)	0.4 m
Likely severity of barrier	None/minimal
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	1413 m
Shortfin eel	2105 m
Koaro	<1 m
Banded kokopu	651 m
Redfin bully	977 m
Brown trout	31 m

NZFFDB records for site	No
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Potential as migratory barrier	Low
Priority for remediation	Low



Above: Inlet

Below: Outlet. The drop through the boulders is no greater than any natural features visible nearby.



Site no.: S25:164664	
Location: unnamed stream, Mangaore Rd, bridge near road end	
Easting	2716470
Northing	6066473
Date assessed	3/04/2008
Structure	bridge
Type	box
Construction	concrete
Length	6.4 m
Diameter	5.5 m
Water depth (inlet)	0.26 m
Water depth (outlet)	0.07 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	0.3-0.4 m
If perched (undercut)	0 m
Likely severity of barrier	None/minimal
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	5592 m
Shortfin eel	2474 m
Torrentfish	1 m
Koaro	340 m
Banded kokopu	2 m
Redfin bully	141 m
Brown trout	4222 m
Rainbow trout	9 m

NZFFDB records for site	Yes (see Appendix 3)
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Potential as migratory barrier	Low
Priority for remediation	Low



Above: Inlet

Below: Outlet



Site no.: S25:118700	
Location: unnamed stream, Buckley Shannon Rd, railway culvert	
Easting	2711802
Northing	6070007
Date assessed	3/04/2008
Structure	culvert
Type	pipe
Construction	concrete
Length	17.7 m
Diameter	1.95 m
Water depth (inlet)	0.2 m
Water depth (outlet)	0.23 m
Inlet cross section	flat
Outlet cross section	flat
If perched (height)	-
If perched (undercut)	-
Likely severity of barrier	None/minimal
Potential barriers known upstream	0
Potential barriers known downstream	1 (S25:118700 road)

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	4026 m
Shortfin eel	5219 m
Koaro	2 m
Banded kokopu	1842 m
Redfin bully	1760 m
Brown trout	148 m

NZFFDB records for site	No
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Potential as migratory barrier	Low
Priority for remediation	Low



Above: Inlet

Site no.: S25:069607	
Location: Koputoroa Stream, Denton Rd, near Levin	
Easting	2706997
Northing	6060785
Date assessed	4/04/2008
Structure	culvert
Type	pipe
Construction	concrete
Length	20.9 m
Diameter	1.05 m
Water depth (inlet)	0.04 m
Water depth (outlet)	0.05 m
Inlet cross section	flat
Outlet cross section	flat
If perched (height)	-
If perched (undercut)	-
Likely severity of barrier	None/minimal
Potential barriers known upstream	0
Potential barriers known downstream	0

Below: Outlet



Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	1814 m
Shortfin eel	1232 m
Torrentfish	67 m
Koaro	2 m
Banded kokopu	579 m
Redfin bully	1330 m
Brown trout	93 m

NZFFDB records for site	No
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Potential as migratory barrier	Low
Priority for remediation	Low



Above: Inlet

Below: Outlet



Site no.: S25:085659	
Location: Waoku Stream, Potts Rd, near Levin	
Easting	2708549
Northing	6065926
Date assessed	4/04/2008
Structure	culvert
Type	pipe
Construction	corrugated iron
Length	18.5 m
Diameter	3.55 m
Water depth (inlet)	0.09 m
Water depth (outlet)	0.11 m
Inlet cross section	flat
Outlet cross section	flat
If perched (height)	-
If perched (undercut)	-
Likely severity of barrier	None/minimal
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	17884 m
Shortfin eel	15882 m
Torrentfish	89 m
Koaro	566 m
Banded kokopu	4973 m
Redfin bully	8895 m
Brown trout	1813 m
Rainbow trout	<1 m

NZFFDB records for site	No
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Potential as migratory barrier	Low
Priority for remediation	Low



Above: Inlet

Below: Outlet



Site no.: S24:289749	
Location: unnamed stream, Scotts Rd, Gordon Kear Forest	
Easting	2728942
Northing	6074988
Date assessed	20/04/2008
Structure	culvert
Type	pipe
Construction	concrete
Length	16 m
Diameter	2.05 m
Water depth (inlet)	0.13 m
Water depth (outlet)	0.16 m
Inlet cross section	flat
Outlet cross section	flat
If perched (height)	-
If perched (undercut)	-
Likely severity of barrier	None/minimal
Potential barriers known upstream	6 (S24:287748, 284745, 284745clearing, 282744A+B, 280740)
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	334 m
Shortfin eel	42 m
Koaro	2022 m
Banded kokopu	2 m
Brown trout	4815 m
Rainbow trout	1849 m

NZFFDB records for site	Yes (see Appendix 3)
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Potential as migratory barrier	Low
Priority for remediation	Low



Above: Inlet

Below: Outlet.



Site no.: S24:287748	
Location: unnamed stream, Scotts Rd, Gordon Kear Forest	
Easting	2728741
Northing	6074869
Date assessed	20/04/2008
Structure	culvert
Type	pipe
Construction	concrete
Length	7.3 m
Diameter	1.3 m
Water depth (inlet)	0.1 m
Water depth (outlet)	0.04 m
Inlet cross section	flat
Outlet cross section	perched
If perched (height)	0.03 m
If perched (undercut)	0.65 m
Likely severity of barrier	None/minimal
Potential barriers known upstream	5 (S24:284745, 284745clearing, 282744A+B, 280740)
Potential barriers known downstream	1 (S24:287749)

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	282 m
Shortfin eel	22 m
Koaro	1596 m
Banded kokopu	1 m
Brown trout	3548 m
Rainbow trout	762 m

NZFFDB records for site	Yes (see Appendix 3)
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Potential as migratory barrier	Low
Priority for remediation	Low



Above: Inlet

Below: Outlet.



Site no.: S24:293764	
Location: unnamed stream, Scotts Rd, Gordon Kear Forest entry gate	
Easting	2729353
Northing	6076491
Date assessed	20/04/2008
Structure	bridge
Type	box
Construction	concrete
Length	7.7 m
Diameter	2 m
Water depth (inlet)	0.11 m
Water depth (outlet)	0.04 m
Inlet cross section	flat
Outlet cross section	flat
If perched (height)	-
If perched (undercut)	-
Likely severity of barrier	None/minimal
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	752 m
Shortfin eel	711 m
Koaro	481 m
Banded kokopu	<1 m
Redfin bully	<1 m
Brown trout	6629 m
Rainbow trout	2399 m

NZFFDB records for site	Yes (see Appendix 3)
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Potential as migratory barrier	Low
Priority for remediation	Low



Above: Inlet with debris/mud dam.

Site no.: T23:604284	
Location: Kainga Stream, Makoura Rd, near Utuwai.	
Easting	2760401
Northing	6128406
Date assessed	27/03/2008
Structure	culvert
Type	Box
Construction	concrete
Length	10.6
Diameter	0.6
Water depth (inlet)	0.20
Water depth (outlet)	0.33
Inlet cross section	pooled
Outlet cross section	pooled
If perched (height)	-
If perched (undercut)	-
Likely severity of barrier	High flow
Known barriers upstream	0
Known barriers downstream	0

Below: Outlet



Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	103 m
Shortfin eel	85 m
Torrentfish	< 1 m
Koaro	247 m
Banded kokopu	< 1 m
Redfin bully	1 m
Brown trout	974 m
Rainbow trout	12 m

NZFFDB records for site	Yes (see appendix 3)
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Potential as migratory barrier	Low
Priority for remediation	Low



Above: Inlet

Site no.: S24:222760	
Location: Unnamed stream, Albert Rd, near Tokomaru	
Easting	2722291
Northing	6076002
Date assessed	3/04/2008
Structure	culvert
Type	pipe
Construction	concrete
Length	14.7
Diameter	2.05
Water depth (inlet)	0.41
Water depth (outlet)	0.42
Inlet cross section	flat
Outlet cross section	flat
If perched (height)	-
If perched (undercut)	-
Likely severity of barrier	High flows
Known barriers upstream	0
Known barriers downstream	1 (S24:213760)

Below: Outlet



Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	2160 m
Shortfin eel	3066 m
Koaro	4 m
Banded kokopu	771 m
Redfin bully	579 m
Brown trout	31 m

NZFFDB records for site	None
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Potential as migratory barrier	Low
Priority for remediation	Low



Above: Inlet



Below: Outlet

Site no.: S25:300587	
Location: unnamed stream, Putara Rd, near Eketahuna	
Easting	2730015
Northing	6058727
Date assessed	18/02/2008
Structure	culvert
Type	pipe
Construction	concrete
Length	6.1 m
Diameter	0.86 m
Water depth (inlet)	0.03 m
Water depth (outlet)	0.055 m
Inlet cross section	flat
Outlet cross section	pooled
If perched (height)	-
If perched (undercut)	-
Likely severity of barrier	Low flows
Known barriers upstream	0
Known barriers downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	266 m
Shortfin eel	4 m
Torrentfish	<1 m
Koaro	<1 m
Redfin bully	2 m
Rainbow trout	<1 m
Brown trout	182 m

NZFFDB records for site	None
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Potential as migratory barrier	Low
Priority for remediation	Low



Above: Inlet. Note double decker culvert design. The culvert is a replacement for one destroyed in February 2004 flood event.

Below: Outlet



Site no.: T23:483114	
Location: Unnamed stream, Pohangina, Pohangina Valley West Rd	
Easting	2748374
Northing	6111460
Date assessed	30/01/2008
Structure	culvert
Type	box
Construction	concrete
Length	15.2 m
Diameter	2.4 m
Water depth (inlet)	0.09 m
Water depth (outlet)	0.05 m
Inlet cross section	flat
Outlet cross section	flat
If perched (height)	-
If perched (undercut)	-
Likely severity of barrier	Low flows
Potential barriers known upstream	1 (T23:485117)
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	1918 m
Shortfin eel	381 m
Banded kokopu	220 m
Koaro	1138 m
Redfin bully	531 m
Brown trout	695 m

NZFFDB records for site	Yes (see Appendix 3)
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Potential as migratory barrier	Low
Priority for remediation	Low



Above: Side view of this natural substrate ford

Site no.: T23:485117	
Location: Unnamed stream, Kuku Rd ford, Pohangina	
Easting	2748419
Northing	6111915
Date assessed	30/01/2008
Structure	ford
Type	ford
Construction	natural substrate
Length	4 m
Diameter	1.15 m
Water depth (inlet)	0.05 m
Water depth (outlet)	0.04 m
Inlet cross section	flat
Outlet cross section	flat
If perched (height)	-
If perched (undercut)	-
Likely severity of barrier	Low flows
Potential barriers known upstream	0
Potential barriers known downstream	1 (T23:483111)

Below: Outlet



Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	1918 m
Shortfin eel	381 m
Banded kokopu	219 m
Koaro	1138 m
Redfin bully	531 m
Brown trout	695 m

NZFFDB records for site	Yes (see Appendix 3)
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Potential as migratory barrier	Low
Priority for remediation	Low



Above: Inlet



Below: Pooled outlet

Site no.: T25:343573	
Location: Unnamed stream, South Rd, near Eketahuna	
Easting	2734338
Northing	6057398
Date assessed	18/02/2008
Structure	culvert
Type	box
Construction	concrete
Length	7.75 m
Diameter	1.5 m
Water depth (inlet)	0.03 m
Water depth (outlet)	0.10 m
Inlet cross section	flat
Outlet cross section	pooled
If perched (height)	-
If perched (undercut)	-
Likely severity of barrier	Low flows
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	904 m
Shortfin eel	294 m
Koaro	2 m
Brown trout	5576 m
Rainbow trout	4 m

NZFFDB records for site	None
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Potential as migratory barrier	Low
Priority for remediation	Low



Above: Inlet. Note the debris that had to be removed to access the second pipe.

Below: Outlet



Site no.: T25:320650	
Location: Unnamed stream, Mangaraupiu Rd, near Eketahuna	
Easting	2732051
Northing	6065070
Date assessed	26/02/2008
Structure	culvert
Type	double pipe
Construction	concrete
Length	10 m
Diameter	0.74 m
Water depth (inlet)	0.02/0.07 m
Water depth (outlet)	0.02/0.19 m
Inlet cross section	flat
Outlet cross section	pooled
If perched (height)	-
If perched (undercut)	-
Likely severity of barrier	Low flows
Potential barriers known upstream	0
Potential barriers known downstream	0

Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	1654 m
Shortfin eel	108 m
Koaro	579 m
Banded kokopu	<1 m
Redfin bully	16 m
Brown trout	228 m
Rainbow trout	34 m

NZFFDB records for site	None
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Potential as migratory barrier	Low
Priority for remediation	Low



Above: Inlet

Site no.: S24:182712	
Location: Unnamed stream, Kingston Rd, north of Shannon	
Easting	2718266
Northing	6071293
Date assessed	3/04/2008
Structure	culvert
Type	double pipe
Construction	concrete
Length	13.56 m
Diameter	1.2 m
Water depth (inlet)	0.11/0.01 m
Water depth (outlet)	0.11/0.11 m
Inlet cross section	flat
Outlet cross section	flat
If perched (height)	-
If perched (undercut)	-
Likely severity of barrier	Low flows
Potential barriers known upstream	1 (S24:183711)
Potential barriers known downstream	1 (S24:182713)

Below: Outlet



Predicted length of suitable fish habitat upstream (calculated using predictive model and REC)	
Longfin eel	3553 m
Shortfin eel	1715 m
Koaro	168 m
Banded kokopu	835 m
Redfin bully	2473 m
Brown trout	543 m
Rainbow trout	2 m

NZFFDB records for site	No
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Potential as migratory barrier	Low
Priority for remediation	Low (barriers up/downstream)

4. Discussion

4.1 Are barriers to fish migration important?

In the Manawatu, diadromous native fish species that require high water quality and/or smaller forested streams need free access through the relatively degraded lower catchment in order to find suitable habitat. The Manawatu River and its major tributaries are low gradient and have few significant natural barriers such as waterfalls until they reach the Tararua and Ruahine ranges. Therefore it is important to ensure that structures are not preventing such taxa from reaching areas of suitable habitat. In-stream structures are also important from a legal perspective under the Freshwater Fisheries Regulations (1983) and the Resource Management Act (1991) (see Appendix 1).

4.2 Why not just consider the fish present?

Ideally, the barrier potential of a structure should be assessed based on the fish presence/absence upstream and downstream. Unfortunately, although 22 of the sites assessed in this report had NZFFDB records from the vicinity of the actual structure or from relatively nearby (within ~8 km up/downstream) there is insufficient fish distribution data to make any definite claims about any structure. It should also be noted that even if a species is present upstream of a suspected barrier it does not necessarily mean the structure is not having an impact. For example, ARC (2004) found the same species diversity above and below a perched culvert however there was a distinct difference in community structure. Upstream of the culvert large galaxids dominated with a low abundance of juveniles leading to the conclusion that the culvert may be affecting upstream recruitment skewing the population to a few large individuals. Additionally, apart from affecting the free movement of diadromous

species, barriers may also truncate the distributions and influence the population dynamics of non-migratory species such as upland bully, Cran's bully and dwarf galaxias. For example, if flooding or disease results in the decline (or disappearance) of non-migratory taxa then barriers may prevent their upstream recolonisation of habitat.

4.3 What structures do we have in the Manawatu catchment and how do we assess them?

Most of the structures assessed in this preliminary investigation were concrete box or pipe culverts on public roads relatively close to the Tararua and Ruahine ranges.

Around two thirds of the 91 structures assessed were perched to some degree. The perch heights of these structures were generally less than 0.4m. Only a handful of sites had existing fish pass structures and none of these appeared functional. Some were collapsed ramps, some were dry and well out of the water, one was blocked by concrete and some were eroded and blocked by debris. Only 24 structures were assessed on site as having none/minimal impact on fish passage while 52 were assessed as impeding fish passage at most flows. However, we do not suggest basing any potential remediation solely on these designations. Numerous factors must be considered when deciding where to spend money on the repairing/altering of barrier structures to allow fish passage. Boubée *et al.* (1999) provided the following list of factors that need to be considered:

- presence of other migration barriers up and downstream of structure;
- the composition and distribution of fish within the catchment;
- size and type of habitat available upstream;

- timing of fish migrations, duration, and flow requirements of the species concerned;
- altitude and distance from the sea.

We were able to estimate the amount of suitable habitat upstream for a number of fish species based on the predictive modelling of Joy & Death (2004) which was based on the distribution of fish in the entire North Island. This took into account the size and type of habitat upstream and altitude and distance from the sea based on REC information. We also were able to take into account the presence of other known potential barriers up and downstream. Finally, the relative difficulty and expense of fixing various barriers was considered. It was usually obvious whether a structure required a relatively simple fix (e.g. a load of gravel) as opposed to major works (e.g. construction of an elaborate fish pass).

4.4 What needs to be done?

Of the 91 structures assessed, 68 were rated as a low priority for any remedial work as they either did not present a barrier to fish, they had minimal suitable upstream habitat or are likely to be difficult to repair. Another eight sites were rated medium priority leaving a total of 15 structures designated as of high priority for remediation. Of these 15 sites, 13 were designated as such because the correction of the perched inlet/outlet would be a relatively easy job. These structures typically have a small perched outlet that requires the building up of the streambed using rock material to make it level with the outlet (e.g. see pgs 34, 39). One such structure is on the Whakaruatapu Stream which has a significant length of upstream catchment (see pg 30). Care must be taken when performing such repairs otherwise the emplaced gravel and rocks can act as a

dam during low flow periods and prevents the passage of fish under such conditions (e.g. see pg 36).

The remaining two structures are perhaps both the most difficult and highest of priority. On the upper Manawatu River is a large ramp and weir structure with an eroded and unmaintained fish pass up the middle (see pg 28). Upstream of this structure are the high quality forested headwaters of the Manawatu River in the Ruahine Ranges. The repair/alteration of the existing fish pass here may improve the ability of fish to move upstream of this structure. The other difficult structure is the double concrete block weir below a bridge over the Rokaiwhana Stream (see pg 29). This structure forms a waterfall complex where formerly there was none and again there is a significant area of high quality forested catchment upstream. There is also evidence of some old fish pass structures on the upper weir that are no longer operational. Given these weirs were likely built to prevent scour around the base of the bridge, then serious consideration is required at this site to ascertain what can be done to improve fish passage.

Before difficult remediation efforts are performed it is vital that a full assessment of the potential costs and benefits is conducted. Such an assessment should initially include:

1. firstly a comprehensive fish survey upstream and downstream including coverage of all the upstream habitats present;
2. a full habitat assessment should be conducted to get an idea of what species *could* live upstream of the barrier;
3. fish sampling downstream around the time of upstream migrations of potential barrier-excluded species (if known);

4. consideration to whether the barrier is actually a benefit by excluding certain species (e.g. protecting dwarf galaxias from trout predation).

If the distribution of desirable species is shown to be impacted by the structure then a feasibility study including potential design solutions should be performed.

If significant effort is put into the remediation of a barrier then it is important to both monitor the results and have a regular maintenance schedule. Too often, fish passes are installed and forgotten about with no consideration to their success or failure. Floods can damage and destroy poorly built passes while over time they erode and without regular maintenance may fall into a state of disrepair and no longer be effective.

4.5 Installation of new culverts

Where new culverts are being installed or existing ones replaced it is imperative that they are designed and constructed to allow the free passage of fish. Many culvert designers and installers probably have little knowledge of freshwater fish let alone diadromy and fish migration. Boubee *et al.* (1999) includes a section on culvert design and installation and some regional councils have developed their own guidelines (e.g. ARC, 2000). It is much more cost-effective to design a culvert to prevent perch and undercutting and promote fish passage rather than repairing or altering existing ones. Properly engineered and maintained culverts should never have perch and undercutting anyway. It would appear that a number of the assessed structures were designed and installed purely from a landscape drainage point of view with no ecological consideration whatsoever. It is quite possible poor culvert design for new installations still contributes to a lack of fish passage. It is probably even worse on private land where landowners may use whatever materials are on hand and might not

seek consent. Horizons must continue to ensure that new culvert consent applications and currently consented culvert installations provide for the free passage of fish.

4.6 What about intermittent and ephemeral streams?

The RMA (1991) defines a river as “a continually or intermittently flowing body of freshwater; and includes a stream and modified watercourse”, thus legally intermittent streams must be treated the same way as permanent streams with regards to the fish passage legislation. However, intermittent streams may not harbour permanent fish populations as dry beds generally are not good fish habitat. This raises the question of whether structures on such streams should be assessed using the same criteria as those on permanent streams. This is further complicated in systems that have flowing reaches truncated by dry sections during low flows. If there are periods when the upstream is totally dry then dispensation under the Freshwater Fisheries Regulations could be applied for if necessary when new structures are planned. If there are permanently wetted upstream reaches then ensuring passage under the RMA is warranted.

Structures in such intermittent situations may need to be considered on a case by case basis depending on the nature of the hydrology upstream. This will require some onsite investigation to determine the potential for permanent fish populations to be present upstream of the proposed structure. The same is true for ensuring the correct management of existing structures on intermittent streams that have been identified as barriers to fish passage.

5. Concluding remarks

Although the majority of assessed structures were perched to some degree, only 15 were identified as being of high priority for remediation. Thirteen of these could be repaired relatively easily with some minor works. For some structures the barrier could be repaired by making the outlet level with that of the stream bed using rocks as has been attempted at a structure on Inglis Rd (pg. 36). Such repairs would also reduce the undermining of the culvert structure in some cases so are possibly required culvert maintenance anyway. Some others have barriers formed by debris or boards across the culvert entrance (e.g. see pgs 31, 38) which simply require removal. Two sites are of very high priority given the amount of quality upstream habitat. The Manawatu River site has an existing fish pass that requires some maintenance while the Rokaiwhana Stream site requires a detailed assessment of its actual impact as a barrier before any alterations are planned.

This assessment did not identify who was responsible for the maintenance of each structure (e.g. Horizons, local body councils or private entities). Future work could identify who is responsible and in some cases it may be possible to initiate improvements as part of normal maintenance procedures.

While a significant number of structures that were likely barriers to fish migration were rated as a low priority for remediation, the legality of these structures requires deeper investigation. We suggest the formation of a known probable fish barrier database. When resource consent applications for the replacement of existing culvert structures are received this database can be searched and it can be ensured from the start that the replacement structure will fulfil its legal obligations.

All new culvert installations must either ensure fish passage or if this is not feasible, get the appropriate permission to impede fish. Engineers, contractors and

other culvert installers need to be made aware of the legal obligations at the design stage to prevent costly add-ons and post-installation remediation.

One of the major challenges in determining the barrier potential of structures and subsequently prioritising them for remediation is the lack of any reliable and tested methodology. We have developed some prototype decision trees to assist in this; however we suggest Horizons apply for an Envirolink Tools Development Grant to develop such a methodology for the region.

Finally, Horizons should identify key catchments that are important to the more sensitive diadromous fish (e.g. Kahuterawa River for shortjaw kokopu) and ensure unimpeded connectivity to and from the ocean. This does not only apply to physical barriers but also to sediment, chemical and water quality barriers, an area where much more research is required.

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Appendix 1 – Some legislative requirements relevant to fish passage

Resource Management Act 1991

Part 2 Purpose and principles

Section 5 - Purpose

(2)(b) safeguarding the life-supporting capacity of air, water, soil, and ecosystems;

Section 6 - Matters of national importance

(6)(c) the protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna:

Section 7 - Other matters

(d) intrinsic values of ecosystems:

(h) the protection of the habitat of trout and salmon:

Part 3 Duties and restrictions under this Act

Section 17 - Adverse effects

Duty to avoid, remedy, or mitigate adverse effects

(1) Every person has a duty to avoid, remedy, or mitigate any adverse effect on the environment arising from an activity carried on by or on behalf of that person, whether or not the activity is in accordance with a rule in a plan, a resource consent, a designation, section 10, section 10A, or section 20A

Freshwater Fisheries Regulations 1983

Part VI

Fish passage

41. Scope—

(1) This part of these regulations shall apply to every dam or diversion structure in any natural river, stream, or water.

(2) For the purposes of these regulations “dam or diversion structure” shall not include—

(a) Any net, trap, or structure erected and used solely for the purpose of taking or holding fish in accordance with the provisions of the Act, or of these regulations:

(b) Any dam constructed on dry or swampy land or ephemeral water courses for the express purpose of watering domestic stock or providing habitat for water birds:

(c) Any water diversion not being incorporated into or with a dam, that is solely and reasonably required for domestic needs or for the purposes or watering domestic stock and that empties, without dead ends, into any viable fish habitat:

(d) Any structure authorised by a Regional Water Board not requiring a water right that in no way impedes the passage of fish.

(3) For the purposes of this Part of these regulations, the term “occupier” includes the owner of any land when there is no apparent occupier; and also includes any person doing any work by contract for the occupier.

42. Culverts and fords—(1) Notwithstanding regulation 41(2)(d) of these regulations, no person shall construct any culvert or ford in any natural river, stream, or water in such a way that the passage of fish would be impeded, without the written approval of the Director-General incorporating such conditions as the Director-General thinks appropriate.

(2) The occupier of any land shall maintain any culvert or ford in any natural river, stream, or water (including the bed of any such natural river, stream, or water in

the vicinity of the culvert or ford) in such a way as to allow the free passage of fish:

Fish Passage at Culverts in New Zealand A2

Provided that this requirement shall cease if the culvert or ford is completely removed or a written exemption has been given by the Director-General.

43. Dams and diversion structures—(1) The Director-General may require that any dam or diversion structure proposed to be built include a fish facility:

Provided that this requirement shall not apply to any dam or diversion structure subject to a water right issued under the provisions of the Water and Soil Conservation Act 1967 prior to the 1st day of January 1984.

(2) Any person proposing to build such a dam or diversion structure shall notify the Director-General and forward a submission seeking the Director-General's approval or dispensation from the requirements of these regulations, shall supply to the Director-General such information as is reasonably required by the Director-General to assist him in deciding his requirements (including plans and specifications of the proposed structure and any proposed fish facility).

(3) Should the Director-General consider that the information supplied is inadequate, he shall, within 28 days, advise the applicant as to what further information is required.

44. Requirement for a fish facility—(1) If, in the opinion of the Director-General, a fish facility is required or dispensation from such a requirement is acceptable, the Director-General shall as soon as practical but in no case longer than 6 months if a fish facility is required from the date of receiving all information required, or 3 months where a fish facility is not required from the date of receiving all information required, forward his written requirement or dispensation to whomsoever made the submission.

(2) Where in the opinion of the Director-General a fish facility is required he shall specify what is required to enable fish to pass or stop the passage of fish, and while not limiting this general requirement may specify.

(a) The type, general dimensions, and general design of any fish pass to be utilised:

(b) The type, general dimensions, general design, and placement of any fish screen utilised.

(3) Subject to the Water and Soil Conservation Act 1967 and any determination under that Act, the Director-General may specify—

(a) The type and placement of any water intake to be utilised where fish screens are not required:

Fish Passage at Culverts in New Zealand A3

(b) The flow of water through any fish pass and the periods of the day and year when the pass must be operational:

(c) The volume, velocity, and placement of additional water to attract migrating fish to any fish pass:

(d) The type and scope of any remedial works in connection with any fish screen or fish pass to enable fish to approach the structure or to be returned to the normal course of the water channel:

(e) The volume or relative proportion of water that shall remain downstream of any dam or diversion structure and the period of day or year that such water flows shall be provided.

(4) Every approval given by the Director-General shall expire 3 years from the date of issue if the construction of the dam or diversion structure is not completed, or

such longer time as he may allow.

(5) The manager of every dam or diversion structure in connection with which a fish facility is provided shall at all times keep such fish facility in good and satisfactory repair and order, so that fish may freely pass and return at all times or are prevented from passing as specified under these regulations.

45. Adequate water—The manager of every dam or diversion structure in connection with which a fish facility is provided shall, subject to the Water and Soil Conservation Act 1967 and any relevant determination under that Act, maintain a flow of water through or past such fish facility sufficient in quantity to allow the facility to function as specified at all times or periods specified; but no person shall be liable for a breach of this regulation due to drought, flood, or other sources beyond his control if the default is made good as soon as reasonably possible.

46. Required maintenance or repair—The Director-General may serve notice in writing to the manager of any fish facility notifying him of any defects or want of repair in such fish facility and requiring him within a reasonable time to be therein prescribed to remove any defect or make such repairs as may be required:

Provided that nothing in this regulation shall affect the liability of a manager under regulation 44 of these regulations.

47. Damage—No person shall wilfully injure or damage any fish facility.

48. Alterations—No person shall, without the written consent of the Director-General, make a structural alteration in any fish facility.

Fish Passage at Culverts in New Zealand A4

49. Inspection of fish facilities—Any Officer may at all reasonable times enter upon any fish facility and upon any remedial works or upon the land bordering such fish facility or remedial works for the purpose of their inspection.

50. Protection of fish—No person, other than an Officer acting in his official capacity, shall take or attempt to take any fish on its passage through a fish facility, or place any obstruction therein or within a radius of 50 m of any point of a fish facility, or shall within a radius of 50 m of any point of a fish facility use any contrivance whereby fish may be impeded in any way in freely entering or passing through or passing by a fish facility except as may be provided by the Director-General in writing to the manager of the fish facility.

In the interpretation of the Freshwater Fisheries Regulations 1983, unless otherwise stated:

Act means the Conservation Act (as amended by the Conservation Law Reform Act 1990).

Dam means any structure designed to confine, direct, or control water, whether permanent or temporary; and includes weirs.

Director-General is the Director-General of Conservation.

Diversion structure means any structure designed to divert or abstract natural water from its natural channel or bed whether permanent or temporary.

Fish facility means any structure or device, including any fish pass or fish screen inserted in or by any water course or lake, to stop, permit, or control the passage of fish through, around, or past any dam or other structure impeding the natural movement of fish up stream or down stream.

Fish pass means any structure providing passage through or over any barrier to their passage.

Fish screen means any device whether moving or stationary designed to

impede or stop the passage of fish.

Officer means a warranted officer as provided for under the Conservation Act 1987

Stream bed level relative to culvert base:	Same	Above	Below
Stream width relative to culvert:	Same	Narrower	Wider
Stream alignment:	Straight in-out	Straight in-curved out	Curved in-straight out
Bank erosion at culvert ends:	Yes	No	
Photos:			
Outlet looking upstream with culvert occupying 30-50% of photograph: taken			
Outlet looking upstream: taken		Inlet looking downstream: taken	

Other comments:

Appendix 3 – New Zealand Freshwater Fish Database records for assessed sites

Site no.: T24:483900			
Feb 2000 spotlighting		Feb 2000 electrofishing	
Cran's bully	6	Common bully	3
Redfin bully	17	Redfin bully	2
Longfin eel	16	Upland bully	18
Brown trout	53	Longfin eel	10
		Brown trout	10

Site no.: T23:604284	
April 2000 electrofishing (~2 km downstream of culvert)	
Upland bully	100
Longfin eel	9
Eel spp.	22
Brown trout	2

Site no.: T23:485117	
February 2000 electrofishing (at site)	
Shortfin eel	1
Longfin eel	3
March 2003 electrofishing (~500 m upstream of culvert)	
Koaro	common

Site no.: T23:435946	
March 2003 electrofishing (~500 m downstream of culvert)	
Eels	abundant
Lamprey	occasional
Inanga	occasional
Brown trout	abundant
Upland bully	abundant
Common bully	abundant

Site no.: T23:483111	
February 2000 electrofishing (~500 m upstream of culvert)	
Shortfin eel	1
Longfin eel	3
March 2003 electrofishing (at site)	
Koaro	common

Site no.: T23:477073 Waitokanui Stream	
May 2000 electrofishing	
Longfin eel	2
Redfin bully	2
Upland bully	12
Brown trout	2

Site no.: T24:465828	
March 2003 electrofishing	
Eels	abundant
Common bully	abundant
Upland bully	occasional

Site no.: T23:689102. Rokaiwhana Stream			
Feb 1987 electrofishing		Jan 2004 electrofishing (~3 km upstream of site)	
Longfin eel	common	Longfin eel	1
Upland bully	common	Dwarf galaxias	52
Dwarf galaxias	abundant	Bullies	abundant
Jan 2004 electrofishing (~1 km downstream of site)		April 2004 electrofishing and spotlight (ef/sp)	
Longfin eel	3	Brown trout	1
Eels	12	Dwarf galaxias	7/2
Dwarf galaxias	6	Bullies	1
Upland bully	4		

Site no.: S24:284745 (GPS cords from clearing 50 m away) and all Gordon Kear Forest sites			
Jan 2000 electrofishing (~ 2 km downstream)		April 2000 spotlighting (~ 7 km downstream)	
Longfin eel	19	Longfin eel	19
April 2000 electrofishing (~ 7 km downstream)		Redfin bully	23
Longfin eel	11	Upland bully	6
Redfin bully	17	Shortjaw kokopu	21
Upland bully	18	Brown trout	7
Shortjaw kokopu	1		

Site no.: S25:164664			
Jan 2000 spotlighting		Jan 2000 electrofishing	
Longfin eel	3	Longfin eel	9
Redfin bully	61	Eels	6
Shortjaw kokopu	3	Redfin bully	19
Brown trout	36	Koaro	11
		Brown trout	12
May 1995 electrofishing (~2 km downstream)		May 1995 electrofishing	
Longfin eel	12	Redfin bully	2
Redfin bully	6	Torrentfish	1
Torrentfish	11	Koaro	2
Koaro	3		
Brown trout	1		

Site no.: U23:856230 Mangamokio Stream/Butchers Creek			
Feb 1986 electrofishing (~4 km upstream of site)		May 2000 electrofishing (~0.5 km upstream of site)	
Longfin eel	common	Longfin eel	13
Cran's bully	occasional	Upland bully	22
Feb 1999 electrofishing			
Longfin eel	common		
Upland bully	rare		
Brown trout	common		

Site no.: U23:776110 Whakaruatapu Stream			
Dec 2003 electrofishing		Dec 2003 electrofishing (~4 km upstream of site)	
Longfin eel	1	Eels	2
Upland bully	17	Longfin eel	8
		Upland bully	13

Site no.: U23:821241			
Feb 1985 handnetting		Feb 1999 electrofishing (~2 km upstream of site)	
Brown trout	rare	Longfin eel	2
Cran's bully	common	Upland bully	100 (common)
Jan 1986 electrofishing		Feb 1999 electrofishing	
Longfin eel	common	Longfin eel	common
Upland bully	abundant	Brown trout	common
		Upland bully	common