State of the Environment Report

The Health of Freshwater Fish Communities in Tasman District 2011

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September 2011

This report presents results of an investigation of the abundance and diversity into freshwater fish and large invertebrates in Tasman District conducted from October 2006-March 2010. Streams sampled were from Golden Bay to Tasman Bay, mostly within 20km of the coast, generally small (1st-3rd order), with varying types and degrees of habitat modification. The upper Buller catchment waterways were investigated in the summer 2010. Comparison of diversity and abundance of fish with respect to control-impact pairs of sites on some of the same water bodies is provided.

Prepared by:
Trevor James Tasman District Council
Tom Kroos Fish and Wildlife Services

Report reviewed by Kati Doehring and Roger Young, Cawthron Institute, and Rhys Barrier, Fish and Game
Maps provided by Kati Doehring

Report approved for release by:
Rob Smith, Tasman District Council

Survey design comment, fieldwork assistance and equipment provided by:
Trevor James, Tasman District Council; Tom Kroos, Fish and Wildlife Services; Martin Rutledge, Department of Conservation; Lawson Davey, Rhys Barrier, and Neil Deans: Fish and Game New Zealand

Fieldwork assistance provided by:
Staff Tasman District Council, Staff of Department of Conservation (Motueka and Golden Bay Area Offices), interested landowners and others.
Cover Photo: Angus MacIntosch, University of Canterbury

ISBN 978-1-877445-11-8 (paperback)
ISBN 978-1-877445-12-5 (web)

Tasman District Council Report #: 11001

File ref: G:\Environmental\Trevor James\Fish, Stream Habitat & Fish Passage\ FishSurveys\ Reports\ FreshwaterFishTasmanDraft2011. Doc

Trevor James
Resource Scientist
Tasman District Council
189 Queen St
Private Bag 4
RICHMOND
Trevor.james@tasman.govt..nz

Tom Kroos
Managing Director
Fish & Wildlife Services
PO Box 3207
Richmond
Nelson 7050
tomkroos@xtra.co.nz

Executive Summary

Tasman District Council (TDC) has functions under the Resource Management Act to monitor and manage the life-supporting capacity and natural character of wetlands, lakes and rivers and their margins, as well as significant habitats for indigenous fauna and introduced sports fish such as trout and salmon. The overall aim of Council's Freshwater Fish monitoring programme is to compare the diversity and abundance of freshwater fish in streams of varying habitat condition caused by certain land use and stream disturbance activities. This information can also be used to identify streams of particularly high value that require greater protection with respect to certain habitat disturbances which is used in drafting the Tasman Resource Management Plan Part IV and with the processing of specific resource consent applications. More specific objectives include:

- compare the diversity and abundance of freshwater fish in streams of varying habitat condition caused by various resource use activities, particularly works in the beds and banks of streams.

- assess the efficacy of stream rehabilitation projects, such as riparian plantings, and restoration at structures that present a barrier to fish migration

- provide baseline data from which to build a more complete picture of fish distribution and abundance patterns in the region.

This information can also be used to identify streams of particularly high value that require greater protection with respect to certain habitat disturbances which will then be used in the Tasman Resource Management Plan Part IV and with the processing of specific resource consent applications.

This project involved cooperation between TDC, Department of Conservation (DoC), and Fish and Game New Zealand Nelson Marlborough Region (F&G) for survey design and implementing fieldwork. All three organisations have responsibility for monitoring fish populations under a range of legislation and have over-lapping objectives in this programme. Contract assistance was provided by Fish & Wildlife Services.

The streams sampled were generally small (1^{st}-3^{rd} order) with varying types and degrees of habitat modification. From 2006-2010 a total of 247 sites were assessed on 89 individual streams, with a focus on coastal streams in Golden and Tasman Bays as well as some streams in the upper Buller and Motueka catchments. Streams selected were primarily sampled by backpack electric fishing or spotlighting but, in some circumstances, gee minnow traps and/or fyke nets were employed.

In Tasman there are 20 species of indigenous freshwater fish, fifteen of which are diadromous (migrate to and from the sea to complete their life cycle). In addition there are three sport-fish, the most abundant of which is brown trout.

Freshwater fish were recorded in all but three sites with an average number of 3.0 fish species/site and a maximum of 8 fish species/site. When combining spring and summer surveys, longfin eels/tuna were observed most frequently (74.5% of sites), followed by adult inanga (46%) and shortfin eel/tuna (45%). Longfin eel, a species recognized as 'in decline' nationally, is the most widespread of any freshwater fish species in the district. The relatively high abundance of eels and inanga was a feature of the stream habitats

targeted. Inanga migrating into freshwater during spring investigations (n=87) were abundant (>20 individuals/site) in 28% of all sites sampled. Inanga, common bully and shortfin eel have a tolerance to poor water quality and degraded habitat, particularly smaller farmland streams with silt-laden beds, moderate sediment load, intermediate in-stream cattle disturbance and streamside corridors dominated by pasture grasses. However, even these less habitat-sensitive fish have been found in much fewer numbers in streams or drainage ditches that are dug out regularly and, for inanga and common bully, streams with excessive aquatic plant growth over the last few decades.

Banded kokopu, koaro, shortjaw kokopu, giant kokopu, torrentfish, bluegill bully and redfin bully have been found to be more sensitive to disturbance and they are absent or rare in sites where streamside vegetation has been removed, channels straightened or where there are high loads of fine sediment input by, for example, machinery or larger farm animals. Habitat-sensitive native fish species were observed in 21% of the sites surveyed. Giant kokopu, for example, are very rare in the region (only 44 records at 42 sites since 1990; NZFFDB) due to their preference for deeper, slow-flowing streams associated with lowland wetlands which are now also very rare within the region. This relationship between quality and quantity of habitat and the health of fish communities is similar to that found elsewhere in New Zealand.

Brown trout, followed by eels, are the most significant freshwater fishery in the region. In the Motueka River, one of New Zealand's best trout fisheries, numbers have rebounded since the mid 1990's but fluctuate from year to year depending on flooding, food supplies and water temperatures. Based on distribution patterns and abundance of native fish compared to trout, it would appear that trout and eels dominate larger waterways (over approximately 3 cumecs) and native fish appear to dominate smaller waterways that discharge directly to the coast. In fact there are no trout or very few in many of these streams so native fish will not be affected by trout predation.

Trend analyses for freshwater fish populations over time is not possible due to inadequate data available, pointing out the importance of future data collection. A search of the NIWA Freshwater Fish Database provided 59 historical records that can be compared to sites sampled in this monitoring programme. Caution should be considered when comparing historical records to 2006-2010 results as survey methods and seasons sampled may be dissimilar.

Access to suitable habitat and spawning grounds for migratory fish is largely prevented due to migration barriers such as undercut culverts, weirs, dams, and tidal flap gates. Water takes are also known to dry up a significant area of streams in summer. Several survey results demonstrated the success of fish passage restoration projects such as that on Tui Stream (Wainui Bay), Reservoir Creek (Richmond) and Maisey Creek (Waimea estuary).

The general absence of habitat-sensitive native species from modified streams provide justification for implementing measures that better manage habitats of native fish from activities such as drain clearance, stream straightening, cattle trampling, fine sediment discharges, riparian vegetation removal and other land uses impacting the beds and riparian zones of small order streams in the Tasman District. Avoiding, mitigating or remediating adverse effects on small lowland or spring-fed streams located within 10-15km of the coast are particularly important as these streams have both, the highest fish species abundance and diversity and the most vulnerable fish species.

Acknowledgements

Tasman District Council would like to thank all the people who have assisted in this monitoring programme. In particular we would like to thank landowners who provide access to monitoring sites and NIWA for data from the New Zealand Freshwater Fish Database (NZFFD). Thanks also to Cawthron Institute and Landcare Research which assisted with field investigations in the Motueka River Catchment under the Integrated Catchment Management (ICM) project in 2006. Thanks to Network Tasman and their support for fisheries investigations on the upper Matakitaki River catchment.

Thanks to Nelson Pine Industries and Waitapu Fishing Company (Hika Roundtree) for providing materials to restore fish passage. Thanks to Jim Thawley and Rhys Barrier for organising labour for remediation of a barrier in the Moutere River catchment.

Cooperation with the following people and organsiations has been productive and led to production of a plan and remediation of many culverts: New Zealand Transport Agency, Marc Papke of Downer EDI Works, Matt Lord of Opus Consultants, Council's consultant engineer Braeden Lobb of MWH (Golden Bay Office) and Council's roading section of the Engineering Department.

Abbreviations:

Fish and Invertebrates

BF - Black flounder	GK - Giant kokopu	SJK - Shortjaw kokopu
BGB - Bluegill bully	I - Inanga	SFE - Shortfin eel
BK - Banded kokopu	Ko - Koaro	Sm - Smelt
BT - Brown trout	Ka - Koura	Sr - Shrimp
CB - Common bully	Ly - Lamprey	To - Torrentfish
DG - Dwarf galaxiid	LFE - Longfin eel	UB - Upland bully
FM - Freshwater mussel	NFG - Northern flathead galaxiid	YEM - Yelloweye mullet
GB - Giant bully	RFB - Redfin bully	

General Abbreviations

Ck - Creek	MALF - mean annual low flow	SoE - State of the Environment
d-s - Downstream	REC - River Environment Classification	Stm - Stream
u-s - Upstream	RMA - Resource Management Act	TDC - Tasman District Council
E. coli - Bacteria indicative of faecal pollution	Rv - River	TRMP - Tasman Resource Management Plan

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1. INTRODUCTION

1.1 TASMAN'S FRESHWATER FISH MONITORING PROGRAMME

Tasman District Council's primary objective of this monitoring programme is to determine the effects of various resource use activities on the life-supporting capacity of streams. Specifically this monitoring programme aims to:

- compare the diversity and abundance of freshwater fish in streams of varying habitat condition caused by various resource use activities, particularly works in the beds and banks of streams.
- assess the efficacy of stream rehabilitation projects, such as riparian plantings, and restoration at structures that present a barrier to fish migration
- provide baseline data from which to build a more complete picture of fish distribution and abundance patterns in the region.

For practical reasons fish surveys have been mostly on wadable streams with higher predicted biodiversity.

This data will be used to better manage resource use activities that affect stream habitat. Once enough data is collected, Council will be able to update models to more-accurately predict the presence of particular freshwater fish species in a particular reach of a waterway. This will mean that decisions on all resource consent applications will take into account this critical information. Currently it is considered disproportionately expensive and onerous for applicants of resource consents for small operations to collect freshwater fish data, however the environmental effects are likely to be significant to the survival of New Zealand's freshwater fish species.

The contributing organisations to this monitoring programme participate in freshwater fisheries investigations for similar and different purposes; Fish and Game (F&G) is primarily concerned for management of the sport fish resource and Department of Conservation (DoC) for managing of threatened fish and the conservation estate. The objectives of all these organisations overlap. For example, under RMA s6 TDC must protect significant natural habitats as well as the habitats of trout and salmon and in order to monitor the impact of activities it is important to have good reference (control) sites and these are often in conservation land. F&G have a programme of drift dive surveys for trout on river reaches throughout the district. DoC has carried out its own fish surveys, mostly on conservation estate to determine the distribution of pest fish (mostly in ponds and impoundments), brown mudfish and short-jaw kokopu amongst other projects.

This report provides an analysis and discussion based on freshwater fish surveys carried out from 2005-10, with reference to existing records in the national freshwater fish database. Both F&G and DoC have monitoring roles under the Conservation Act. Prior to 2005 TDC had not undertaken any programmed monitoring of fish populations and there was a relative paucity of freshwater fish data in developed landscapes in Tasman District compared to other regions in New Zealand.

TDC has responsibilities under the Resource Management Act (1991) to protect and monitor the life-supporting capacity and natural character of wetlands, lakes and rivers (including their margins). Resource management organisations, including Councils, nationally and internationally are starting to realise the importance of producing 'State of the Environment' monitoring programmes and reports for the health of waterways that integrate information about water quality, stream habitat and aquatic life. While Council is moving in this direction, this report only cross-references to water quality information rather than providing a fully integrated picture of river health.

Method 27.1.20.3 (proposed in July 2011) requires not only the "*carrying out* (of) *fish surveys and stream habitat assessments to determine freshwater fishery values*" but also "*regular reporting on measures adopted to improve aquatic habitat, including provision of fish passage and adoption of best practice for land drainage activities*".

Most of the sampling effort to date has been focused on small coastal streams and in developed landscapes such as farmland, forestry, horticultural or urban land uses because this was the biggest gap in knowledge of freshwater fish knowledge in the district. In addition, it has been recognised in the last decade that the only really effective way to assess some native galaxiid populations is by spotlighting. This means any early records using other methods may be inaccurate as far as identifying the presence of these particular fish is concerned. Most surveys determined the presence or absence of any fish species (rather than abundance).

1.2 NATIVE FRESHWATER FISH SPECIES

There are 51 indigenous freshwater species currently recognised in New Zealand (including estuarine species that inhabit lower reaches of waterways), of which 18 are diadromous (they undergo migrations between fresh and salt water as a necessary part of their life cycle). In the Tasman District, there are 20 native fish species, 16 of which are diadromous. 12 are in recognized as being in decline nationally, including longfin eel, giant kokopu and brown mudfish (Table 1). One of the main reasons for their decline is due to habitat destruction, such as lowland freshwater wetlands which are the preferred habitat of these species. It is estimated that about 95% of these wetlands have been drained in Tasman District.

Each species has different habitat requirements and ecological niches, so it is important to provide for the variety of habitats so as to support the natural variety of fish species present in Tasman's streams. These fish are an important part of New Zealand's freshwater biodiversity. Most migratory species in New Zealand occur in a scattered fashion throughout extensive geographic ranges, and occupy large numbers of catchments of widely varying size. By contrast, most non-migratory species show relatively high levels of occupancy of smaller geographic ranges, and most are restricted to a few large catchments, particularly in the eastern South Island. Migratory species are generally found most frequently in low-gradient coastal rivers and streams with warm, maritime climates. Non-migratory species are usually found in inland rivers and streams with cool, strongly seasonal climates, typified by a low frequency of high-intensity rainfall events. While both groups are likely to be equally susceptible to local, disturbance-driven extinction, the much greater dispersal ability of migratory species has allowed them to persist over wide geographic ranges. By contrast, the distributions of most non-migratory species are concentrated in a few large catchments, mostly in regions where less intense natural disturbance regimes are likely to have favoured their survival.

EELS

Figure 1: Longfin Eel (Photo: T Kroos)

Longfin eel/ tuna are the largest and most widespread of any freshwater fish species in the Tasman District and New Zealand. Longfin eels are particularly good climbers when they are juveniles (elvers) and can get past most natural barriers or structures, even crossing damp ground to continue their journey.

In autumn or early winter both eels species migrate downstream towards the sea, males followed by females. Female shortfin eels migrate at around 23 years old and female longfin eels at around 34 years old. Males of both species mature much earlier than females. Nobody knows for sure where they go to spawn (lay eggs) but it is thought to be in the Tonga Trench between Tonga and New Caledonia. Their fertilized eggs float to the surface and hatch into leaf-shaped larvae which drift with the ocean currents feeding on plankton. When they enter the rivers they are transparent and are called ‘glass eels’.

Longfin eels are listed as in significant decline nationally (Allibone et al. 2010), partly due to entrainment in hydro-electric power plants during downstream migration, commercial harvest and habitat loss or disturbance. There is increasing evidence of overexploitation of longfin eels, including reduced recruitment, reduction in catch rates, reduction in abundance and average size, and a regional reduction in the proportion of females (Jellyman, 2007). Eels are managed under the quota management system, although individual and regional quotas are set from catch histories because biological parameters are inadequate (Jellyman, 2007). Maori have been allocated 20% of commercial quota, with additional quota set for customary take. The annual commercial catch of eels has halved over the past decade, and is now ~700-800 t, of which the shortfin eel comprises 66% of the catches. Recent management developments have included enhancement of upstream waters with juvenile eels, consolidation of processing into fewer but larger units, setting aside of additional reserve areas to increase escapement of silver eels (those due to spawn), increased management involvement of Maori, and development of regional management strategies.

Figure 2: Shortfin Eel (Stephen Moore)

Shortfin eel/ tuna are typically found in soft-bottomed, low elevation streams, wetlands and lakes. Although there aren’t as many concerns about the status of this eel species, compared to the longfin eel, the distribution and the abundance has been compromised by wetland loss.

1.2.1 GALAXIIDS

Inanga are well known to most New Zealanders because they make up approximately 90% of the 'whitebait' catch. Together with longfin eel, and shortfin eel, inanga are the most common freshwater fish in the region and seem to survive with moderate levels of disturbance and limited riparian woody vegetation.

Figure 3: Inanga (Photo: S.C. Moore)

They require riparian rushland near the top of the tidal influence in streams and rivers to spawn and a considerable proportion of this habitat has been lost in the District. They are poor 'climbers', which is why they are commonly found close to the coast, unless the river has a gradual slope. Inanga are active during the day and can often be seen shoaling in open water of streams, lakes and wetlands, especially around spawning time (February to May).

Other galaxiid species that make up the whitebait run are banded kokopu, koaro, shortjaw kokopu and giant kokopu. All these species are much more sensitive to habitat disturbance than inanga. Unlike inanga these species are nocturnal, so are best seen at night using a spotlight.

Banded kokopu like small and stony streams with pools and riffles, shade to keep the water cool and a lot of overhanging vegetation that provides cover. This species, particularly the juveniles, are good climbers and can be found upstream of large waterfalls or dams. They prefer small, hill-fed streams with relatively high vegetative cover moderately close to the coast.

Figure 4: Banded Kokopu (Photo: S.C. Moore)

Koaro, like eel elvers, have a legendary ability to climb and are found in large numbers above the tallest waterfalls in the district. Their pectoral and anal fins have claw-like appendages for grip and they use surface water tension to attach to wet rock and slither upwards in an eel-like motion. They are widespread in the mountains of Kahurangi and Nelson Lakes National Park. Their markings often mimic the bed for camouflage and can have golden blotches that glitter in the sun, particularly in waterways with deposits of iron pyrites (fool's gold). Koaro travel the furthest inland of any of the migratory galaxids. The habitats preferred are fast-flowing riffles in small, steeper bush-covered streams. While koaro are typically diadromous they can sustain populations that are landlocked.

Figure 5: Koaro (Photo: S.C. Moore)

Shortjaw kokopu are nationally threatened and one of the rarest of the galaxiids. Shortjaws require rocky stream habitat with native bush cover. In Tasman District they are found mostly in Abel Tasman National Park, on the West Coast of the district (Westhaven Inlet south) and many Golden Bay streams. They are fairly good climbers but prefer parts of the stream where the gradient just starts to flatten. The shortjaw kokopu is distinctive with the lower jaw shorter than the upper one, and it has a characeristic dark patch behind its gill opening.

Figure 6: Short-jaw Kokopu (Photo: T.Kroos)

Giant kokopu are in decline nationally and threatened (Alibone et al. 2010). These fish are sometimes colloquially-known as 'native trout' or 'mountain trout' (although banded and short-jaw kokopu are sometimes similarly-named). However, galaxid species are not related to trout at all. After eels, they are the largest of the native fish, growing up to 400mm long. Preferred habitat types are reaches overgrown with riparian vegetation. There are very few sites (42 since 1990) in Tasman where this fish survives. This is as a result of historic wetland drainage particularly in the former strongholds of Moutere and Motueka Ecological Districts.

Figure 7: Giant Kokopu (photo: R.M McDowall)

Dwarf galaxias are non-migratory and nationally threatened and declining (Alibone et al. 2010). These fish are not migratory, occur widely in the top of the South Island and live in gravel/cobble riffles of smaller streams, and riffly margins of larger rivers, mostly in foothill catchments. They often occur in large numbers and have an amber to olive grey colour and a slender, pencil-shaped body.

Figure 8: Dwarf Galaxias (Stephen Moore)

Another non-migratory galaxiid is the **"Northern flathead galaxias"** which is nationally classified as "naturally uncommon" and therefore at risk (Alibone et al. 2010). This fish of low-high altitude rivers was previously described as the Canterbury galaxias but DNA analysis has indicated that this is a new undescribed species which is found north of the Clarence River

Figure 10: Northern Flathead Galaxias

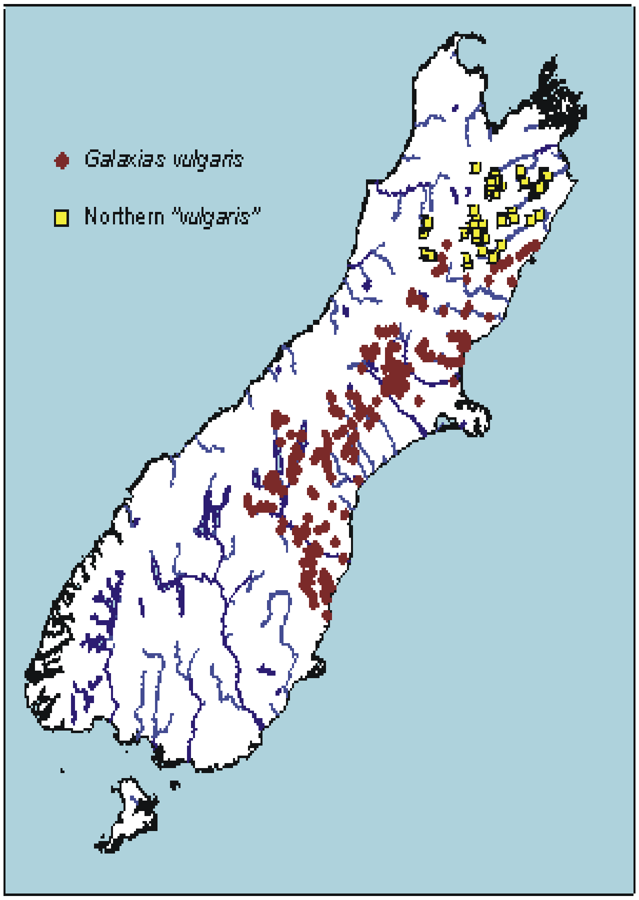


Figure 9: Distribution of canterbury galaxiid and Northern flathead galaxiid in the South Island of New Zealand (NZFFD, NIWA)

(Figure 10). Only seven records exist for this species: two on Cave Stream (upper Tadmor), one on each of Station Creek and Nardoo Creek (both on Mt Ella Station, upper Matakitaki), two in the Rappahannock catchment and one in the Motueka River.

Brown mudfish are now only found in small numbers on the West Coast part of the district, particularly Mangarakau Swamp. Although there are no records, it is thought that

Figure 11: Brown mudfish (Photo: S.C. Moore)

their former range covered much of the lowland parts of region, including the Waimea plains (McDowall.2010). Drainage of wetlands in the 1800's and early 1900's is the main cause of this rapid decline. During seasonal dry periods this fish can bury into sediment and go dormant. DNA analysis has shown that these mudfish are genetically distinct from others of this species that exist within the West Coast region from around Karamea to Hokitika.

Figure 12: Map of distribution of brown mudfish in Tasman District (courtesy of Department of Conservation, Golden Bay)

Figure 13: Brown mudfish habitat at Mangarakau Swamp

1.2.2 BULLIES

Upland bullies are non-migratory and have a stocky build, blunt snout and orange spots on the head and fins. These bullies are found in most habitats from farm drains, wetlands, lakes, streams and large rivers. They are found at high elevations and up to 150km distance from the sea in the upper Buller Catchment, Wangapeka River and Cobb reservoir.

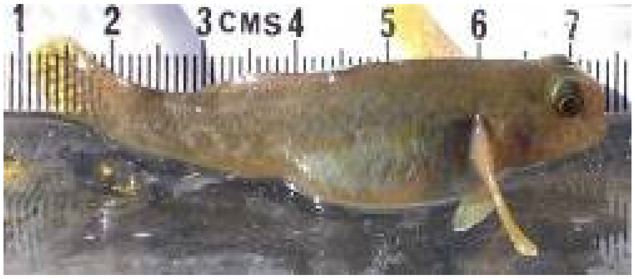


Figure 14: Upland Bully (Photo: T.Kroos)

Common bullies live throughout Tasman District but usually not far inland as they are known to have only moderate climbing ability. They are found in small streams and along river margins, but also inhabit lakes and wetland margins. As the name suggests the common bully is well known because they are often seen out in the open during the day. They appear to be moderately tolerant of fine sediment discharges that adversely affect many other fish species.

Figure 15: **Common Bully (Photo: S Moore)**

Redfin bullies have recently been placed on the national threat classification list as declining (Allibone et al. 2010). These colourful fish occupy moderately fast flowing lowland cobble streams often at the tails of small pools.

Figure 16: Redfin Bully (Photo: K. Doehring)

Bluegill bully is now classified nationally as declining (Allibone et al. 2010). There are relatively few records of bluegill bullies in the Tasman District, mostly in Golden Bay and West Coast. These fish prefer swift rapids. Fry returning from the sea is sometimes seen in large shoals making their way upstream (whale bait).

Figure 17: Bluegill Bully (Photo: Stephen Moore)

Giant bullies are true to their name being the largest of the bullies and grow to about 250mm, but are more commonly around 150mm. Giant bullies never travel much more than a few kilometres from the coast and are found in streams flowing into the Whanganui, Parapara, Motupipi, Moutere and Waimea inlets. They prefer slow moving water with over-hanging or in-stream cover such as logs or boulders with large spaces underneath.

Figure 18: Giant Bully. First dorsal fin always has 6 spines (Photo: T.Kroos)

1.2.3 OTHER NATIVE FISH SPECIES IN THE TASMAN DISTRICT

Torrentfish, like the bluegill bully, is another native fish that occupies fast water habitats (riffles, rapids and cascades) and is now threatened and declining. Torrentfish are closely related to blue cod. They have been found in the Kaituna, Parapara, Tukurua, Onekaka, Takaka, Anatoki, Abel Tasman, Riwaka, Motueka and Waimea and inland as far as the Matakitaki River inland from Murchison. Despite their ability to live in fast flowing water, torrentfish are poor climbers and only go inland where the river gradient is low.

Figure 19: Torrent-fish (Photo: Stephen Moore)

Common smelt are slender fish occasionally confused with inanga being a similar size and colouring. They are common on larger low-gradient rivers such as the Waimea and Motueka Rivers. They occur in large roving schools in estuaries and lowland rivers, usually in still or gently flowing waters. Sometimes referred to as cucumber fish by whitebaiters due to a distinctive smell.

Figure 20: Common Smelt (Photo: Stephen Moore)

Adult **lamprey** parasitize marine fishes by attaching themselves with a sucking disc, rasping flesh and sucking the host's juices. Adults stay at sea for four to five years then migrate upstream in winter and spring, usually by night, and hide within boulder aggregations, beneath over-hanging banks or other in-stream cover. Like smelt the very secretive lamprey is another native fish that perishes after spawning in freshwater. The juvenile lamprey (ammocoete) lives in burrows in sandy/silt, but not really muddy substrates, along stream margins where flow is gentle. Lamprey have been found in very few locations in Tasman District: 3 sites in Golden Bay (mid to lower reaches of: Onekaka, Waikoropupu and Anatoki catchments), Totaranui, 6 sites in the Motueka Catchment (including Brooklyn, Lower Dove, Lower Tadmor and Lower Moutpiko) and Eves Valley Stream.

Figure 21: Lamprey (Photo: Stephen Moore)

1.3 Introduced Freshwater Fish Species in the Tasman District

There are currently five species of introduced freshwater fish found in the Tasman District, three of which are actively managed sports fish, brown, rainbow trout and chinook salmon (Table 1a), as well as goldfish and the pest fish: *Gambusia* (mosquitofish). In Tasman District, brown trout are by far the most widespread and abundant and tend to frequent larger river systems and for spawning use inland tributary streams. These fish prefer very good water quality and gravels for reproductive sites (redds). Trout are visual feeders in clear water rivers. They obtain much, if not most of their food by intercepting drifting invertebrates. Large trout (e.g., 2 kg or more) need to be able to see up to 3 or 4 metres to selectively intercept some of the larger invertebrates drifting in our rivers to reach a large size, hence the importance of good water clarity.
Schedule 30.1 of the TRMP lists streams of relative importance for salmonid angling.

Table 1a Introduced Freshwater Sportsfish of Tasman District's Waterways

Common Name	Scientific Name	Distribution	Migratory?
Brown trout*	*Salmo trutta*	Widespread in larger catchments	Y/N
Rainbow trout*	*Oncorhynchus mykiss*	Localised	Y/N
Chinook salmon	*Oncorhynchus tshawytscha*	Localised, uncommon	Y

* These species can have both migratory and non-migratory populations

There are six pest fish species known to have been in the District (Table 1b). Perch and *Gambusia* (mosquitofish) are voracious feeders on native fish. Perch and tench are thought to have been eradicated but there has been mixed success with *Gambusia* with new populations recently found in coastal drains near Richmond. It appears that *Gambusia* have migrated from Orphanage Creek to these drains via the Wamea estuary. It was previously thought that this fish was intolerant of saline water. This is of concern because this fish may readily self-invade streams around the estuary. Eradication programmes of *Gambusia* are currently being undertaken by DoC

Table 1b Introduced Freshwater Pest Fish which have been recorded in Tasman District's Waterways

Common Name	Scientific Name	Comment
Mosquitofish	*Gambusia affinis*	Re-occurring incursions
Perch	*Perca fluviatilis*	Thought to be eradicated
Rudd	*Scardinius erythrophthalmus*	Thought to be eradicated
Koi carp	*Cyprinus carpio*	Thought to be eradicated
Grass carp	*Ctenopharyngodon idella*	Thought to be eradicated

1.3.1 Brown Trout

Brown trout Brown trout are the most successful introduced fish species and are found throughout Tasman District, particularly in larger catchments such as the Aorere, Takaka, Motueka, Waimea and Buller (see maps in Appendix 1). They are found in diverse habitat from estuaries and low elevation tidal lakes, to fast-flowing boulder headwater streams and subalpine lakes. Trout require good water quality (less tolerant of pollution than most native fish), particularly cool, well-oxygenated waters. While trout are known to consume native fish once they get over 350mm in size, in Tasman district there are relatively few known instances of major predatory pressure on existing native fish populations as is the case in other parts of New Zealand such as Canterbury and Otago.

Figure 22: Brown trout

Brown Trout arrived from Melbourne and Tasmania to Nelson in 1868 and the first liberations in the Tasman District took place on the Wairoa River in 1872. This delay was because, although 75-80% of the ova hatched, the Acclimatisation Society was largely unsuccessful in raising them in a Nelson pond (built in 1867 facing Hardy St at Queens Garden) and only a few were released into the Matai. Not until another consignment of 1000 ova arrived in 1872 from Southland were brown trout liberated into the Wairoa River.

Angler effort in the Nelson-Marlborough region in mainstem and lowland rivers in the 2007-08 season was only about half that recorded in the 1994-95 (Unwin, 2009). Most of the decline is in the Motueka and Buller Rivers, usage of which has fallen 59% and 54% since 1994/95. Angler activity in the headwater and backcountry streams is virtually unchanged.

1.3.1.1 TROUT MIGRATION PATTERNS

The maximum distance brown trout in New Zealand are known to migrate is over 500km, for a fish from the Selwyn River in Canterbury migrating to Mataura River in Southland (Young 2000a). It is not uncommon for brown trout in the Waikato and other North Island Rivers to travel over 200km. In Tasman District, a tagging study of 50 fish in the Owen River showed one exceptional 'mover' ('Blue 452') which travelled 73km down to the Buller River and then 46km up into the Matakitaki River over a period of 19 months (Young 2000a). The remaining 19 recaptures were all within a few hundred meters of the release point, with the exception of one that moved 5km upstream.

In large river catchments it is often the smaller tributaries that provide the best conditions for spawning and rearing of juvenile brown trout. In a study of trace element signatures of juvenile and adult brown trout, otoliths from eight tributaries of the Motueka River catchment were matched to one of the eight tributary signatures (Olley et al. (*in review*)). The recruitment patterns from these tributaries suggests that adult trout within the Motueka and Wangapeka River main stems recruit from up- and downstream, and from localised and distant parts of the catchment. The average distance travelled by the adult trout over a year in this study was approximately 30 km, roughly 30% of the total catchment length. The movements of adult trout captured in the Motupiko River (a sub-catchment of the Motueka River) have been examined by radio telemetry (Young et al. 2010). Movements over an 11 month period ranged from less than 100m to greater than 40km confirming that large scale movements are a common strategy employed by some individuals in brown trout populations. Rates of movement steadily declined over the spring-summer period as flow decreased and water temperature increased.

The most obvious reason trout move is to get to spawning grounds. The importance of spawning migrations in river trout populations probably depends on the position of good spawning gravels compared with the position of good adult trout habitat. In some rivers spawning is likely to occur on site, whereas in other rivers trout will move considerable distances to appropriate spawning areas.

The search for food is another common reason for adult trout movement. The abundance of whitebait and other native fish in the lower reaches of many of our rivers may explain the movement of trout down to these parts of rivers during whitebait migrations. A trout living on a fish-based diet will grow more quickly than one on an invertebrate-based diet (Young 2000a).

Habitat features may also drive trout movement patterns. Water temperature, for example, is a key variable controlling trout growth and survival. If it is too cold (<4°C) trout will stop growing. However, high temperatures will also restrict growth and are known to kill trout if they exceed 25°C. Trout can potentially maximize their growth by moving downstream to warmer waters in the winter and/or seeking cooler waters in the summer. Reductions in habitat caused by summer low flows may also force trout out of smaller rivers and into larger rivers, estuaries, or the ocean downstream.

1.3.2 RAINBOW TROUT AND CHINOOK SALMON

Rainbow trout. From 1897-1906 147,000 rainbow trout fry were released into the Maitai, Wairoa and Wai-iti Rivers. From 1923 the liberations centred at Lake Rotoroa and later (1930) the Maruia River. The Cobb Dam was stocked from 1948. Current drift diving and angler creel survey results show that rainbow trout are found in: Cobb River and Reservoir, Lake Rotoiti, Travers River, Lake Rotoroa, Sabine River, D'Urville River, Gowan River and Maruia River, Lake Daniells.

Chinook salmon were liberated in the Waimea and Motueka Rivers in 1877 followed by whitefish in 1878 (Lake Rotoiti) and Atlantic salmon in 1887 (Aorere and Wairoa Rivers). None of these liberations proved particularly successful. A few recent records in the lower Takaka/Waikoropupu Rivers and the Waimea and a dozen caught in the Aorere in 2006-07 have been attributed to fish escaping from the present salmon rearing facility on the Waikoropupu River.

1.4 LARGE INVERTEBRATES

Koura (freshwater crayfish) are a native crustacean most likely found in stable, small streams with native bush canopy and in-stream woody debris (Figure 23), although they are known, but less commonly found in larger rivers like the Waimea and Motueka Rivers

Figure 23: Koura

The **shrimp**, *Paratya* is New Zealand's only (endemic) species of freshwater shrimp and is characteristic of slower-flowing lowland streams with weedy beds. They are mostly found within a few kilometres of the coast.

Figure 25: Shrimp (Paratya)

One species of **freshwater mussel/ Kakahi** (*Echyridella onekaka*) is found in north-west South Island (west of a line between Takaka and Cape Foulwind) but it is rare in Tasman district (Fenwick and Marshall, 2006). Historic records exist from within the lower Aorere Valley (streams between Bainham and north Ruataniwha Estuary). Surveys

Figure 24: Freshwater Mussels

undertaken by the Council-led monitoring found these mussels at: Onekaka River near Washbourne Reserve, Little Kaituna Stream upstream SH60, at Island Lake (in the farm park on Farewell Spit) and in lake Otuhie and Kaihoka Lakes (Schallenburg, 2011). The mussel, *Echyridella menzieii,* are more common in lakes in other parts of the region, particularly Lake Rotoroa (they are very numerous near the main jetty) and Lake Matiri. At Lake Rotoiti the population is sparse, probably due to substrate and food. Another record exists for an unnamed spring-fed creek near Kohatu Junction in the mid-Motueka Catchment.

1.5 FRESHWATER FISH THREAT STATUS

The threat status of New Zealand's native fish have recently been reviewed (Allibone et al. 2010; see Table 2). The main reasons for the decline of many native fish species throughout the country are; the impact of introduced fish species, declining water quality, effects of water abstraction, loss of habitat associated with land-use change and land-use activities and waterway modification. Taxa not ranked as 'threatened' in the 2005 ranking, but now ranked, include the riffle and run dwelling species bluegill bully, koaro, torrentfish and redfin bully. Analysis of the NZFFD records showed significant declines in the presence of these four species in database records in the last 10 years with all being rarest in the last decade. Two additional whitebait species, inanga and shortjaw kokopu, were also classified as declining because of loss of habitat for both species (e.g. via land-use change on the West Coast with farm development).

1.6 LIFE CYCLES

Juvenile eel first enter estuaries in spring and begin their journey up-river in summer-autumn. The downstream migration of eels (from rivers to the sea) is in summer-autumn with males heading off first (Jones, J., 2005). Shortfin eels begin downstream migration in February-April, ahead of the longfins in April (males) and May (females). Eels only migrate down rivers during small floods and usually in the dark.

Juvenile inanga (whitebait) begin their upstream migration mostly in late winter-spring (August-October). Smelt, koaro and banded kokopu have a similar peak.

Many fish have very defined breeding seasons (see Table 3). Most of the migratory galaxids (GK, BK, SJK, Ko) spawn in late autumn-winter, during flood events; although few have witnessed such events. These fish all spawn amongst leaf litter and rocks at the top of stream banks in forested streams. Inanga spawn earlier and over a greater time range (February to May inclusive, on high tides). Brown trout spawn in winter (May to September, inclusive) in smaller streams in inland waters. Bullies and dwarf galaxias spawn mostly in spring-summer. Spawning of eels is most likely to be outside New Zealand's territorial waters (thought to be near Samoa for longfins and near Tonga for shortfins), although this has not been witnessed and the timing is unknown.

Table 2 Native Freshwater Fish of Tasman District's Waterways and Threat Status

Common Name	Scientific Name	Threat Classification (Allibone et al. 2010)	Migratory, see Chapter
Shortfin eel/ Tuna	*Anguilla australis*	Not Threatened	Y
Longfin eel/ Tuna	*Anguilla dieffenbachii*	Declining	Y
Lamprey	*Geotria australis*	Declining	Y
Torrentfish	*Cheimarrichthys fosteri*	Declining	Y
Giant kokopu	*Galaxias argenteus*	Declining	Y
Koaro*	*Galaxias brevipinnis*	Declining	Y/N
Dwarf galaxias	*Galaxias divergens*	Declining	**N**
Banded kokopu *	*Galaxias fasciatus*	Not Threatened	Y/N
Inanga	*Galaxias maculatus*	Declining	Y
Shortjaw kokopu	*Galaxias postvectis*	Declining	Y
Northern flathead galaxias	*Galaxias* 'Northern sp.'	Naturally Uncommon	**N**
Brown mudfish	*Neochanna apoda*	Declining	**N**
Giant bully	*Gobiomorphus gobioides*	Not Threatened	Y
Upland bully	*Gobiomorphus breviceps*	Not Threatened	**N**
Common bully	*Gobiomorphus cotidianus*	Not Threatened	Y
Bluegill bully	*Gobiomorphus hubbsi*	Declining	Y
Redfin bully	*Gobiomorphus huttoni*	Declining	Y
Common smelt	*Retropinna retropinna*	Not Threatened	Y
Black flounder	*Rhombosolea retiaria*	Not Threatened	Y
Yelloweye mullet	*Aldrichetta forsteri*	Not Threatened	Y

* These species can have both migratory and non-migratory populations

Table 3: Fish migration calendar for the Tasman District showing the peak and range periods for migration activity, migration status and life stage at time of migration. Modified from Hamer 2004. Key: u/s=upstream, d/s=downstream Peak Range

Species	**Direction**	**Life stage**	**Summer**			**Autumn**			**Winter**			**Spring**		
			Dec	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**
Lamprey[25]	u/s	Adult												
Lamprey	d-s	Juvenile												
Longfin & shortfin eel	To	Glass												
Longfin eel [1,2,22]	u/s	Juvenile												
Longfin eel [1]	d-s	Adult												
Shortfin eel[1,2,22]	u/s	Juvenile												
Shortfin eel[1]	d-s	Adult												
Common smelt (sea	u/s	Juvenile												
[1]	d-s	Larvae												
Inanga [5,22]	u/s	Juvenile												
[1]	d-s	Larvae												
Giant kokopu [1,2,4,22,25]	u/s	Juvenile												
[1,22]	d-s	Larvae												
Shortjaw kokopu [1,2,4,22]	u/s	Juvenile												
[13]	d-s	Larvae												
Banded kokopu [1,2,22]	u/s	Juvenile												
[1,22]	d-s	Larvae												
Koaro[1,7]	u/s	Juvenile												
[1,13]	d-s	Larvae												
Torrentfish [1,25]	u/s	Juvenile												
[1]	d-s	Larvae												
Redfin bully [1,22]	u/s	Juvenile												
[1,22]	d-s	Larvae												
Common bully [1,22,25]	u/s	Juvenile												
[1]	d-s	Larvae												
Bluegill bully [1]	u/s	Juvenile												
[1]	d-s	Larvae												
Giant bully [1]	u/s	Juvenile												
[1]	d-s	Larvae												

References for Table 3

1. McDowall 1995
2 Jellyman eta al 1999
3 Stancliff et al 1988
4 McDowell and Kelly 1999
5 McDowell 1990
6 Wilding et al 2000 (and references therein)
7 G. Maclean (pers.comm.)
8 Rowe and Graynoth (MfE) 2002
9 Dedual and Jowett 1999
10 Rowe et al 2002
11 Ward et al 2005
12 Mitchell and Penlington 1982
13 Charteris et al 2003
14 Allibone and Caskey 2000
15 Scrimgeour and Eldon 1989
16 Jellyman et al 2000
17 Staples 1975
18 McDowall and Eldon 1997
19 Barrier and Hicks 1994
20 Thompson 1987
21 Hopkins 1971
22 Boubee et al 2000
23 Chris Annandale (pers.com.)
24 Ben Wilson (pers.com.)
25 Martin Rutledge (pers.com.)

Table 4: Fish spawning calendar for Tasman District showing the peak and range periods of spawning activity and spawning habitat.

Species	Spawning habitat	Summer			Autumn			Winter			Spring		
		Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov
Lamprey	Upper catchment	Range									Range	Range	Range
Long & shortfin eel	Pacific ocean												
Long & shortfin eel	Pacific ocean												
Common smelt (sea run)	Sand banks of rivers	Range	Range	Range	Peak	Peak	Peak	Range	Range				
Inanga	Tidal estuary edge vegetation			Range	Peak	Peak	Peak	Range	Range				
Giant kokopu	Mid-low reaches (unconfirmed)					Range	Range	Peak	Peak	Peak (part)			
Banded kokopu	Stream margins at flood among vegetation and debris					Range (part)	Peak	Peak					
Shortjaw kokopu	Stream bank rocks, debris and vegetation during flood						Peak	Peak					
Koaro	Cobbles at stream edge					Peak	Peak	Peak / Range					
Dwarf galaxias	Small cobbles instream	Range									Range	Range	Range
Brown mudfish	Freshwater wetlands					Range (part)	Range	Range	Range	Range / Peak	Peak / Range	Range (part)	
Torrentfish	Lowland rivers/estuaries	Range	Peak	Peak	Peak	Peak	Range				Range	Range	Range
Redfin bully	Under rocks in flowing water								Range	Range	Range	Range	Range
Common bully	Under firm flat surfaces	Range	Range	Range								Range	Range
Bluegill bully	Similar to other bullies	Range	Range	Range							Range	Range	Range
Giant bully	Estuaries (unconfirmed)	Range	Range	Range									
Upland bully	Under large flat rocks	Peak	Range	Range								Peak	Peak

Key: Peak (dark shading) Range (light shading)

1.7 NATIONWIDE TRENDS IN NATIVE FISH POPULATIONS

While trend analysis is not possible in Tasman due to the limited data, trend analysis across New Zealand using the NZ Freshwater Fish Database has produced some concerning results for streams through pastoral and urban land (Joy, 2009). An index of biological integrity (IBI) was used to assess trends in New Zealand fish communities in rivers flowing through different land use types (Joy, 2009). The term biotic integrity is based on the concept that to function, an ecosystem must have all its component parts, thus any loss of parts is effectively lost integrity. Using the IBI approach enables comparisons between-site and between-river class as it takes into account natural elevational and distance from coast variation in fish communities caused by the largely migratory New Zealand fish fauna. It also not sensitive to different sample sizes between data sets being analysed. This approach is commonly used worldwide.

Strong relationships between fish biotic integrity scores and land-cover type were revealed using the River Environment Classifications. IBI scores and number of species were significantly higher at sites in native vegetation than sites in pasture or urban catchments. Trends over the period from 1970 to 2007 show a significant reduction in IBI scores in pasture and urban sites, but no significant change at native forest, exotic forest or scrub sites (Figure 26).

The increase in IBI for indigenous forest is likely to be due to sampling efficiency improving over time. For example, spotlighting methods have only become commonplace in the last 10-20 years.

The low IBI for exotic forestry in the 1990's was possibly the result of increased rate of harvest over this period, following the intense period of planting that took place in the 1960s. While growing, exotic forests do provide protection for streams. However, clearfelling often leads to high sediment inputs to streams, greater flood peaks causing disturbance and dramatic changes to physical in-stream habitat. However, there was no significant linear trend for both years and decades.

The strong association between fish IBI and land use shows the influence degradation of terrestrial systems has on freshwater ecosystems.

Because of a lack of consistent detail in the database on sampling intensity and fish abundance, all data used in this analysis were necessarily reduced to presence/absence. This restriction means that all results are inherently conservative. This is because any species within a fish community/population will show a gradual decline before local extirpation even with relatively sudden environmental impacts. Thus, for a reduction in IBI score, fish species must become extinct at that reach. Accordingly, the observed changes exposed in this analysis reveal the endpoints of longterm cumulative changes to fish communities (Joy, 2009).

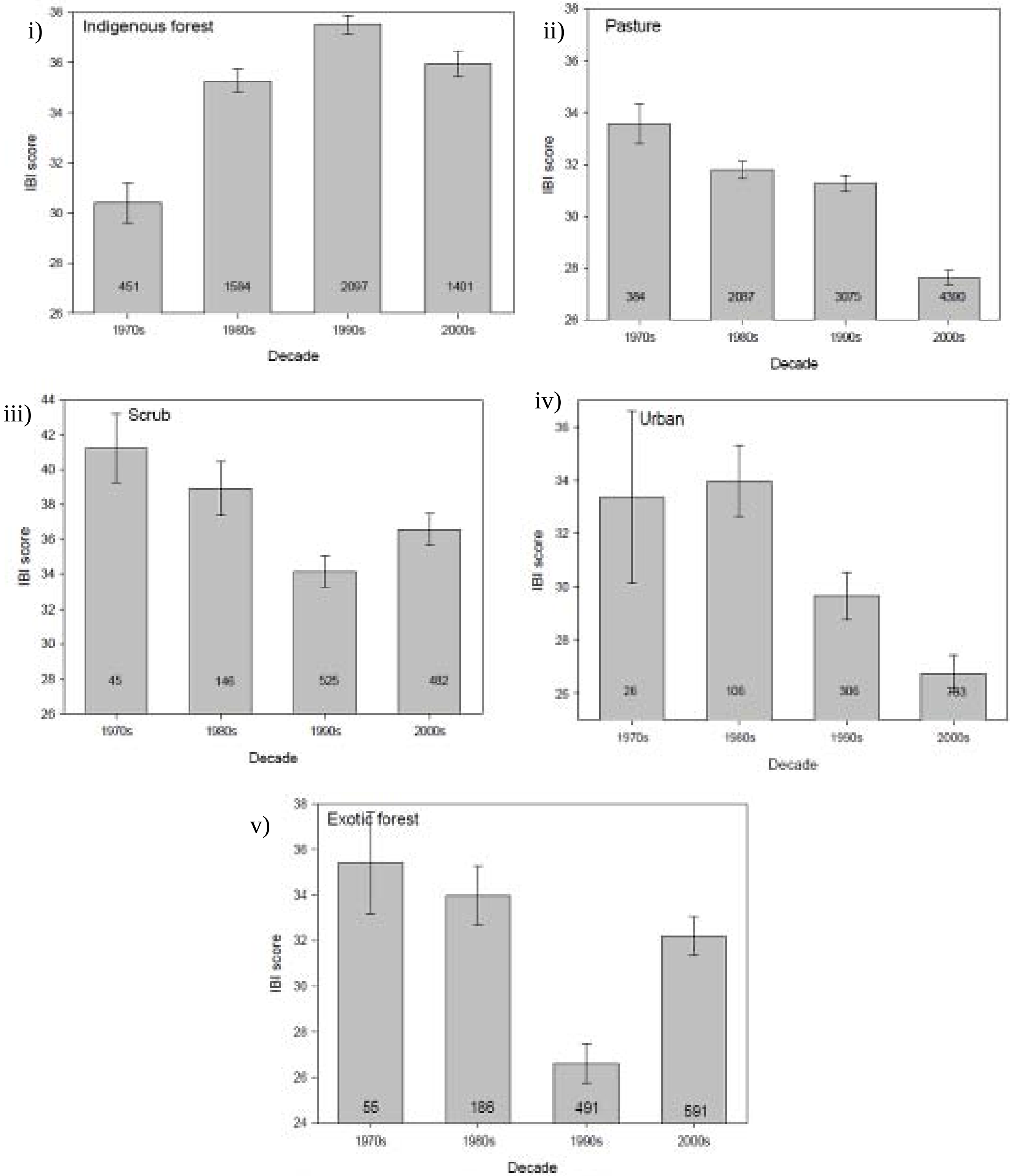


Figure 26: Average decadal IBI scores for river environment classification (REC) land cover: (i) - Indigenous forest, (ii) - Pasture, (iii) - Scrub, (iv) - Urban, (v) - Exotic forest. (Numbers per site inside bars) (Joy et al 2009)

2. METHODS

2.1 SITE SELECTION

The rationale for selecting the sites sampled in this programme is based on the following criteria:

- Reference and impact sites on adjacent or nearby reaches of the same waterway for a variety of existing stream disturbance activities or structures that may cause an adverse effect on fish communities. Water quality at each of the paired reference and impact sites is similar.
- Wadable stream size (1-4th order)
- A range of stream types (i.e., native bush streams, different land use types with different levels of stream disturbance and land use intensities).
- A focus on sites close to the coast because of the higher biodiversity values, but inland areas were included where there were specific issues.
- Moderate or high risk of degradation of high-biodiversity-value fish communities.
- Moderate or high risk of degradation of high-sportfish-value fish populations.
- Before and after stream rehabilitation including: riparian re-vegetation, and restoring stream form such as reintroducing natural meanders, natural run-riffle-pool sequences and channel cross-sections or in-stream habitat.
- Upstream and downstream of fish passage barriers before and after remediation of the structure.
- Significant gap in knowledge of fish populations.
- Compare trends at sites with historic records.

Potential sites to survey within the Tasman District were suggested by Tasman District Council and then discussed and refined in consultation with F&G and DoC. This ‘expert-panel’ approach was considered more appropriate than a stratified random approach given the cost of the latter approach. However, while this really only informs us of what is happening at the sites sampled it does allow us to make best-guess assumptions about fish populations in similar situations elsewhere in the region, especially once this information is included in the modelled fish distribution map project.

2.1 FISH SURVEY

Due to seasonal fish migrations it is necessary to sample at least twice at each site, once in summer (January-March) and once in spring (October-December), in order to make any conclusions on the presence or absence of a particular fish species, Streams were surveyed in the spring (2006, 2008) and summer (2006, 2008, and 2010). Some surveys carried out in early April during continued summer-like weather conditions were classed as spring.

Figure 27: Electric fishing (left) and spotlighting (right) are the most commonly used survey methods for the Tasman fish survey.

It is well recognised that no one capture/identification technique is sufficient at all sites and even within the same site due to the habits of the different species and their susceptibility to being caught by the particular method. For example, electric fishing is particularly successful in assessing eel populations, but spotlighting is best for assessing nocturnal galaxiids, such as kokopu species, when water clarity and depth is not at issue.

Each site was approximately 150m^2 in area. Several contiguous sites were investigated on some streams of special interest.

A total of 247 sites were surveyed on 89 different streams. A total of 122 sites were electric fished using a Kainga 300 backpack machine. This method of assessment was semi-quantitative, occasionally passing twice over a section of waterway and fishing into a pole net. Stops nets upstream and downstream of the fished reach were not used as the benefit was not considered enough to justify the extra effort.

National fish sampling protocols have been recently produced (David et al. 2011) that will allow a more consistent approach and enable the production of more definitive abundance data. It is likely that these protocols will be adopted in future surveys.

Figure 28: Fish Monitoring Methods; fyke netting (left) and gee-minnow trapping (right).

Spotlighting methods were used at 155 sites to assess presence/absence of freshwater fish, some of these sites coincided with those previously electro-fished giving a total number of sites monitored of 247. This method was very useful especially where waterways were too deep to effectively electro-fish or those covered in extensive macrophyte beds. Spotlighting was not a preferred method in windy conditions or where the water colour was stained by natural organic substances (e.g. lower Waiwhero Creek). Spotlighting generally involved one pass with two people with strong lights about 2-5m apart, both systematically identifying and recording fish in the stream.

Gee-minnow traps and fyke nets were employed at seven locations when electric fishing and spotlighting techniques would have provided limited result. Trapping was employed in deep, stained, slow moving water, sometimes in the outlet or inlets of wetlands.

The drift-dive technique was used in the upper Matakitaki River to assist Fish and Game assess the abundance of small-large brown trout in a sports fishery that could be affected by a hydro-electric power development. Drift diving is commonly used in the larger rivers to assess trout populations. Fish and Game hold a long-term record in this region.

Figure 29: Fish Monitoring methods: drift diving

No sampling techniques were successful during periods of high rainfall and surveys at these times were avoided.

Information collected on site was recorded onto NIWA Freshwater Fish Database Forms and submitted to the national database.

Data analysis undertaken in this project was basic and exploratory and it is acknowledged that more powerful and revealing analysis could be undertaken if sufficient long-term data and other resources were available. The abundance of individual species was analysed using coded abundance classes:

- Rare: 1-4
- Occasional: 5-10
- Common: 11-20
- Abundant: > 20

These abundance classes must be considered in reference to the area of stream bed surveyed (generally about 150m^2). Analysis of six species of galaxiids (giant kokopu, koaro, shortjaw kokopu, banded kokopu, northern flathead galaxias and dwarf galaxias), torrentfish and blue-gilled bully were considered separately because of their known sensitivity to habitat disturbance.

2.2 DATA ANALYSIS

The relationship between habitat disturbance and fish diversity/ and abundance was analysed by assigning each site a disturbance class (from 1-4, 4 being the least disturbed) based on the characteristics in Table 5.

Table 5 Habitat Disturbance Class and Characteristics

Disturbance Class	Characteristics
1	Any one of the following characteristics found at the site: Stream straightened for over 80% of its length, heavy cattle trampling, and heavy sediment deposits.
2	Reasonably natural stream meander but very limited rank riparian vegetation, low-moderate cattle trampling (no fencing provided), limited in-stream cover, low-moderate sediment deposits.
3	Natural stream meander and bank form, low-moderate in-stream cover, patchy rank riparian vegetation.
4	A natural stream: Natural stream meander and bank form with considerable riparian woody vegetation or rank grasses providing a high degree of shade and over-head cover, in-stream cover extensive.

Analysis of Variance (ANOVA) was conducted for all sites (202 sites) sampled by TDC in the years 2006, 2008 and 2010 to test for differences between the mean number of fish species recorded per site among years and seasons. Paired *t*-tests were conducted at sites that were sampled in both 2006 and 2008 (21 sites) and sites that were sampled in both 2008 and 2010 (21 sites, Appendix 4) to test for any differences between the number of fish species per site recorded between the years. There were only two sites that were sampled in all three years (i.e., 2006, 2008 and 2010; Appendix 4), which is not enough for statistical analysis.

2.3 ASSESSING FISH PASSAGE

Each summer since 2004-05 Council has carried out assessments on structures that have the potential to be barriers to fish passage. A barrier to fish passage was defined if any of the following criteria applied:

- Height of vertical or near-vertical face - over 300mm for inanga and non-climbers
- Water velocity & turbulence - over 0.5m/sec
- Undercut by more than 10mm and raised above surface by 200mm
- Shallow water (for larger swimming species only, i.e., trout, giant bully, giant kokopu) - less than 10mm deep. In some cases water takes caused a stream to either almost or completely dry for significant periods.

Other factors that are difficult to develop a threshold for were also recorded:

- Channel length without resting areas and climbing medium (need continuous wetted margin).

- Water chemistry due to discharges, natural or unnatural. Some basic water quality measurements (pH, conductivity, temperature and dissolved oxygen) were taken at the few sites where this was thought to be an issue.

In addition to at least six photos at each site, a detailed assessment form was completed for all probable barriers (see Level 3 Form; Appendix 2) and the structure was classified into five different classes of barrier, depending on the flow in the waterway:

- All flows - the most severe type of barrier.
- Most flows - there may be times when fish could get up.
- Low flows - likely to be a barrier at low flows only
- High flows - likely to be a barrier at high flows only
- Incoming tide - mostly tidal flap gates that close and prevent fish passage on an incoming tide

For structures that were obviously not a barrier, such as bridges or box culverts with no structure in the invert (only natural bed material), the only records transferred to the database were the date of the assessment, the person who carried out the assessment and classification of "none/minimal" for barrier type (this is called a "Level 1" assessment). No photos were taken in "Level 1" assessments. For structures that most probably provided fish passage, but may become a barrier in the future, or were marginal, were assessed using a "Level 2" assessment which was not as detailed as the "Level 3" assessment but a bit more information about the type of structure. Photographic records are also part of the "Level 2" assessment. All this information is stored in a database with hyperlinks to photos and interrogated via GIS.

In addition to the above assessment, a DIDSON acoustic camera was used to assess fish passage through several tide-gated culverts in the Waimea Estuary and Motueka Delta. This project was led by the Cawthron Institute as part of the Motueka River Integrated Catchment Management (ICM) research project (Doehring et al. (in press)).

3. RESULTS

3.1 Patterns of Distribution and Abundance of Individual Fish Species

In the following analysis, only the data from the monitoring carried out by Council and partners have been used, as the focus of this report is the distribution of fish in streams flowing through land affected by human development. However, data from the New Zealand Freshwater Fish Database between 1990 and 2010 is used in the maps (Appendix 1) in order to get a full overview of fish distribution in the district.

Native fish were observed or captured in all but three of the 247 sample sites. The average number of fish per station was 3.0 with a range of zero to eight fish per station.

Barriers to passage were responsible for two of the three “no” fish sites. The rate of occurrence of fish (ie number of sites in the 'State of the Environment' programme) is shown in Figure 30.

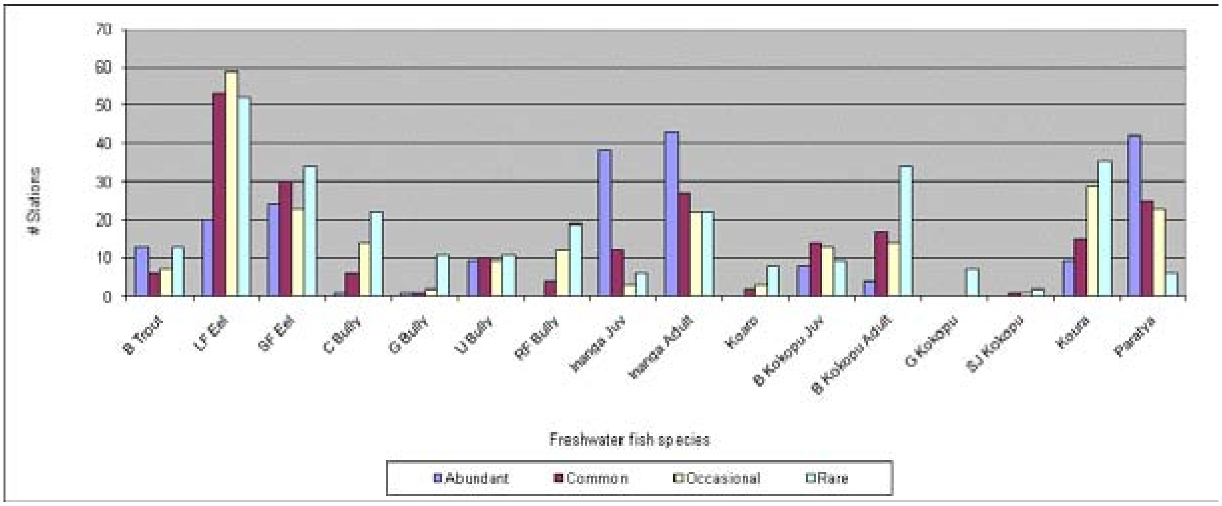


Figure 30: Occurrence of all freshwater fish species across all survey sites

In order to be relatively confident about the presence or absence of a particular fish species at a particular site, it is necessary to sample, not only a sufficient area of river, but also during the same seasonal period such as summer and spring. Juvenile inanga and banded kokopu were able to be analysed separately because they were relatively easy to identify in the field compared to other galaxid species. It is important to distinguish between spring whitebait runs and adult habitat because adult habitat can be identified and migration patterns inferred as well as fish passage issues. Appendix 3 illustrates fish density patterns across survey sites and some of the seasonal variations by sub catchment.

Maps are provided showing the distribution of most species (see Appendix 1).

3.1.1 NATIVE FISH SPECIES

3.1.1.1 EELS/ TUNA

Longfin Eel
Of the 247 sites sampled, the native and threatened longfin eel (tuna) were the most frequently observed native fish species (n=184 sites). While this eel is in gradual decline for the whole of New Zealand they were abundant or common in 73 sites.

Shortfin Eel
Shortfin eel (n=45 sites), was the third most observed species in this investigation, particularly in low elevation streams with little or no woody riparian vegetation. At some sites on small streams (e.g. Tasman Valley Stream and Berkett Creek, Motupipi catchment) they were found in particularly high abundance burrowed in the silty/grassy margins of the stream. Shortfin eel were particularly common to abundant during the spring surveys and this may be a direct response to feeding activity during the whitebait run.

3.1.1.2 GALAXIIDS

Seven species of galaxiids were observed in this investigation. Site selection and survey period were a major factor in this result. The dwarf and northern flathead galaxiids were only reported from the Buller catchment during the 2010 summer survey. There were few reported barriers to fish passage at sites assessed so that is not a factor in explaining fish species presence or abundance.

Figure 31: Juvenile galaxiids (whitebait) (Photo: K.Doehring)

Inanga

Adult inanga was the second-most reported native fish and was found in 114 sites. Again, site selection was a major factor of this result. Most of the survey sites were low elevation streams, slow flowing and close to the sea. When observed during the summer months they were often common or abundant.

Not surprisingly, inanga juveniles were a predominant feature of spring surveys that coincided with the whitebait run. In 24 sites they were reported as abundant and when separating inanga into age classes, juveniles ranked as the fifth most reported species overall.

Unlike most galaxiids, inanga appear to cope with a relatively high degree of habitat modification and moderate pollution levels and were not considered to be a habitat-sensitive native fish species for the purposes of this investigation. However, their abundance within the region appears to be related to the presence of spawning habitat, unless there is inter-regional transfer from coastal currents.

To date the greatest distance inland they have been recorded to is the Upper Moutere Village or upstream of Devils Boots on tributaries of the Aorere River (both about 15km inland).

Banded kokopu

Banded kokopu was the fourth most sighted native fish in this investigation and adults were found in 28% of the sites while juveniles, predominant in spring migrations, were found in 18% of all sites sampled. Adult banded kokopu were generally associated with habitats where good in-stream, riparian and overhead cover prevailed. With the exception of four streams where Banded Kokopu was abundant, they were rare or occasional in 70% of the streams that they occupied. With their remarkable climbing ability they were found in unexpected waterways upstream of fish passage barriers, such as Reservoir Creek and the old water supply weir at Kaiteriteri, yet absent in ideal physical habitat conditions such as James Cutting (which has poor water quailty.

Giant kokopu

Giant kokopu were found at seven sites during surveys from 2005-2010 with a total of 42 sites recorded in the NIWA database.

One giant kokopu was recorded in Dominion Creek in 2009 prior to diversion of the waterway for the Ruby Bay Bypass (SH60) construction (Figure 32). After the diversion occurred and the significant habitat disturbance the fish was not found in a subsequent survey. Once the riparian vegetation along the diversion is 2-5 years old it is expected that the habitat will again be suitable for this species of fish.

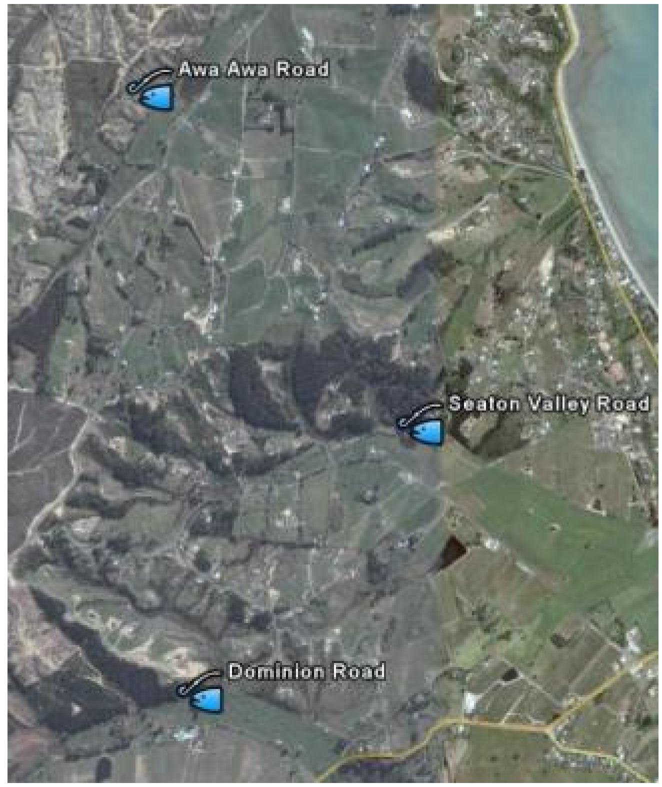


Figure 32: Three New Locations of giant kokopu in the Tasman-Mapua Area (from surveys in 2008-09)

Giant kokopu were new discoveries form the three streams surveyed in this programme 2006-2010 (i.e. no previous records of for the sites). Given that the preferred habitat types for this species are often overgrown, weedy/boggy streams, swampy lagoons and lake margins, and these habitats are difficult to survey effectively, the records may under-estimate the population. However, these habitats are very uncommon in the region so the current abundance is likely to be very low compared to centuries past. While several streams sampled were likely habitat, wetland and lake habitats were not well represented in sites surveyed in this investigation, potentially reflecting the low numbers found, so far.

Koaro

Sites selected for this survey were coastal which did not particularly favour the threatened and declining koaro. Adults were observed in 11 sites while juveniles were seen in three sites during the spring whitebait run. All adults were observed in hill-fed, clear, riffle-cobble habitat often within or near native forest. They were frequently (71%) associated with waterways where fish passage was difficult for most native species, which attests to their remarkable climbing ability. Koaro are found in most steep waterways in Abel Tasman and Kahurangi areas. They usually do not overlap with shortjaw kokopu which prefer to occupy flatter sections of stream below a steep section. Maybe there is competition between these species.

Shortjaw kokopu

As with koaro, sites selected for this survey did not particularly favour shortjaw kokopu. Adults were observed at four Golden Bay sites in distinctive, small, medium-stable, cobble-boulder streams encased within native forest. They are classified in the threat classification as “declining”.

A three-year study targeting this species was undertaken by Department of Conservation ending in the late 1990's early 2000's (Jack, 2001). The Abel Tasman and Kahurangi National Parks provide significant populations of shortjaw kokopu nationally. Remarkably high numbers of shortjaw kokopu were found in the western Golden Bay and north-western coast, particularly the northern side of the Aorere Valley with the largest population occurring in the Kaituna River catchment. In many streams in the Aorere, shortjaw kokopu were found in association with small (40-250mm) brown trout. Significant numbers of juvenile and shortjaw kokopu were found throughout the Department of Conservation study, possibly indicating recruitment success and habitat availability in these areas.

Dwarf galaxias

Dwarf galaxias were observed in almost one third of the Buller River Catchment streams (11 out of 35 sites in the Buller) surveyed in the summer of 2010. Habitats generally favoured were reaches of low-gradient near foothills and in the shallows of the Matakitaki River and in the gravel riffle areas of small (sometimes spring fed) Buller River tributaries. Shoals of these fish were observed during the summer survey period and they were common-abundant in 73% of the habitats occupied. These results were expected although densities were low or absent in small streams where brown trout and longfin eels were abundant. Dwarf galaxias appears to cope well with disturbance in mountain-fed streams, and were observed in this survey returning to streams within two years after heavy mechanical disturbance. This disturbance created more interstitial space and therefore may have favoured this species as this space provides more escape cover. Dwarf galaxids seem to have adapted well in their evolution to living in the mobile beds of mountain-fed streams.

Northern flathead galaxias

The "northern flathead" was found during the summer 2010 survey in two tributaries of the Matakitaki River (Nardoo and Station Creeks) and where they had not been recorded previously. Unconfirmed sightings have been reported from the mid-Glenroy catchment. As far as the authors have ascertained no genetic analysis has been undertaken of the Motueka, Matakitaki and Maruia communities of this species.

3.1.1.3 Bully Species

At least one of the five species of bullies were found in 136 sites, or at 55% of all samples.

Upland bullies

Upland bully were found in 48% of the streams surveyed and was often the dominant native species observed in inland high-elevation, gentle flowing streams. Upland bully was the sixth most frequently encountered native fish in the survey. When found it was often common or abundant. Like dwarf galaxias, upland bullies are present in mountain-fed streams which are regularly disturbed by floods reworking the gravels. However, this species seems to tolerate human-induced disturbance such as with heavy machinery. Until the 2010 survey, site selection priorities were more coastal streams which did not favour finding this species.

Common bully
Common bully was the most frequently observed of the five bully species and ranked as the fifth most observed native fish in the survey. Although the species seems to cope well with heavy loads of deposited fine sediment and was widespread throughout many habitat types such as small sandy streams and gravelly rivers, they were only recorded as abundant in one site (Wainui River at Abel Tasman Drive). Many of the sites targeted for this survey were ideal habitats for common bully i.e. small coastal streams and many had been impacted by fine sediment discharges that may displace other fish species allowing reduced competition for common bully so it was somewhat surprising that it was not more abundant.

Redfin bully
Redfin bully featured in 14% of the rivers surveyed with an overall ranking of the seventh most frequently observed. Never abundant at any site, they were rare-occasional 89% of the time at sites where they were present. Redfin bullies have recently been placed on the national threat classification list as 'declining'. These colourful fish occupied moderately fast flowing lowland cobble streams (such as the Onekaka and Puremahia Rivers) often at the tail of small pools.

Bluegill bully
The bluegill bully is classified nationally as declining and was observed only once during the survey (Jordan River in the Riwaka Catchment). However, the low number of records found might be related to this species' habitat preference (i.e., swift flowing water), as it is difficult to survey these types of habitat with the spotlight method and the electric fishing machine has its limitations in deeper flowing water where they may be present.

Giant bully
Giant bully were observed in 15 survey sites, always in or near cover and close to the coast. They are difficult to distinguish from common bully and these results may be conservative. This species was recorded abundant at only one site (Wainui River) and rare in 73% of the sites where identified.

Torrentfish
Like the bluegill bully the torrentfish is another native fish that occupies fast water habitats and is now threatened and declining. Torrentfish were only found in Tukurua Stream and Onekaka River, but their abundance in these streams was high. Sites selected under this programme did not include many small to medium sized partially braided rivers with high velocity that favour these fish.

Common smelt
The common smelt was observed in five waterways that were connected to the Waimea Inlet and Moutere River and tributaries during summer surveys. This result was expected as smelt only enter freshwater in summer and autumn to spawn and die soon after.

Lamprey
Like smelt, the very secretive lamprey is another native fish that perishes after spawning in freshwater. Lamprey were only observed at two sites in this survey (a tributary of Waikoropupu River and Dove River). Lamprey are nationally threatened and in decline, and difficult to survey effectively due to their life-history.

3.1.2 Introduced Fish

Brown trout
Brown trout were captured in thirty nine sites or 16% of the waterways surveyed. In lowland streams trout co-existed with longfin eels, shortfin eels, common bully and inanga. Upland waterways were almost always shared with longfin eel, dwarf galaxiid and upland bully. Habitat-sensitive native species were observed in eight trout-occupied waterways (21%), but two thirds of these sightings were in medium to large waterways in the Buller Catchment in association with dwarf galaxiids.
Most of survey sites were not expected to, and did not, provide ideal habitat for brown trout, which may explain the relatively low incidence of this species in the study. For more comprehensive information of the health of the regional trout fishery, contact Fish and Game.

Rainbow trout
While no rainbow trout were found in this monitoring programme. There are 11 records in the Freshwater Fish Database, all in the Maruia and One Mile Catchments (Appendix 1t). In addition, it is well known that they are found in the Travers River and Lake Rotoiti, two tributaries of Lake Rotoroa and Maruia (Davey, *pers comm*.).

3.1.3 Large Invertebrates

Koura
The native crustacean koura (freshwater crayfish) were documented during this survey and were found in 37% of the sites sampled. Seldom found in large numbers, they were recorded as rare-occasional at 73% of the sites where they were found. They are vulnerable only where escape cover does not exist. However, extremely high densities have been observed in streams without fish predation eg Moa Park area in the headwaters of Awaroa River in Abel Tasman National Park and the water race for the intake for Pupu Hydro electric power scheme. Most of the koura records are in small streams in the absence of any large predators (eels or trout) or in spring-fed or soft-bottomed streams where they can burrow to escape predation. Koura are may be vulnerable to predators (eg trout, eels, stoats) and co-existed with brown trout in only 3% of the sites where koura were found.

Shrimp
Paratya was observed in over 50% of all lowland waterways (96 sites) sampled without fish passage barriers (fish passage barriers were found at 71 sites of the 247 sampled). They were the most abundant species recorded during the summer months when the juveniles are migrating upstream. There appears to be a strong correlation with the abundance of adult inanga and *Paratya* during the summer months although it is likely that one affects the presence of the other.

Freshwater Mussels / Kakahi
Freshwater mussels were found at two sites: Mackay Creek and Little Kaituna in Golden Bay. The sampling technique used to assess freshwater fish could easily miss detecting mussels, and closer inspection of streams for these molluscs at the time of the fish survey

would be useful, particularly in soft-bottomed streams such as Little Kaituna. Freshwater mussels would be worth investigating at the following sites: Pearl Ck, Neiman Ck and Pupu Springs

3.2 SEASONAL PATTERNS

As expected, juvenile inanga (the left of the two inanga groups listed in Figures 33 and 34) were more common in spring (60%) than in summer, however, koura and *Paratya* shrimp were more common in summer/autumn than in spring. There were no shortjaw kokopu recorded during the spring survey, however, this species was common at a few sites in summer/autumn.

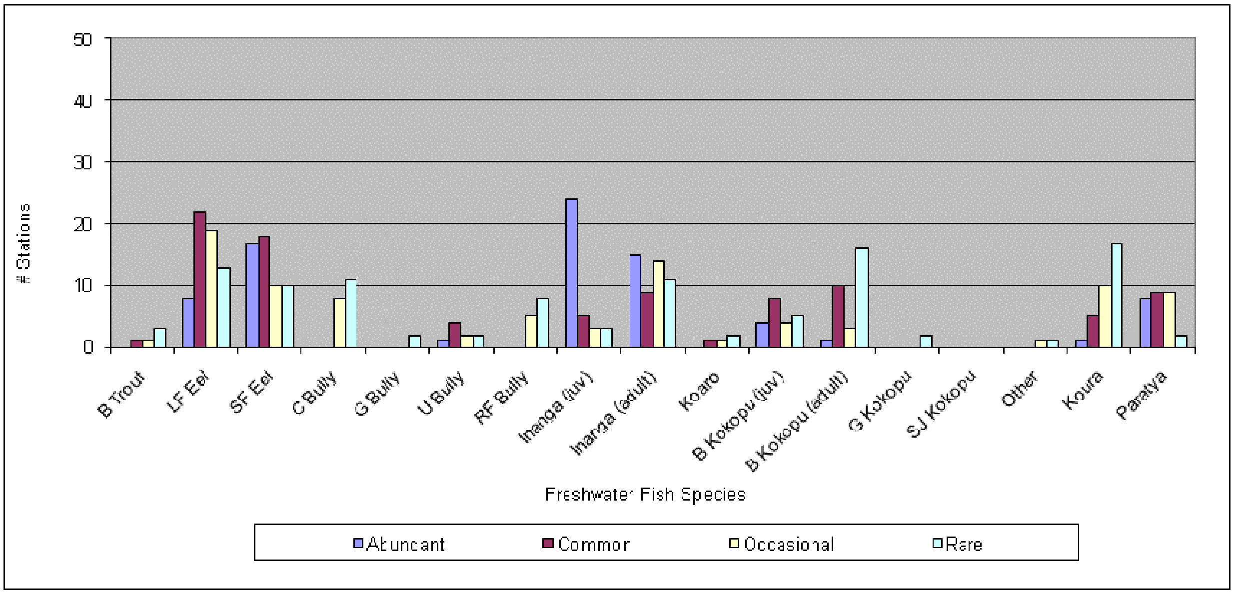


Figure 33: Abundance of all freshwater fish species across all survey sites - <u>spring</u> results only. Abundant (>20 species/site), Common (11-20), Occasional (5-10), Rare (1-4). "Other" includes: yelloweye mullet and torrentfish.

Analysis of Variance (ANOVA) showed no significant differences in the mean number of fish species recorded per site among all years (i.e., 2006, 2008 and 2010; F_4 = 0.88= 6.09, P = 0.47). However, there was a significant difference in the mean number of fish species recorded per site between summer and autumn (F_2 = 4.37, P<0.05), with fewer fish species per site recorded in autumn (2.55) than in summer (3.33).

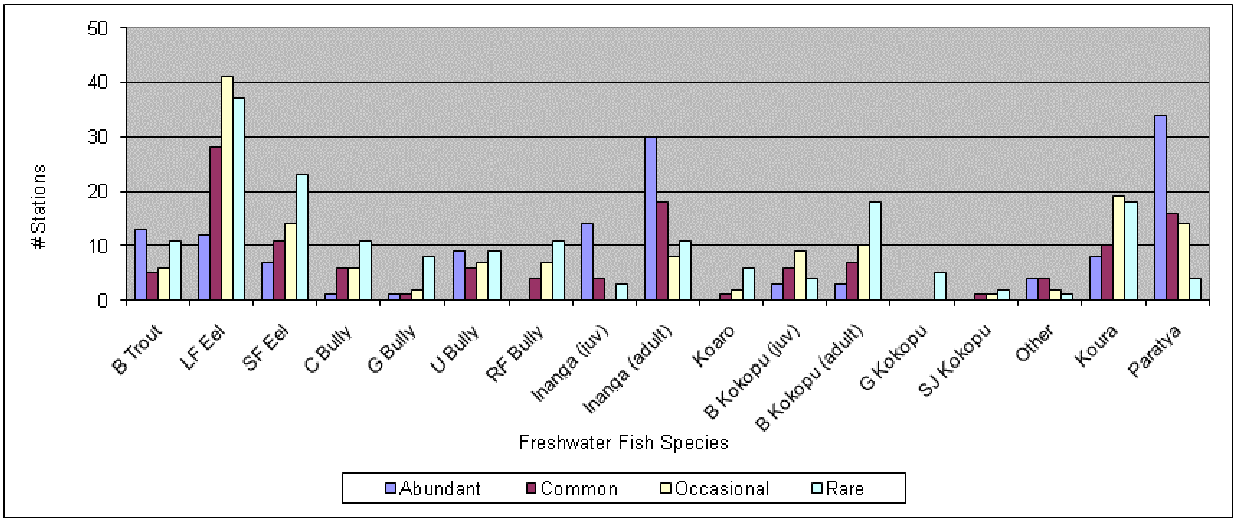


Figure 34: Abundance of all freshwater fish species across all survey sites - <u>summer/autumn</u> results only. Abundant (>20 species/site), Common (11-20), Occasional (5-10), Rare (1-4). "Other" includes: Lamprey, Smelt, bluegill bully, northern flathead galaxias, yelloweye mullet

3.3 HABITAT-SENSITIVE FISH SPECIES

For the purpose of this survey, six galaxiids were identified as a habitat-sensitive species; koaro, banded kokopu, giant kokopu, shortjaw kokopu, and northern flathead galaxias. In addition, red-fin and blue-gill bullies as well as torrentfish are considered habitat-sensitive. At least one of these six fish species was captured or observed in 110 of the sites (46%). The highest number of habitat-sensitive species recorded at a site was three (Tui Stream, Wainui Bay) with twelve sites having two sensitive species present. Banded kokopu were the most widespread of the galaxiids found in 74% of the habitat-sensitive species occupied waterways and were represented in each site where more than one habitat-sensitive species was observed. Two habitat-sensitive non-galaxiid species were observed; one bluegill bully (Jordan River) and one torrentfish (Tukurua Creek).

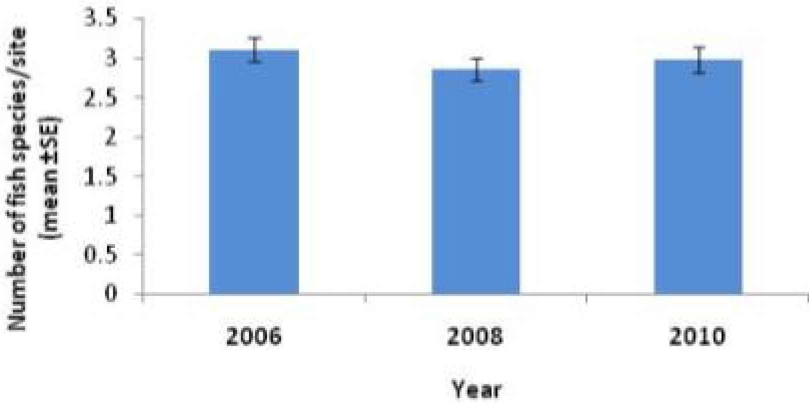
About 15 reference-impact pairs of sites in this survey were investigated to compare fish communities between partially modified and extensively modified reaches on the same water body. The results of the majority of these were profound with much higher fish diversity and abundance in reference streams with good in-stream and riparian cover, natural meander and limited disturbance. Some selected examples are included in Table 6. These examples were selected because they were not complicated by water quality, fish passage or other issues and show a range of levels of disturbance. The examples demonstrate locally the value of in-stream habitat improvement at sties where land-use is not causing significant water quality issues. The only example that clearly showed a positive effect in terms of number and type of species from major human-induced disturbance was in the Maud Creek which is a mountain-fed river that gets a high level of disturbance anyway (frequent high flows that cause bed movement). Dwarf galaxias, was found in this river but not in the reference site that had almost no human-derived disturbance showing they cope well with disturbance.

Table 6: Some Examples of the differences between reference and impact pairs

STREAM	REFERENCE REACH DESCRIPTION	REFERENCE REACH FISH COMMUNITY	IMPACT REACH DESCRIPTION	IMPACT REACH FISH COMMUNITY
Plumbago Stream *(Figure 40)* *Hill-fed*	~200m reach almost adjacent to impact reach Almost full canopy of riparian tree cover. Natural meander	**BK (c), GK (r),** RFB (o), LFE (o), Ka (o), S (a)	~150m reach Straightened Full cattle access but little trampling evident No riparian trees or vegetation cover	LFE (o), SFE (c), I (c), CB (r), Ka (o), S (o)
Mackay Creek *(Figure 42)* *Lowland-fed*	A 100m reach, ~600m d-s from impact reach Partial to majority canopy of riparian native bush Natural meander	**RFB (o),** CB (o), I (o), LFE (a), SFE (a), Ka (o), S (c),	~150m Partial straightening Partial fencing, minor stock trampling	LFE (o), SFE (a), I (o), UB (r)
Little Kaituna Stream *(Figure 45)* *Lowland-fed*	~100m reach immediately upstream of impact reach Original riparian podocarp forest and highly meandering	**BK (a), RFB** (o), I (c), LFE (c), SFE (c)	180m Straightened Fenced & no stock access Overhanging grass & the odd shrub	BK (r), SFE (r)
Horton/Tasman Valley Streams *(Figure 69)* *Lowland-fed*	~100m tributary of Tasman Valley No stock access High % tree canopy cover Natural meander	**BK (c), GK** (r), LFE (r), SFE (o), S (r)	~100m reach within 1km of reference site but about 3x the flow No fencing but not heavy trampling No riparian trees	I (a), CB (r), LFE (r), SFE (a), S (c)
Seaton Valley Stream *(Figure 70)* *Lowland-fed*	1.2km reach immediately upstream of impact reach Regenerating scrub (mix of exotic and native; partial to full canopy) Natural meander	**BK (a), GK** (r), I (c), CB (o), LFE (c), SFE (o), Ka (c)	~900m Straightened Free stock access & heavy trampling Sediment & aquatic plants dug out every 1-2 years	SFE (c), LFE (r), I (o), Ka (r)
Maud River *Mountain-fed*	~150m reach in pine forest with riparian beech forest Natural meander	T (a), UB (r)	~200m Completely cross-bladed (bed turned over with a bulldozer) 2.5 years earlier	T (a), UB (c), DG (r), LFE (r)

Habitat-sensitive native fish highlighted in bold.
r= rare, (o) = occasional, (c) = common, (a) = abundant

A



B

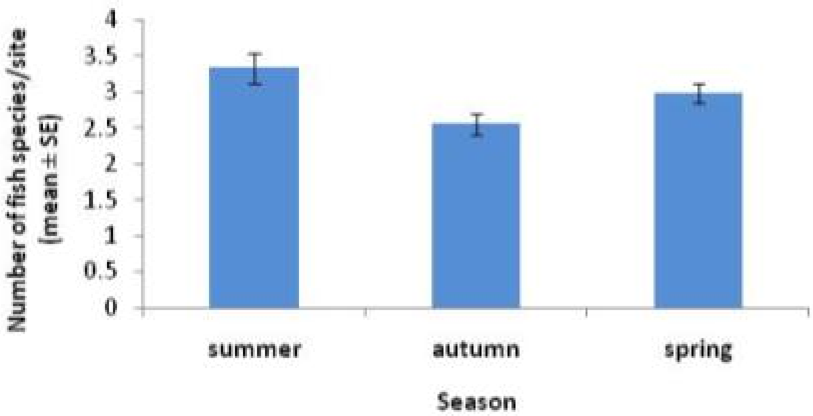
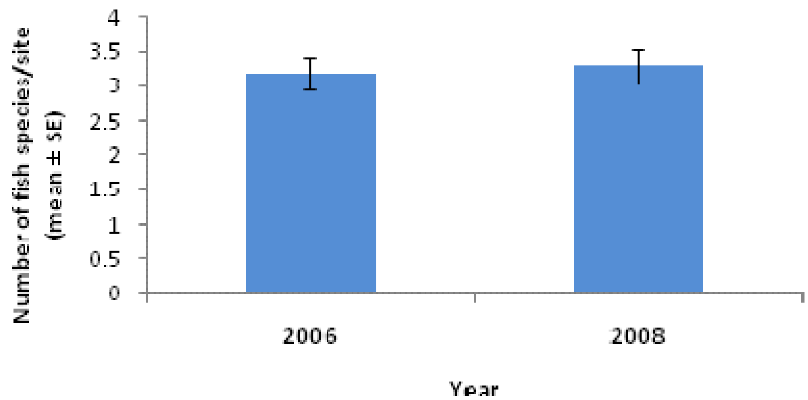


Figure 35 : Mean (± S.E.) number of fish species per site recorded at all sites in 2006, 2008 and 2010 (A) and in summer, autumn and spring for the years 2006, 2008 and 2010 (B).

A



B

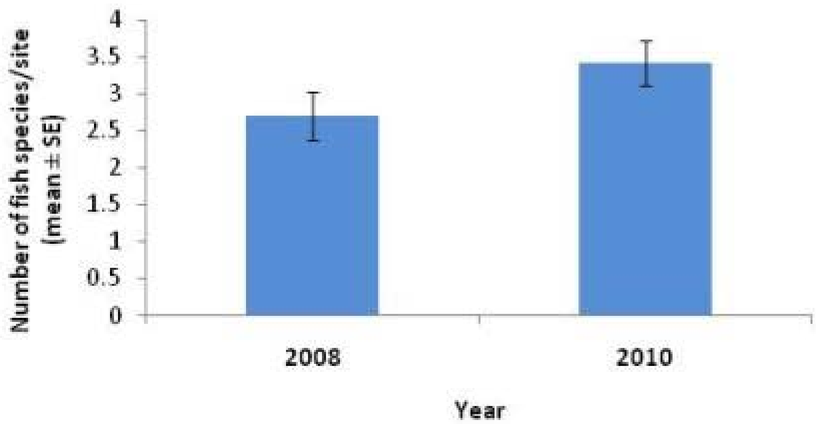


Figure 36: Comparison of the number of fish species recorded per site (mean ± SE) at the same sites between 2006 and 2008 (A), and 2008 and 2010 (B).

3.4 DISTRIBUTION OF FISH SPECIES WITH ALTITUDE AND DISTANCE INLAND

Records from the NZFFD showed that altitude (Figure 37A) and penetration inland (Figure 37B) had an important influence on fish species richness in the TDC area, showing a clear decrease in species richness as you move further inland and to higher altitude sites. Data about altitude and penetration inland for individual species is listed on Table 7.

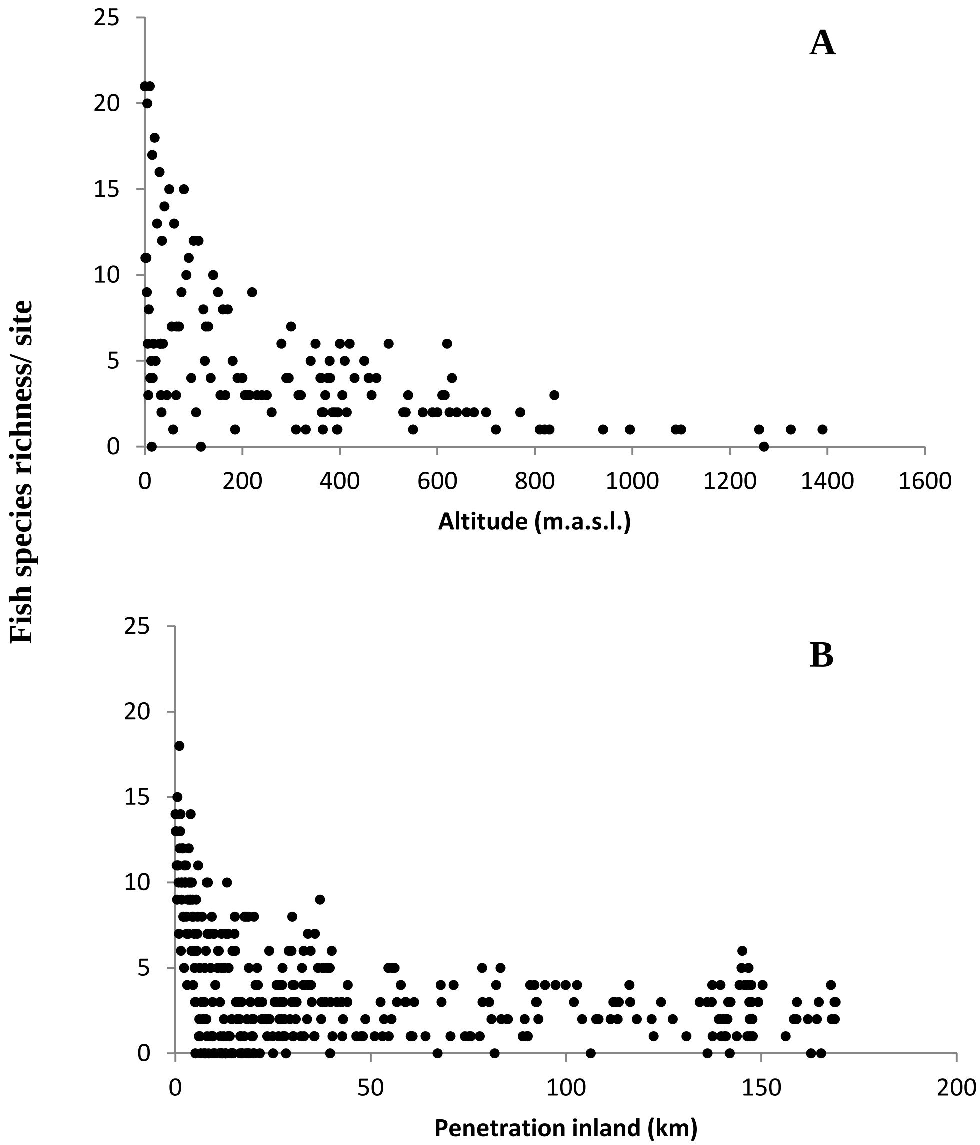


Figure 37: Number of fish species per site in respect to altitude (metres above sea level; A) and penetration inland (km; B) in the Tasman District between 1990 and 2010. Data were derived from the New Zealand Freshwater Fish Database (NZFFD).

Table 7: Average, maximum (Max) and minimum (Min) inland penetration (km) and altitude (metres above sea level) for 27 fish species in the Tasman District between 1990 and 2010. Data were derived from the New Zealand Freshwater Fish Database (NZFFD). * indicates non-migratory fish species.

Penetration inland (km)	Average	Max	Min	Altitude (m.a.sl.)	Average	Max	Min
Flathead galaxias *	146.6	146.6	146.6	Rainbow trout	830	840	820
Northern flathead galaxias *	134.1	146.1	90.2	Flathead galaxias*	378	378	378
Dwarf galaxias *	94.8	159.0	0.1	Northern flathead galaxias*	362	400	350
Upland Bully *	75.2	161.9	0.0	Dwarf galaxias*	303	535	0
Brown trout	61.3	169.0	0.0	Upland Bully	231	630	0
Rainbow trout	60.7	61.1	60.2	Brown trout	205	840	0
Bluegill bully	38.2	145.7	1.0	Koaro	194	1390	0
Longfin eel	26.8	169.0	0.0	Longfin eel	108	770	0
Lamprey	24.5	68.1	0.0	Bluegill bully	101	375	3
Koaro	20.1	169.0	0.0	Freshwater crayfish	99	995	0
Torrentfish	16.6	107.7	0.1	Shortjaw kokopu	76	940	0
Freshwater crayfish	15.5	156.2	0.0	Lamprey	71	205	0
Shortjaw kokopu	15.1	113.5	0.0	Torrentfish	43	210	0
Common smelt	11.6	34.2	0.5	Rudd*	41	100	0
Shortfin eel	8.4	167.8	0.0	Redfin bully	40	290	0
Redfin bully	8.0	83.2	0.0	Shortfin eel	35	620	0
Common bully	7.6	167.8	0.1	Common smelt	33	80	0
Rudd *	5.9	18.8	0.2	Common bully	29	620	0
Goldfish *	4.1	18.8	0.7	Banded kokopu	28	220	0
Banded kokopu	3.7	37.0	0.0	Tench*	22	50	0
Giant kokopu	3.7	20.0	0.0	Goldfish*	17	100	1
Tench *	3.7	9.3	0.2	Giant kokopu	17	80	0
Brown mudfish *	3.6	4.4	0.5	Inanga	17	150	0
Inanga	3.6	39.0	0.0	Brown mudfish*	14	15	10
Giant bully	2.2	13.2	0.0	Giant bully	7	31	0
Estuarine triplefin *	1.5	1.5	1.5	Yelloweye mullet*	3	10	0
Yelloweye mullet *	1.2	2.4	0.0	Estuarine triplefin*	0	0	0

4. DISCUSSION

4.1 Patterns of Fish Distribution and Abundance

The results of surveys carried out under this programme fill an important gap in the regional knowledge of fish distribution. Previously very little fish data existed in small streams dominated by pastoral land use.

The SOE Fish survey accounts for 80% of the records in the NIWA freshwater fish database from 2006-2010. Of the sites surveyed 33% also had historical records since 1990 (a further 1% had records prior to 1990).

4.2 Patterns of Distribution and Abundance of Habitat-Sensitive Fish Species

Almost all (95%) sites containing habitat-sensitive fish had habitat with good riparian vegetation and overhanging cover. In general very few species were found where cattle trampling of banks and bed was evident. Berkett Creek, Redwood Valley Stream, Stringer Creek, some unnamed creeks in Wainui Bay and Little Kaituna Stream were the only waterways surveyed that contained a habitat-sensitive species (banded kokopu adult only) where cattle had access on both the true right and left banks. This was in response to small pockets of available habitat and reasonable water quality. Seventy nine of the 110 sites containing habitat-sensitive species in pastoral land use were either entirely fenced or fenced on one side. Poor water quality likely to be a limiting factor (dissolved oxygen regularly below 40% in summer) to most fish species in the lower reaches lowland streams dominated by pastoral land use such as Tasman Valley Stream and Seaton Valley Stream. Giant kokopu were observed in the upper reaches of this waterway in areas where water quality (particularly dissolved oxygen) was much better. These types of lowland streams with reasonable water quality should be a priority for in-stream habitat improvement.

4.3 Discussion by Catchment/Area

4.3.1 Small Coastal Streams in Northern Golden Bay

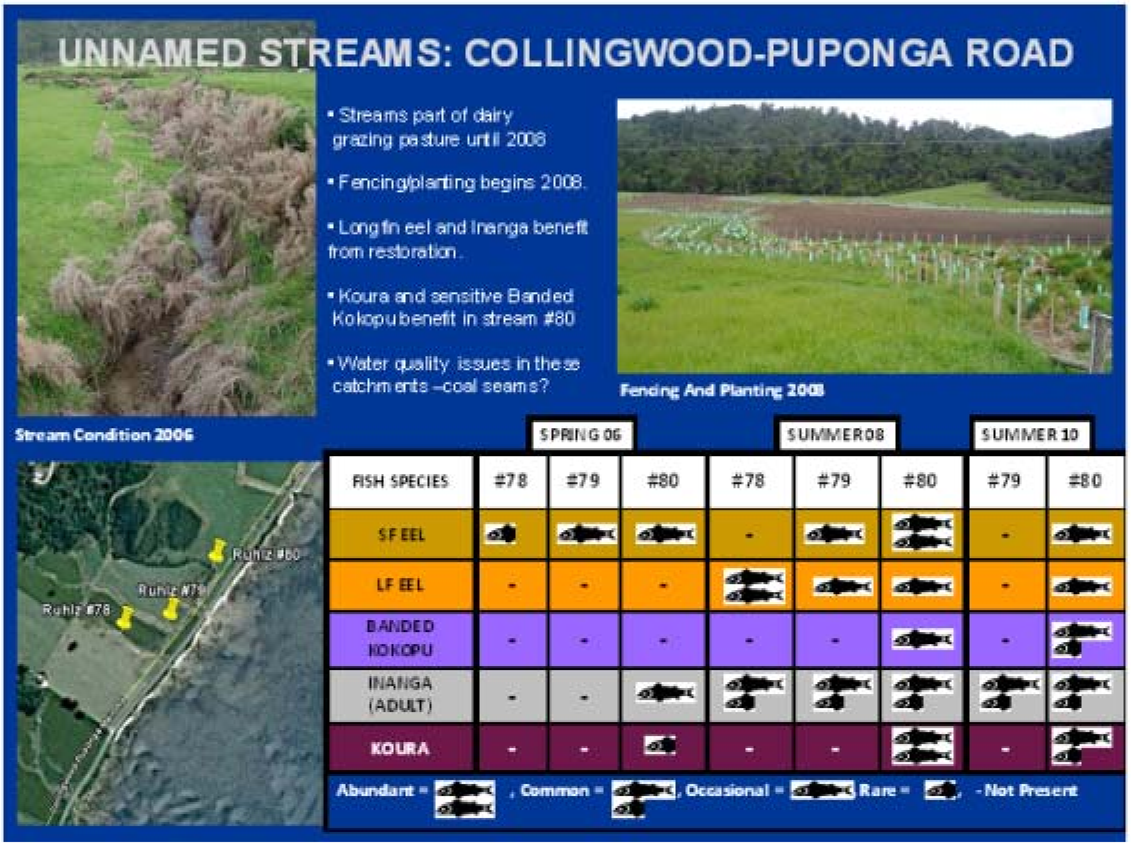


Figure 38: Collingwood Puponga Road fish types, abundances and monitoring information.

(# = culvert number).

A series of five small unnamed streams which enter Golden Bay by culverts under the Collingwood - Puponga Road, north of Taupata Stream were surveyed in spring 2006 and again in 2008 and 2010 (see results in Figure 38). Some of these waterways are ephemeral (only flow for a short period of time) during the summer months. Land use adjacent to these streams is dairy farming, and historically cattle had full access to these waterways. In spring 2006 one landowner commenced fencing followed by extensive native plantings in 2008 on streams identified as culverts 78, 79 and 80. Subsequent fish surveys were implemented on these waterways during the summers of 2008 and 2010. Results indicate that longfin eels and adult inanga took up residency in all of these streams following restoration. In addition, adult banded kokopu were observed as occasional in 2008 and common during the 2010 survey in the creek at culvert #80. Koura numbers have also responded to the restoration effort in greater density in culvert #80.

Limiting factors to native fish density and diversity are: habitat limitation due to low water flows during the summer months and poor water quality (particularly the extremely low dissolved oxygen levels, high levels of fine sediment and moderately high water temperatures and cover of filamentous green algae). The anoxic conditions in several of the creeks may be due to natural discharges from coal seams in these catchments.

Flowers Creek

Flowers Creek enters the Pakawau Inlet approximately 75m above the Collingwood-Puponga Road bridge. The lower reach below Pakawau-Bush Road contains a diverse and abundant number of native fish, particularly where over hanging cover and deep pools provide habitat and year around access to the sea. Immediately below the Pakawau-Bush road bridge a perched concrete apron partially restricts fish passage for poor climbing native fish such as inanga and common bully. Approximately 200m upstream from Collinson Road, native fish habitat conditions are good with overhanging native bush cover, rocky runs and undercut banks. Invertebrate numbers are low, as is fish abundance with longfin eel (occasional), adult banded kokopu (occasional-abundant) and limited numbers of redfin bullies, representing the majority of native fishery. Freshwater shrimp are common while koura are occasional. Above this reach fish habitat conditions are near perfect as the stream flows through native bush. Here, longfin eel are rare and banded kokopu are occasional. Invertebrate numbers are low. It may be that there is a natural water quality issue associated with coal seams. A one-off selected water chemistry screen showed moderately high conductivity and concentrations of sodium, sulphate and iron in this creek (see Appendix 5).

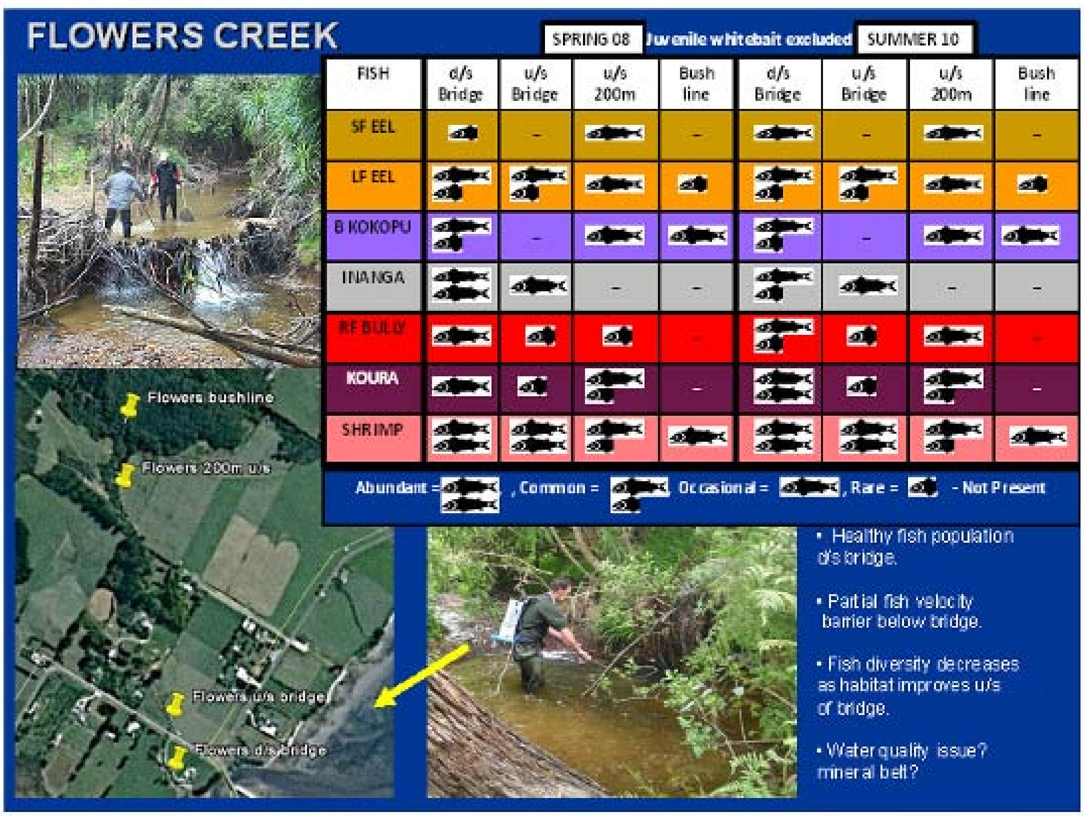


Figure 39: Flowers Creek fish types, abundances and monitoring information.

Plumbago Creek

Plumbago Creek enters the Ruataniwha Inlet 200m north from Opou. Below Collingwood - Puponga Road the creek has been straightened and dairy cows have access to the bed. Overhanging vegetation occurs along the riparian edges but no overhead canopy (trees) is present. Longfin and shortfin eel, inanga, and shrimp are common. The common bully and koura are rare. Upstream (225m) from the road the creek is fenced on both banks and cascades through a dense native bush canopy. The bed consists of boulder and rock with associated pools and undercut banks. Native fish diversity and density, like Flowers Creek, was surprisingly low. Longfin eel and banded kokopu were common while redfin bully and koura were occasional. One giant kokopu was captured. The habitat encountered was ideal for both shortjaw kokopu and koaro. Again some mechanism is operating in this waterway that limits native fish abundance that is not habitat related. Selected water chemistry one-off results for this creek showed moderately high conductivity and concentrations of calcium, and alkalinity (see Appendix 5). More analysis is needed in this regard.

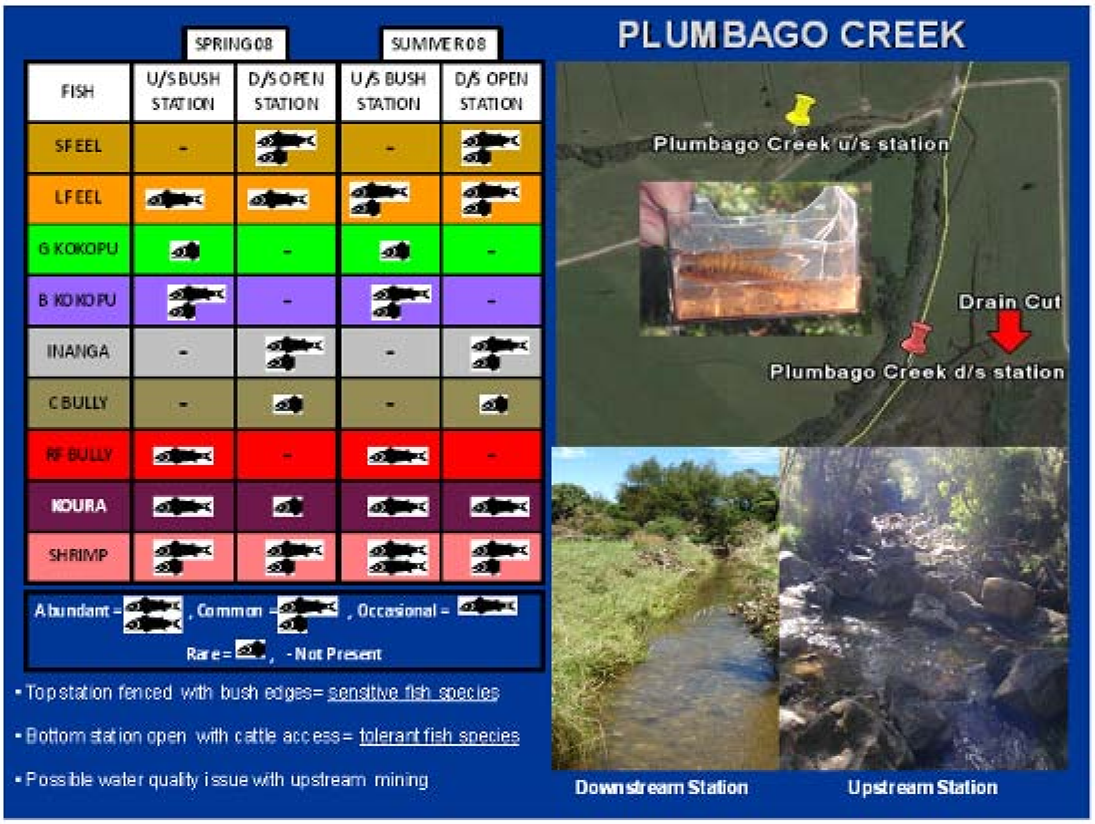


Figure 40: Plumbago Creek fish types, abundances and monitoring information.

Gorge Creek

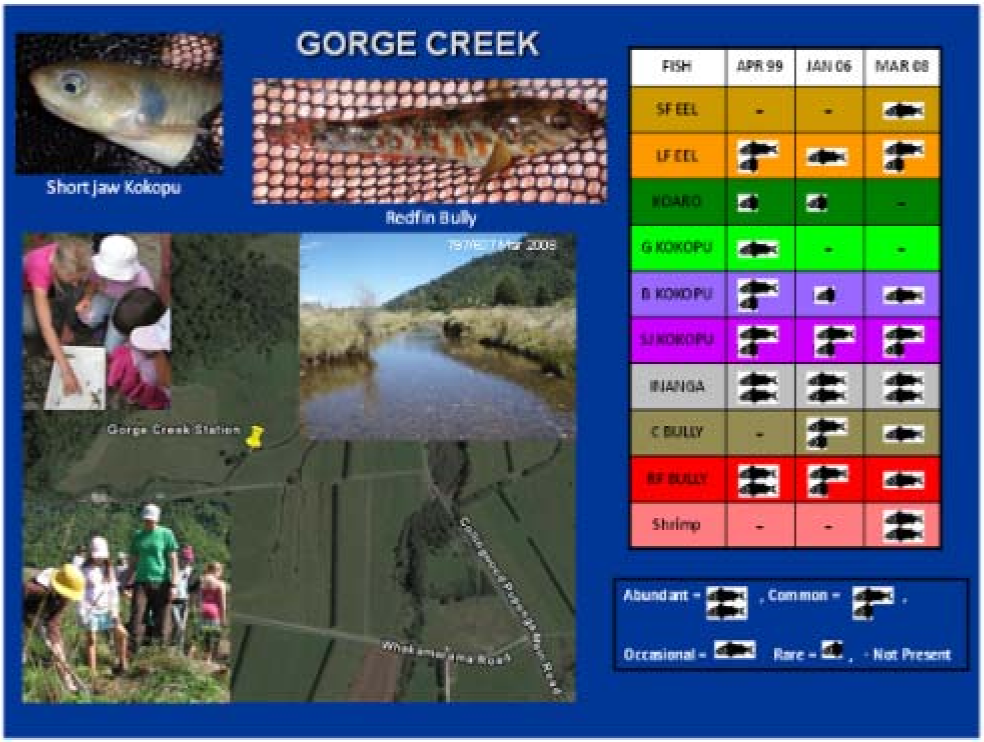


Figure 41: Gorge Creek fish types, abundances and monitoring information

Gorge Creek flows through a steep native bush catchment and dairy pasture before entering the Ruataniwha Inlet 2km north of the Aorere River. The creek is fenced and has been the focus of a community streamcare project that aims to restore an ecological corridor from Kahurangi National Park to the sea. The waterway contains the most diverse native fish community in Golden Bay with the declining shortjaw kokopu observed as common. Seven native fish species were recorded in the summer of 2008 in a reach 400m upstream from the Collingwood - Puponga Road to the bush line. In addition, brown trout were observed below the survey section.

4.3.2 Coastal Lakes

Kaihoka Lakes

These dune lakes, located just north of Westhaven Inlet, have no stream outlet and have been identified by Department of Conservation as having high scientific and conservation value (Shallenberg, 2011; Allibone, 1995) and recognised for having rare landlocked populations of banded kokopu. Landlocked populations of banded kokopu are rare in New Zealand, but are known to exist in some west coast North Island dune lakes and Lake Okataina (near Rotorua). Apart from one very large longfin eel found in Kaihoka Lake East, no other fish species were found in the lakes. Genetic analysis suggests that these fish have been isolated for many centuries and possibly millennia. This restricted genetic variation suggests that the population will be more vulnerable to environmental change, including introductions of new species to the lake. Trout have been introduced in these lakes in the past but have presumably died out due to lack of spawning sites in the catchments.

Lake Otuhie

Lake Otuihe was also recently investigated as part of a nationwide study of small coastal lakes (Schallenberg, 2011). This lake is considered to have a typical fish community for a shallow lake with unimpeded connection to the sea containing LFE, SFE, I and CB. It is common for eel fishers to catch giant kokopu in the lake and outlet stream and the result reported by Schallenberg shows how difficult giant kokopu are to catch. Brown trout have been found in this lake in the past but not in this recent study, probably due to lack of recruitment from the sea (the catchment is considered unsuitable for trout recruitment). As for the Kaihoka Lakes, the lack of trout in these lowland lakes confers added ecological significance as their food webs and native aquatic fauna are unaffected by trout, which is not common in New Zealand.

4.3.3 AORERE CATCHMENT, NEAR COLLINGWOOD

Mackay Creek, tributary of Kaituna River, Aorere catchment

Mackay creek is small, has over 80% of the catchment in intensive pastoral land use and although it has relatively poor water quality, its lower reaches provide good fish habitat and contained LFE, SFE, CB, RFB, and I. Daily minimum dissolved oxygen was very low in the mid reaches (Collingwood-Bainham Rd) at 20-30% saturation but improved to 60% at the downstream site. High concentrations of nutrients are evident from dominant filamentous algal blooms throughout the middle and lower reaches as well as downstream of the confluence of Kaituna River. High levels of *E. coli* indicate a source of effluent or stock defecation in the waterway.

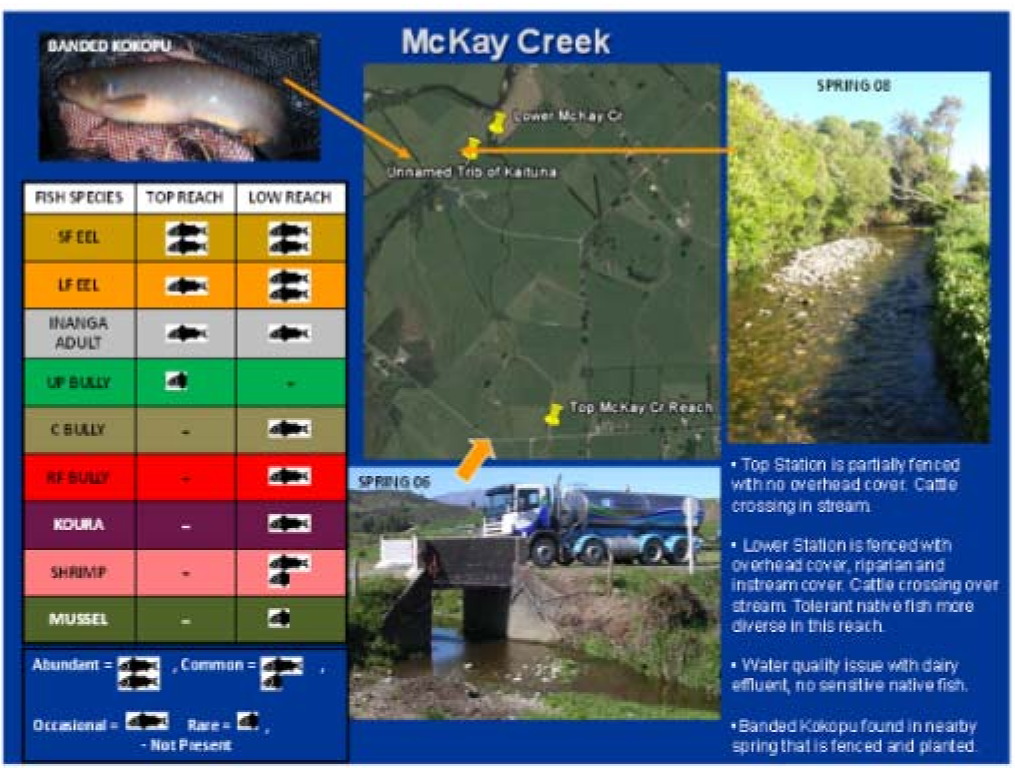


Figure 42: McKay Creek fish types, abundances and monitoring information.

The top survey reach at Collingwood-Bainham Road is characterized by adjacent dairy pasture with partial riparian fencing and no overhead cover. There was a cattle crossing immediately upstream of the station at the time of the surveys (now removed). Native fish diversity was low in spring 2006 and summer 2008 consisting primarily of species tolerant to poor water quality conditions (i.e., longfin and shortfin eels,inanga).

The lower survey reach near the Kaituna River confluence also flows through dairy pasture but is completely fenced with native and exotic trees providing shade and cover on the true right bank. A discharge of dairy effluent was noted at the time of the spring 2008 investigation. Unlike the upper station, a cattle crossing was culverted. This reach was well represented by the tolerant native fish species as identified above, but also contained common bully, redfin bully, koura, shrimp, and freshwater mussel. No habitat-sensitive native fish species were recorded. A small spring tributary of the Kaituna River that ran adjacent to the lower McKay reach was both fenced and planted with native vegetation. Longfin eel and very large adult banded kokopu were common in this tributary. These results indicate that water quality is very likely to act as a limiting factor to habitat-sensitive native fish occurrence.

James Cutting and Dall Creeks

James Cutting and Dall Creek are two tributaries of the Aorere River that enter on the true left approximately 800m and 850m (respectively) east of the Collingwood - Puponga Road. Both catchments have historically contained a connecting wetland complex, however only small remnants exist today. Both waterways meander through open converted pasture, most of which is fenced close to the stream margins. The waters are tannin-stained and have good in-stream habitat provided by undercut banks and good pool-run ratios. Surveys on both streams were conducted in spring 2006 and summer 2008 at the Collingwood - Bainham Road bridge crossings.

The results indicate that native fish diversity is the same at both sites with representation of three water quality tolerant species; longfin and shortfin eel and inanga. The two surveys also included a reach of James Cutting 300m downstream of the bridge where the stream entered a dense area of native bush with deep pools and undercut banks. This habitat was considered ideal for the sensitive banded kokopu but only longfin eel and inanga were observed.

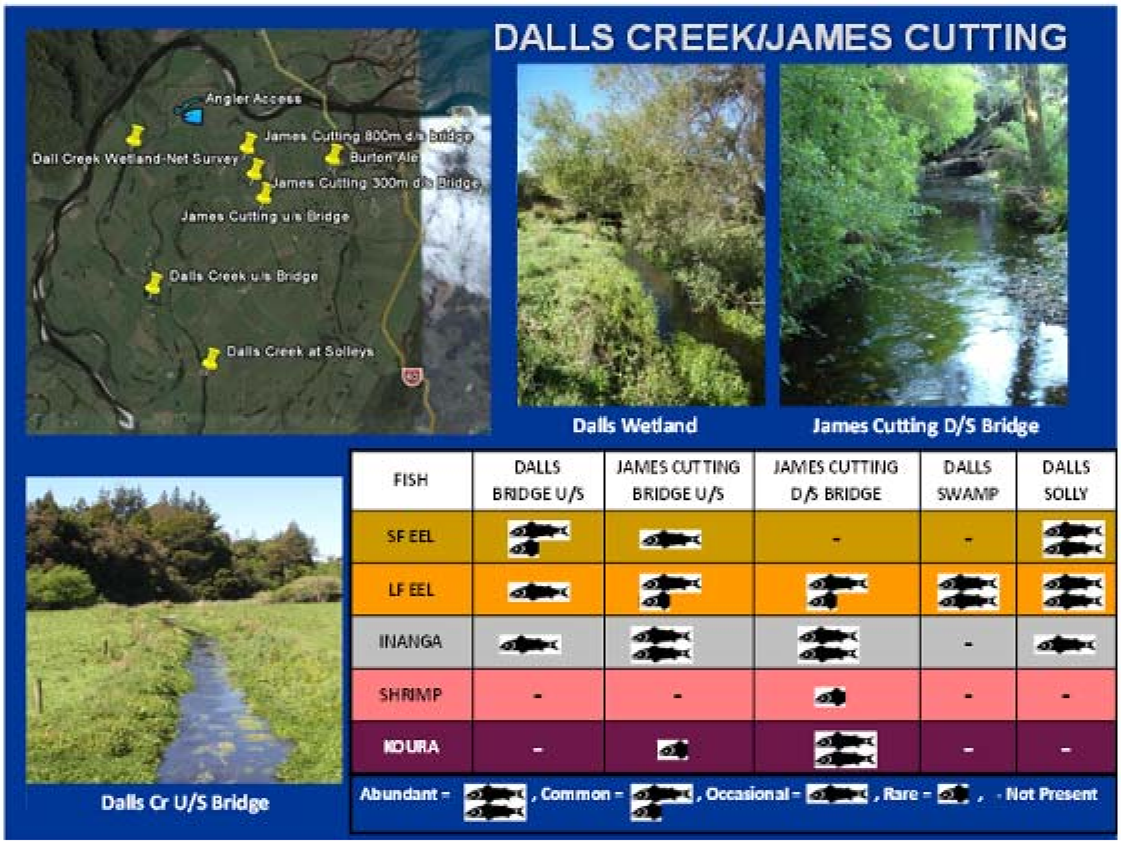


Figure 43: Dalls Creek and James Cutting fish types, abundances and monitoring information.

Giant kokopu habitat was sampled with large fyke nets in lower Dalls Creek (2008). This was a very deep willow lined channel flowing out of a wetland. Only an abundant number of large longfin eel were captured. The presence and abundance of inanga in both mid reaches of these streams suggests that there are no barriers to fish passage. The reasons for the absence of habitat-sensitive native fish diversity in optimum habitat conditions, such as in Dalls Creek are unknown but may be in response to water quality. James Cutting Creek has particularly high conductivity at times and moderately high conductivity and sulphate concentrations were found in Dall Creek (see Appendix 5). More analysis is needed in this regard.

4.3.4 Coastal Streams between Aorere and Takaka Rivers

Parapara River

The Parapara catchment has relatively low abundance of fish but has a similar diversity of species (I, LFE, Ko, BK, SJK and RFB) to that observed in other similar streams within Golden Bay (Barrier and Davey, 2004). The river is characterised by inanga/banded kokopu habitat in the lowest stream bed gradient section of the river (Studholme 1999), grading to banded/shortjaw kokopu habitat in the intermediate stream bed gradient section immediately below the gorge outlet and finally changing to koaro and longfin eel habitat within the higher stream bed gradient gorge section. Fish abundance was highest within the 500m intermediate-gradient reach immediately below the gorge outlet and lowest in the lower gorge (Barrier and Davey, 2004). Low-moderate numbers of SJK (0.0025 fish m^2) were found in the reach below the gorge and low numbers of LFE and KO within the gorge, probably due to the high stream bed gradient. The density of koaro located in favourable run/riffle habitat above the dam and gorge is over three times higher than the density of koaro located in favourable run/riffle habitat within the gorge itself. Density of juvenile longfin eels is slightly lower in favourable run/riffle habitat within the gorge than in favourable run/riffle habitat above the gorge.

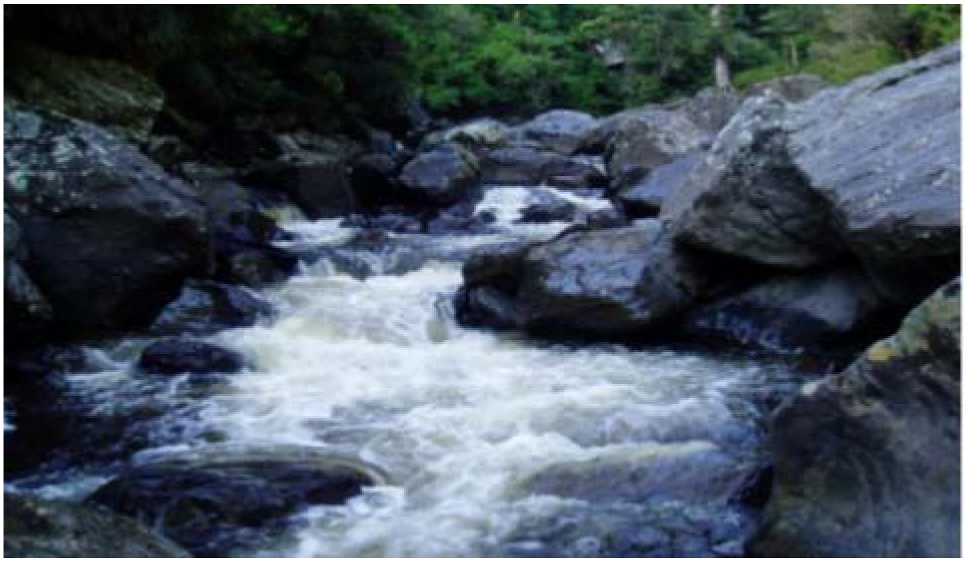


Figure 44: Typical terrain encountered in the lower gorge of the Parapara River

Little Kaituna Stream, north of Onekaka

Figure 45: Little Kaituna Stream with the remnant forest reach and the straightened fenced reach

Where the lowland reaches of Little Kaituna Stream flow through a remnant section of podocarp forest with original meanders, a relatively diverse and abundant fish community exists (RFB, BK, I, LFE, SFE). In an adjacent reach that has been straightened, fenced and has overhanging grass as riparian vegetation, only a few eels and on one occasion several banded kokopu were found. Freshwater mussels were found in the soft-bottomed sections this stream just upstream of SH60.

Onekaka River
Monitoring of fish, invertebrate and habitat conditions of the Onekaka River and tributaries has been undertaken as a requirement of resource consent conditions for the Onekaka Hydro-electric power scheme that utilises a dam built in the 1930's. Heavy fine sediment deposits were found in the stream in 2003 as a result of sediment being cleared from behind the dam.

A rich fish community exists in the catchment (TF, Ko, RFB, BGB, LFE, SFE, BT, Ka). Although fish numbers were lower in 2005 than in 2003 or 2004, fish monitoring will have to be continued for at least another year before a meaningful time trend can be determined (Stark 2005). The current monitoring programme is insufficient to determine whether there have been any effects of the power scheme or natural floods or fish passage past the road to Shambala.

The lower reaches of this river have good water quality apart from moderate levels of fine sediment in the bed of the river at times. Invertebrate communities are very diverse (20-31 taxa).

Figure 46 Onekaka River at the lower site at Shambala ford (top left) and at the upstream site at Ironstone Ck (bottom left), typical sediment plume from kicking in the stream bed (right).

Puremahaia River

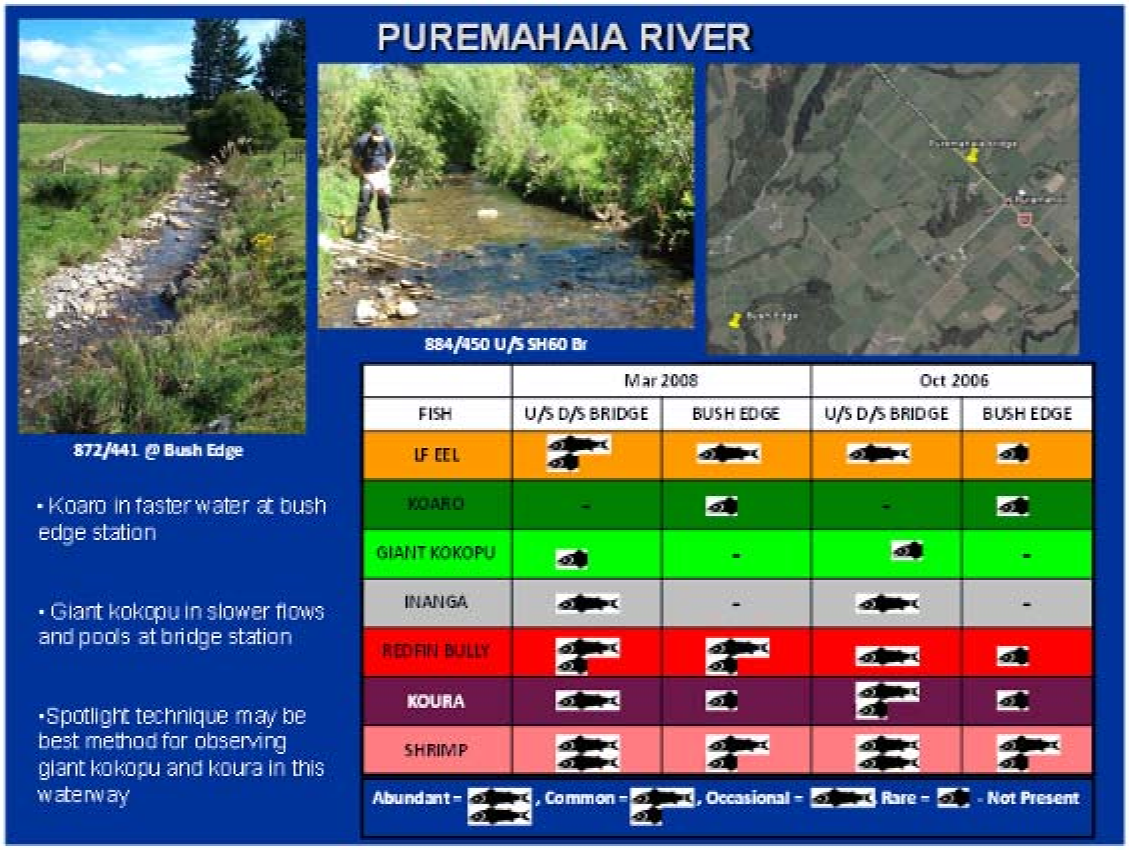


Figure 47: Puremahai River fish types, abundances and monitoring information

The surveyed reaches on the Puremahia River provide an example that slight habitat modification does not lead to significant change in the fish species likely to occupy the site. Both of the sites sampled (u/s d/s Bridge and Bush edge) contained natural meanders, good canopies of native riparian trees, good substrate and flow diversity but slightly channelized streambanks at the lower site. The in-stream habitats were naturally different at these sites (ie steeper and shallower at the upstream sites) and species composition reflected this. Habitat-sensitive native species like koaro was found in the faster water at the Bush edge site. Banded kokopu were observed at this site in 1993, but not since. Giant kokopu occupied slower habitats with pools both above and below the bridge in 2006 and 2008. Water quality sampling showed good conditions for aquatic ecosystems in this waterway.

4.3.5 SMALL CATCHMENTS NEAR TAKAKA

Motupipi Catchment

Inanga are abundant in the Motupipi catchment (near Takaka) in spring and summer. Sampling carried out in spring 2006 and summer 2008 found a similar assemblage of fish to sampling carried out in winter 1992 and spring 1996 (Deans, N; 1996). In these earlier studies, the river was subject to regular discharges from the Takaka milk factory which may have affected the abundance of fish. During early mornings in summer dissolved oxygen concentrations at several sites in the spring-fed main stem regularly fall to about 30% saturation due to prolific growth of aquatic plants. It is not known how fish survive these very low dissolved oxygen levels. High nutrient concentrations (nitrate concentrations regularly >1.7g/m^3; average 1.25g/m^3) and high fine sediment bedloads (average of 300mm on top of a cobbly bed) issues affect this catchment (James, T; 2007). The sedentary and non-migratory redfin bullies were found only in one riffle. Their survival here is likely to be due to significant re-aeration provided in these areas. Previous studies also found redfin bullies in this same location (Deans, N; 1996). Giant Bullies were also found in this earlier study but were only found in Powell Ck in 2008.

Daily ecosystem respiration calculated during the period 2006-10 reflected poor ecosystem health, which explains the extremely low dissolved oxygen concentrations observed in this stream, while gross primary production was satisfactory to poor (Young, et al; 2010). The cover of filamentous green algae in the Motupipi River regularly covers 70% or more of the bed. Macro-invertebrate condition was mostly poor or very poor in this catchment.

Shortfin and longfin eel numbers throughout the catchment were high on each sampling event. They were high even considering that there was a commercial harvest in the weeks prior to undertaking the 2006 survey (attempts to obtain data on eel catches were unsuccessful). Shortfin eel were particularly abundant in the small grass-edged tributary streams. Good giant kokopu habitat (i.e., deep slow-flowing pools with lots of riparian cover) exists in the section of mature nature forest adjacent to Sunbelt Crescent, but none were found at this location.

Berkett Creek

Figure 48: Berkett Creek downstream of the wooded section (left) and within the wooded section (right).

Berkett Creek is a small hill-fed stream in the eastern part of the Motupipi catchment, which harbours about 150-200m of very good stream habitat in the mid section (over 80% shade by woody vegetation, large and deep residual pools and good in-stream cover provided by woody debris and undercut roots). The average width in the mid-section was over twice that of the lower section, indicating the importance of stream fencing and riparian vegetation. Adjacent sections of this waterway were heavily trampled by cattle and flowed through grazed pasture in the lower and upper sections of the waterway. Unexpectedly, there were no habitat-sensitive native fish found in the mid section. This could have been due to a potential fish barrier downstream of the site or poor water quality arising from upstream. Further surveys would be necessary to understand the reason for this.

The pest plant, *Glyceria maxima*, is found in Powell Creek upstream and downstream of the confluence of Berkett Creek. This is a serious threat to inanga (and habitat-sensitive native fish if they were present) due to the plant's ability to extensively 'choke up' the waterway by limiting the available 'space' in the stream. Eels are expected to be unaffected by this situation as they are known to 'burrow' into these weedy areas. The plant has been sprayed several times but continues to re-grow. Other spray strategies are being trialled.

Te Kakau Stream

Te Kakau Stream is spring-fed and also has very low summer-time dissolved oxygen in sections dominated by prolific growth of aquatic plants, similar to the main stem of the Motupipi. Inanga were found in reasonable numbers in this waterway in spring when dissolved oxygen concentrations are acceptable (ANZECC, 2000). One banded kokopu was found in a section of waterway well above the weedy reaches in an area considered very good stream habitat for this species (i.e., shade and cover provided by willows).

Ellis Creek

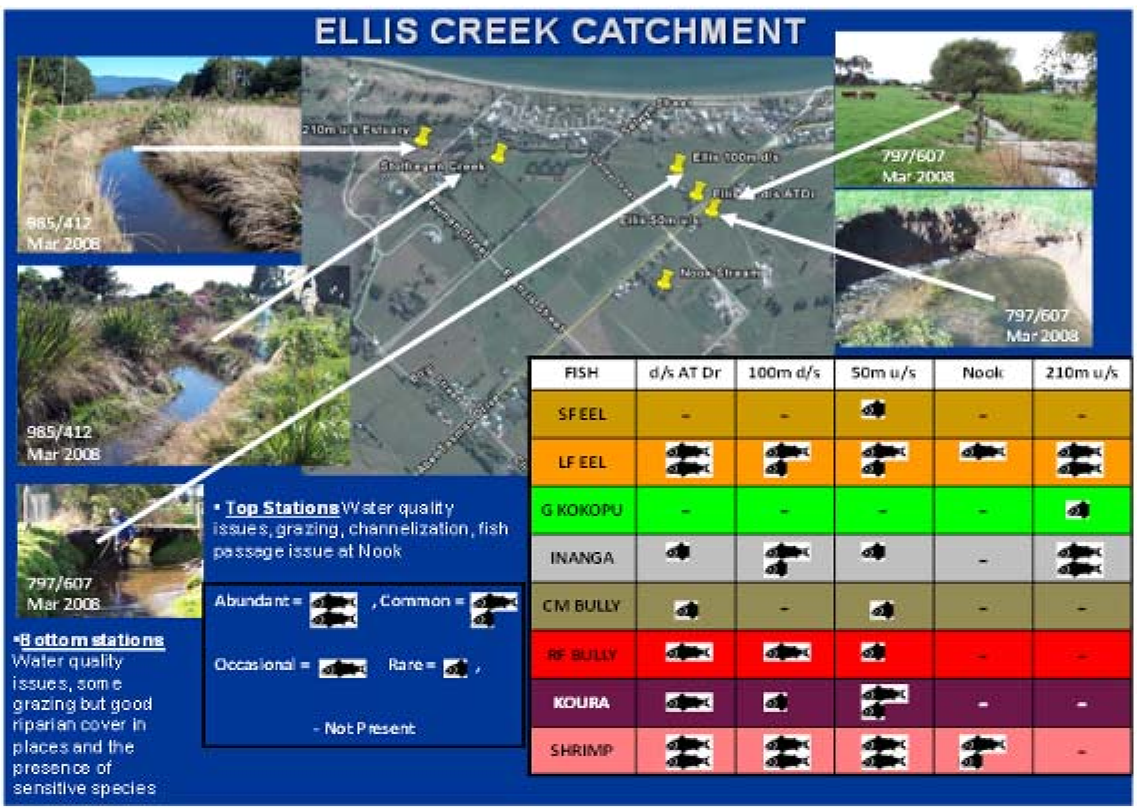


Figure 49: Ellis Creek Catchment fish types, abundances and monitoring information

Ellis Creek is a lowland-fed, low-gradient waterway near Pohara that flows into the eastern arm of the Motupipi estuary. Giant kokopu was found at the 210m u/s site. Much of the lower part of the stream and tributaries have been straightened and restoring these lower parts by adding meanders and natural substrate could provide considerable improvements in habitat value for giant kokopu. One landowner in the lower reaches has already undertaken significant works to enhance habitat for this species.

4.3.6 TAKAKA CATCHMENT

The Cobb power scheme dam

The Cobb Power Scheme has both positive and negative effects on the river ecosystem downstream (Young, 2003)

- Positive effects from the Cobb Power Scheme are that the parts of the Takaka River that naturally lose water to the underlying aquifer downstream of Lindsays Bridge are dry for a reduced amount of time. The scheme results in flows returning to this reach more than once a season compared to probably only one drying event prior to the operation of the scheme. The likelihood of stranding of fish on the second drying event in a season is low as fish are not drawn to this reach due to the lack of food.

- Negative effects include:

    - Water quality is poorer (4^{o}C warmer in summer, lower clarity and higher concentrations of dissolved organic carbon, and dissolved iron and dissolved manganese) downstream of the discharge from the power station compared to upstream.
    - Migration of longfin eels and koaro is obstructed by the dam and a section of the Cobb River is dewatered. In the absence of recruitment, the remnant population of longfin eels in the Cobb Reservoir is not sustainable and will eventually disappear (Young, 2003). The transfer of elvers (young eels) into the Cobb Reservoir could maintain the eel population. However, growth rates within the reservoir are likely to be very slow due to the large variation in water level and poor food supplies (Young et al*.* 2000b) and therefore the potential for the reservoir to become a productive eel fishery is limited.
    - During an average year of stream flows, predicted loss of stream invertebrate habitat from flow fluctuations of 10m^3/sec (actual is 7.5m^3/sec) compared to a hypothetical constant median flow is 30%, trout spawning habitat is 55-60%, trout fry is 25-50% and suitable native fish habitat is 10-70%. During a dry year these habitat reductions will be even greater. Whether these predicted reductions translate to a direct effect on fish and invertebrates is not clear. There is evidence that flow fluctuations have a large effect on the density and diversity of the invertebrate community. Actual brown trout abundance at Harwoods is lower than predicted by the '100 Rivers' model (Young et al. 2000b) and appears to have declined (see Figure 50). Possible reasons for this include the appearance of thick and extensive cover of *Didymosphenia geminate* in 2007 and the daily/weekly flow fluctuations as a result of power generation.

The fishery in the Cobb Reservoir is based on both brown and rainbow trout. These fish are relatively small and appear to be food limited. The presence of rainbow trout in the Cobb Reservoir and the upper Cobb River relies on the presence of the reservoir. Trout abundance downstream of the Power Station is below average compared with other rivers around the country (Young et al 2000b). Suitable habitat appears to be limiting in the constrained reach around Harwoods, while the drying zone and its effects downstream of Lindsays Bridge are the most likely reasons for the low numbers there. Interviews with local anglers indicated that large sea-run trout are an important component of the fishery and may be vital for maintaining reasonable fishing in the drying zone during periods when the drying zone is inundated.

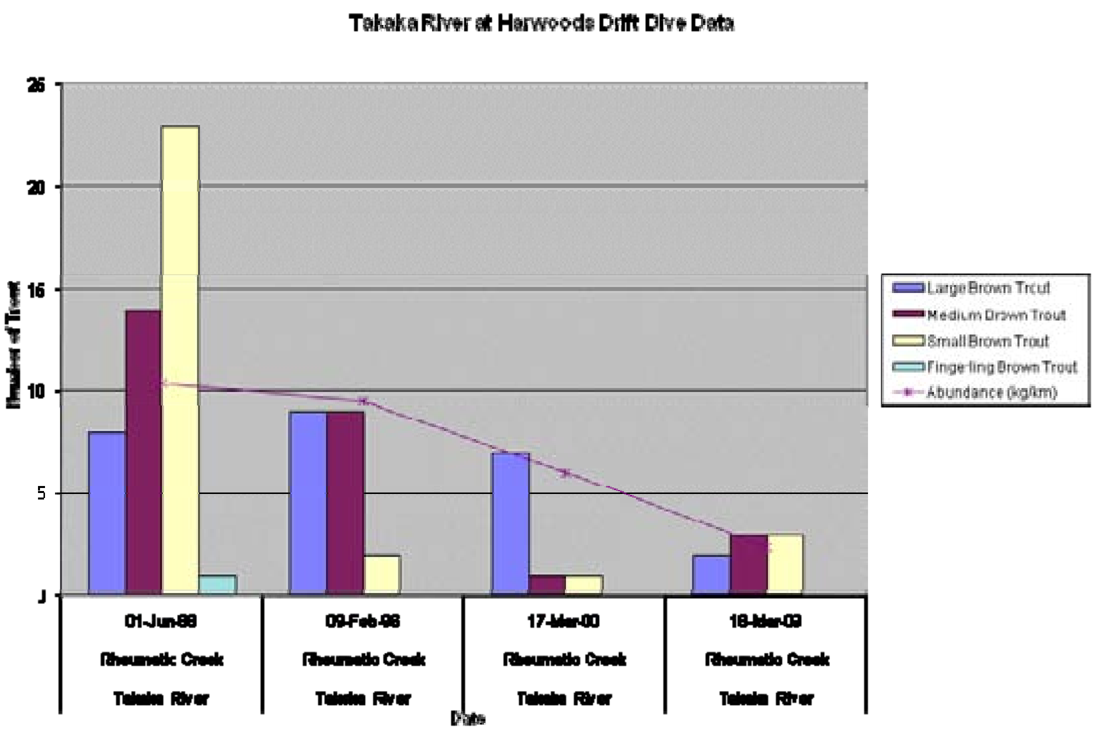


Figure 50: Brown trout drift dive data for the Takaka River at Harwoods for the years 1988, 1996, 2000 and 2009.

While most information known about this catchment is related to trout, two significant points about the Cobb Reservoir is that the lake and catchment upstream supports a self-sustaining landlocked population of koaro. Unfortunately, due to the restriction on fish passage due to the power scheme eels in the catchment are likely to disappear.

One Spec Creek

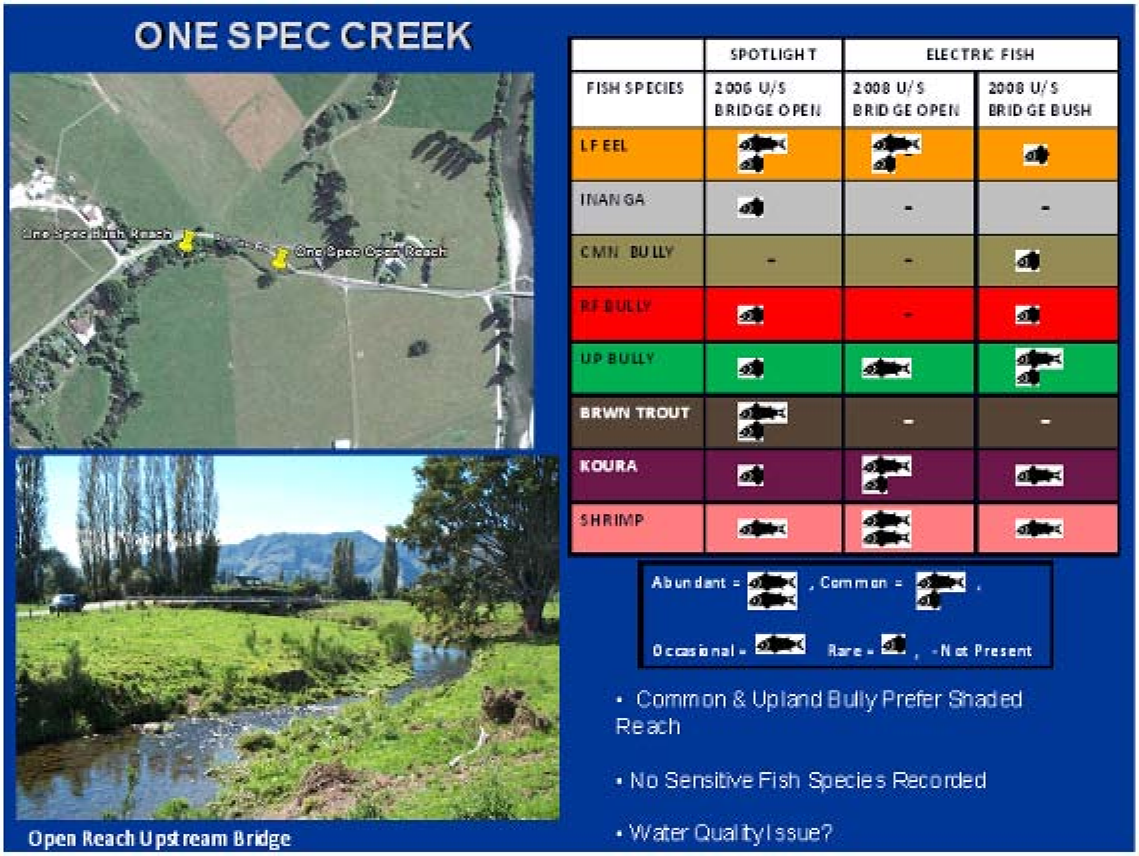


Figure 51: One Spec Creek fish types, abundances and monitoring information.

One Spec Creek enters the Takaka River on the true left opposite the village of Takaka. The stream flows intermittently in the lower reaches but residual pools persist. This situation is likely to affect brown trout and inanga movements. Surveys above the One Spec Road Bridge employed two techniques with spotlighting in spring 2008 and electric fishing in summer 2008. The summer survey also compared an open reach to another 50m upstream that was encased and shaded with bush. Common and upland bully had preference for shade and cover but eel abundance in the 300-400mm size range was greater in daylight open water where the bed contained large cobbles and woody debris.

Waitui River

A survey was undertaken in 2010 to determine the freshwater fish significance of this medium order waterway that drains out of the western flank of the Arthur Range to its confluence with the Takaka River catchment near Upper Takaka Village. The investigation was in response to an application to take water for hydroelectric power generation and pasture irrigation. A combination of electric fishing and spotlighting techniques were employed in the middle and upper reaches of the stream, as well as in the reach between the locally known “Sheep Dip” waterfall and the Waitui Forks where foot access is particularly difficult. Native fish and brown trout were observed and/or captured in the middle reaches below the Sheep Dip waterfall (see Figure 52). The 2001 survey was conducted by DoC and found redfin bully that was not found in the 2010 surveys. No fish were observed in the survey station upstream of Sheep Dip waterfall despite excellent weather, water clarity and conductivity conditions. Especially noticeable was the high macroinvertebrate diversity and density in the Waitui Stream from Sheep Dip waterfall upstream. Fish appear to be absent in these areas of high macroinvertebrate abundance.

Limiting factors that contribute to freshwater fish density and diversity in the Waitui Stream are considered to be the distance from sea for migratory native fish. The 2.5km reach of ephemeral summer flows between the proposed intake structure and Takaka River and the numerous natural vertical and velocity barriers from Sheep Dip waterfall to the rivers source are likely to limit upstream fish recruitment.

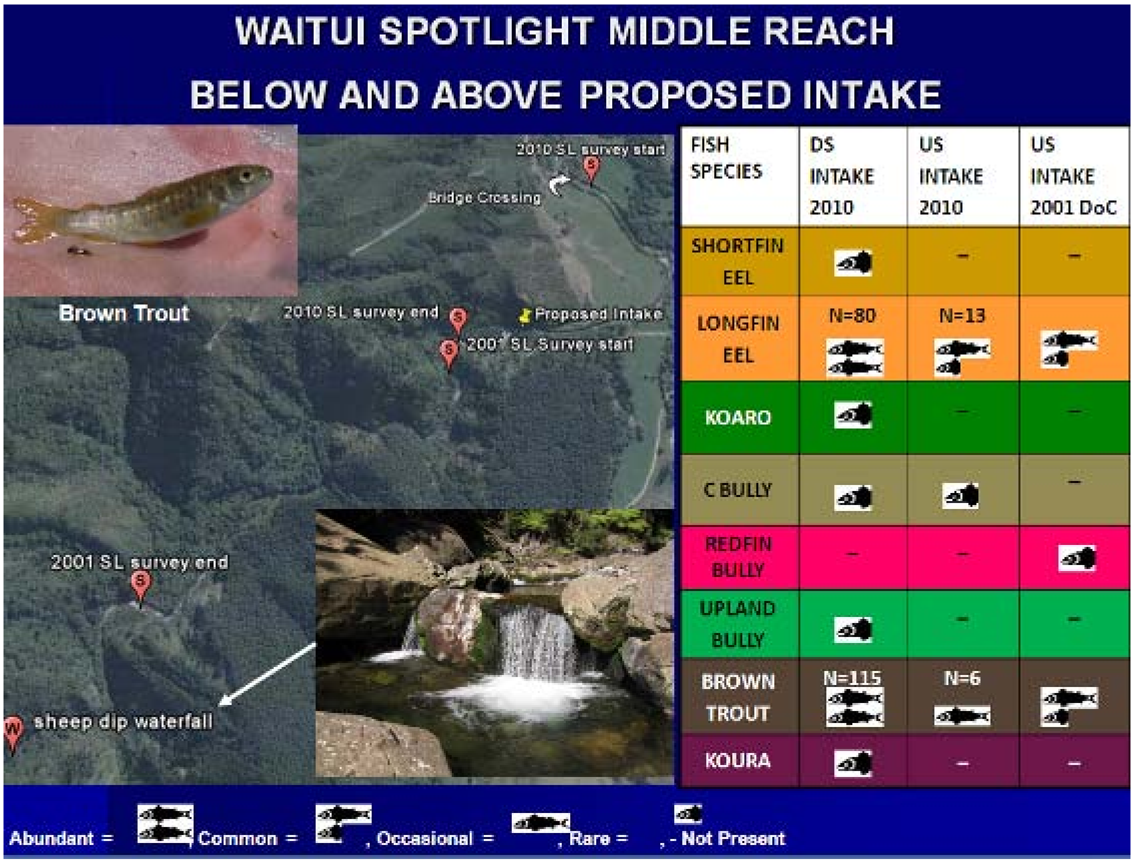


Figure 52: Waitui Middle Reach above and below proposed intake fish types, abundances and monitoring information

4.3.7 STREAMS OF ABEL TASMAN NATIONAL PARK AND WAINUI BAY

Figure 53: Wainui River 1Km upstream Abel Tasman Dr

Within the streams of the park and nearby native forest areas reside relatively high numbers of longfin eel, koaro, banded kokopu and shortjaw kokopu (Studholme, 1999). Koaro typically inhabit the upper high-gradient reaches, banded kokopu the smaller streams and shortjaw kokopu the areas of gradient change between the steep and flatter reaches.

Wainui Bay, Eastern Golden Bay

Like many streams in Abel Tasman National Park, a diverse and abundant fish population is found in streams flowing into Wainui Bay. Wainui River itself has a reasonably high diversity (9 species) with the presence of shortjaw kokopu common. Abundance of most of these species was higher in the lower gradient sections of the stream (particularly upstream and downstream of Abel Tasman Drive).

Figure 54: Anatimo Stream, Wainui Bay and Unnamed stream at culvert 9

Even though the bed of smaller streams in Wainui Bay, like most in Separation Point Granite, is very mobile and potentially limiting invertebrate abundance, summer low flows are relatively high and the quality of habitat in these streams is very good with a mature canopy of native bush over most of the catchment. Even very small streams like that flowing through Culvert 9 (average width of 400mm) support relatively diverse fish populations with banded kokopu being abundant. Relatively few fish were found in stream sections open to disturbance by dairy cattle.

Brown trout were found in the Wainui River upstream of the Wainui Falls (Rhys Barrier, pers. Comm., 2009). This fish population must originate from translocated individuals as they could not have traversed the falls.

Restoration of fish passage barriers (see Chapter 5) in this catchment has made a big difference to the abundance and diversity of fish in several streams in this catchment. Fencing and planting small streams in the lower reaches where they flow through dairy farmland is recommended.

Kaiteriteri Stream

The former waterworks weir on Kaiteriteri Stream is located approximately 1km upstream from the Kaiteriteri Inlet. The stream was surveyed both below and above the weir to establish if the structure was impeding fish passage. Fish observed at both sites are known for good climbing ability (e.g., banded kokopu) and at present the weir is not restricting access for these species.

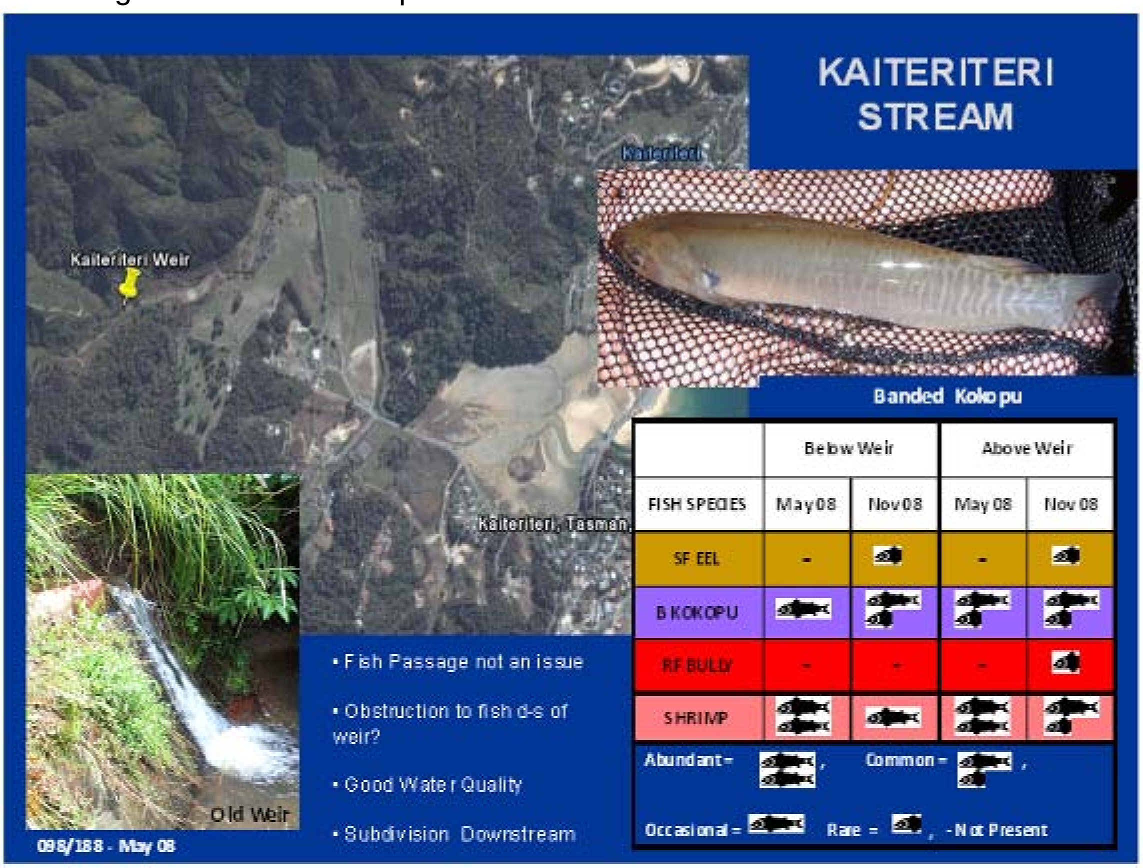


Figure 55: Kaiteriteri Stream fish types, abundance and monitoring information

4.3.8 MOTUEKA-RIWAKA RIVER CATCHMENT

Riwaka River

The Riwaka River is fed by karst springs in the north and south branches, has native bush in the upper catchment and horticulture and pastoral farming in the lower catchment. Both branches were sampled in summer 2010 to determine the status of brown trout recruitment into the sports fishery, which was low. Initially the electric fishing technique was applied to sample the fishery but this did not prove to be effective in this waterway. However, a spotlight survey was much more successful (Table 8) that clearly illustrated the advantage of this technique for the given conditions.

Table 8 Survey method comparison in the Riwaka North Branch

Fish	Electric Fishing	Spotlighting
Brown Trout	Not Present	Rare (N=2)
Redfin Bully	Not Present	Rare (N=2)
Koaro	Rare (N=1)	Rare (N=2)
Longfin Eel	Not Present	Common (N=12)
Koura	Not Present	Rare (N=2)
Shrimp	Not Present	Occasional

The numbers of fish in this waterway are surprisingly low and the reasons for this are unclear. Very few juvenile trout are found in the Riwaka and there is discussion about stocking this river with trout fingerlings. There is good diversity and abundance of invertebrates, so food supply is not an issue. It may be that this river is more susceptible to flooding. In-stream habitat flow analysis in the Riwaka River shows that water abstraction below Haywoods Bridge (1.5km upstream of SH60) may have adverse effects on native fish and brown trout when flows go below mean annual low flow (MALF) (Hayes, 1998).

The Riwaka River is currently the only river in the district that has a minimum flow requirement (set at 400 litres/second). This is achieved by rostering organised amongst the 26 water users in the catchment (J. Thomas, *pers.com.*). Peak demand for water from the Riwaka River not only occurs in summer due to irrigation needs, but also in winter and early spring for frost fighting, to protect developing kiwifruit buds. However, the effect of water takes in winter-spring are likely to be lower than in summer because flows in the river are higher at this time, the water takes are spasmodic and for short duration, and the metabolic demands of fish and other aquatic life will be lower when stream temperatures are lower. However, substantial reductions in flow during winter-spring may have an effect on trout eggs incubating in the bed. Reduced flow could lead to critical reductions in oxygen supply to the eggs while larger reductions could lead to trout redds being left high and dry above the water level. Habitat modelling predictions indicate that flow reductions between May and October to near natural MALF would result in up to 50% reduction in availability of suitable spawning habitat (Young, 2007). However, this prediction exaggerates any effects since natural flow reductions will also affect habitat availability, and spawning habitat suitability criteria used in the model will over-estimate the effect.

Brooklyn Stream

This waterway confluences with Motueka River about 3.5km above the delta with the upper 80% of the catchment in native forest or scrub. In the lower reaches it was found to contain nine species found in the various surveys recorded since 1996 (LFE, SFE, CB, UB, Tt, Ko, Ly, GB and RFB). This puts this stream as having amongst the highest fish diversity of any stream in the district. It is not known why this richness is present here but native bush streams draining to near the mouth of large rivers are often of such high value.

Little Sydney Creek

The upper part of the Little Sydney catchment is moderate-gradient hill-fed with native forest cover. The lower part of the catchment which was a large flax swamp has been channelized into straight sections adjacent to roads with the channel cross-section being very uniform (trapezoidal) with little variety of substrate and depth zones.

Although fish survey was not undertaken in the upper part of this waterway as part of this programme, fish models (Leathwick et al. 2008) predict that this waterway has high fish values in the upper catchment (SJK and Ko "reasonably likely", and BK "very likely"). In the lower, lowland part of the waterway (Little Sydney Road and near the Factory/Swamp Road intersection) relatively few species were found for a lowland stream (LFE, SFE, I, CB). In addition, a few trout and giant bullies were found on one occasion.

Water quality for ecosystem health is generally good, although levels of fine sediment in the bed is moderately high.

It is very likely that any restoration efforts will succeed in improving fish diversity and abundance (it could be prime giant kokopu habitat). The reason for this is that the waterway is permanently-flowing with relatively high base flows, low gradient, and proximity to the coast, as well as having good water quality for fish and invertebrates. Water quality information has been gathered for this waterway since 2000. Although there is a tidal flap-gate on the bottom of this waterway, it is obvious that many fish are passing through this structure. *Gambusia* (mosquitofish) control (using Rotenone) has been undertaken by Department of Conservation in farm ponds in this catchment.

Ferrer Creek

Ferrer Creek is a small groundwater fed waterway that flows into Tasman Bay between the Riwaka and Motueka Rivers. The creek was sampled in the summer and spring 2008 above the tidal flap gate upstream of School House Road. Three water quality tolerant native fish species ranged in abundance from occasional to abundant. The density of inanga whitebait and adult indicates that the tidal flap gate is not a barrier to fish passage. Habitat conditions for fish in the survey section are good and diversity was expected to be higher. Water quality may be a limiting factor. There is an opportunity to enhance water quality by extending the periods that the floodgates are open thus providing better flushing. Given the low gradient and proximity to the coast tree planting could provide ideal habitat for giant kokopu, if water quality issues were first addressed.

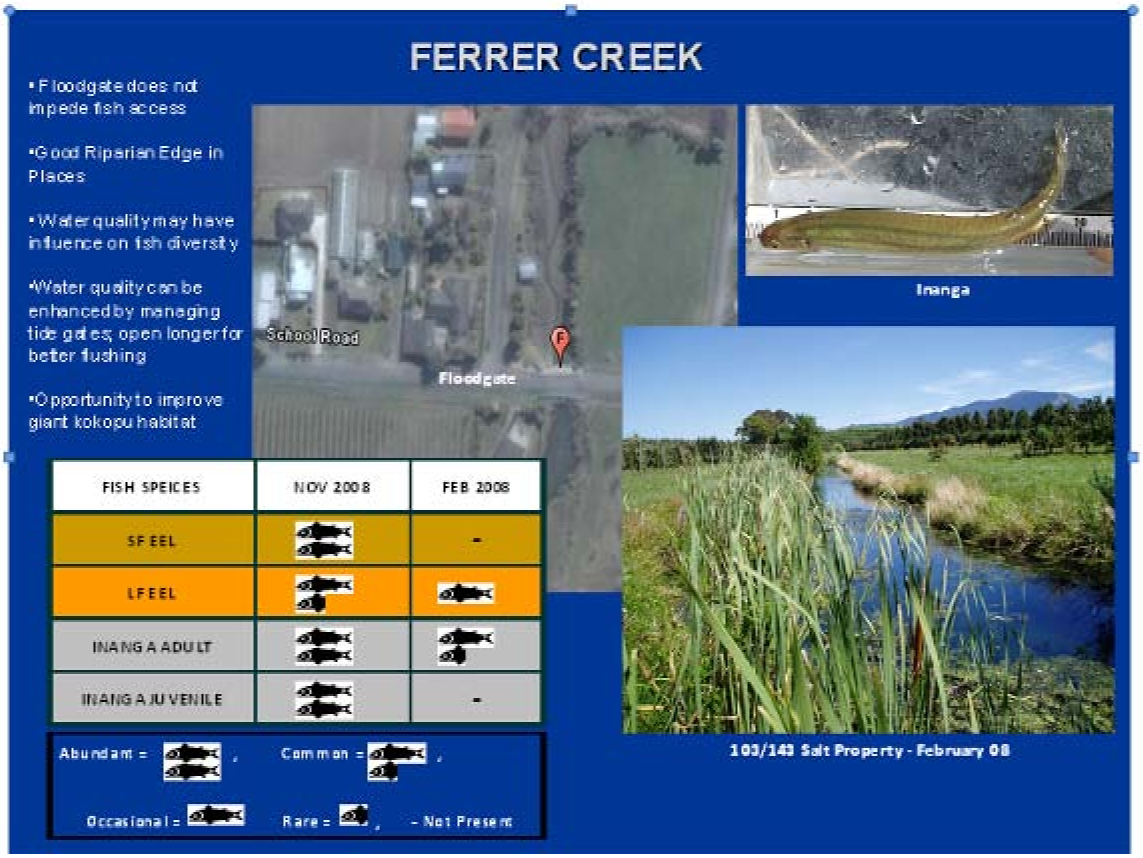


Figure 56: Ferrer Creek fish types, abundance and monitoring information

Dove River

Fish passage was also examined on the Dove River in December 2006 below, in between, and above two concrete fords that may have an influence on fish passage. All of the fish species observed in the river were more highly represented in the upper sites. It is most unlikely that the fords are preventing access for trout, upland bullies and eels. Torrentfish, lamprey and smelt that have been recorded in previous surveys, were not observed in this investigation. It is not known if the concrete fords present a barrier for upstream migration for these species, however given they were previously recorded in the river, the season flow fluctuation may be a bigger barrier to recruitment for some species than the fords.

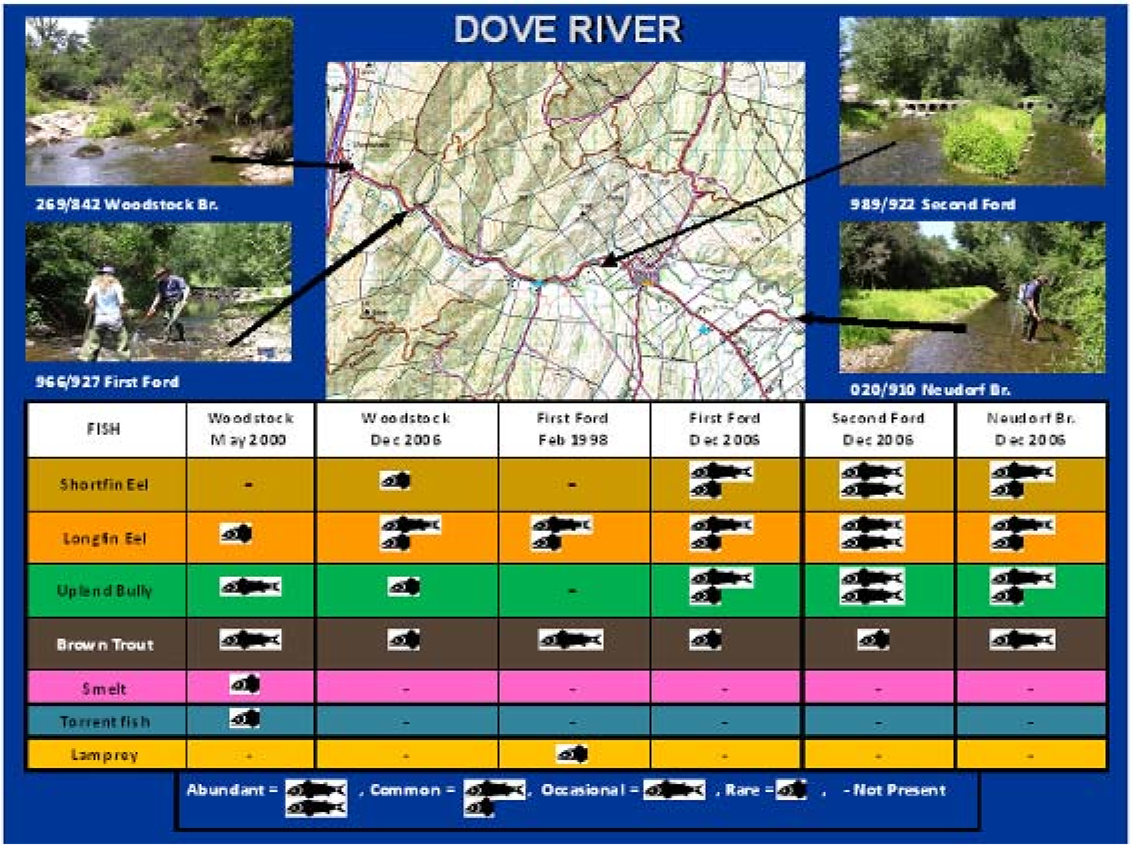


Figure 57: Dove River fish types, abundance and monitoring information.

Humphrey Creek

Humphrey Creek in the Dove catchment is a water-supply catchment with mostly native bush. A fish survey upstream of the intake weir was undertaken as part requirement of the resource consent for the water take and associated intake structure. This creek is mostly in Separation Point Granite geology and therefore has relatively high summer base flows. The notable result from this survey was the number of mature redfin bullies, a species that is usually not common in the Motueka catchment. The presence of brown trout and redfin bullies upstream of the weir suggests that at certain flows, fish passage is provided at these structures. The conditions of the renewed consent requires modification of the structure to provide better fish passage.

Waiwhero Creek

This small Moutere hill-country stream flows into a wetland, not far from its confluence with the Motueka River downstream of Ngatimoti. Giant kokopu have been found in the stream/wetland complex and at Waiwhero Road. Earlier records show that upland bully are also present in this waterway. Anecdotal evidence suggests that during summer there is less water in the wetland since the Paratiho Dam was installed in the catchment.

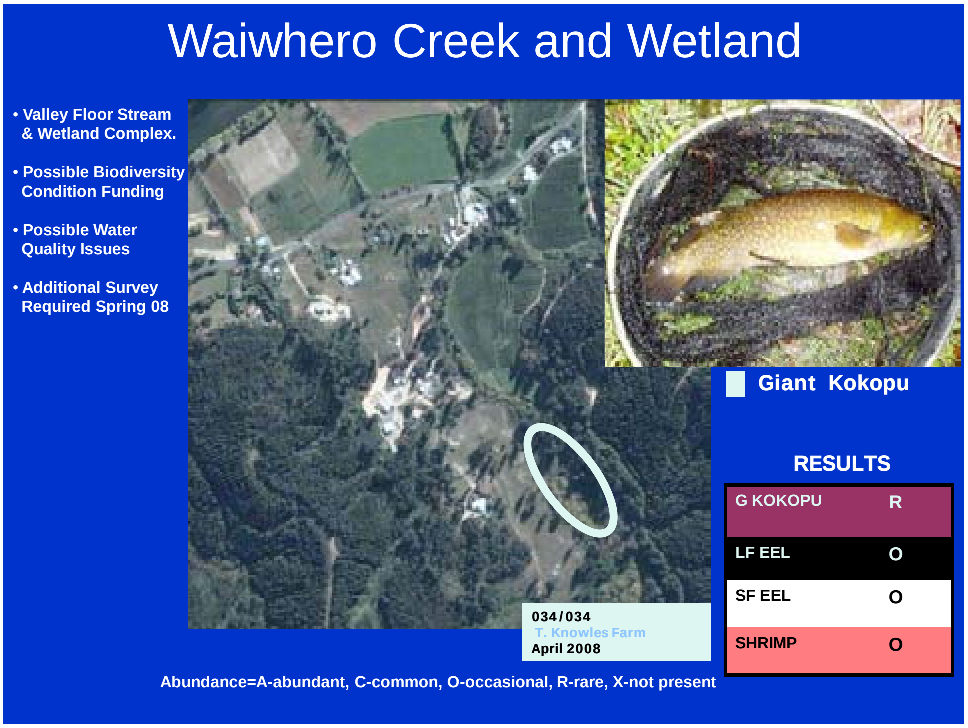


Figure 58: Waiwhero Creek and Wetland fish types, abundance and monitoring information

Trout in the Motueka Catchment

Trout values have been recognized with a Water Conservation Order covering much of the Motueka catchment. In many parts of the Motueka catchment, geology, vegetation cover and climate combine to create river channels and flow patterns that provide excellent habitat for trout. Teirney & Jowett (1990) found that trout density in the Motueka River was 5th highest of the 158 river reaches included in their study, and was only exceeded by reaches within lake outlet rivers such as the Buller, Hurunui and Gowan. Abundance ranged from 40 - 192 adult trout per km.

The river channel of the Motueka River downstream of the Wangapeka confluence is mostly confined and U-shaped, which is known to provide plenty of deep, moderately-flowing water preferred by adult trout. The headwater fishery in the Wangapeka River is rated highly and fishes well at the beginning of the season.

Much of the Motueka catchment comprises hard rock or glacial gravels which provide coarse gravel and small cobble substrates, ideal for trout spawning, and larger cobbles and boulders that provide plenty of structure for trout living habitat. These coarse substrate elements are essential ingredients of good trout rivers other than spring creeks and lake outlets. However, Separation Point Granite in the central catchment and across the lower parts of most of the west bank tributaries, erodes readily into fine sand when the vegetative cover is removed. Large quantities of fine substrate are detrimental to trout populations and represent a potential threat to the trout fishery especially in respect of future exotic forest and replanting operations in this area.

However, the extensive native forests in the catchments of the western Motueka tributaries are likely to have a mitigating effect on sedimentation during floods and base flow conditions and produce waters of good quality (e.g., median visual water clarity in the Wangapeka River is 6m). Higher, sustained base flow and clear water are key factors in maintaining adult trout habitat over the low rainfall period in summer (Young et al. 2005).

In the Motueka River at Woodstock the mean annual water temperature is 13 ^{o}C, the optimum for brown trout growth. Trout in the mid and lower reaches of the Motueka can grow all year round as winter water temperatures do not fall below 4^{o}C, the temperature below which trout growth stops. Even in the upper reaches winter water temperatures seldom fall below 4^{o}C.

In the mid-late 1990's the brown trout numbers in the Motueka River plummeted and stayed low for five years prompting concern in the fishing community (Figure 59). The reason for this was attributed to a series of moderate-sized floods during the early and mid 1990's during the critical trout fry emergence period in key spawning streams (Young et al. (in prep)). This reduced several cohorts of the trout population.

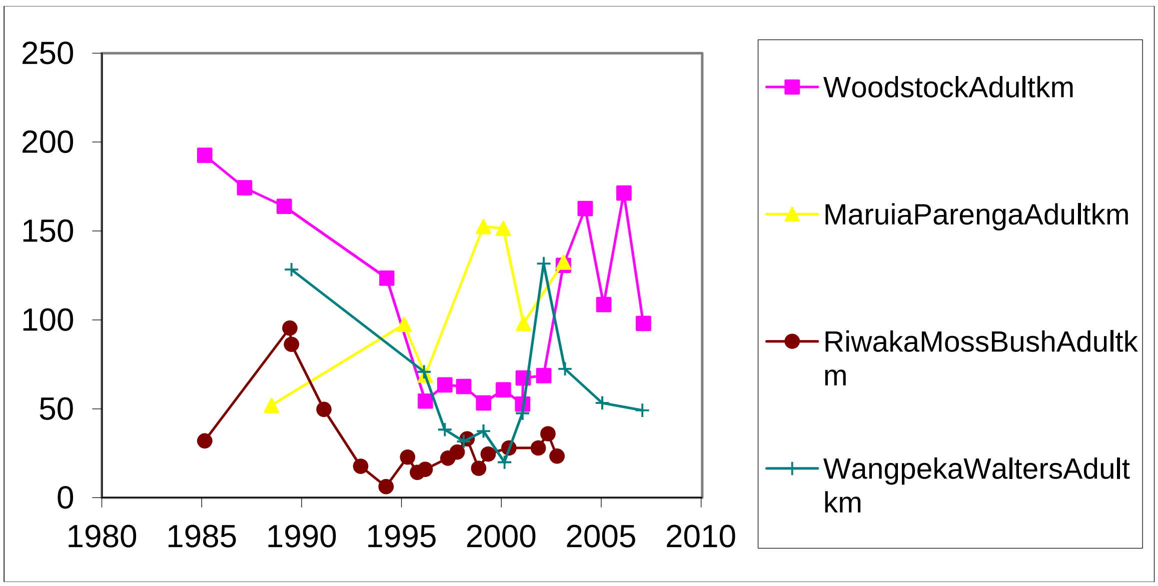


Figure 59: Trout numbers from drift dive data collected by F&G between 1985 and 2007.

There are relatively few barriers to fish passage in the Motueka catchment. The removal of a ford in the Baton River in the late 1990's lead to a doubling of trout recorded upstream (Hayes, 2002).

The Effects of Floods in the Motueka Catchment

An extensive multi-year study on the Rainy River, a tributary of the Motueka that is important for trout spawning, showed that a large flood (50-year return period) substantially reduced trout density (by 66%) and biomass (by 73%) (Hayes et al. 2010). However, the cohort responded with compensatory survival to achieve similar density and biomass within 6 months.

The effects of floods on trout populations of the Motueka River were found to be extensive, and over-ride human induced land use factors (Young et al. (in prep)). The magnitude of the largest flood recorded at any stage in the trout's life, at any time of the year, can have an important impact on trout population dynamics. A severe, 50-year flood occurred in the Motupiko Catchment in March 2005 and was associated with mortality of 60-70% of tagged fish in the Motupiko River prior to the flood, confirming that flood-induced mortality can affect a substantial proportion of an adult brown trout population (Young et al. 2010b). Similar mortality was recorded for juvenile and adult fish. The greatest mortality was in the Motupiko catchment due to higher bed load movement.

The Effects of Low Flows in the Motueka Catchment

Several studies have predicted the effects on in-stream trout habitat in the Motueka from flow reductions (e.g. using In-stream Flow Incremental Method (IFIM) models; Hayes, 2002). A low flow event (return period >8.4 years) when flows fell to 56% of the 7-day mean annual low flow (MALF) was found to have no effect on the trout population in the Rainy River (Hayes et al. 2010). This shows that minimum flows equivalent to MALF (often advocated by resource management, conservation and fisheries management organisations) are not always necessary for sustaining juvenile trout populations, at least in this situation.

Olley et al, (in review) studied the otoliths of 48 adult brown trout in the Motueka River to find matches between tributary fingerprints and the main stem. Of these 48, 29 fish were able to be traced to a particular catchment: 10 appeared to have originated from the Baton, eight from the Dart, seven from Blue Glen, two from the Rainy, one from the Motupiko, one from the Upper Motueka, and none from either the Graham, or the Upper Wangapeka (Figure 60). Water samples taken from the Pearse and Pokororo rivers suggest no signs of significant recruitment from these tributaries either.

Water samples from the Sherry and Dove tributaries also suggest a limited likelihood of brown trout contribution; both of these tributaries are small lowland streams with significant rural activity and most importantly, seasonally dry conditions, so this is not surprising.

In this study it was unclear why so few trout (3 of 48) from the mid- and lower-Motueka River seem to originate from the mid-catchment Moutere gravel lowland rivers (e.g. Motupiko catchment). These tributaries offer good winter spawning conditions, and records from the Rainy River indicate high numbers of spawning fish, high redd counts, and abundant juvenile fish.

The Baton River appears to supply a large number of fish to the Motueka River but these fish appear to disperse far less widely than fish originating from the Dart or Blue Glen catchments. This suggests that localised habitat conditions within the Motueka River catchment are more likely to mould the migration strategies of brown trout rather than large scale energy cost and benefit controls resulting from influences such as altitude and migration distances.

Studies of redd counts confirm (Fish and Game unpublished data) that the Blue Glen Stream and tributaries are a very important spawning area, providing a proportionally large number of trout to the Motueka River.

Despite groundwater adding reasonable flow, few significant cold water springs have been found in the middle reaches of the Motueka River that would provide refuge and enhance the survival of trout during summer-time when unfavourably high water temperatures can occur in the Motueka River (Olsen and Young, 2009). An exception to this is Hinetai Spring downstream from Tapawera which has had mean water temperatures close to 16^{o}C throughout summer.

Within the Motueka Catchment, trout density, abundance, frequency of occurrence and biomass has been calculated (see Figures 61, 62 and 63). The highest densities of fish are found in the Rainy River, a tributary of the Motupiko River. The number of adult fish per km and biomass follow a similar pattern apart from the Riwaka River, which appears to contain larger fish.

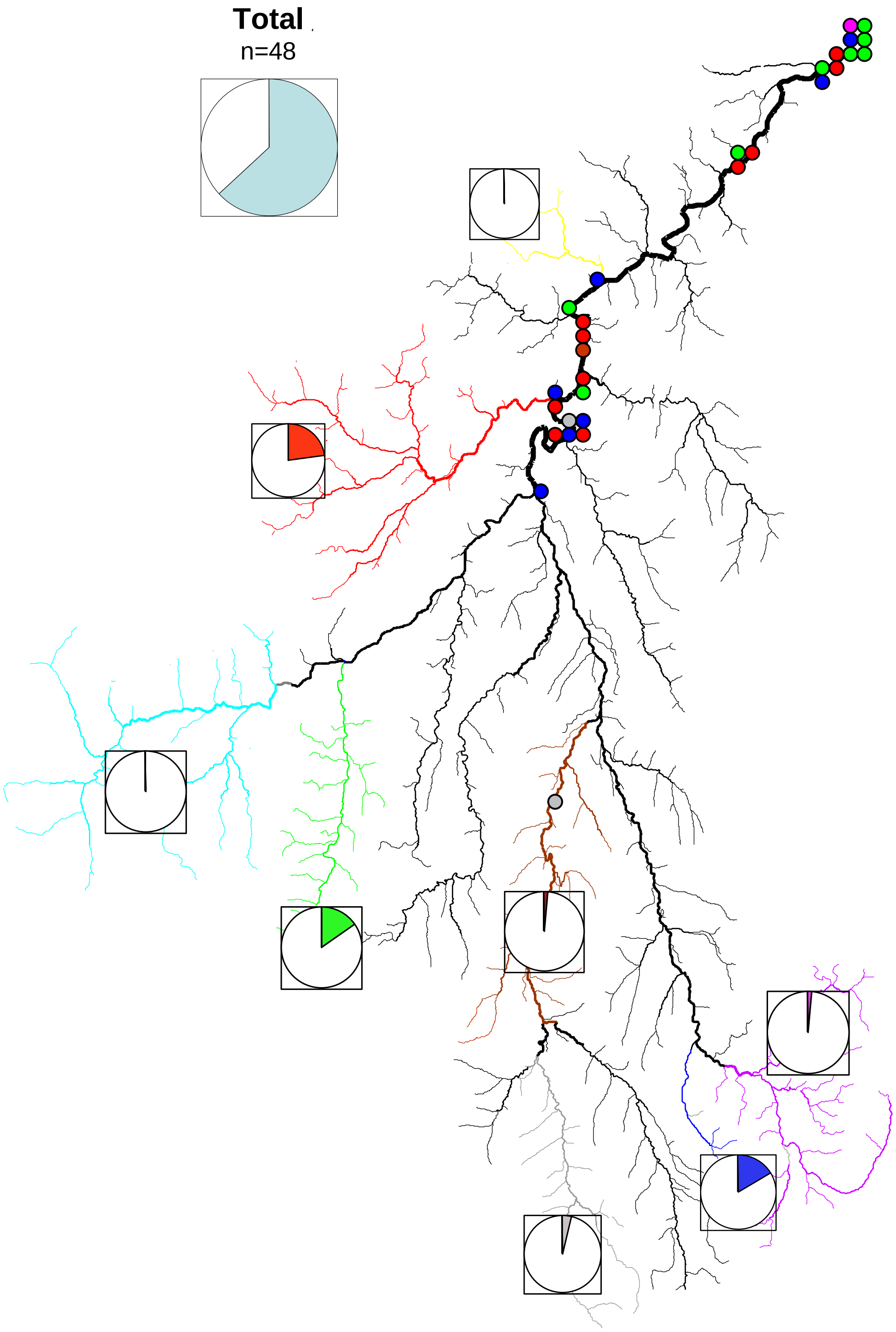


Figure 60: Map of the Motueka River catchment showing the eight tributaries examined and the proportion of the total 48 adult fish that matched each tributary with 95% confidence (pie charts). The sample locations of the 29 fish that matched one of the eight tributaries are shown as filled circles; these are colour coded to represent the tributary to which each fish was predicted to have originated. (Olley et al. (in press))

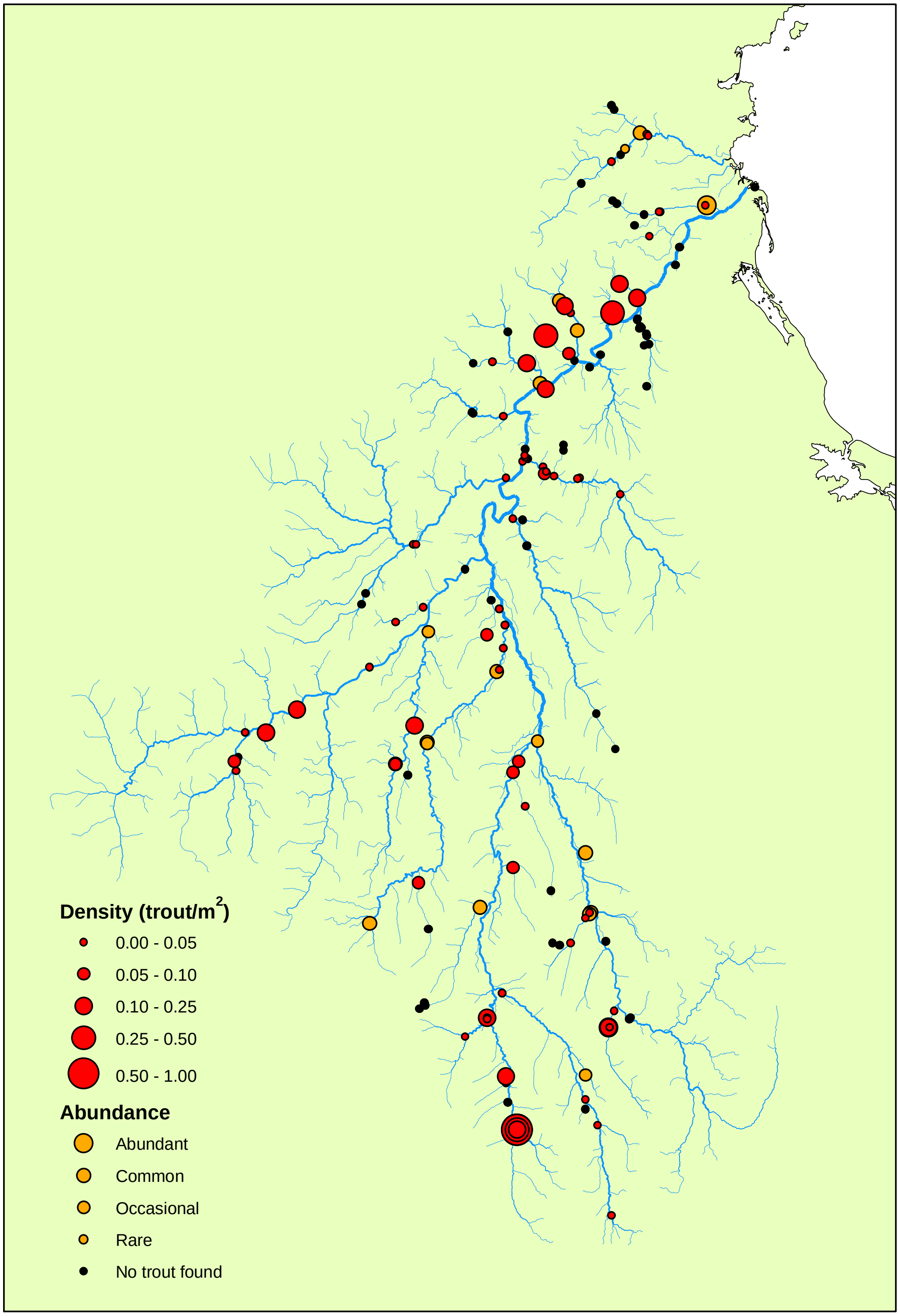


Figure 61: Trout density and abundance within the Motueka catchment (Young, unpublished)

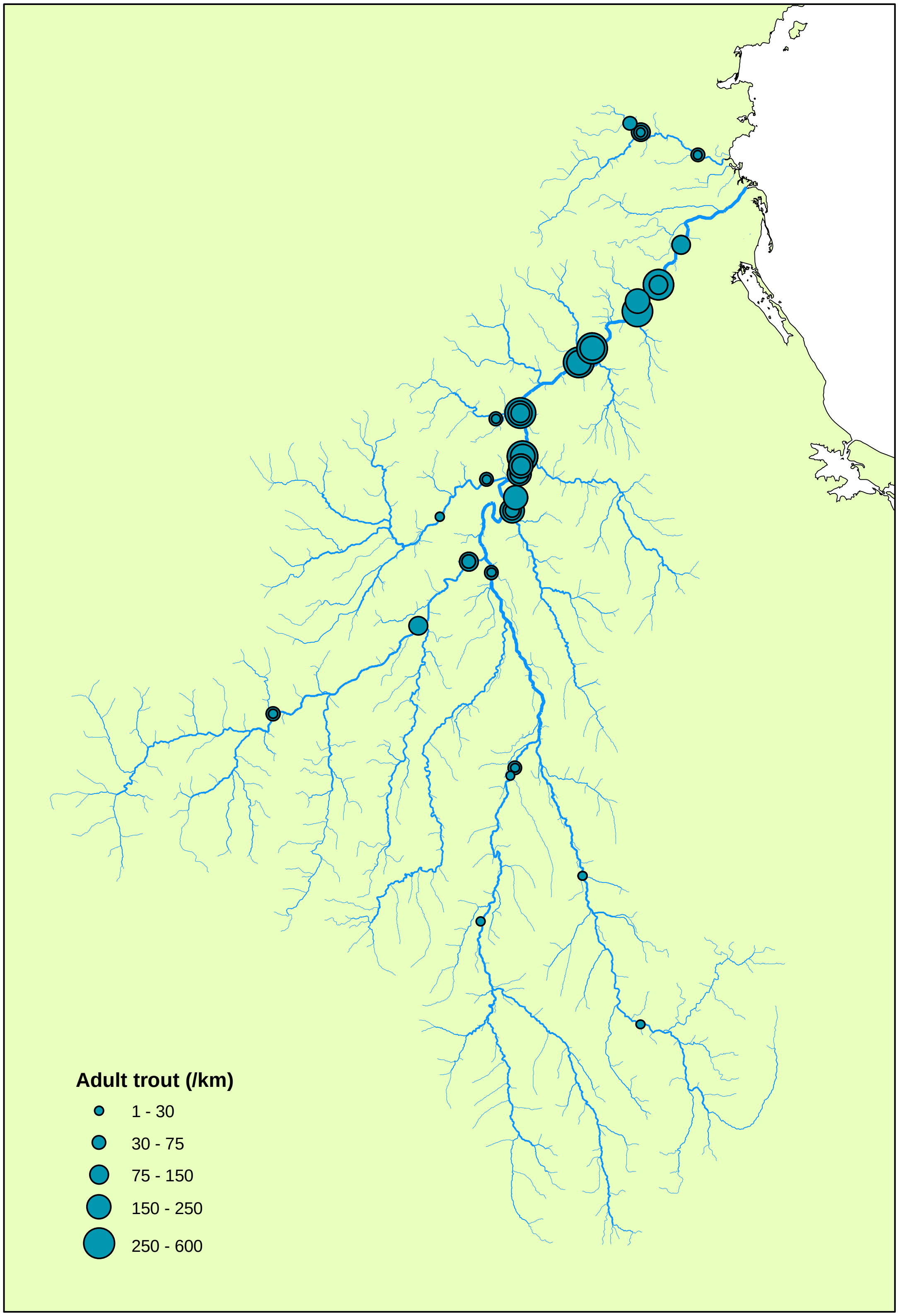


Figure 62: Adult trout frequency per km within the Motueka catchment ((Young, unpublished)

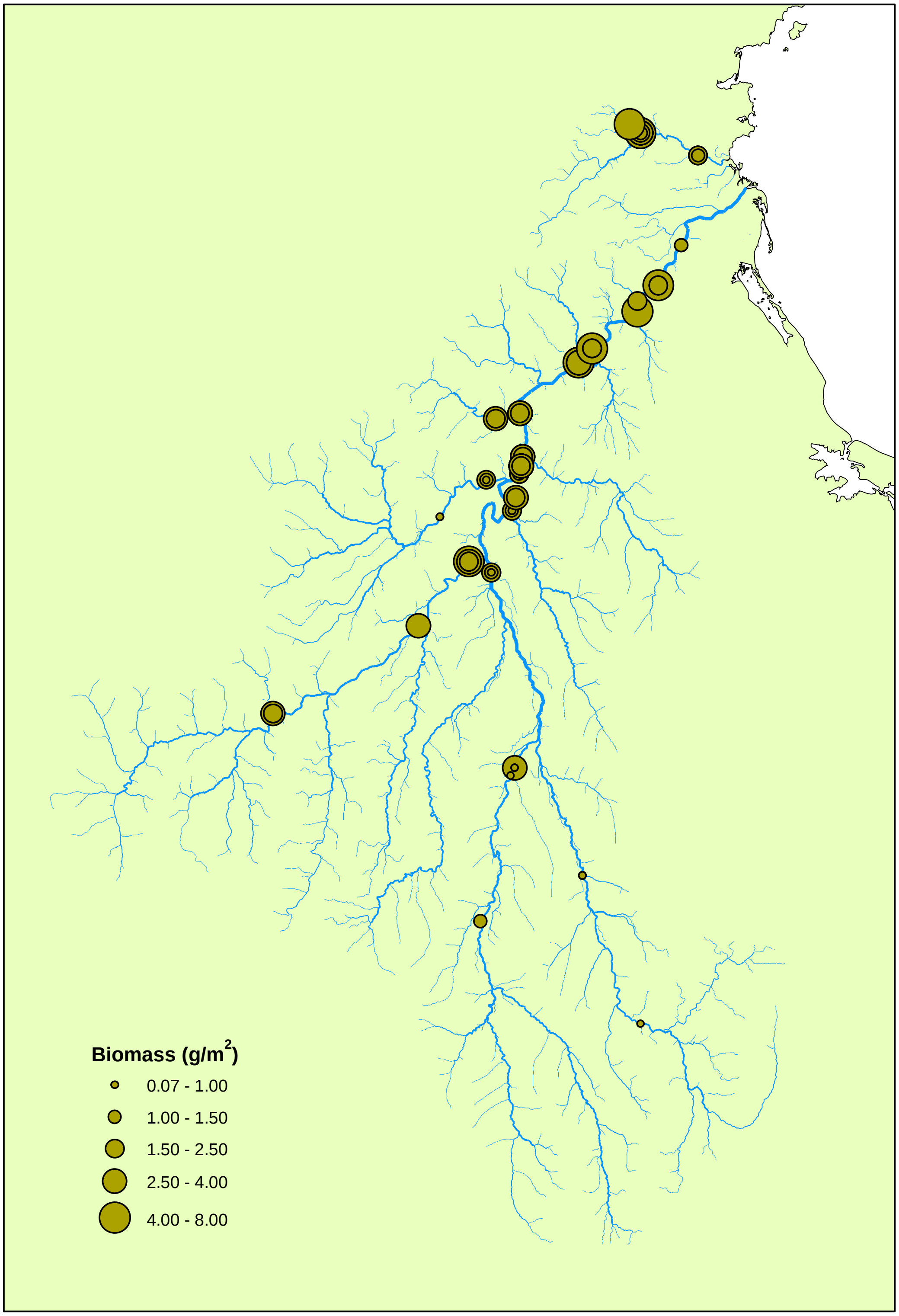


Figure 63: Trout biomass within the Motueka catchment (Young, unpublished)

4.3.9 SPRING FED STREAMS IN THE MOTUEKA AND WAIMEA PLAINS

Thorp Drain

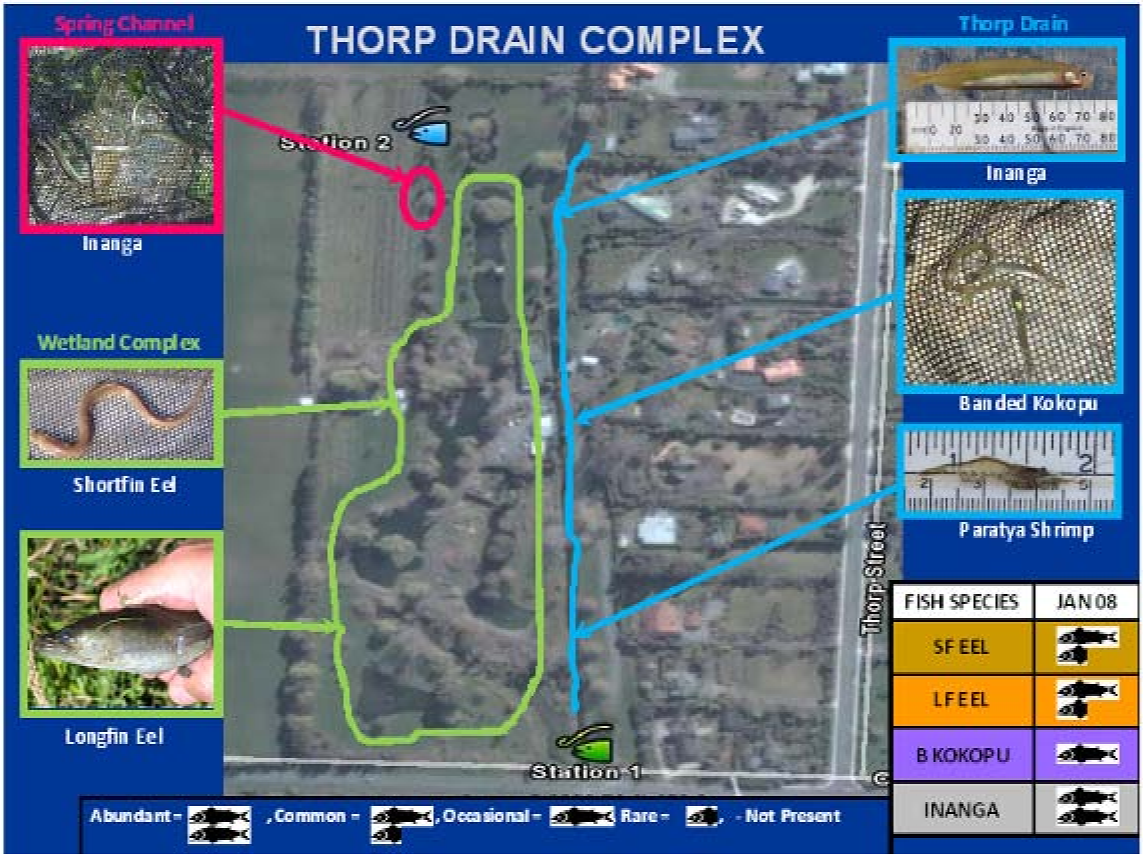


Figure 64: Thorp Drain fish types, abundance and monitoring information

The adjacent wetlands along Thorp Drain flow into the Moutere Estuary at Old Wharf Road in Motueka. Fish sampling sites were selected on the Thorps Drain and along the edges of the wetland complex. In addition, a small channelized spring area was investigated which was likely the original bed of Thorps Drain. Inanga were most numerous and ranged in size from 40-120mm. The threatened longfin eel were common (200-700mm) as were shortfin eel. Banded kokopu were occasionally observed in Thorps Drain. The presence of inanga throughout the site, including the small spring fed channel west of the wetland complex, indicates that there are no existing barriers to fish passage from the Moutere Inlet. Stormwater from Motueka residential areas could adversely affect habitat and water quality for habitat-sensitive native species. Installation of wetlands to intercept stormwater would be advantageous at the end of feeder drains to this waterway. The use of herbicide sprays on this creek should be discouraged in order to protect stream habitat.

Pearl Creek

Pearl Creek located on the western side of the Waimea River is two kilometres long (from Appleby gravel aquifer to the Waimea Inlet). Pearl Creek is regionally significant and provides wetland and stream habitat for the threatened and declining giant kokopu, longfin eel and inanga. This small complex also provides important and significant habitat for kotuku, bittern, fernbird and banded rail. The site is regarded as taonga to iwi and an important area of European colonization from 1842.

Riparian rehabilitation along Pearl Creek was initiated by adjoining landowners in the mid 1980's and was assigned regional importance by Department of Conservation (Allibone, 1995) due to the presence of threatened species. Improvement of stream habitat and fish passage was recommended. Following this an esplanade reserve and a QEII National Trust covenant was invoked. Partners in on ongoing restoration project include: The landowners, Tasman Environmental Trust, Fish & Game, TDC, DoC, Nelson Polytechnic and Appleby School. In 2003 the Tasman Environmental Trust became involved and adopted Pearl Creek as their flagship restoration project. Ten years later most of the noxious weeds and willow trees have been removed and replaced with some 10,000 native seedlings. Although the restoration will have a positive effect on the stream ecosystem in the long term, it is likely that total willow canopy removal and associated sediment runoff had a short-term negative effect on giant kokopu habitat by increasing light causing excessive growth of filamentous green algae.

It is clear from a 24-hour deployment of a DIDSON camera and observations of schools of whitebait milling around at the flap-gate that the tide gate could be improved for fish passage. However, any significant alteration of salinity levels within the creek upstream of the tide-gate may affect giant kokopu and other fish due to saline tolerance levels. Additionally water takes from the immediate area for irrigation may be affected. The best practice solution for this type of situation is a "smart tide gate" that can be adjusted to manage salt water intake.

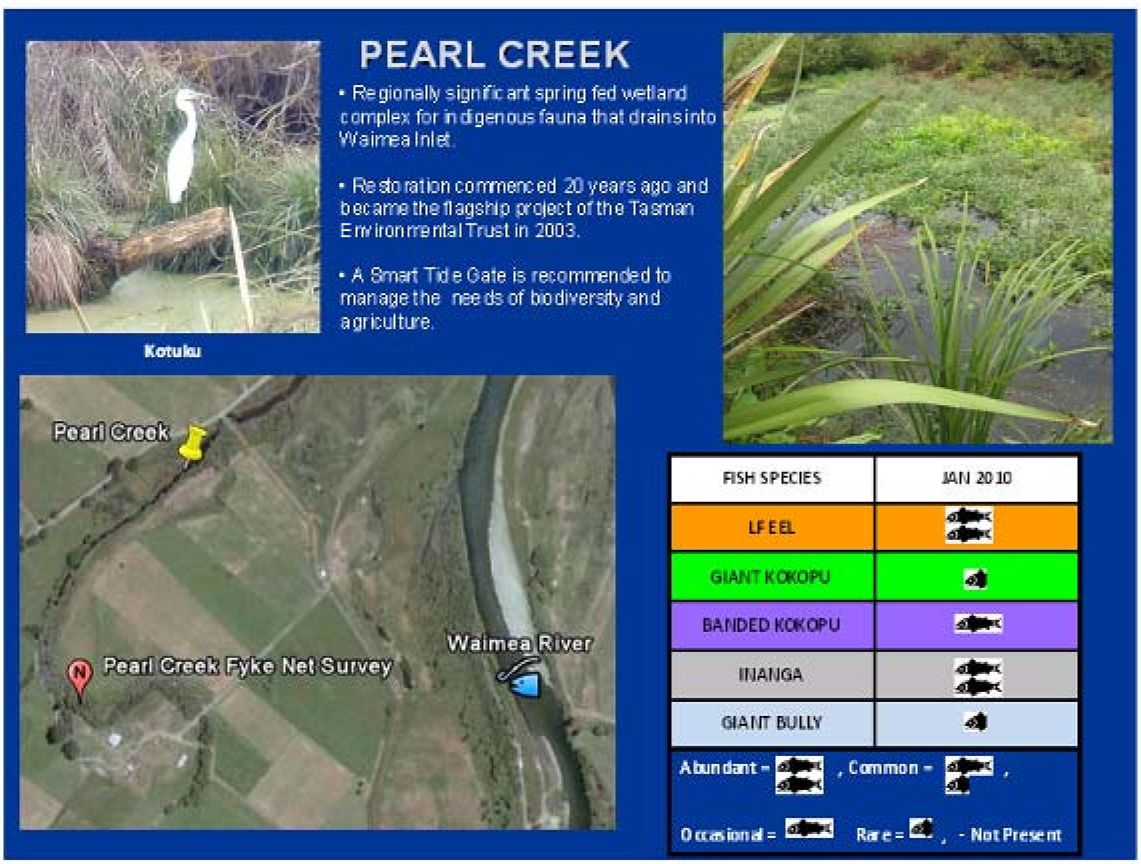


Figure 65: Pearl Creek fish types, abundance and monitoring information

Neimans Creek
Neimans Creek is a spring-fed creek that is located on the eastern side of the Waimea River. It is similar to Pearl Creek but with unrestricted fish passage. With extensive planting of the upper reaches of this water way by the landowners it is anticipated that there is every chance that giant kokopu should be found in the creek in the future. Two surveys were carried out in the lower tidal section of the waterway in 1988; one hand net method: CB, SFE, LFE, BT, I and other by seine net method: LFE, SFE, IA. Due to depth and the mass of emergent macrophytes, future spotlight and g-minnow or fyke netting might be more successful in finding additional species.

4.3.10 COASTAL MOUTERE HILL-COUNTRY STREAMS

Streams in the Moutere Hill Country are characterised by having low summer flows, high water temperatures where there is no riparian shade, and poor water clarity due to the glacial clay particles that take a long time to settle. Most of the original native forest and 98% of wetlands have been removed from this area during the mid and late 1800's. Residual pools are critical for maintaining aquatic biodiversity in this area. Protection of life in these pools involves shading and avoiding sediment discharges or erosion from large-scale stripping of land cover.

Moutere River Catchment
Many waterways in the Moutere catchment were modified generally by straightening and diversions in association with draining the large flax swamps that existing in the catchment. A new channel for the lower Moutere River was dug in the 1850-1860's. As a consequence m any of the habitat-sensitive fish species such as giant kokopu are either not present or present in very low numbers. However, the mouth of the catchment supports a reasonable whitebait fishery and reasonable numbers of eels are known from many parts of the catchment, particularly in farm irrigation ponds and reservoirs.
Schools of hundreds of smelt penetrate about 10km inland. This species was found in Gardiner Valley Stream, but were not found upstream of an old hydrology weir near Old House Rd (see section 5.2 on fish passage and Figure 104, top). Banded kokopu survive in streams with good riparian cover, including Blue Creek, one of the original channels of the Moutere River near Edwards Road. Redfin and bluegill bullies have not been found in this catchment.

Figure 66: Moutere Ditch at Edwards Rd

Summer-time dissolved oxygen saturation in upstream reaches of the catchment at Kelling Rd, 'Neudorf' Stream (flowing east of Neudorf Saddle) and the Moutere Ditch ranged from was satisfactory (60-80%) to good (80-100%). Several tributaries of the Moutere River had low dissolved oxygen levels, however, oxygen levels around spring inflows appear to be suitable for fish as shown by the presence of banded kokopu. While species diversity is low in the lower catchment, longfin eel are notably high in number and large in size in reaches of this catchment.

There is high potential for improvements to aquatic ecology in streams in the Moutere catchment. In particular, the following actions are recommended:

- restoration of wetlands in key locations to improve summer flows
- ensuring water takes are sustainable
- riparian tree planting and restoration of fish passage barriers.

Gardner Valley Stream

Gardner Valley Stream is sourced with water draining the Old Coach Road saddle collecting groundwater seeps as it travels approximately 2km adjacent to Gardner Valley Road to the Moutere Highway Mission Bridge. The stream then runs parallel to the highway (true right) and the Moutere River (true left) for 2km where it is joined by the Moore Road catchment. The waterway confluence with the Moutere River is another 1.5km below Wilson Road (see Figure 67).

In September 2008 a review of the NIWA Freshwater Fish Database indicated that previous fish survey work in the Moutere catchment had only targeted the mainstem of the Moutere River and tributaries above Gardner Valley Road. Several local dams had been investigated by DoC for noxious pest fish (pers comm., R Maley). Spotlight surveys were conducted in October 2008 and February 2010 on three reaches of this stream.

The results show that seven species of native freshwater fish occupy Gardner Valley Stream together with koura and shrimp. It is an important waterway for the declining longfin eel and inanga. Banded kokopu and smelt have been found as far upstream as above Mission Bridge. There appears to be uninterrupted fish passage from the sea to the upper reaches.

As with the Moutere River, restoration of Gardner Valley Stream is highly desirable. Sustainable water takes, wetland restoration especially on exotic forest land, and riparian planting is recommended.

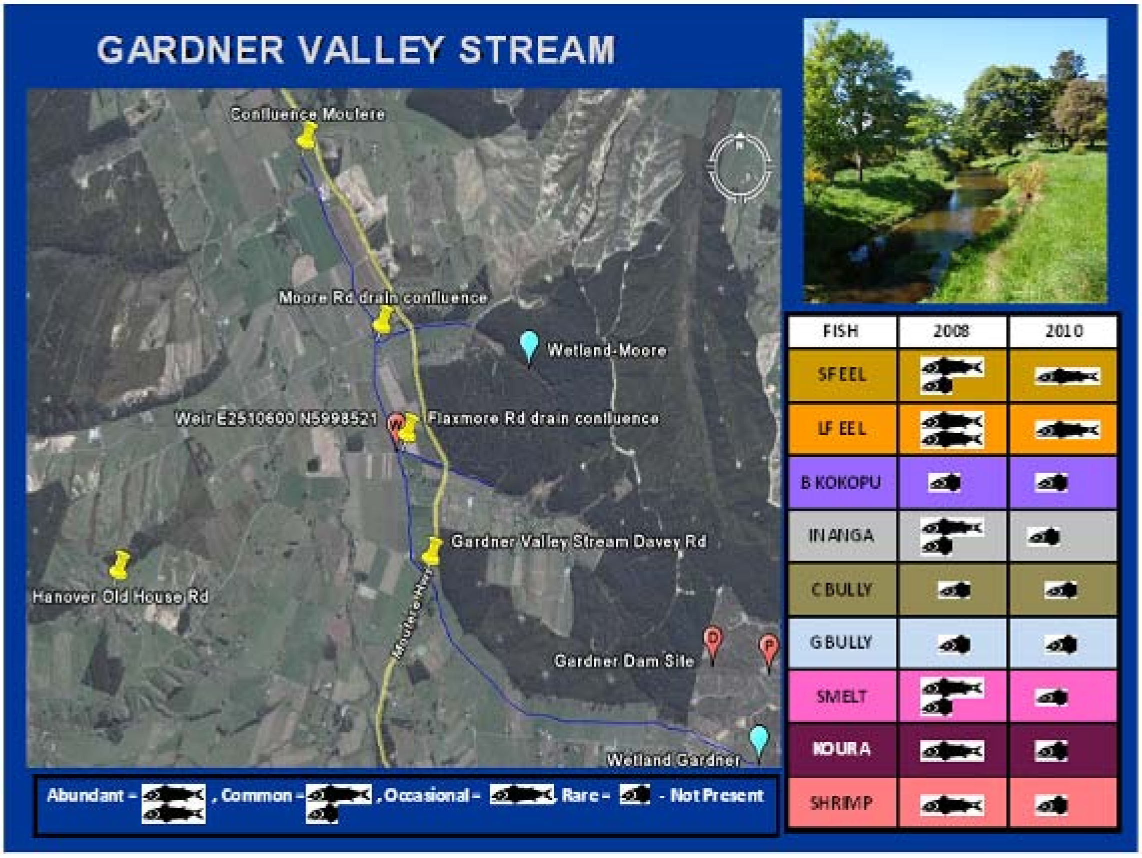


Figure 67: Gardner Valley Stream fish types, abundances and monitoring information

Tasman Valley Stream and Field Stream

Tasman Valley Stream is a small stream with a catchment of approximately 1200 hectares. Although the upper stream reaches dry out during the driest part of summer, residual pools still hold water. Base flows in the lower part of the stream range from 1-60 litres/second. The land use in the catchment is primarily horticulture (mainly apples), forestry, rural-residential and sheep and beef farming. Exotic pine forest in the upper catchment has been recently removed and been replaced with rural-residential subdivisions. In the process of this land use change, both wetlands in the upper (Awa Awa Rd) and lower (Horton Rd) valley floors have gained formal protection (as part of a subdivision and QEII respectively). Water yield downstream of these waterways has undoubtedly improved.

Currently woody riparian vegetation exists in patches along the stream, however, approximately 3.5-4km have no woody vegetation at all. There is over two years of water quality record (monitored quarterly at base flows) at a site in the lower catchment. In summer there are moderately high water temperatures (up to 23^{o}C) and low dissolved oxygen (down to 20-30%) at this site (these measurements are only from spot sampling and so the true maximum and minimum levels are likely to be more extreme). About 20% of samples do not comply with stock drinking water guidelines during base flows (1000 faecal coliforms/100ml, ANZECC 1992).

Giant kokopu are present within a few remnant patches of wetland and native bush within Horton Valley Stm and Awa Awa Stm, demonstrating the potential for restoration.

Water quality in Tasman Valley Stream is generally poor with high water temperatures, high levels of fine sediment in the bed and low summertime dissolved oxygen concentrations.

Field Stream near the village of Tasman and Dominion Creek near Mapua are small hill-fed low elevation waterways that drain into the Moutere and Waimea Inlets respectively.
In October 2009 construction began on the 10.7km Ruby Bay bypass from Trafalgar Road to Harley Road near Tasman. Approximately 1.3 million cubic metres of earthworks was moved and included 18km of drainage installation and seven major culvert placements.

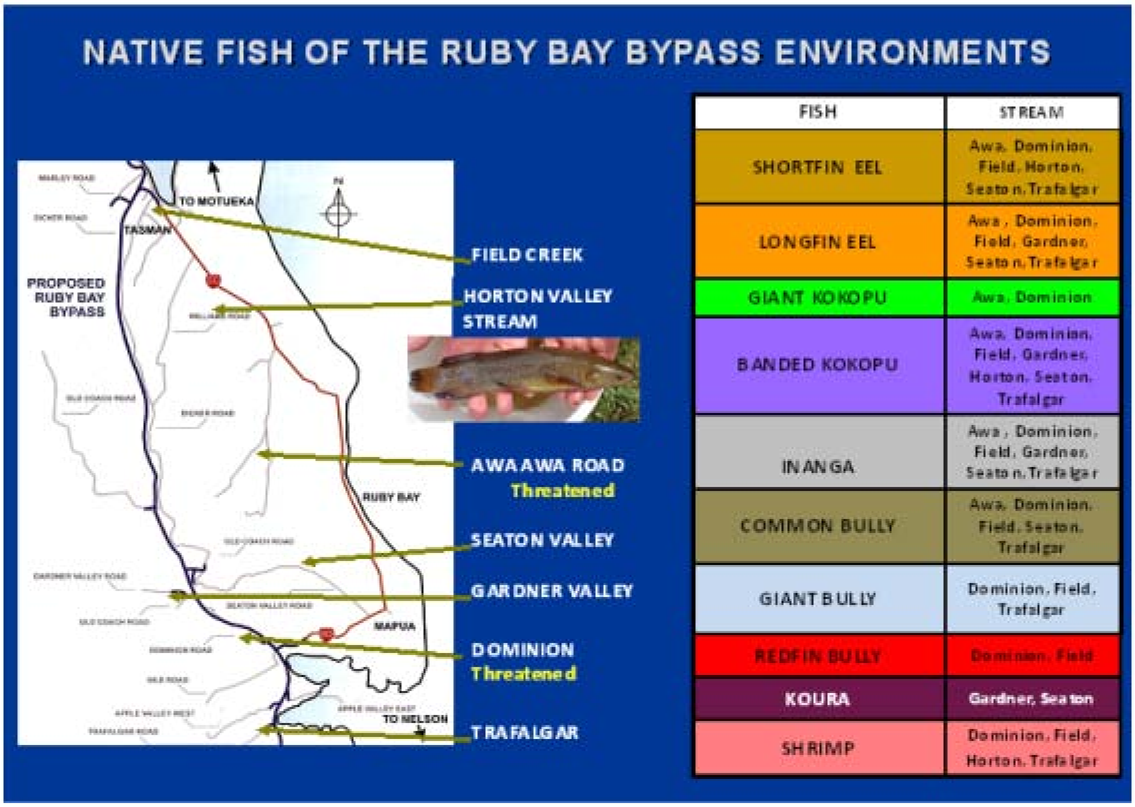


Figure 68: Ruby Bay Bypass fish types, abundances and monitoring information

Fish survey work commenced in November 2008 to identify in-stream habitat requirements and to provide mitigation strategies for Field Creek and Dominion Stream during channel realignment and subsequent restoration. Survey results indicated that the waterways contained populations of migratory native fish typically found in lower reaches of streams in and around the Moutere and Waimea Inlets. Fish salvage and transfer was undertaken during in-stream construction. The majority of these fish were large eel species and inanga, though dozens of adult banded kokopu and several giant kokopu were also transferred to suitable local waterways.

The potential for improvement to water quality and aquatic ecology in these Moutere and Waimea Inlet waterways is likely to be great, especially near to the coast and estuary where fish biodiversity is expected to be high. Apart from the lower 1.5km, much of the original meander pattern exists in this catchment, the benefits of which are shown in the fish community. Being small streams, streamside planting will, within only a few years, bring stream temperature down to acceptable levels. With shading in place, dissolved oxygen is also likely to improve by reducing respiration from aquatic plants. With reaches of these streams recently restored, and other restoration imminent, there is momentum in the community for further restoration work. Council is facilitating a StreamCare Group in this catchment. These streams are highly visible from the road throughout its main stem which will help to promote the project.

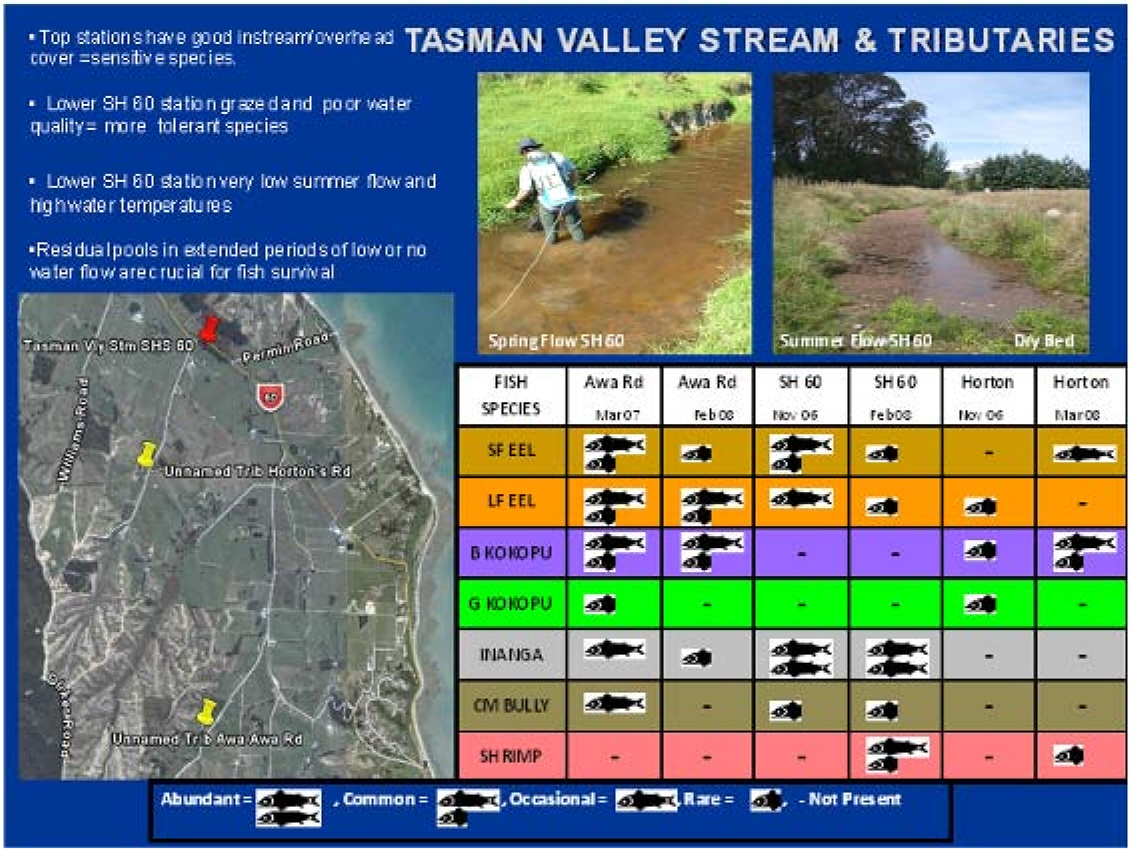


Figure 69: Tasman Valley Stream fish types, abundances and monitoring information.

4.3.11 WAIMEA INLET STREAMS

These streams are small order, often ephemeral waterways, with many potential impacts from land uses, water takes, drain clearance and discharges from regional landfill and/or farmland. Some have high native fish values (shortjaw, banded & giant kokopu).

Seaton Valley Stream

The upper and mid-upper reaches of Seaton Valley Stream have good water quality, natural meanders with good overhead shade and areas of dense riparian vegetation of shrubs and gorse. In the headwaters of the valley, there are two flax swamps under QEII covenant. These contribute to higher summer flows, and without which the creek flows would probably cease in summer. Generally there is still 1-2 l/sec flow at Stafford Drive (until recently SH60) during the driest periods. In comparison, the next station downstream in the lower-middle reach has been straightened, and provides unlimited access for cattle (i.e., heavy trampling, all riparian trees/scrub have been removed), as well as silt and debris dug out every 1-2 years. The top site assessed in this investigation had both, more species diversity (including koura and shrimp) and higher abundances than those downstream.

The lower reach of Seaton Valley Stream below Arunui Road in Mapua was spotlight surveyed on 13 March 2008. Only shortfin eel and adult inanga were observed as common, demonstrating their tolerance to modified reaches with poor water quality. Water quality in the mid- and lower reaches is characterised by very low dissolved oxygen, high water temperatures and high levels of fine sediment in the bed.

In February 2011 a small 40m section of the surveyed reach near Mapua School was diverted to make way for a new culvert placement. During construction, eels were observed and a salvage operation was conducted. The results were surprising (Figure 71) in that longfin eel and inanga were abundant, shortfin eel occasional and giant bully rare in a 50m² area. A similar phenomenon occurred on Dominion Stream in that native fish diversity and density was found to be much greater during diversion/salvage operations than prior results provided by spotlighting and electric fishing techniques.

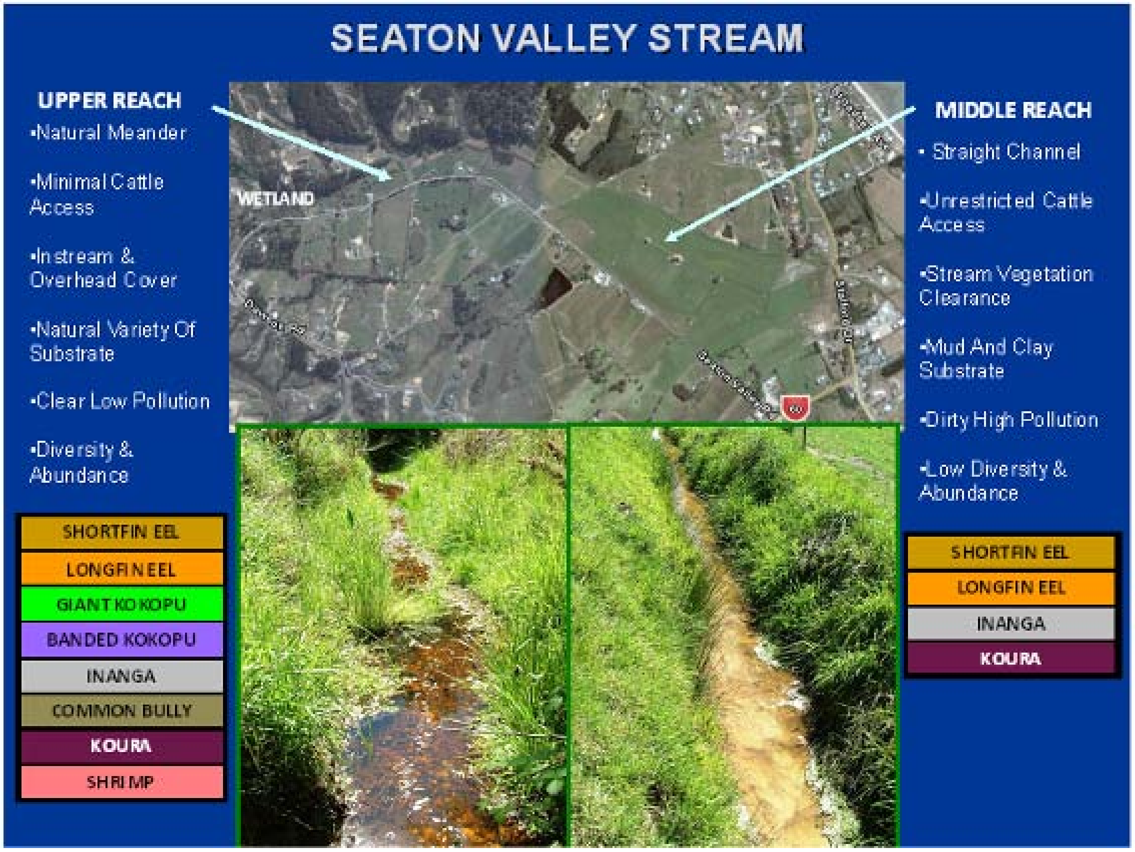
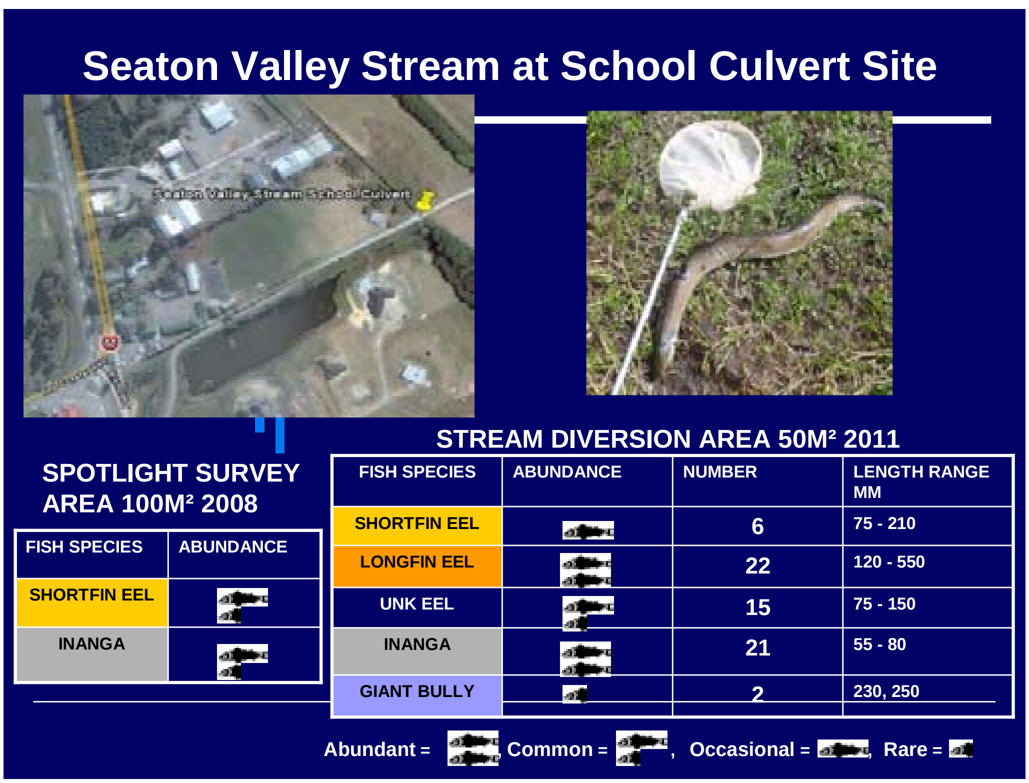


Figure 70: Seaton Valley Stream fish types



SPOTLIGHT SURVEY AREA 100M² 2008

FISH SPECIES	ABUNDANCE
SHORTFIN EEL	
INANGA	

STREAM DIVERSION AREA 50M² 2011

FISH SPECIES	ABUNDANCE	NUMBER	LENGTH RANGE MM
SHORTFIN EEL		6	75 - 210
LONGFIN EEL		22	120 - 550
UNK EEL		15	75 - 150
INANGA		21	55 - 80
GIANT BULLY		2	230, 250

Figure 71: Seaton Valley stream at School fish types, abundances and monitoring information.

Maisey Creek

Maisey Creek runs parallel to Maisey Road with a small former dam approximately 800m from the Waimea Inlet. The stream typically has very low summer flows. As part of a subdivision proposal Maisey Creek was surveyed in February 2005. This investigation indicated that a newly constructed culvert from the dam outlet was preventing fish passage to the dam and upstream. In October 2005 Tasman District Council granted a Land Use Consent that required the installation of a 300mm-diameter culvert for fish passage and to undertake works and planting along the stream margins. Following installation, the fish passage culvert became operational in 2006 while extensive native plantings along the dam and stream margins continued into 2008. The project has been a major success. While stream flows remain very low during the summer months, the water is shaded and cooler. Above the functioning wetland (former dam) adult banded kokopu find refuge in residual pools. Five native fish species and freshwater shrimp were recorded in 2010 where only one inanga and several shortfin eel were observed in 2005. Below the wetland, adult inanga are now common while longfin eel and banded kokopu are also found.

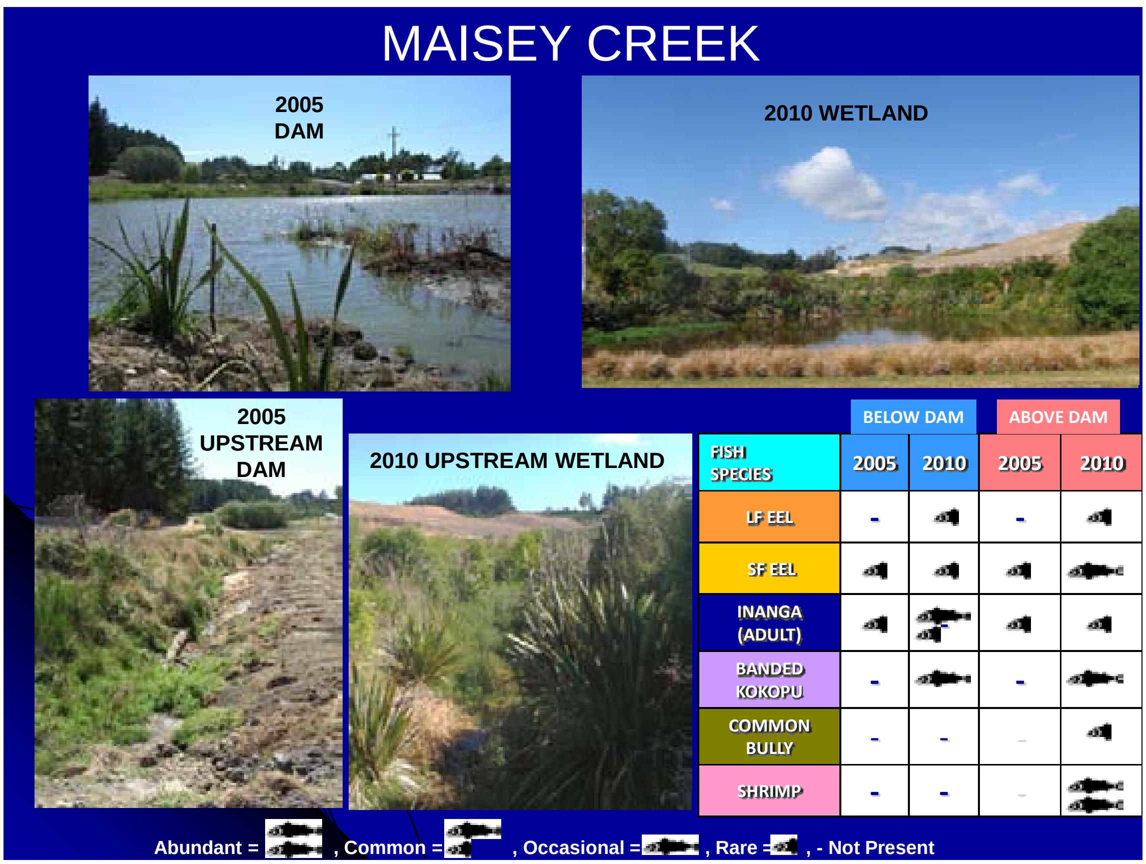


Figure 72: Maisey Creek fish types, abundances and monitoring information

Redwood Valley Stream

In the middle reaches of Redwood Valley Stream, natural meanders exist with a high degree of shade from a canopy of willows. There is good in-stream cover and many pools that are likely to contain residual water all year round. Good riparian cover that will reduce evaporation of water from the pools. In comparison, the upper reaches had some meanders and trees with cattle grazing while the bottom reach regularly experienced cattle in the stream, on-going removal of adjacent vegetation and only a few willow trees and limited natural meanders. With the exception of shortfin eels and inanga, the middle reach site had both a greater species diversity and abundance than sites above and below. Like many streams in Moutere gravel country, this stream dries up in summer. However, the presence of deep residual pools shaded by riparian trees in the mid-sections is thought to be the reason for the numbers of habitat-sensitive native fish found in this survey.

Figure 73: A pool in Redwood Valley Stream. Pools like this contain water even when the stream stops flowing, providing essential refuges for fish.

Most pools in the mid reaches held water right through the summer. These residual pools are formed in the parent Moutere Gravel sequences that are like conglomerate, rather than re-worked eroded gravels.

Water quality in this stream is generally within guidelines in the lower reaches. However, disease-causing organisms are occasionally above guidelines (13% of samples; 2 out of 15) and water temperature is occasionally above 22°C (based on spot samples; no continuous data available). This is also evident in Eves Vly Stm to the south. If this is the case, it would be very important to protect these types of streams from disturbance, including direct modification with machinery or from significant erosion caused by increased peak flow run-off from removal of large areas of vegetation in the catchment, as has been experienced in Eves Vly Stm. There is a possibility of a fish passage issue for inanga between the middle and upper sites on Redwood Valley Stream, and this should be investigated also.

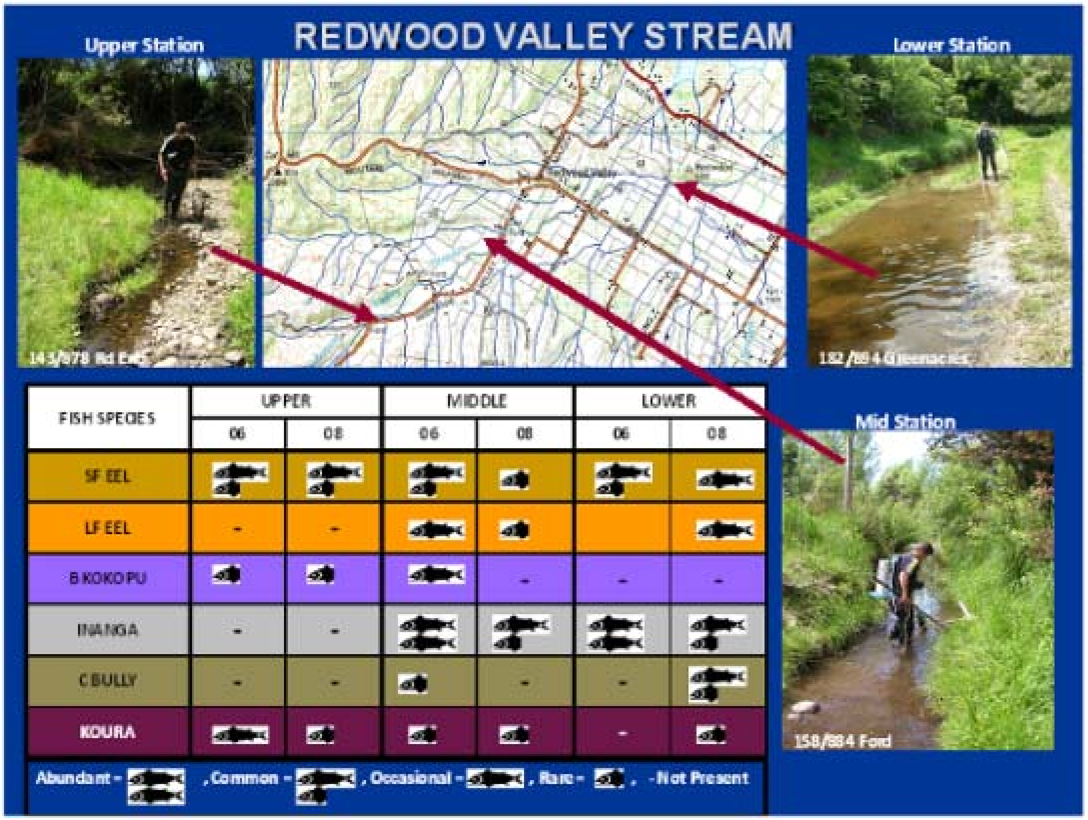


Figure 74: Redwood Valley Stream fish types, abundances and monitoring information.

Waimea River Catchment

Biological data of this catchment was reviewed in 2005 (Hay and Young, 2005). Fifteen different species of fish have been recorded from the Waimea catchment, 13 of which are native. Brown trout are found throughout the catchment. Torrentfish have primarily been recorded in the lower Wairoa and Waimea Rivers. Inanga are common in the lower reaches of the Waimea River have been found as far upstream on the Wai-iti River as above the Teapot Valley Christian Camp, ~12km upstream from Waimea Estuary (Deans, N, pers. comm.). In contrast, koaro have only been found in the upper parts of the Wairoa, Lee and Roding Rivers or their tributaries, and only in streams draining native forest. Dwarf galaxias and banded kokopu have only been recorded once in the catchment. The dwarf galaxias was recorded from the Wairoa and the banded kokopu from a small tributary of the Roding River. Upland bully are common throughout the catchment. Redfin bully are reasonably widespread but not in the Wai-iti catchment. Records for blue-gill bully in the NZFFD only exist downstream of SH60 (Appleby Bridge) but have been reported from the Lee River. Common smelt are common in the Waimea and lower Wairoa River and both species of eels are common throughout the catchment.

Water temperatures in the lower Roding, Lee and Wairoa Rivers may be high enough to impact the fish populations with maximum temperatures recorded over 27^{o}C.

A study of the Roding River catchment commissioned by Nelson City Council in relation to the effect of the water supply dam (Hayes and Stark, 1995) showed a relatively poor density but relatively high number of taxa of macro-invertebrates and only five fish species (LFE, SFE, CS, UB and BT) and a few koura. However, habitats of KO, BK, SJK were not investigated. It is possible that the influence of the ultramafic mineral belt in the upper catchment is responsible for the low ecological productivity in this catchment. This study and one associated with the proposed Lee River Dam recommend providing for fish passage over the dams for the strongest migrants LFE and koaro.

The proposed water augmentation can be seen as an opportunity to redress the balance between in-stream and out-of-stream (e.g. irrigation) water uses. Current water allocation in the catchment is heavily biased toward out-of-stream users, and the in-stream values have suffered as a result. If adequate environmental flows for trout in the Waimea River (greater than 1000 litres per second) are considered in the river, the water resource used for irrigation, urban and industrial supply is over-allocated by 50 % (Hayes, 1998b). The estimated natural MALF of 1300 litres/sec is proposed as the environmental benchmark minimum flow for the Waimea River upstream of the Appleby Bridge (Hayes and Young, 2005). A minimum flow of 800 litres/sec would retain 80% of the habitat available at natural MALF for adult brown trout. At present water rationing begins when flows get to 2500 litres/second. At that stage water users have to cut back by 20% of the consented maximum allowance. Further stepped rationing occurs as flows reduce below certain triggers. The proposal for release from the proposed Lee Dam is to top up the river to maintain flows at 1100 litres/second. However, to provide environmental benefit through water augmentation, flushing flows would also need to be provided.

Trout angler use in the mid 1990's of the Waimea River was ranked 6th highest in the Nelson-Marlborough Fish and Game Angler Surveys. The latest survey suggests this ranking has increased slightly.

Wai-iti Catchment

The Wai-iti catchment has naturally low water yield during the summer months and typically naturally dried in the lower reaches in summer during low rainfall years. From 2007 supplementary water from the Kainui Dam was supplied to the catchment downstream in summer for out-of-stream use and to compensate over-allocation. The target is to maintain flows at over 100 litres/second in low rainfall periods. This dam is located in the upper reaches of the Wai-iti River (headwaters of the Gordon Range) and uses the Kainui Stream to convey water to users downstream. In a study forming part of the Assessment of Environmental Effects for the dam, fish abundance and diversity was found to be relatively low in Quail Valley Stream, the adjacent catchment to Kainui Stream. Species recorded include: LFE, SFE, UB, BT and Ka. This poor diversity is despite the habitat being ideal for these species and high abundance and moderate diversity of invertebrates (Davey and Deans, 2002). However, moderate pollution, particularly from sedimentation from stock access to the stream, was evident in Quail Valley Sstream. Kainui Stream on the other hand was virtually devoid of all freshwater fish life, with only seven eels found at the three sites investigated. Habitat was limiting with insufficient flow and water depth, a large percentage of fine sediment in the bed and few invertebrates. The lack of fish numbers in Kainui Stream could be due to fish passage issues as there are a number of culverts, dams and a v-notch weir in the lower reaches. The operation of the Wai-iti water augmentation scheme was expected to enhance the aquatic ecology of the Kainui Stream. Flow over the dam is required to facilitate eel passage over the dam and is required by the resource consent, along with monitoring of the effectiveness of this provision. Trap and transfer operations exist in this stream during periods when flow over the dam is not occurring. These operations have been successful in transferring eels. For example, in May 2011 3,760 shortfin eels (length range: 90-180mm, average 120mm) and 250 longfin eels (length range: 120-400mm, average 220mm). The low proportion of longfin eels in this catch (along with other such operations around the country) is a concern because it further indicates a decline in this species.

Reservoir Creek, Richmond

Reservoir Ck is a small urban stream which has been diverted or modified in parts of the lower reaches that flow through residential land. Several fish passage barriers exist in this stream, including the Hill Street culvert, the Easby Park intake weir and the old in-stream historic reservoir above the residential area and before the creek steepens up onto the Barnicoat Range.

Figure 75: Banded Kokopu from Reservoir Ck

While the habitat for sensitive native fish in the upper reaches is generally very good, especially upstream of the reservoir where there is a canopy of mature native forest over the stream, only LFE, SFE and BK were observed. We might have expected some bully species and koura.

The same was found upstream of Hill Street in Richmond (below the reservoir) which contains some natural meanders and riparian vegetation, including trees and shrubs that offer overhead cover and shade. The possible explanations for low fish diversity is the culvert and associated intake structures in Reservoir Creek from Hill Street to Easby Park, acting as a barriers to passage of several fish species with less climbing ability. Eels are very good climbers and can move on many wet surfaces. It is not known if banded kokopu are migrating through the culverts from Hill Street or are land-locked and migrating to and from the reservoir.

Water quality has been measured quarterly at Easby Park and downstream Salisbury Rd since 2000. High levels of fine sediment, high water temperatures and possibly untreated discharges from households in the mid reaches have been identified as the main issues for aquatic ecology.

Figure 76: Reservoir Creek fish species, abundances and monitoring information.

Parts of the mid- to lower reaches have been heavily modified, including a 300m section of rock-lined straight channel for flood management. This particular situation arose from inadequate land area being designated for the stream corridor when the land was subdivided. A waterfall that formed in the soft bed material of this creek in the lower reaches appears to be preventing inanga, and possibly other fish species from migrating upstream (see Section 5.3).

A project funded by Council and Ministry for the Environment (sustainable management fund) improved several reaches of the waterway with riparian planting involving schools and the ‘Keep Richmond Beautiful’ community group. This programme ran for two years from 2006 to 2008 (Tasman District Council, 2007).

Jimmy-Lee and Eastern Hills/ Borck Creeks, Richmond

Figure 77: Borck Creek along Headingly Lane, Downstream

Both these creeks have been heavily modified in their lower reaches with most of their length straightened and with over 1km of stream running through culverts in the commercial zone of Jimmy-Lee Creek. Upstream of Hill St both these creeks have a natural form of cascades and pools and mostly complete forest canopy. Unfortunately, there are significant fish passage barriers (eg engineered stormwater detention ponds and irrigation pond) in these streams that prevent all fish other than eels accessing these natural sections. Koura are abundant in the upstream sections of both these streams. Some banded kokopu were recorded once in the mid section of Jimmy-Lee Creek. Inanga are abundant in lower Borck Creek and up Eastern Hills Creek (a tributary of Borck Creek) to the redundant irrigation dam downstream of Hill St. This is despite very high nitrate concentrations (average over four times ANZECC guidelines) in lower Borck Creek. In order to increase flood carrying capacity in this section to anticipate more urban development and therefore impervious surface and higher flood peaks, plans have been made to widen this stream corridor from 4-5m to 70m. There is a lot of potential to enhance fish habitat if the low-flow channel is meandered and riparian wetlands and trees established. A concept plan for this is shown in Figure 78 where the objective is to integrate the ecological, recreation and flood capacity needs. Elongated patches of bush and wetland parallel to the stream low flow channel are located adjacent to the waterways for over 80% of the stream margin with grassy playing areas in the flood fairway.

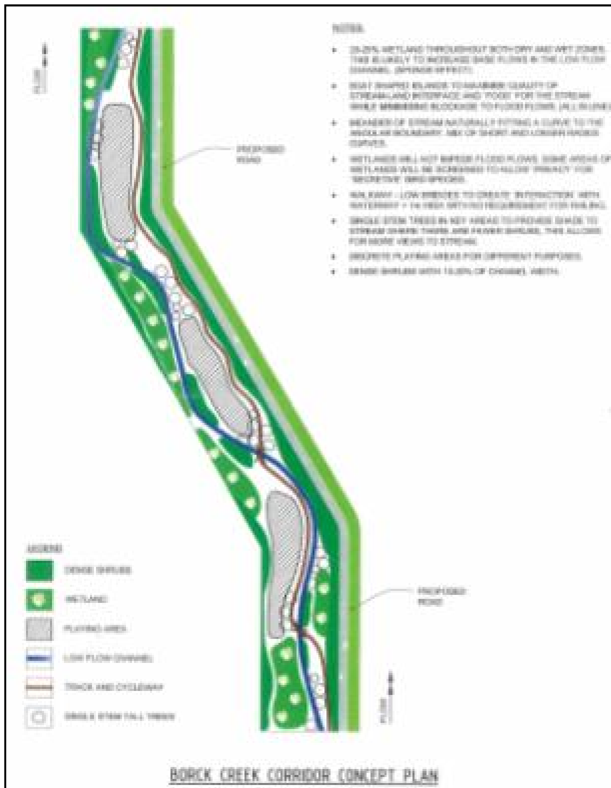


Figure 78: Borck Creek corridor concept plan as part of the Richmond West Development Plan.

Buller/ Kawatiri Catchment

Although the Buller river native fish fauna is diverse, it is not especially abundant when compared with the neighbouring Grey catchment (Hayes, 1995). Thus the same species in the Grey catchment tend to occur at a higher percentage of sites than in the Buller catchment. This may be due to the high proportion of beech forest in the Buller catchment, as streams in undisturbed beech forest appear to be less productive than streams in podocarp-broadleaf forests. The steeper gradients of streams and the unproductive granite geology in the Buller catchment may also contribute to lower abundance of fish in the Buller compared to the Grey catchment.

Overall native fish are widely distributed throughout the catchment, with a slightly higher proportion in the lower reaches. Undoubtedly trout, known to prey on native fish, will have reduced numbers of koaro in Lake Rotoiti and Rotoroa.

The Buller River catchment possesses the third highest number of "headwater trout fishery"[1] tributaries in New Zealand, after the Clutha and Waitaki Rivers (Hayes 1995). This has been recognized with a Water Conservation Order covering much of the catchment. Lake outlets provide flow and habitat conditions most suitable for trout. The outlets of Rotoiti and Rotoroa lakes have some of the highest trout biomasses in New Zealand. The presence of the invasive alga *Didymosphenia geminata* (Didymo) in these rivers may be adversely affecting this biomass. These fish must leave their refuges for shallower water upstream when they spawn. With the absence of disruptions to fish migration in the Buller, trout have full access to this diversity of habitat.

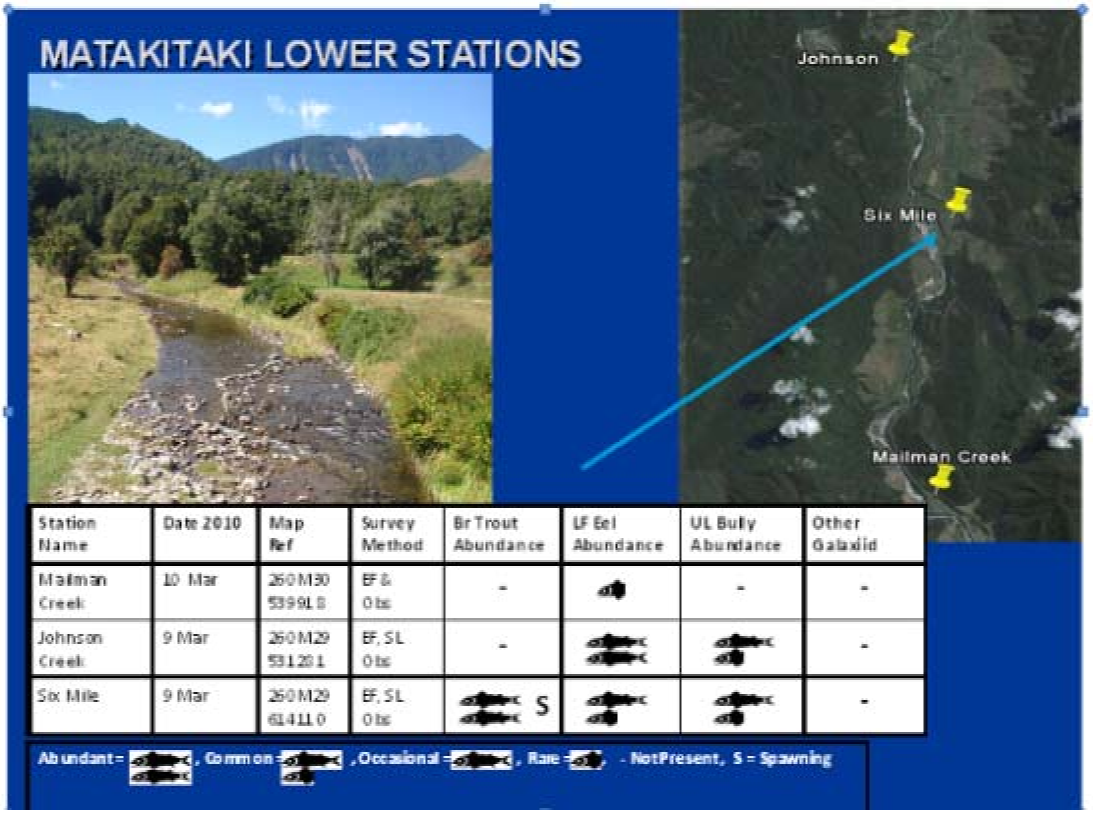
The Upper Buller trout fishery below Lake Rotoiti has significantly declined over the decade from 2000-10, the cause of which remains unclear.

The Upper Matakitaki Catchment

In October 2008 Network Tasman announced plans to investigate the Matakitaki River for hydroelectricity generation. Pre-feasibility studies have since indicated the rivers mid-upper reaches are best suited for development. With a limited fisheries database TDC and project partners elected to survey various waterways that could be affected by hydro development as part of the fish survey in the summer of 2010.

[1] Headwater fisheries are defined as those in scenic, often remote, clear water rivers characterized by a reasonably high catch rate of large, wild trout caught mainly by fly fishing.

Lower Matakitaki Sites



Station Name	Date 2010	Map Ref	Survey Method	Br Trout Abundance	LF Eel Abundance	UL Bully Abundance	Other Galaxiid
Mailman Creek	10 Mar	260 M30 539918	EF & Obs	-		-	-
Johnson Creek	9 Mar	260 M29 531201	EF, SL Obs	-			-
Six Mile	9 Mar	260 M29 614110	EF, SL Obs	S			-

Figure 79: Matakitaki Lower Sites fish species, abundances and monitoring information.

Three tributaries of the Matakitaki River were selected in an area south of Murchison. Mailman Creek appeared to have a fish passage barrier between the Matakitaki confluence and the study site as only one large longfin eel was observed. Upland bullies and longfin eels were abundant to common in the remaining two streams. Brown trout were abundant in Six Mile which is also important for spawning and rearing.

Mid to Lower Matakitaki Sites

MATAKITAKI MID LOWER STATIONS

Station Name	Date 2010	Map Ref	Survey Method	Br Trout Abundance	LF Eel Abund	UL Bully Abund	Dwarf Galaxiid
Knight Creek	10 Mar	260M30 553116	EF & Obs	Abundant, S	Occasional	Occasional	Abundant
East Br Glenroy	10 Mar	260M30 552092	EF & Obs	Abundant, S	Rare	-	-
Warbeck Stream	10 Mar	260M30 544116	EF & Obs	Common, S	-	-	-

Abundant = , Common = , Occasional = , Rare = , - Not Present , S = Spawning

Figure 80: Matakiataki mid to Lower site fish species, abundances and monitoring information.

Three tributaries were surveyed within the 3km downstream of Horse Terrace Bridge. Each of these waterways contain important habitat for trout spawning. Over 500 dwarf galaxiids were observed in a small spring attached to Knights Creek where no other fish species were observed.

Mid Matakitaki Gorge

Station Name	Date 2010	Map Ref	Survey Method	Br Trout Abundance	LF Eel Abund	UL Bully Abund	Other Galaxiid
Unnamed Stream 1	10 Mar	260M30 610115	EF & Obs	Common S	Rare	Common	-
Potberry	9 Mar	260M30 614110	EF & Obs	-	-	-	-
Wheeler Creek	9 Mar	260M30 594106	EF & Obs	Rare S	-	-	-
Murty Creek	9-10 Mar	260M30 585109	EF & Obs	Abundant S	Occasional	-	-

Abundant = , Common = , Occasional = , Rare = , - Not Present, S = Spawning

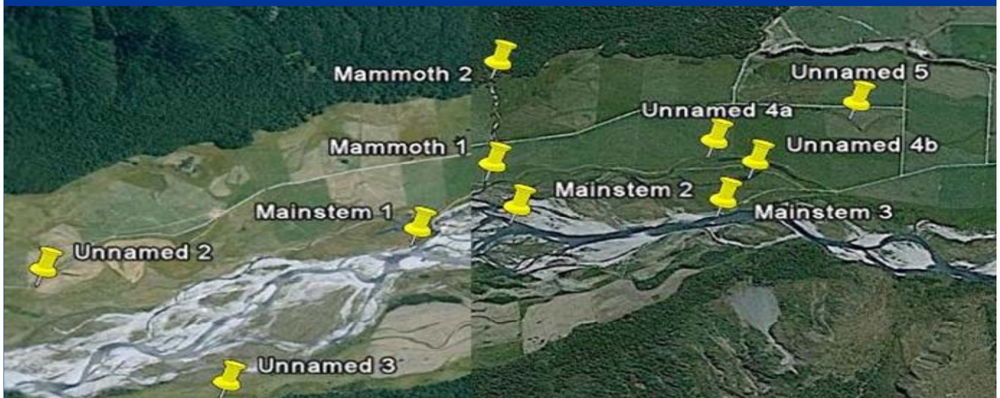
Dive Site	Date	Map Ref	Distance Visibility	Brown Large	Brown Medium	Brown Small	Notes
Top Gorge-Wheeler Ck	11 Mar	260M30 606112-595106	1400m 9.4	67	28	24	N=16> 10lbs
Wheeler Cr-Murty Flat	11 Mar	260M30 595106-584104	2100m 9.4	102	29	99	N=12> 10lbs N=1>15 lb

Figure 81: Matakitaki mid Gorge fish species, abundances and monitoring information.

Approximately 3km upstream of Horse Bridge is a 1km long gorge in the Matakitaki River main stem. Four tributaries were assessed in the vicinity of the gorge while two drift dive sites totalling 3.5km were surveyed in the Matakitaki River from the top of the gorge downstream. No fish were observed in Potberry Creek despite good water quality and habitat conditions. No galaxiids were discovered in the four tributaries, though the abundance of trout and large longfin eels in Murty Creek may have been a limiting factor to galaxiid presence. The drift divied reaches identified 169 large trout of which 26 individuals exceeded 10lbs. In addition, 180 medium to small trout were observed confirming the rivers notoriety as one of the best sports fisheries in the Nelson Region.

Upper to Mid Matakitaki Sites

MATAKITAKI MID STATIONS



Station Name	Date 2010	Map Ref	Survey Method	Br Trout Abundance	LF Eel Abund	UL Bully Abund	Other Galaxiid
Mammoth Stream 1	10 Mar	BS23 539511	EF& Obs	Abundant S	-	Rare	-
Mataki 3 Mainstem	10 Mar	BS23 553505	EF& Obs	Occasional S	-	-	Rare K
Unnamed Creek 4a	10 Mar	BS23 549511	EF& Obs	Abundant S	Rare	Rare	-
Unnamed Creek 2	9 Mar	260M30 620116	EF& Obs	-	Occasional	Common	-
Mammoth Stream 2	9 Mar	260M30 638125	EF& Obs	Common S	Rare	Abundant	Occasional D
Unnamed Stream4b	10 Mar	260M30 650124	EF& Obs	-	Rare	Occasional	Abundant D
Unnamed Creek 5	10 Mar	260M30 654126	EF& Obs	-	-	Occasional	Common D
Mataki 2 Mainstem	10 Mar	260M30 639123	EF& Obs	Rare	-	Occasional	-
Unnamed Creek 3	10 Mar	260M30 619110	EF& Obs	Common S	Common	-	-
Mataki 1 Mainstem	10 Mar	BS23 536503	EF& Obs	Abundant S	Rare	Occasional	-

Abundant = [two fish symbols], Common = [fish symbol and small fish symbol], Occasional = [fish symbol], Rare = [small fish symbol],

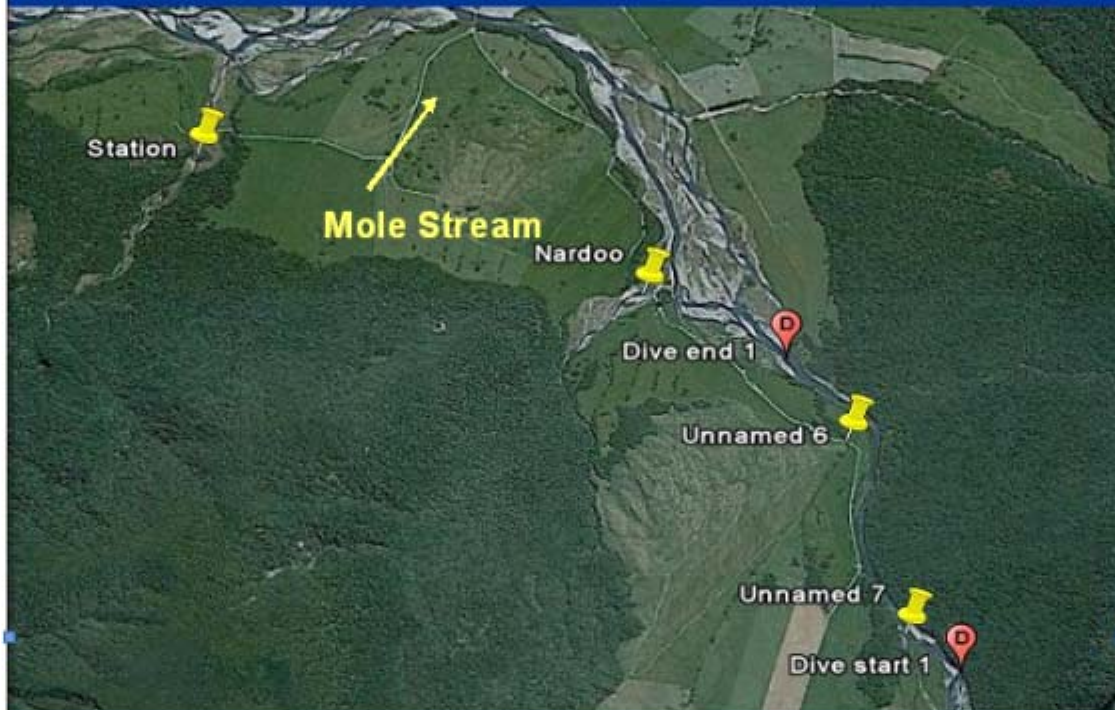
- Not Present, S = Spawning, D = Dwarf, K = Koaro

Figure 82: Matakitaki mid-Sites fish species, abundances and monitoring information.

Seven small tributaries and three reaches of the Matakitaki main stem were surveyed up to 5km upstream from the top of the gorge. Upland bullies were found in 80% of the waters assessed, though only abundant in one site. Their numbers may be influenced by brown trout occupancy that was abundant or common in half of the sites sampled. Dwarf galaxiid numbers also appeared to be related to trout density, being abundant or common where no trout were present.

Matakitaki Upper Sites

MATAKITAKI UPPER STATIONS



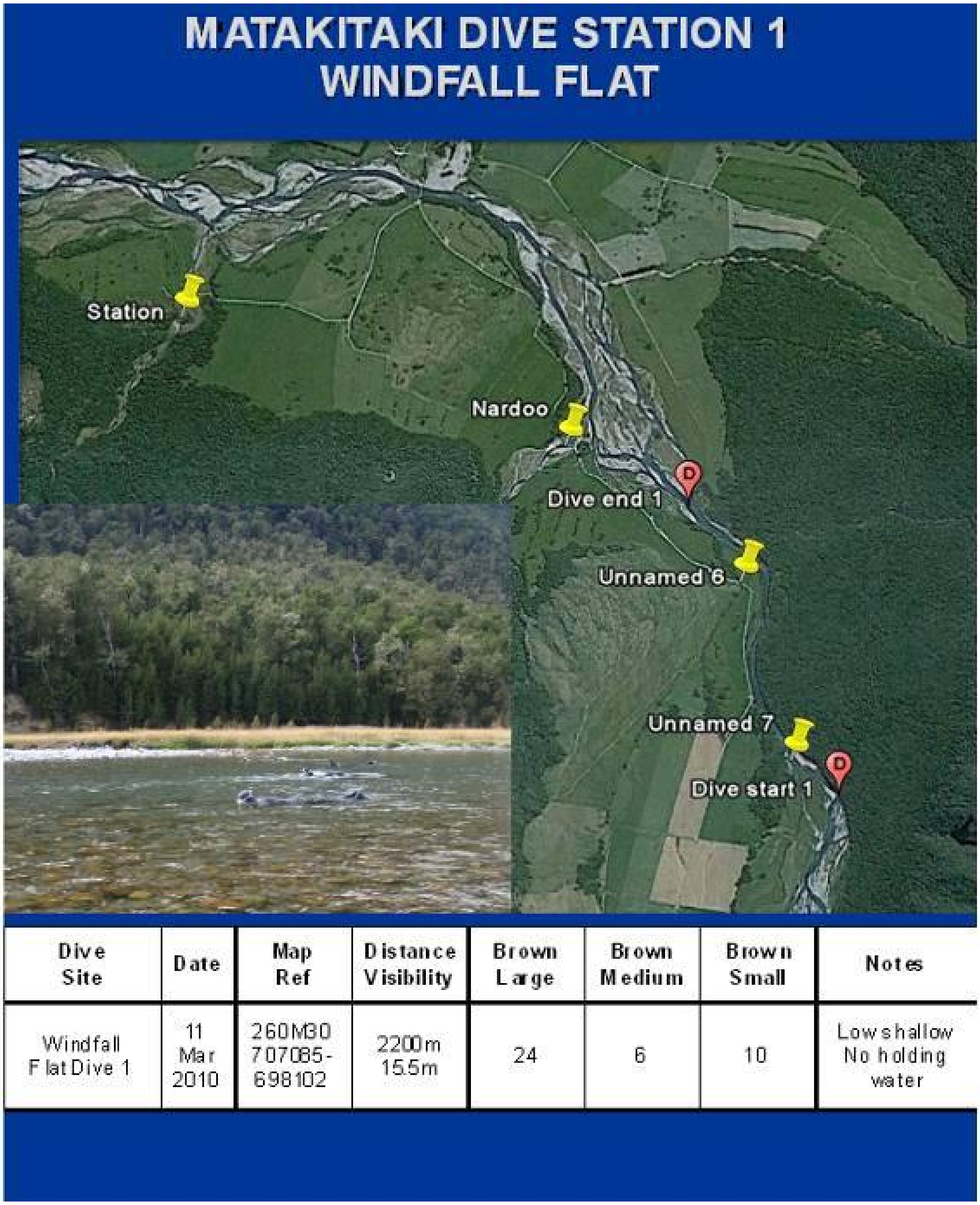
Station Name	Date 2010	Map Ref	Survey Method	Br Trout Abundance	LF Eel Abund	UL Bully Abund	Other Galaxiid
Nardoo Creek	9 Mar	BS23 593487	EF & Obs	Abundant S	-	Rare	Rare NG
Station Creek	9 Mar	BS23 574498	EF& Obs	Abundant S	Rare	Rare	Rare NG
Mole Stream	9 Mar	BS23 597535	EF& Obs	Occasional S	-	-	-
Unnamed Creek 6	9 Mar	260M30 703097	EF& Obs	Abundant S	Rare	-	-
Unnamed Creek 7	9 Mar	260M30 706083	EF& Obs	Common S	Rare	-	Abundant D

Abundant = , Common = , Occasional = , Rare = ,
- Not Present , S = Spawning , D = Dwarf , NG = Northern galaxiid

Figure 83: Matakitaki Upper Sites fish species, abundances and monitoring information

Five tributaries were selected starting from Station Creek to the last station 5km upstream. Brown trout were abundant in all of the tributaries sampled and this is an important reach for tributary spawning. Northern flathead galaxiid were found but rare in two of the sites, both of which were larger waterways. Longfin eel and upland bully were either rare or not present.

Drift Dive at Windfall Flat



Dive Site	Date	Map Ref	Distance Visibility	Brown Large	Brown Medium	Brown Small	Notes
Windfall Flat Dive 1	11 Mar 2010	260M30 707085-698102	2200m 15.5m	24	6	10	Low shallow No holding water

Figure 84: Matakitaki Upper Site fish species, abundances and monitoring information.

A dive count in the Matakitaki main stem was conducted through the upper station reach. The trout numbers were significantly lower than those observed in the gorge and the reach below. This was a result of low water levels and reduced holding water (i.e., long deep runs and deep pools).

Station Creek

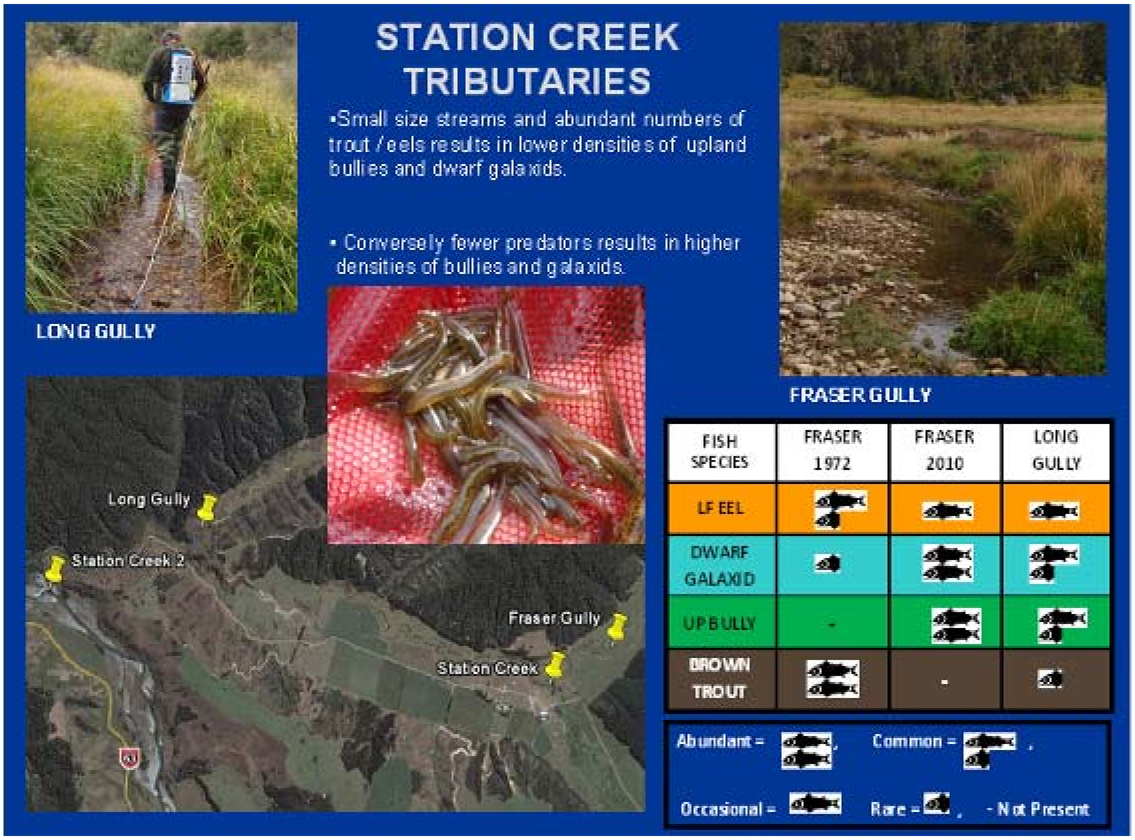


Figure 85: Station Creek fish species, abundances and monitoring information.

Station Creek enters the Buller River approximately 4km east from the junction of SH6 and SH63. A fish survey was undertaken to compare results from previous investigations dating back to the1970's. The survey showed that upland bully and dwarf galaxiid were abundant to occasional, despite sharing the creek with large numbers of brown trout. In two small tributaries of Station Creek, Fraser Gully and Long Gully, galaxiid and bully densities were lower when trout and eel numbers were high (1972) but were moderately high when predator populations were rare or absent (2010). However, regular monitoring of trout, eel and dwarf galaxias abundance in the Rainy River shows big variations from year to year. Analysis has not been done to see if there's any relationship between the densities of the different species.

Lake Matiri Catchment, Kahurangi National Park

Fish surveys in the Lake Matiri catchment showed that LFE, SFE, KO and UB were present. Koaro present in the catchment are landlocked and use the lake for the normally seagoing (whitebait) phase of their life-cycle (Mitchell, 2009). Evidence for this is from low strontium levels in koaro otoliths (earbones), low vertebral counts and the lateness of spawning (spring/early summer). Trout were introduced to the lake over a century ago but appear to have died out. Freshwater mussels (kakahi) are relatively abundant in the lake. Eels dominate the fish community in the catchment but appear to have declined between 1979 and 2007. Eels are the only fish migrating through the large boulder cascade at the lake outlet. Eel passage was a key issue in the Matiri Hydro-electric power scheme consent hearing and special provisions for this include:

- intake screens on the penstocks
- continuous residual flow over the weir for the whole nine months of the eel migration period (late spring-early winter)
- a plunge pool at the base of the weir to avoid damage to eels upon downstream migration
- rat trapping in the vicinity of the weir to reduce their predation on elvers and monitoring the effectiveness of eel pass provisions.

4.4 Relationship of Stream Habitat condition with Fish Abundance and Diversity

Streams were classified into four classes based on physical disturbance with 1 being the most disturbed. When calculating the average number of species into corresponding classes it was noted that the sample size of disturbance class 1 (5% of all sites) was too small to make a significant comparison. For this assessment, 21 sites were removed because only physical habitat was considered. Any waterway with a fish passage barrier or impedance structure was taken out of the analysis.

While it was on average three times more likely to find habitat-sensitive fish species at a sites in a virtually undisturbed stream compared to highly disturbed streams, there was a lot of variation in this relationship and these differences were not statistically significant (ANOVA; F_3=1.39 P=0.25, **Figure 86**).
There were also no significant differences among stream disturbance classes when comparing species richness for all fish species recorded per site (ANOVA; F_3=1.00 P=0.39; Figure 86B).

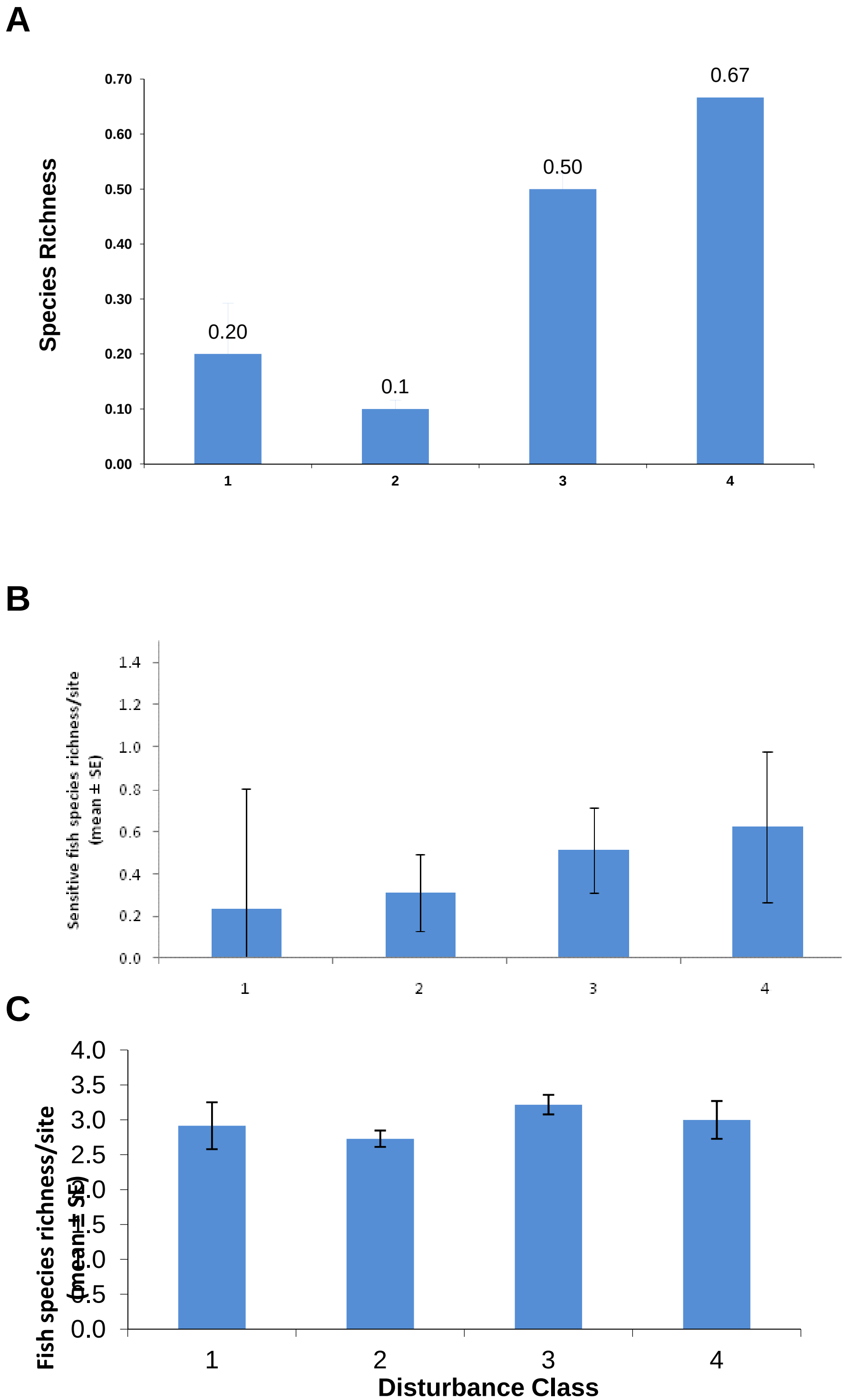


Figure 86: Mean habitat-sensitive fish species richness per site 2005 (A) and 2005-2010 (B) and overall fish species richness per site (C) for the four site disturbance classes (class 1 represents the highest and class 4 the lowest disturbance).

The number of species and relative abundance of habitat-sensitive native fish (see list of these in Section 2) was highest in the least disturbed streams, class 3 and 4 streams. This relationship was strongest in the earlier (2005) surveys which were all coastal lowland streams with more clear-cut habitat differences (Figure 86A). These least-disturbed streams contained 74% of all habitat-sensitive native fish recorded over all surveys.

Table 9: Proportion of streams containing habitat-sensitive species

	Class 1	Class 2	Class 3	Class 4
Proportion of streams in class containing habitat-sensitive species	9%	11%	30%	17%
Comment	100% of these (3) were banded kokopu	81% of these were banded kokopu and the remaining fish were dwarf galaxiid	2.3 % of these had more than one habitat-sensitive species	25% of these sites had two or more habitat-sensitive species

The habitat-sensitive species richness is illustrated in Figure 86A and B. These data show that sound riparian management practices such as fencing out cattle and riparian vegetation establishment is crucial for supporting habitat-sensitive native fish species.
In order to protect stream habitat, Part IV of the TRMP prescribes that streams must not be straightened or diverted, disturbance minimised and no destruction or removal of vegetation by root-raking, blading, or other methods that cause similar soil disturbance on the banks. It is permitted to take only 1m^3 of gravel and only from the dry bed of rivers more than 10m wide. Removal of pest plants such as grey and crack willow is permitted provided the tree roots remain in place to reduce erosion risk.

4.4.1 Effects of "Stream Cleaning" on Fish

While the controls in the TRMP give some protection to streams, it still allows for regular digging out of silt and deposits in lowland streams and this has been found to have significant adverse effects for 3-10 years after the disturbance. Faster recoveries of fish communities are known in higher-gradient mountain or hill-fed streams but recoveries can be even slower in low gradient lowland, wetland and spring-fed streams. It is these latter streams that are much more likely to accumulate sediment as settling velocities are much greater and therefore cleaning out of silt and other deposited material from these streams is relatively common. Concomitantly, the fish values of many of these streams can be

Figure 87: Stream clean of a creek near Murchison

high, particularly if giant kokopu are likely to inhabit the waterway. The concept of requiring consents only for high-value streams has been met with reasonable support across the resource user community, but unfortunately identifying and mapping these streams is difficult. This is due to the accuracy of the current digital elevation model and information on loss and gain of stream water to groundwater used by the New Zealand River Environment Classification (Snelder et al. 2004). Accurate mapping systems are critical if any rules that identify particular streams are introduced into regional resource management plans.One stream sampled in this programme that is subject to “cleaning” every two years or so, is the lower-mid reaches of Seaton Valley Stream. It is clear that the habitat and ecological health of this stream is greatly compromised by this activity. In the 1.2km upstream of Stafford Drive only a few inanga and shortfin eel were found compared to the reach immediately upstream which had virtually the same gradient and flow as this “cleaned” section. Because the upstream reach has been left undisturbed, it has good habitat with over-hanging trees and this results in high biodiversity (inanga, banded kokopu and shrimp were common, both species of eel and koura were also found). The “cleaned” area immediately upstream of Stafford Drive has been over-deepened causing the build-up of organic material and silt that has become anoxic to the extent that it is affecting the dissolved oxygen of the water column as well as the stream bed.

Cross-blading involves mass movement of bed material and probably has the greatest potential of all in-stream works to cause adverse effects on the stream ecosystem where the stream gradient and annual rainfall levels are low. Surprisingly, two years after this activity on Maud Stream (a tributary of the Howard in the upper Buller Catchment) the fish community appeared reasonably healthy with all four species present that were expected at this site. The reason for this is likely to be that mountain-fed streams in moderate or high rainfall areas recover naturally in a shorter period of time.

4.4.2 EFFECTS OF IN-LINE PONDS

While in-line ponds (ponds taking all the stream water at the inlet) can create landscape interest, they can cause water quality issues (particularly high water temperature and low dissolved oxygen) and remove quality flowing habitat. The installation of these in-line features needs to consider long-term effects on stream communities carefully. Research into the effect of in-line ponds (James, T, 2007; Maxted et al. 2004) show significantly hotter stream temperatures downstream of the pond outlet compared to the inlet. For this reason ponds should generally be constructed out of the stream or else good shade cover should be provided.

Figure 88: Templemore Pond in Reservoir Creek. This pond is approx 800m^2 and was shown to increase the critical temperature (midpoint of daily mean & daily maximum) by 2^{o}C.

Again it is often a question of scale and a few small (e.g., 200m^2) and well-shaded in-line ponds will probably not cause any adverse effect.

4.4.3 EFFECTS OF STREAM TEMPERATURE

Trout are the most sensitive fish in the district to high stream temperatures. When stream temperatures get above 19^{o}C trout will cease feeding, if they get above 25^{o}C for a sustained period they will begin to die and if they get above 30^{o}C trout cannot survive, even for a short period (Elliot, 1994). Trout deaths are recorded most summers in the Motueka catchment. A threshold temperature of half way between the midpoint of the daily mean and the daily maxima of 20^{o}C was used in assessing effects on fish. Temperature studies carried out at 50 sites around the district between 2004-2009 recorded 35 sites exceeding this threshold (Young et al. 2010a). Some of these sites exceeded the threshold for more than 50% of the record: Sherry and Tadmor Rivers (downstream 25% of catchments), Te Kakau Stream, Dove River, Moutere River, Powell and McConnon Creeks in the Motupipi catchment.

High stream temperatures is a widespread issue in Moutere hill streams and for many farmland streams where more than a third of their catchment is in pasture and without riparian shade. For this reason, streamside planting to create shade is strongly recommended.

4.4.4 EFFECTS OF PIPING STREAMS

Reticulating streams in culverts is known to reduce the diversity and abundance of fish and invertebrate life. Fortunately this activity does not occur frequently in Tasman District. However, a 140m section of modified stream (Eastern Hills Creek, a tributary of Borck Creek) was piped in 2008 to make way for a footpath beside Hart Road in Richmond. While the gradient was such that the culvert would unlikely cause a barrier to fish passage due to high water velocity, the quality of the stream habitat would be adversely affected if the bed was the raw concrete invert of the culvert. To solve this problem, baffles were installed within the culvert to retain substrate and therefore improve habitat. The ecosystem within the stream is still likely to be impaired because there is virtually no primary productivity (mostly algae growth) occurring within the pipes to provide food for macroinvertebrates which are, in turn, food for fish.

It is important also to consider the scale and contiguous nature of piping. Assuming good in-stream habitat and continuous fish passage such as provided by box culverts; (Doehring et al. 2011), piping short lengths (e.g., up to 100m) of stream are unlikely to cause significant adverse effects on the fish population, as fish might benefit from the cover provided. This was demonstrated at a site on a tributary of Kaiteriteri Stream running through a 50m section of box culvert in Bethany Park where there was no significant difference in the fish community inside or outside the culvert.

4.4.5 Effects of Fine sediment Discharges

Fine sediments clog the interstitial spaces between stones and blanket surfaces, thus rendering these areas unsuitable for production of invertebrates. Most of New Zealand's native fish species are crevice dwellers, at least for part of their life history, and again, open substrate is important. Of the 20 species recorded in Tasman, at least 13 are crevice dwellers for most of their lives in freshwater, with non-crevice dwellers being three pelagic (open water) species (inanga, smelt, yelloweye mullet) and the three kokopu species.

In general, Tasman compares well to the rest of New Zealand for water clarity (Young et al. 2010a). However, there are a large number of smaller lowland streams flowing through intensively used land (mostly urban or intensive pastoral) which are degraded. Significant discharges of fine sediment have been recorded in the district in the last decade from earthworks associated with road building, subdivisions, re-contouring or disking (e.g., for farming or horticulture) and forest harvesting (see Section 6.4 of Young et al. 2010a).

Figure 89:. Fine sediment in the bed of the Onekaka River

4.4.6 Effects of discharge of toxic substances

Most fish kills from substances toxic to fish have occurred in urban areas, in both industrial and urban zones. Uncontrolled discharges to the stormwater systems have been evident in Richmond, Motueka and Takaka. Some examples include:

- February 2003. Pesticide was discharged from the residential area in the mid-catchment of Jimmy-Lee Creek Richmond. Eels and some banded kokopu were killed.
- March 2004. A spill of unknown chemical to Woodland Drain a small coastal stream in Motueka. Unknown number of eels and inanga killed.
- January 2007. A spill of ammonia from a coolstore to Woodland Drain a small coastal stream in Motueka. Almost 200 eels and inanga were killed.
- 2007. Hi-cane (an anti-budding chemical) from a kiwifruit orchard in the Riwaka catchment was alleged to have been responsible for fish kills in that river.
- 2010. Eels and inanga killed from cement washing discharges in Reservoir Creek, Richmond.
- March 2011. Eastern Hills Drain (tributary of Borck Creek) upstream of Gladstone Rd. Department of Conservation application of Rotenone to try and eradicate *Gambusia* (mosquitofish). Eel deaths recorded.

Department of Conservation occasionally use lethal means to manage pest fish. Unfortunately there are sometimes a few native fish killed also, despite efforts to try and fish-out as many fish as possible from the affected reaches first. Rotenone (a natural product) has been used to try and eradicate *Gambusia* (mosquitofish) from small creeks and drainage ditches in Richmond with resultant eel deaths. These fish are expected to have spread from Orphanage Creek in Stoke (Rotenone was used in this creek in 2008).

5. RESTORATION OF FISH COMMUNITIES

5.1 RESTORING STREAM HABITAT

Rehabilitating streams by re-establishing a natural meander pattern, channel cross-section profile and variety of water depth and widths, as well as riparian planting is well-known to improve the ecological condition of the stream provided that there is good water quality, stream sediment quality and no fish passage barriers. With any project it is important that the objectives are clear and that it is well planned. The riparian planting must be suitable for the particular site e.g. particular grasses or sedges should be planted in areas with potential for inanga spawning, rather than trees. Follow-up weed releasing for the first three years is usually essential to get good riparian native plantings established.

While improving stream habitat can sometimes be a cost to adjacent landowners, in most cases it is not likely to cause significant adverse effects on the economic viability of the surrounding land use. The costs include loss of land from production through retirement of a small strip of land along the stream side. However, there are often significant economic benefits such as health of stock from improved water quality. Reduced rates of soil loss to the stream may be achieved reducing the need for regular stream maintenance. Stock condition may also be improved by having shaded resting areas.

With better understanding of fish distribution and abundance pattern, activities in streams that can potentially cause long-term adverse effects, such as stream 'cleaning' or stream training (in the case of highly mobile stream beds), can be re-designed to be undertaken in a manner that maintains, or enhances, fish populations. This can be achieved by avoiding certain times of the year, minimizing removal or replacement of woody debris into streams, maintaining the natural meander pattern. With council funding available to fence and/or planting stream sides, costs to adjacent landowners can be minimized.

Figure 90: Highly degraded stream on farmland near the Waimea Inlet that needs restoration.

Woody vegetation along the stream not only creates good bank form, in-stream cover and food for stream life (an example being the leaves and insects directly falling into the water) but has indirect affects by lowering water temperature. High stream water temperatures have been found in unshaded streams, particularly in many parts of the Motueka/Motupiko, Moutere, and Waimea areas. These high temperatures cause widespread adverse effects on all life in the waterway. It has been found to take only about 200m for the water to heat up significantly after it flows downstream out of a shaded area (Baillie, B; 2002).

5.1.1 RESTORING INANGA SPAWNING HABITAT

It appears that in this district, as with most of New Zealand, there are better whitebait catches where the amount of spawning habitat and adult habitat is available. Golden Bay has generally better catches than Motueka-Riwaka area which is in turn better than in the Waimea area.

Pools, slow runs or backwaters with over-hanging rushland/grassland or aquatic plants near the upper limit of the salt-water wedge associated with high tides are the preferred habitat for spawning. Ways to protect and restore inanga spawning habitat are outlined in Richardson and Taylor (2002) and in Hickford and Schiel (2010).

There are relatively few sites in the District where inanga spawning has been witnessed. They include: Parawhakaoho River, Puremahia River, Wainui River, Marahau River, Otuwhero River, Riwaka River, a spring-fed tributary of Motueka River, Moutere River, and Pearl Creek. One of the key strategies for improving the whitebait catch is know the location of and protect inanga spawning sites. To date relatively little effort has been put into surveys to find these sites. Spawning grounds do not always remain good for spawning because of being over-run by weeds or by mowing or structures such as rock protection and tidal flap gates. Common riparian plants/weeds not suitable for spawning include: willow, blackberry, gorse, wandering dew, yellow-flag iris, Mercer grass or *Glyceria*.

Council and University of Canterbury have produced information packs for high schools to try and get students interested in some of the less obvious and seldom-seen aspects of ecosystems around them, as well as the spirit of discovery experienced when finding spawning sites that have never before been recorded. There is also a great deal of very integrated and stimulating learning with this project. Examples include:

- relationship of moon and tidal cycles with fish movement
- salt water wedge formation and associated plant communities (mapping out the salt water wedge is easy to do with conductivity meters)
- how pests (mice) and physical conditions (e.g. temperature and moisture) and associated vegetation (or artificial substrate) structure affect egg survival.
- Reproduction strategies for plants favoured for spawning and how to restore such habitat

5.1.2 RESTORING GIANT KOKOPU HABITAT

Several projects around the district have restored wetlands and ponds that are the favoured habitat for the successfully re-introduced (mostly self-introductions) giant kokopu. Figure 91 shows one of a series of small in-line (inlet and outlet connected to the stream) pools in Horton Valley, a tributary of Tasman Valley Stream where wetland restoration has been conducted as part of a subdivision project (see Section 4.3.10). Prior to this project, Horton Valley stream was a straight drainage ditch. Rather than hard structures to reduce erosion on the dams forming the pools, vegetation was used. While some erosion has occurred using this approach, this is considered minor and has created some natural channels. Figure 92 is a photo of a wetland near Puponga developed by Department of Conservation which was colonised by giant kokopu (M Rutledge, pers.com).

Figure 91: In-line pools with Horton Vallev Stream. near Tasman

Figure 92: A Department of Conservation giant kokopu restoration project near

Future projects include Challies Island wetlands in Appleby that will eventually be connected to the Waimea River, Christofski ponds near Mariri and Mapua Wetlands near Aranui Park, Mapua. Whitebait from the spring 2011 run will be caught from streams in the area (not the Waimea River as this was found to contain Didymo) and released into these areas (about 3000 (2kg), 2000 (1.5kg) and 1500 (1kg) of fish for each of these respective areas).

5.2 Fish Passage Barriers

With a few notable exceptions, most migratory species are less common above obstacles to upstream migration. Manmade structures have been estimated to exclude at least some fish species all the time from about 400km of stream in Tasman (these are "all flow barriers" and identified on Figure 94, 95 and 96 as red dots) (Joy 2011). A further 1000km of stream is restricted most of the time. This is an estimate based on GIS analysis of the current 'River Environment Classification' river network which does not include some first and second order streams and includes some streams that dry for the majority of the year. While reasonable effort was made to correct for these discrepancies, in several cases the information is not available. In addition, to verify the exact severity of restriction at many sites requires a fish survey which is unrealistic due to the expense. However, we are reasonably confident that the estimates for "all flow" barriers would be within 10-20% of the true value.

5.2.1 The Current Situation in Tasman District

From December 2004 to December 2010, 1150 structures were surveyed according to the methods described in Appendix 2A[2] (Figures 94-96). Of these:

[2] As at Dec 2010, excluding structures which have been fixed.

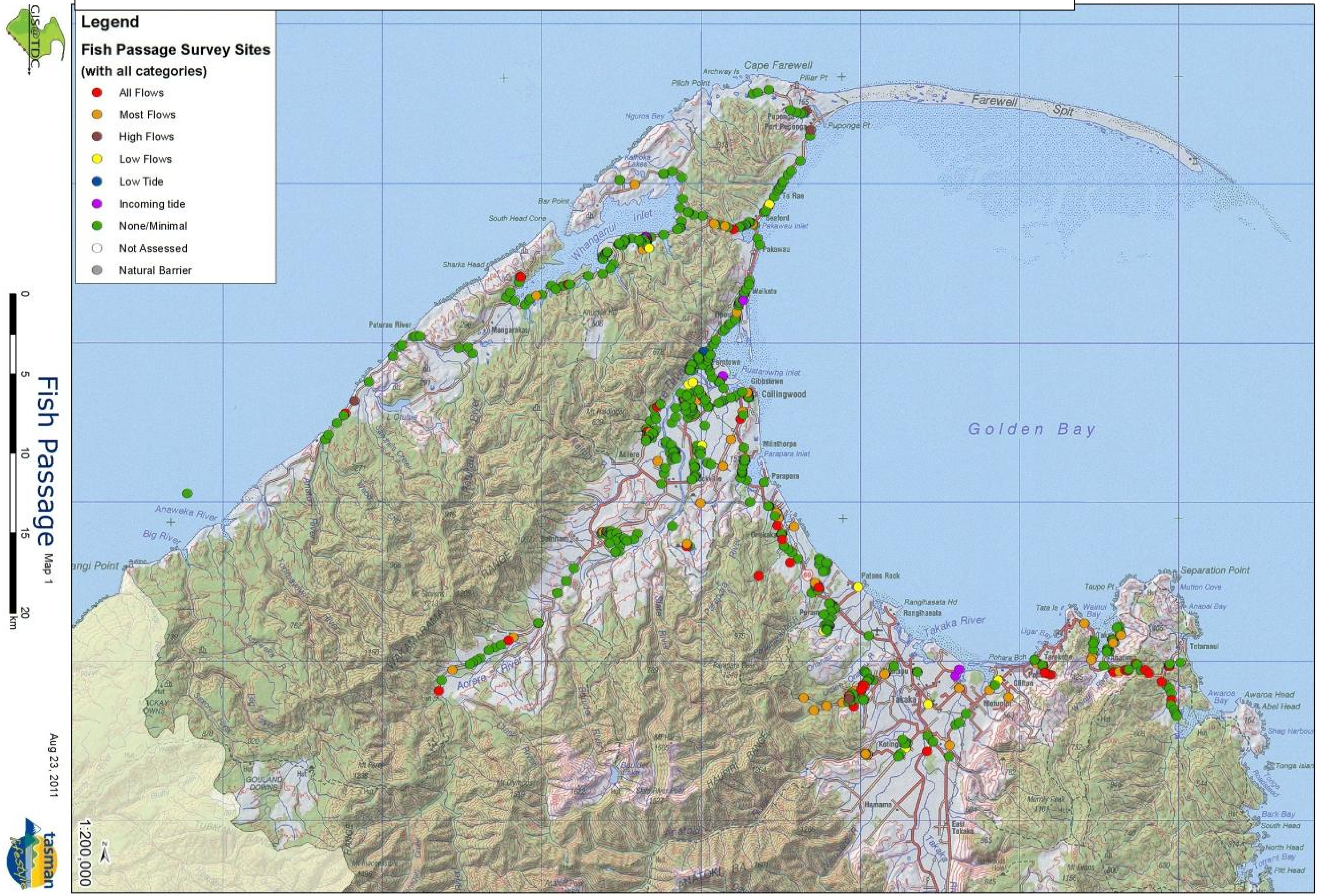
- 345 (~30%) are likely to be barriers to, or impede, fish migration
- 240 are perched culverts (70% of all likely barriers)
- 115 are serious barriers at all flows (~10% of likely barriers)
- 24 are tidal flap-gates (~7% of likely barriers)

A disproportionately high number of fish passage barriers are present in streams of Separation Point geology (Land Disturbance Area 2 as defined in the Tasman Resource Management Plan). This area includes most of Abel Tasman National Park and Wainui Bay, a band along the lower Motueka Valley (particularly the West Bank) and up the Dart/Sherry River Valleys to Kawatiri Junction and Mt Murchison (see brown-coloured area in Figure 93). Fish passage barriers form readily in these streams after high rainfall events due to the granite being highly erodible.

Figure 93: 'Land Disturbance Area Two' shown in brown.

Chemical migration barriers are likely at several streams between Pakawau and Puponga (culvert 76-79). The extremely low dissolved oxygen near the coast in summer in these streams may be due to methane vents, a most unusual situation.

Figure 94: Classification of Structures in Waterways for Fish Passage - Golden Bay ("All Flows" means a fish passage barrier at all flows)



Sourced from Land Information New Zealand data. Crown copyright reserved. Aerial photography copyright Terralink International Limited. Rural Imagery flown Dec2000-April2002, Urban Imagery flown Dec2004.
The information on this map is prepared for indicative use only and is not intended for definitive legal, location or formal reference purposes.

Figure 95: Classification of Structures in Waterways for Fish Passage - Tasman Bay -Motueka River Catchment ("All Flows" means a fish passage barrier at all flows)

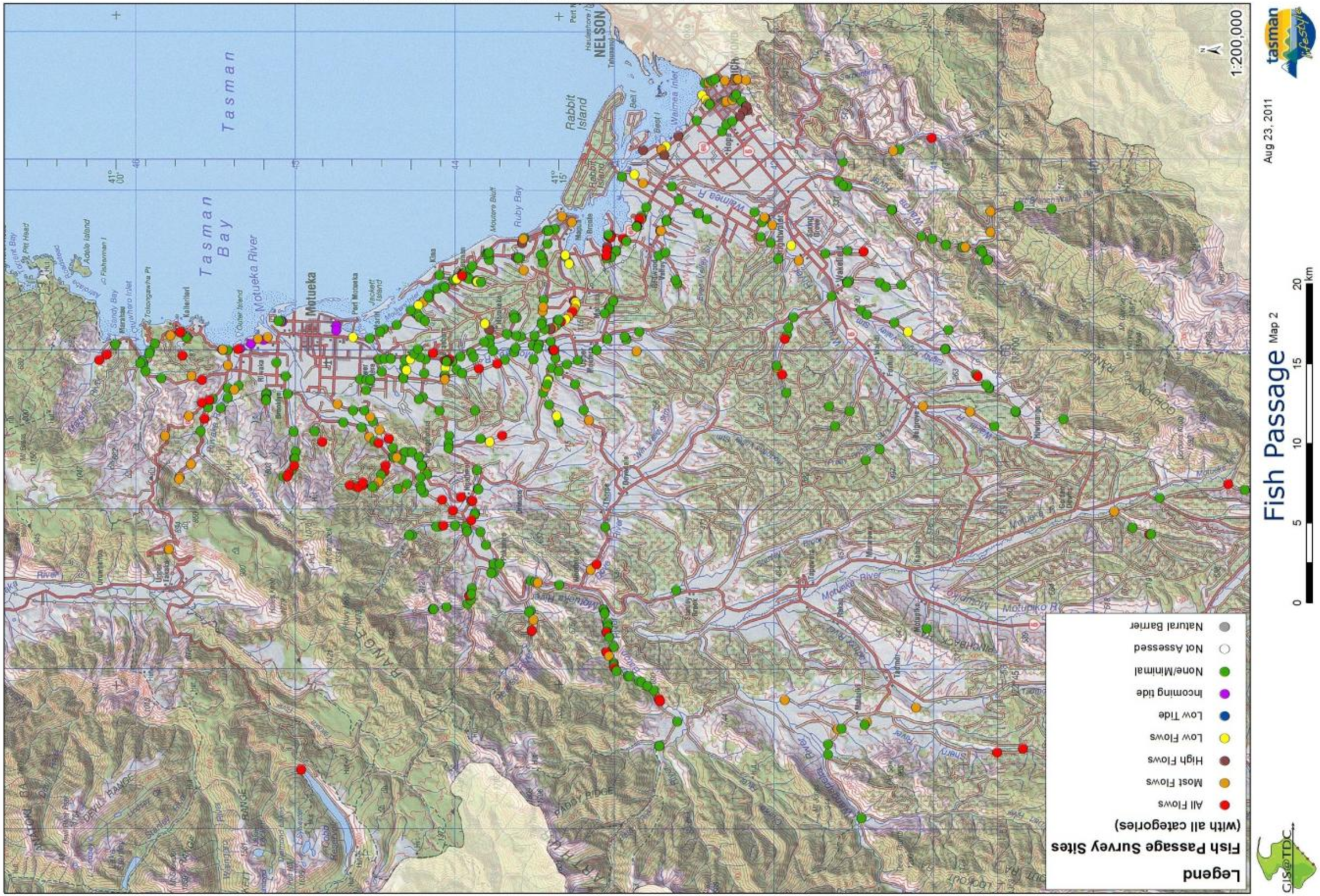
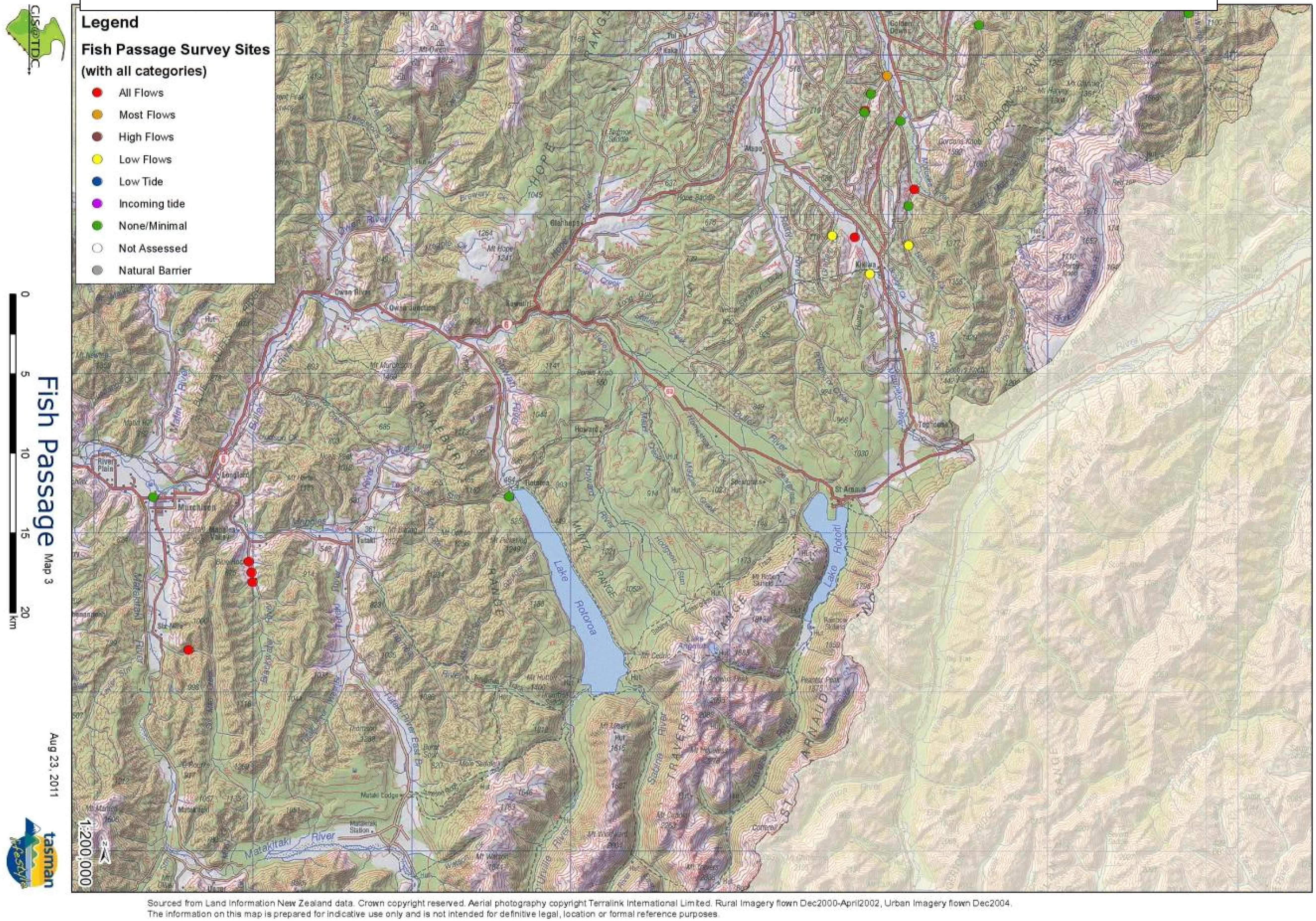


Figure 96: Classification of Structures in Waterways for Fish Passage - Buller and upper Motueka River Catchments ("All Flows" means a fish passage barrier at all flows)



5.2.2 FISH PASSAGE AT TIDAL FLAP-GATES

At least 24 tidal flap-gates are known to exist in Tasman with varying affect on preventing fish migration and water quality (examples shown in Figure 97). While the flaps on these structures open as the tide falls the velocity is often too great for fish to swim up against. Some may allow a few fish to enter just as this flow eases and before the incoming tide that pushes the gate closed again. Because of reduced flushing and flow of water on the landward side of the structure water becomes stagnant and with the general lack of shading in these situations water temperatures are often too high for many fish and the dissolved oxygen too low to provide good habitat.

Figure 97: **Left: Hamilton Drain near Riwaka (FP0412), right: North of Hamilton Drain near Riwaka (FP0850)**

Fish passage through culverts with flap-gates that prevent flow of water upstream on an incoming tide were studied using a Dual-frequency identification sonar (DIDSON) at Pearl Creek, and a spring-fed stream in the Motueka delta (Doehring et al. 2011, Strickland and Quarterman 2007). This technology was very useful as it detects fish continuously at night and in water with poor visibility. Each situation was different with water velocity and poor upstream habitat limiting recruitment potential.

In the Pearl Creek situation the gate (Figure 98) is open for 8.5 hours and closed for 3.5 hours of every tidal cycle. When it is open, there are steady velocities over 0.3 m/sec and galaxiids were observed to accumulate around the gate and attempt head into the culvert but don't appear to cope with the water velocity with none observed to pass through the culvert. Three passes of eel were observed. Good galaxiid rearing habitat exists upstream of the culvert and will improve over time as the plantings of a restoration project mature. However, removing this tidal flapgate is likely to be disadvantageous for giant kokopu in the creek and a local water take as it would increase the salinity of water in the creek. However, there are

Figure 98: Tidal flap gate at Pearl Creek.

smart flap-gates that can release a prescribed amount at any point in the tide cycle. This would mean that it could be programmed to allow only a small amount of saltwater to enter the creek, thereby maintaining the freshwater quality of the creek. Apart from fish passage there is no other need for this culvert to be upgraded at this stage.

In the case of the west-Motueka spring stream culvert, galaxiids were seen to pass through the culvert at times when the water velocities abated at the top and bottom of the tide but few got through in between times. Poor habitat upstream of the tidal flapgate limits fish productivity and diversity in this waterway.

Addressing fish passage at tidal flap-gates will have to be on a case-by-case basis and prioritised on the basis of quality and quantity of habitat upstream.

Fish-friendly tidal flap-gates can be easily retro-fitted to existing culverts and are not expensive to purchase and install (approximately $4-5000). A mechanical arm connects a bracket on the headwall of the structure to the gate (Figure 99). The arm is adjustable which determines how much the gate is held open (Figure 100 A and B). The control arm is fitted with weights of a size that is appropriate to control when the gate will close on the incoming tide. Weights can be added or removed to control the length of time the gate is open (Figure 100C). The weights keep the gate open until such time as the weight of the incoming tide over-powers the weight. Floats that fill with water after a prescribed amount of time can also be used to control the length of time of the flap opening (Figure 100D). In a flood event from upstream a secondary hinge point allows the tidal flapgate to fully open to expel water as the original tidal flapgate was designed to do.

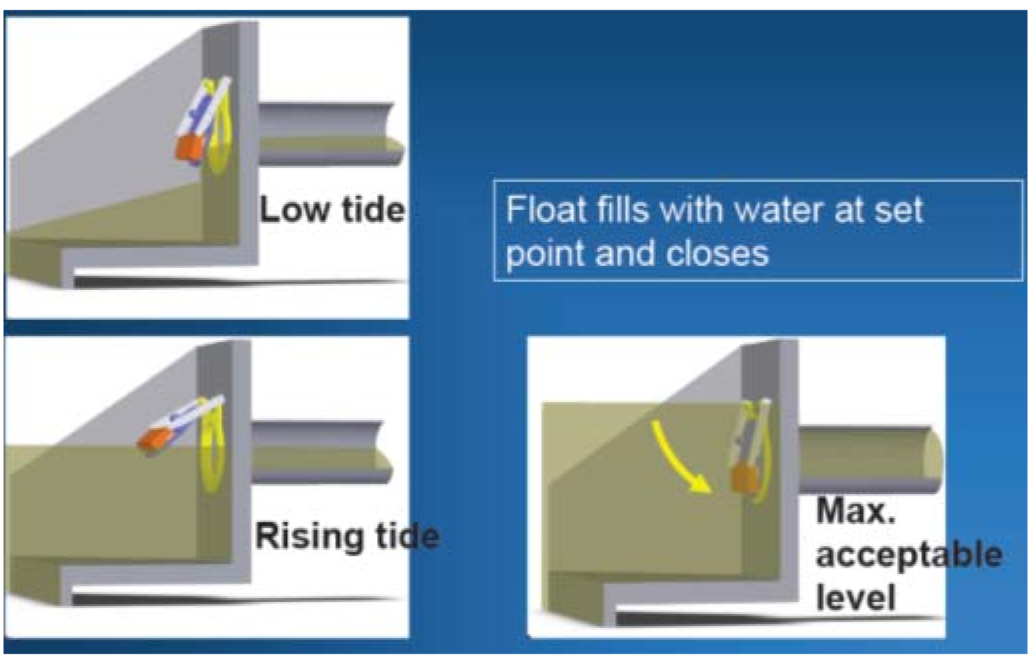


Figure 99: Cross-section of a fish-friendly tidal flapgate showing operation at different points of the tide.

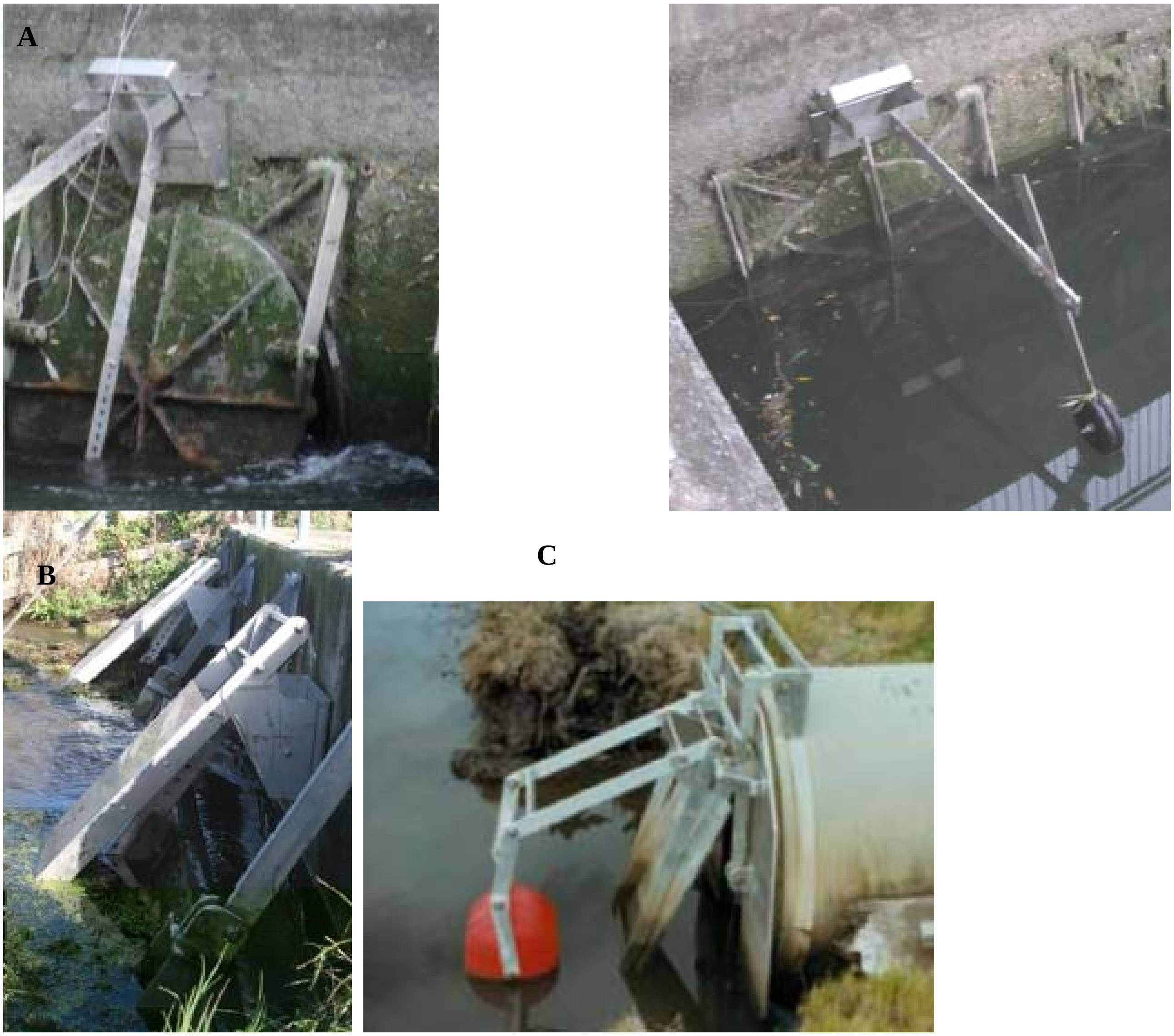


Figure 100: Retrofitted tidal flapgates showing the control arm connection with the tidal flapgate and headwall at low tide (A), the weight controlling the timing of opening at high tide (B), using weights to control the opening times (C) and a fish friendly tidal flapgate using a float (D); Photo courtesy of Kelly Hughes, Advanced Traffic Supplies.

5.3 Restoring Fish Passage

All likely fish passage barriers were put through a spreadsheet matrix to come up with a priority for remediation. This analysis included the following criteria:

- distance from the sea
- catchment area upstream (surrogate for quantity of habitat available upstream)
- proportion of indigenous forest upstream (surrogate for quality of habitat upstream)
- stream bed gradient
- proximity to another barrier (including natural barriers)
- assessment of severity of fish passage restriction (i.e. all flows, most flows, low flows, high flows).

This priority list has been used to guide a programme of remediation across the district but when a number of barriers exist in a particular area, it has often been more efficient to deal with them as a package.

Between 2005-2010, 16 of the top 50 fish passage barriers have been remediated, giving fish access to streams draining a total area of 4200ha. The bulk of that area has been from remediation of an old weir used for hydrology monitoring on Moutere River downstream of Old House Rd. High-quality aquatic habitat has also been opened up again at Wainui Bay in Golden Bay, plus Onekaka and the Aorere Valley.

Under the Tasman Resource Management Plan, every new structure must provide passage for fish where significant populations could exist upstream. For structures existing before 27 February 2010, the proposed rules allow five years before fish passage must be provided. Resource consent is not required for culverts in smaller waterways.

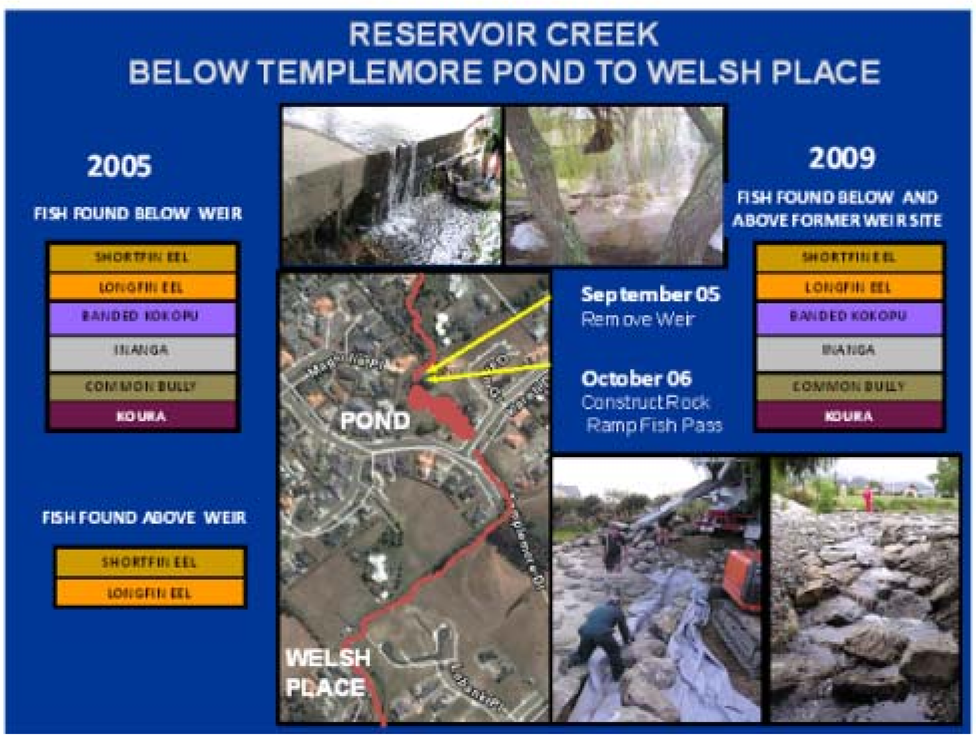


Figure 101: Fish found in Reservoir Creek before and after a weir was removed.

Upstream migration by habitat-sensitive species appears to be restricted by in-stream features in a few of the waterways such as the former hanging culvert mid-way up Reservoir Creek, Richmond. Fish surveys in March 2005 showed inanga below Templemore Pond, but not upstream. In September 2005 an unused weir located below the pond was removed for the express purpose of restoring fish passage. In March 2006, three inanga adults were captured upstream of this site (at Welsh Place). The removal of the weir, however, affected the gradient of the pond outlet and some erosion of the outlet structure caused a fish barrier to develop. In October 2006 the outlet structure was improved to provide fish passage as part of a Ministry for the Environment-funded community project. This was a major success and both banded kokopu and inanga were observed upstream of the new fish pass (Welsh Place/Hill Street) during this SOE investigation. Unfortunately, a new barrier formed at a site about 50m upstream of Salisbury Road. This is a waterfall flowing over the soft-bottomed (clay) bed. It was originally formed when rip-rap rock protection was placed in the stream to protect the (then new) pedestrian underpass (constructed in 2005). Erosion started at the interface of the rock and soft bed and the erosion scarp has retreated steadily since.

Figure 102: Stainless-steel baffles installed in culvert 25 in Wainui Bay

In order to reduce water velocity barriers, baffles have been installed in two culverts in Wainui Bay (culverts 23 and 25 on McShane Rd; Figure 102). The large weir in the Moutere Ditch near Old House Road was deeply undercut and prevented smelt, inanga and banded kokopu from moving upstream. The remediation at this site involved building a substantial ramp of rock and concrete. Because inanga habitat is available upstream on this waterway and inanga are the weakest swimmers, the weir "ladder" incorporates small pools for them to rest in between their burst swim attempts.

Over-hanging culverts make up 70 percent of all observed fish passage barriers. For most sites the maxim "fish are good climbers and lousy jumpers" applies; so even if you have a vertical face, it is much better than an overhang. Often the solution to overhanging culverts is simple and cheap such as using used conveyor belt material.

Figure 103: Conveyor belt material bolted on to the outlet end of culverts to assist fish passage

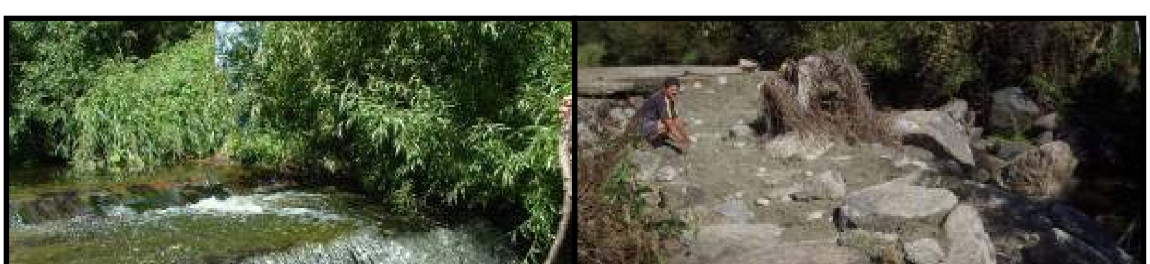


Figure 104: Improvements to structures to provide better fish passage, Moutere River before (top left) and during remediation (top right), Waiwhero Stream (bottom left) and Nile Creek dam (bottom right).

Figure 105: McShane Rd, Wainui Bay (Culvert 9) on before (left) and after remediation for fish passage

Figure 106: McShane Rd Culvert 23 before (left) and after (right)

5.3.1 NATURAL BARRIERS

Natural barriers are mostly found in steep mountainous terrain which is usually distant from the sea. Very few natural fish barriers have been found in the district. A reason for this is that they are usually found in areas which are located in inaccessible terrain. A series of natural barriers were found in the upper Waitui Catchment above which no fish were found at all (see Figure 107**Error! Reference source not found.**). Other waterfalls in the district such as Maruia Falls and Wainui Falls have distinctive and isolated populations upstream.

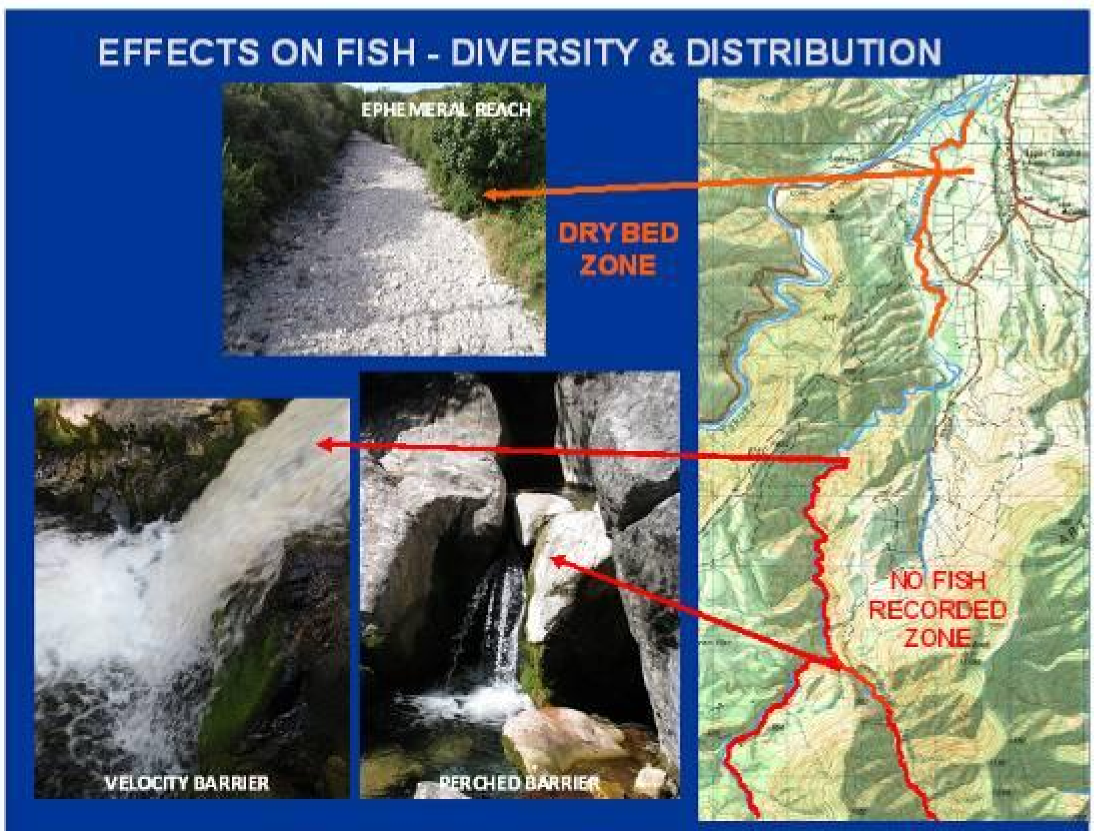


Figure 107: Natural Barriers in Waitui Stream, Upper Takaka

Capture and Transfer via Resource Consent Conditions

In recent years TDC have placed capture and transfer conditions on Resource Consent applications where barriers to fish passage exist for periods longer than usual or where newly constructed permanent structures compromise fish passage all together

An application on the Waitui Stream in Golden Bay for irrigation and hydroelectric power (HEP) is one such example. As part of the irrigation scheme the applicant must mitigate entrapment of fish in a settlement pond if return paths built into the pond are not successful. As part of the HEP, eel elvers and other native fish which are restricted to moving upstream from the tail race must be captured and transferred upstream to ensure continual recruitment. Any fish stranded by the activities must also be salvaged and relocated.

Conditions relating to construction of the Kainui Community Dam, a tributary of the Wai-iti River, state that the applicant must establish an eel monitoring programme and a manual transfer scheme to ensure continual recruitment above the dam. Here migrating eels will be captured (Figure 108) and relocated to wetlands above the weir and dam.

Short-term effects on fish, such as the replacement of culverts where flow diversion is required, also necessitates a salvage transfer operation, such as most recently on Seaton Valley Stream.

Figure 108: Migrating Eel Elver at V-Notch Weir Kainui Dam

6. IMPROVING THE HEALTH OF WATERWAYS

WHAT IS COUNCIL DOING ABOUT IMPROVING THE HEALTH OF RIVERS

The following **initiatives** have been undertaken by Council **to improve stream habitat** in Tasman's rivers:

- In order to reduce disturbance of waterways by farm animals, council has provided funds to construct about 20 km of fencing each year, and 175.85 km of fencing from 2000-2010 has been achieved. Over the last 5 years this work has focussed on the following catchments:
    - Golden Bay: Aorere, Takaka, Waingaro, Wainui, Go A Head, Parawakaoho, Puremahia, Onahau Rv.
    - Motueka: Baton, Wangapeka, Moutere, Motupiko, Stanley Brook, Dove, Orinoco, Sherry
    - Buller: Maruia, Buller, Matakitaki, Mangles, Tiraumea, Gowan, Owen, Howard, Murchison Ck.
    - Waimea catchment: Wairoa, Wai–iti.
- Provided two-day workshops for sediment and erosion control with almost 120 people involved in earthworks (September-December 2009).
- Produced revised engineering standards (including a section on sediment and erosion control) for planners and contractors involved in various developments.
- Worked with several Streamcare groups to provide advice and encouragement to improve water quality and aquatic ecoloty. In some cases assisted in fund applications.
- Put a stop to many operations causing significant pollution.
- In the 2010 planting season Council's Parks and Reserves Dept planted about 10000 trees, shrubs, and tussocks in stream riparian zones. Reservoir Ck (3100), Roding (Hackett, White Gates, and Twin Bridges Reserves; >2000), Lee Rv (Meads and Firestone Reserves; 900), and Wai-iti River (2000 in Two Rivers Reserve and ~2000 in Faulkners Bush and Wai-iti domain). Previous years included plantings at Brooklyn Reserve, and Te Kakau Stm (Feary Cre Reserve). Plantings over the last few years in riparian zones have slowly increased.
- Removed crack willows (*Salix fragilis*) from about 30 km of waterway (between 2008-2010). This willow grows along many of our waterways and propagates easily from detached branches and twigs. A 20-year programme started in 2009, to minimise the existence of crack willow along 285 km of river classified for flood protection and drainage. Council plans to remove such willow along 15-20 km of Classified River banks each year. Where Crack willow has been

removed, Council will be using other plants or control structures to manage the river banks. There are many other river banks and places on private land where propagation of crack willow is now not permitted. Crack Willow is a species that Central Government added to its list of "unwanted organisms" and therefore Council can no longer propagate it for use on river banks and it must be progressively removed. This is also reflected in Council's Regional Pest Management Strategy. While willows create shade and habitat for the waterway, which is a positive influence, they also spread prolifically, cause an increased flooding risk, blockages, a danger to various recreation activities, and are associated with lower biodiversity than for streams with native riparian trees (poorer food supply to the river). They have been declared a pest plant, so Council must have a programme to remove willows.

- Control of priority aquatic weeds such as Hornwort, Reed Sweet Grass, *Lagarosiphon*, Parrots Feather, and Chilean Rhubarb

Council community planning methods to address stream habitat issues

Objective 27.1.2.1 of the Tasman Resource Management Plan (TRMP) sets out that "*The maintenance, restoration and enhancement, where appropriate, of aquatic habitats in the beds of rivers and lakes that is sufficient to:*

(a) Preserve their life-supporting capacity (including the mauri of the water)
(b) Protect their values for native fisheries (including inanga and eels), trout fisheries and wildlife (including indigenous bird species)
(c) Protect or enhance indigenous biodiversity values.

Policy 27.1.3.1 of the TRMP sets out to avoid, remedy or mitigate adverse effects on aquatic ecosystems of structures and activities in, on, under or over river and lake beds, including adverse effects on:

(a) fish passage;
(b) fish habitat, especially that of indigenous species including giant kokopu, whitebait species, eels and including trout;
(c) fish spawning areas;
(d) bird habitat, especially indigenous species and during nesting and rearing;
(e) fish entrainment or stranding;
(f) invertebrate habitat and spawning areas due to smothering by sedimentation;
(g) shelter, shade and detrital food source for aquatic life;
(h) habitat of indigenous aquatic and terrestrial flora and fauna,
(i) riverbed substrate composition, hydraulics and channel morphology.

The list of water bodies and catchments (Table 10) shows where the aquatic habitat is degraded or is at risk from human activities, and would benefit from action to improve or safeguard the water body for the above reasons. This list is not exhaustive and priority

rankings are suggested on the basis of risks to existing uses and values, and benefit versus cost. It should be seen as a provisional outline of what could eventually be a more comprehensive approach to water body management that also takes into account provisions in Part II (in relation to riparian margins), Part IV in relation to activities in the beds of rivers and lakes, and Part V for the TRMP in relation to water quantity.
Several of the streams or catchments listed are **representative of many streams** in that landuse and stream type. Examples include:

- Waiwhero Creek and Moutere River are representative of many small hill-fed streams in Moutere geology, with the majority of the land developed in sheep and beef pasture.
- Seaton and Tasman Valley Streams are representative of lowland-fed streams in Moutere geology.
- Sherry River is representative of hill-fed streams in intensive pastoral land, such as the Tadmor and Hope Rivers.
- Burton Ale, James Cutting, and Mackay Creeks are similar, and are representative of small lowland-fed streams in intensive pastoral land with warm, extremely-wet climate.

Table 10. Waterbodies recommended for remedial action for stream habitat.
* Refer to Table 9 in Young et al, 2010. Values listed in italics are not listed in the Tasman Resource Management Plan Schedule 30.1

River	Water Body Values identified so far in Schedules 30.1, 36.1A and B	Stream Habitat issues	Possible Action required	Possible Priority for Action
Golden Bay				
Kaihoka Lakes (east and west)	*Significant banded kokopu and freshwater mussel communities*	Nutrient run-off from two small catchments feeding the lake. Vulnerability to aquatic weed introductions	Fence and plant (wetlands or forest as appropriate) 30m buffer from the lake edge on each lake. Signage at lake warning about introducing weed. Regular weed surveillance.	High
Pakawau Inlet tribs	Significant whitebait fishery values Includes possible inanga spawning areas	Lack of riparian trees providing shade, cover, woody debris to the stream Lack of riparian wetlands in the lower catchment. Cattle trampling.	Fence and plant (wetlands or forest as appropriate)	High
Plumbago Ck	Significant whitebait fishery values Includes possible inanga spawning area	Lack of riparian trees providing shade, cover, woody debris to the stream Lack of riparian wetlands in the catchment.	Remeandering, fencing and planting	Medium-high
Mackay Ck		General lack of riparian trees in mid reaches. Lack of wetlands buffering flow and mitigating nutrient run-off in flatter reaches. Creek has been straightened near Collingwood-Bainham Rd (both upstream and downstream).	Riparian fencing and planting. Consider placement of a few boulders to encourage meandering.	Medium
James Cutting Ck	*Significant whitebait fishery values*	Lack of wetlands buffering flow and mitigating nutrient run-off in upper reaches. General lack of riparian trees in mid-lower reaches. Potential to improve inanga spawning habitat in lower reaches. Creek has been straightened on the upstream side of Collingwood-Bainham Rd.	Water quality initiatives* Riparian fencing and planting. Provide advice about sustainable nutrient management practices. Consider placement of a few boulders to encourage meandering.	High
Burton Ale Ck	*Significant whitebait fishery values*	Lack of riparian trees providing shade, cover, woody debris to the stream Lack of riparian wetlands in the catchment.	Water quality initiatives* Riparian fencing and planting.	High
Little Kaituna Ck **(**A reach of 175m just upstream of SH60)	*Significant fishery values includes freshwater mussels*	Stream has been straightened Lack of riparian trees providing shade, cover, woody debris to the stream	Remeandering and planting.	Low
Onekaka Rv and tribs in farmland	*Significant whitebait fishery values*	Lack of wetlands buffering flow and mitigating nutrient run-off in flatter reaches. Several straightened sections. Fish passage issue at Shambala Rd and Mulligans Ck.	Provide advice and assistance to remediate this fish passage barrier. .	High
Puremahia Ck	*Significant whitebait*	Lack of riparian trees and	Riparian fencing and	Low

RIVER	WATER BODY VALUES IDENTIFIED SO FAR IN SCHEDULES 30.1, 36.1A AND B	STREAM HABITAT ISSUES	POSSIBLE ACTION REQUIRED	POSSIBLE PRIORITY FOR ACTION
	fishery values	wetlands in parts of the catchment.	planting. This includes planting wetlands in key tributaries that are not incised.	
Waikoropupu Rv	Cultural, spiritual, and landscape values. Hydro power generation. *Important lamprey population found (2010)*	Lack of riparian trees providing shade, cover, woody debris to the stream Fish passage barriers (some remediated).	Continue riparian planting. This includes planting wetlands in key floodplains that are not incised	Medium
Te Kakau Stm		Excessive aquatic weed growth e.g. *Lagarosiphon major.* Lack of riparian trees apart from willow (not ideal) that provide shade, cover, woody debris to the stream Low concentrations of dissolved oxygen during summer.	Riparian planting to provide shading and reduce the excessive growth of aquatic plants	High
Motupipi Rv and tributaries: Watercress Ck, Powell Ck, McConnon Ck, Berkett Ck, Dry Ck	Regionally significant native fish habitat. Cultural, spiritual, and landscape values. *Significant whitebait fishery values*	Excessive aquatic weed growth Lack of riparian trees providing shade, cover, woody debris to the stream Lack of wetlands buffering flow and mitigating nutrient run-off in, particularly around spring sources at the head of Motupipi and Berkett, Powell and McConnon Creeks.	Water quality initiatives* Riparian fencing and planting. This includes planting wetlands in key tributaries that are not incised eg lower Berkett Ck	High
Ellis Ck	Regionally significant native fish habitat. Cultural, spiritual, and landscape values. *Whitebait fishery values* *Giant kokopu found*	Lack of riparian trees providing shade, cover, woody debris to the stream Lack of wetlands buffering flow and mitigating nutrient run-off	Riparian fencing and planting.	High
Wainui Bay tribs (short sections from the coast)	Includes possible inanga spawning areas	Lack of riparian trees providing cover & woody debris to the stream	Riparian fencing and planting.	Medium
Motueka-Riwaka Catchment Streams				
Ferrer Ck (200 or 400m reach)	Includes possible inanga spawning areas	Tidal flapgate prevents flushing and reduces water quality	Re-meandering. Riparian planting. Restoration plan completed.	Low
Little Sydney Ck	Water quality managed for irrigation (the plan does not acknowledge high biodiversity values in this stream).	General lack of riparian trees on the flat lower section providing shade, cover, woody debris to the stream Most of the lower section has been straightened completely. Tidal flap-gate restricts fish passage and could cause water quality issues.	Water quality initiatives* Riparian planting. Re-establish semi-natural meander	Medium
Spring-fed tributaries of Motueka Delta, including Thorpe Drain, Hamilton Drain	Includes possible inanga spawning areas	General lack of riparian trees on the flat lower section providing shade, cover, woody debris to the stream Most of the lower section has been straightened	Planting of rushland for inanga spawning Re-meandering	High

RIVER	WATER BODY VALUES IDENTIFIED SO FAR IN SCHEDULES 30.1, 36.1A AND B	STREAM HABITAT ISSUES	POSSIBLE ACTION REQUIRED	POSSIBLE PRIORITY FOR ACTION
		completely. Tidal flap-gate restricts fish passage and could cause water quality issues.		
Motupiko Rv and tributaries	Regionally significant native fish habitat, contact and non-contact recreation. Quality to be managed for aquatic ecosystems, fisheries, contact recreation, and irrigation.		Riparian fencing and planting in key areas e.g. Brough Creek. Installation of wetlands in key locations to improve summer flows and water quality.	Medium
Sherry Rv	Quality to be managed for aquatic ecosystems, fisheries, contact recreation, and irrigation.	Removal of willows caused bank slumping and water temperature increases.	Water quality initiatives* Riparian fencing and planting. Installation of wetlands in key locations	High (current programme exists)
Dove Rv		Water quantity General lack of riparian trees on the flat lower section providing shade, cover, woody debris to the stream	Review water takes and ensure refuge pools are available.	Low
Waiwhero Creek		General lack of riparian trees in upper reaches providing shade, cover, woody debris to the stream	Riparian fencing and planting. Installation of wetlands in key locations to improve summer flows and water quality.	Low - medium
Moutere Hill Streams				
Moutere Rv catchment	Eel habitat Giant kokopu habitat	Low water flows and high water temperatures in summer. Channel alteration. Little protection of refuge pools	Riparian fencing and planting. Installation of wetlands in key locations to improve summer flows and water quality. Re-meandering in places	Medium
Redwood Valley Stream		Low water flows and high water temperatures in summer. Channel alteration. Little protection of refuge pools	Water quality initiatives* Riparian fencing and planting. Implement a programme to monitor all water takes, to ensure that adverse effects are avoided. Installation of wetlands in key locations to improve summer flows and water quality.	Medium
Seaton Valley Stream	*Whitebaiting in lower catchment*	Stock access and stream cleaning in the lower reaches. Lack of riparian trees providing shade, cover, woody debris to the stream Lack of riparian wetlands in the catchment.	Water quality initiatives* Riparian fencing and planting, and installation of streamside wetlands to improve summer flows and water quality. Obtain esplanade strip (at least 3m wide) as part of subdivision proposal.	High
Tasman Valley Stream	*Whitebaiting in lower catchment*	General lack of riparian trees providing shade, cover, woody debris to the stream Many reaches have been straightened. Very important remnant	Water quality initiatives* Fencing of stream to exclude stock. Planting of streamsides to provide shading to reduce stream temperature, increase	Very High

River	Water Body Values identified so far in Schedules 30.1, 36.1A and B	Stream Habitat issues	Possible Action required	Possible Priority for Action
		habitats that could be expanded on.	dissolved oxygen, and improve habitat. Installation of wetlands in key locations to improve summer flows and water quality. Re-establish a natural meander pattern in straightened sections.	
Waimea Catchment				
Reservoir Ck	*Educational resource being close to several schools*	Fish passage barrier upstream of Salisbury Rd, at Hill St and further upstream. Quick-flow run-off from high percentage of impervious surface affects mid-lower parts of catchment.	Water quality initiatives* Prevent cattle access	Medium
Jimmy-Lee Ck		Stream piped for >1km and in a straight drain (along Beach Rd). Several fish passage barriers	Expected high cost for improvements relative to benefits.	Low
Borck Ck	*Whitebaiting in lower catchment*	Lack of riparian trees providing shade, cover, woody debris to the stream Lack of riparian wetlands in the catchment.	Water quality initiatives* Ensure any redesign of this waterway as part of urbanisation developments maximises ecological benefits, without adversely affecting flooding or incurring undue cost.	Medium (concept drawings completed as part of Richmond West Planning; will be conditional on the development)
Niemans Ck & Pearl Ck	Native fish habitat, including nationally significant native fishery Regionally significant wildlife habitat. *Whitebaiting in lower catchment*	Lack of riparian trees providing shade, cover, woody debris to the stream Nitrate contamination	Water quality initiatives* Planting began at Pearl Ck in 2005	Low
Wai-iti River	Trout spawning. Contribution to Waimea river and groundwater flows. Quality to be managed for aquatic ecosystems, fisheries, fish spawning, contact recreation, and irrigation.	General lack of riparian trees providing shade, cover, woody debris to the stream Disturbance from vehicles. Lack of water in summer due to over-allocation of water takes and lowered groundwater levels	Riparian fencing and planting. Installation of wetlands and pool refugia in key locations.	Low - medium
Buller / Kawatiri Catchments				
Murchison Creek	*Trout spawning*	General lack of riparian trees providing shade, cover, woody debris to the stream Lack of wetlands in the	Water quality initiatives* Riparian fencing and planting. Installation of wetlands in key locations	Medium

River	Water Body Values identified so far in Schedules 30.1, 36.1A and B	Stream Habitat issues	Possible Action required	Possible Priority for Action
		catchment to provide habitat, reduce sediment inputs and improve water quality. Fine sediment deposits.		

What can the Community do to Reduce Pollution of our Waterways

There are many things we can do to improve and maintain our freshwater resource. If everyone who lives in the district did the following it would make a real difference:

- Keep hazardous substances (such as oil and pesticides) out of our stormwater system and away from groundwater wells.
- Conserve water by fixing leaks, using water more efficiently.
- Report to Council any discharges of liquid or rubbish to water, or land where it may enter water, or any drainage of wetlands (Phone: 543 8400 – after hours service available or email: info@tasman.govt.nz).
- Have a go at monitoring the health of your stream. The use of the Stream Health Monitoring and Assessment Kit (Biggs et al., 1998) is encouraged for the monitoring of impacts of discharges or land use on water quality. http://www.niwa.co.nz/our-science/freshwater/tools/shmak

Rural landowners, can to make a difference by fencing off streams, rivers, swamps, wetlands, and seeps to prevent regular access by mobs of stock. The management of land on the stream side of the fence will vary depending on the situation (*e.g.* slope, soils, presence of weeds, potential enhancement of stream life). The best management options for the streamside corridor include: planting in native trees for the 2-3 m adjacent to the stream, then a rank grass strip of 2-3 m. An international review showed that rank grass strips are often better at filtering sediment and disease-causing organisms than forests, but that forest along the stream has a more positive effect than grassland on stream habitat and biodiversity.

- Fence off that small boggy bit of land that drains the paddock to the stream. Better still plant wetland plants. If this area is flooded in rainfall events it could become a spawning site for fish.
- Unless significantly affecting flooding, leave woody debris in the stream. It forms good homes for fish and invertebrates.
- Make sure farm dairy effluent irrigators are operating effectively and are moved frequently to prevent effluent ponding and run-off into waterways.
- Avoid break-feeding or mob-stocking close to waterways, especially in wet weather.
- Form a landcare group (such as the Sherry River Group) with your neighbours to discuss and use better land management practices to protect your local waterways.

Developers or **contractors**, can make a difference by installing stormwater detention areas in new subdivisions to improve water quality (less silt and animal faeces reaches the rivers and streams).

The Reasons to Do it

When considering restoration of a waterway with degraded habitat the priority actions should be considered in the following order and for the following reasons:

1. **Fencing waterways**
   - reduce fine sediment and faecal inputs to the stream and direct disturbance of the stream bed by farm animals.
   - allow the establishment of riparian plants

2. **Stream-side planting**
   - Shade to keep the water cooler
   - Shade will reduce the cover and abundance of chocking growths of aquatic plants leading to better oxygenation in summer.
   - Increase woody debris in the stream for fish cover. Overhead cover will increase terrestrial insect life which is food for fish and increase leaf matter in the stream which is food for many invertebrates including freshwater crayfish.

3. **Remediate fish passage barriers**
   - All the major barriers have been prioritised so as to ensure that we achieve the greatest benefit in the shortest time for the available resources.

4. **Install wetlands and associated deeper-slow-flowing areas in lowland streams**
   - Helps provide higher flows during dry periods, thereby creating more aquatic habitat.
   - Creates habitat for rare species such as giant kokopu.
   - Filters contaminant run-off from surrounding land which improves water quality and benthic habitat.

5. **Control the size and design of in-line ponds**
   - Reduce the problem of high stream water temperatures.
   -

6. R**eshape streams which have been straightened or highly modified**

   Lowland streams near the coast should be the highest priority

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7. CONCLUSIONS

The results of these fish surveys clearly demonstrate the importance of the following waterway attributes to the health of our freshwater fish communities:

- water depth and width
- substrate size and type
- channel bend radius (meander pattern)
- channel cross-section and hydrologic features (slow and fast flowing zones)
- riparian vegetation, particularly overhanging cover.

These attributes are absolutely critical for the survival of the most habitat-sensitive, and in some instances, threatened and declining, native fish: banded kokopu, koaro, short-jaw kokopu, giant kokopu, torrentfish, bluegill bully and red-fin bully. Giant kokopu are particularly rare in the region due to historic clearance of lowland wetlands.

Brown trout populations are relatively healthy in the Motueka and parts of the Buller catchment, and to a lesser degree in the Aorere and Takaka catchments, where a good mix of spawning, rearing and adult habitat exist. Trout have returned to reasonable numbers in the Motueka River after a series of floods in the mid 1990's which are thought to have severely affected the population.

These results support the need for more measures to be taken that will better protect the habitats of freshwater fish in the beds and riparian zones of small to medium-sized lowland waterways in the Tasman District.

The data presented in this State of Environment fish assessment will further assist resource planners to predict more accurately the likely presence or absence of freshwater fish when viewing resource consent applications that may affect stream habitat.

8. FUTURE MONITORING SURVEYS AND TECHNIQUES

- Continue to monitor the success or otherwise of stream restoration projects.

- Investigate the efficacy of using conveyor belt rubber and mussel spat ropes for providing fish passage. Investigate fish passage issues at selected sites based on the survey results. Monitor fish migration where remedial work has been undertaken to correct fish passage barriers.

- Monitor the recovery of fish and invertebrate communities after disturbance events on streams with different sources of flow following stream cleaning, flood control works, or diversions.

- Individual species:
  - Undertake **inanga** spawning surveys to enable better management of the valuable whitebait resource.
  - Undertake surveys of **lamprey** migration in catchments where they have been found. Lamprey are very uncommon in the region and special protection may be necessary.
  - Continue to sample and discover additional streams used by **giant kokopu**. Consider contracting commercial eelers as they often catch this species in their harvesting operations.
  - Assist Department of Conservation Golden Bay in **brown mudfish** surveys. This work requires experience and knowledge of habitat requirements of this rare fish and Department of Conservation is best placed to lead this work.
  - Survey vulnerable sites where **northern flathead galaxias** could be present
  - Undertake a late-autumn-winter sampling run to determine the timing of **eel migration**. Combine this with data from fish monitoring associated with the Waitui River hydro-electric power plant.
  - Follow up sample sites where previous fish surveys have been recorded as being undertaken in the NIWA database, to enable fuller data analysis.
  - Establish sampling sites where all disturbance classes and the same amount of sites per disturbance class are represented.
  - Adopt the Proposed National Fish Monitoring Protocols (David et al 2010) using 150m sampling reaches.
  - Investigate sites that are subject to major (and especially rural) subdivision.
- Re-survey selected sites in a dry summer to quantify flow permanence and to better explain fish distribution over the year.

- Determine if water quality is limiting fish diversity in the following waterways: Mackay Creek, James Cutting Creek, Flowers Creek. University student project.

“The future of our fish communities is in our hands”.

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10. APPENDICES

Appendix 1: Maps of fish distribution

1a: Shortfin eel/ Tuna (or Hao) **(3 maps)**
1b: Longfin eel/ Tuna (or Kuwharuwharu) **(3 maps)**
1c: Lamprey/ Pirahau
1d: Torrentfish/ Papamoko
1e: Giant kokopu/ kokopu **(3 maps)**
1f: Koaro **(3 maps)**
1g: Dwarf galaxias **(3 maps)**
1h: Banded kokopu **(3 maps)**
1i: Inanga (enanga) **(2 maps)**
1j: Shortjaw galaxias **(3 maps)**
1k: Northern Galaxias **(3 maps)**
1l: Brown mudfish
1m: Giant bully
1n: Upland bully
1o: Common bully/ pako
1p: Blue-gill bully
1q: Red-fin bully **(3 maps)**
1r: Common smelt/ Ngaoire
1s: Brown Trout **(3 maps)**
1t: Rainbow Trout **(3 maps)**

APPENDIX 2A: LEVEL THREE ASSESSMENT FORM FOR FISH PASSAGE (THE MOST DETAILED ASSESSMENT)

Tasman District Council

Fish Passage - SITE DETAILS
Field Sheet (V7 L3)

Entered by: ____________
Date: ____________

Stream Name: ____________ **Location:** ____________

Culvert Asset No.: ____________ **GPS Co-ordinates:** **E** ____________ **N** ____________

River Catchment:
○ Aorere ○ Little Sydney ○ Motueka ○ Motupipi ○ Moutere ○ Onahau ○ Onekaka ○ Parapara ○ Takaka ○ Waimea

or Inlet:
○ Motupipi ○ Moutere ○ Parapara ○ Ruataniwha ○ Tasman Bay ○ Waimea ○ Waitui

or Region:
○ Buller ○ Golden Bay ○ Kaiteriteri ○ Mapua ○ Pohara ○ Redwood Vly ○ Richmond ○ Ruwaka

XY Metadata: ○ Aerial Photo ○ GPS Co-ords ○ Envirolink ○ NIWA ○ Other GIS Layer

Owner: ○ DOC ○ Fonterra ○ NIWA ○ NZ King Salmon ○ Private ○ TDC Engineering ○ TDC Hydrology

Barrier Type:
○ Barrier Removed ○ Bridge ○ Culvert ○ Culvert & Weir ○ Dam ○ Flap-gated Culvert
○ Floodgated Culvert ○ Ford ○ Weir ○ Tide-gated Culvert ○ Other: ____________

Material Type: ○ Boulders ○ Concrete ○ Corrugated Iron ○ Earth ○ HDPE Pipe ○ Steel

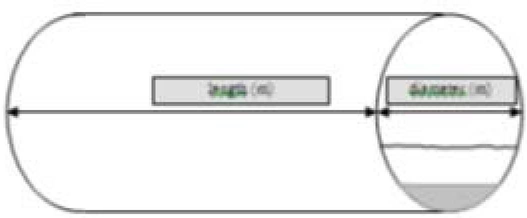
No. of Culverts: ____________

Culvert Type: ○ Apron ○ Boulders ○ Box ○ Corrugated Pipe ○ Earth ○ Pipe ○ Tidal Flapgate

Ford/Weir: ○ Rock ○ V-Notched ○ Vertical

Barrier Dimensions

Height (m): ____________
Length (m): ____________
Diameter (m): ____________
Slope Estimate: ____________



Site Sketch:

Tasman District Council

Fish Passage - SITE INSPECTION
| Field Sheet (V7 L3)

Entered by: ____________

Date: ____________

Culvert Cross Section Type:

Inlet ◯ Flat ◯ Perched ◯ Pooled ◯ N/A Outlet ◯ Flat ◯ Perched ◯ Pooled ◯ N/A

For perched culverts provide an estimate of water fall (for multiple culverts only note maximum):

Overhang Height (m): ____________ Undercut Length (m): ____________

Barrier Dimensions

Inlet Water Depth (m): ____________
Outlet Water Depth (m): ____________
Inlet Sediment Depth (m): ____________
Outlet Sediment Depth (m): ____________

Blockages: ◯ Inlet ◯ None ◯ Outlet ◯ Tidal Flap ◯ Within Barrel

Incurrent Velocity Estimate (ms^{-1}): ____________ Flow Rate (L/s): ____________ ◯ Measured ◯ Estimated

Water flow at inspection: ◯ High ◯ Low ◯ Normal ◯ None

Stream Attributes

Stream Bed Level: ◯ Above culvert inlet ◯ Below culvert inlet ◯ Same as culvert inlet

Stream Width: ◯ Narrower than culvert inlet ◯ Same as culvert inlet ◯ Wider than culvert inlet

Stream Gradient: ◯ Flatter than culvert ◯ Same as culvert ◯ Steeper than culvert

Stream Alignment: ◯ Curved in & out ◯ Curved in & straight out ◯ Straight in & curved out ◯ Straight in & out

Bank Erosion at Culvert Exit: ◯ Minimal ◯ Moderate ◯ Severe ◯ Severe – undercut & collapsing

Likely severity of fish passage restriction:

◯ All flows ◯ High flows ◯ Incoming tide ◯ Low flows ◯ Most flows ◯ None/minimal ◯ Not assessed

Bed Material:	%Plants	%Silt/Mud	%Sand	%Gravel	%Cobbles	%Boulders	%Bedrock	Total*
Upstream								
Downstream								

*total should always = 100%

Comments:

____

____

____

____

APPENDIX 2B: TDC ASSESSMENT FORM FOR FISH PASSAGE.

Stream Name: ____________ **Location:** ____________

Culvert Asset No.: ________ **GPS Co-ordinates:** **E** ________ **N** ________

River Catchment:
○ Aorere ○ Little Sydney ○ Motueka ○ Motupipi ○ Moutere ○ Onahau ○ Onekaka ○ Puremahia ○ Takaka ○ Waimea

or Inlet:
○ Motupipi ○ Moutere ○ Parapara ○ Ruataniwha ○ Tasman Bay ○ Waimea ○ Wainui

or Region:
○ Buller ○ Golden Bay ○ Kaiteriteri ○ Mapua ○ Pohara ○ Redwood Vly ○ Richmond ○ Riwaka

XY Metadata: ○ Aerial Photo ○ GPS Co-ords ○ Envirolink ○ NIWA ○ Other GIS Layer

Owner: ○ DOC ○ Fonterra ○ NIWA ○ NZ King Salmon ○ Private ○ TDC Engineering ○ TDC Hydrology

Barrier Type:
○ Barrier Removed ○ Bridge ○ Culvert ○ Culvert & Weir ○ Dam ○ Flap-gated Culvert
○ Floodgated Culvert ○ Pond ○ Weir ○ Tide-gated Culvert ○ Other: ____________

Material Type: ○ Boulders ○ Concrete ○ Corrugated Iron ○ Earth ○ HDPE Pipe ○ Steel

Ford/Weir: ○ Rock ○ V-Notched ○ Vertical

No. of Culverts:

Culvert Type: ○ Apron ○ Boulders ○ Box ○ Corrugated Pipe ○ Earth ○ Pipe ○ Tidal Flapgate

APPENDIX 3: FISH ABUNDANCE ACROSS SITES COMPARING SPRING AND SUMMER SURVEYS

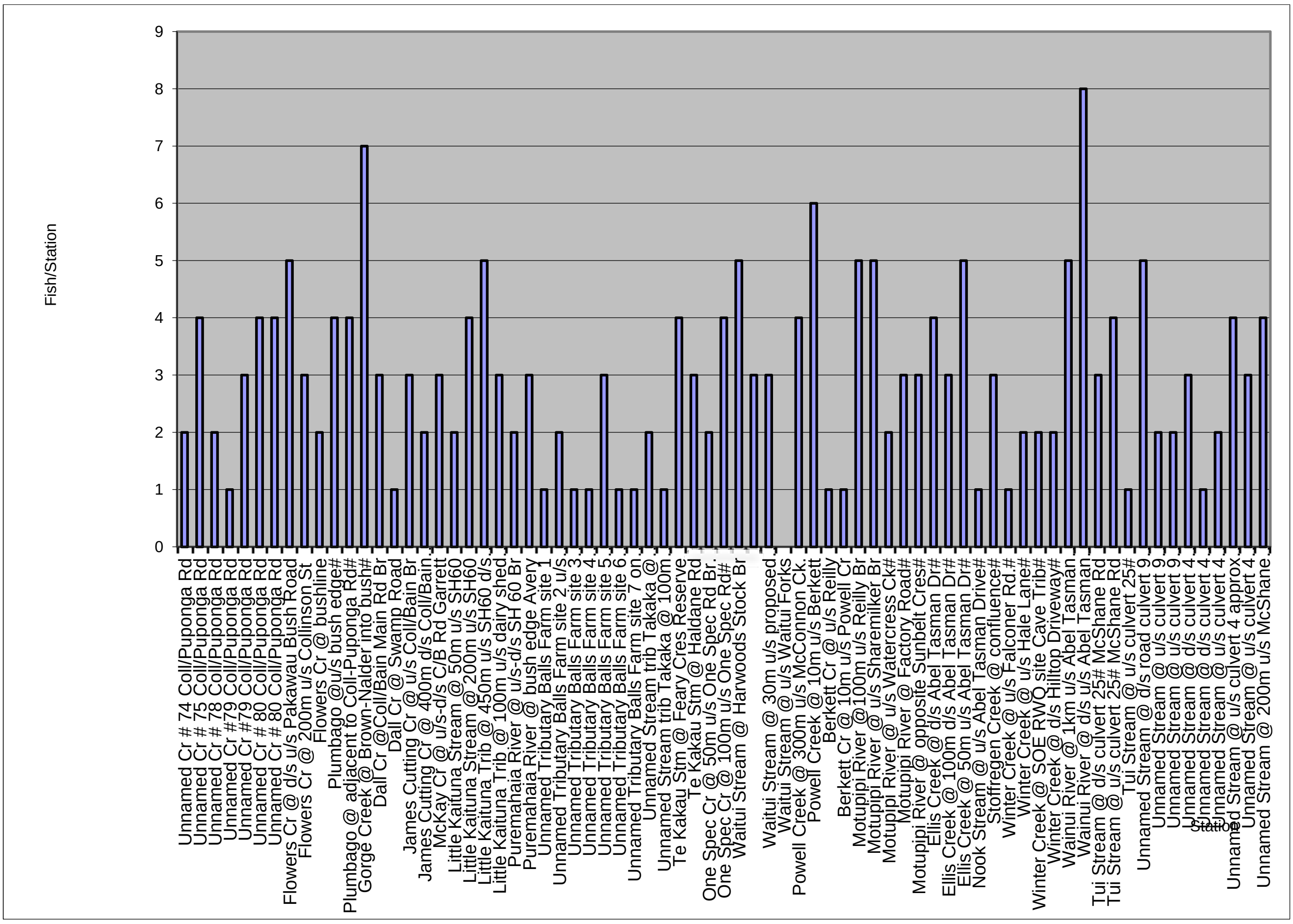


Figure A3.1: Fish density patterns across the survey sites, Golden Bay Catchment, summer

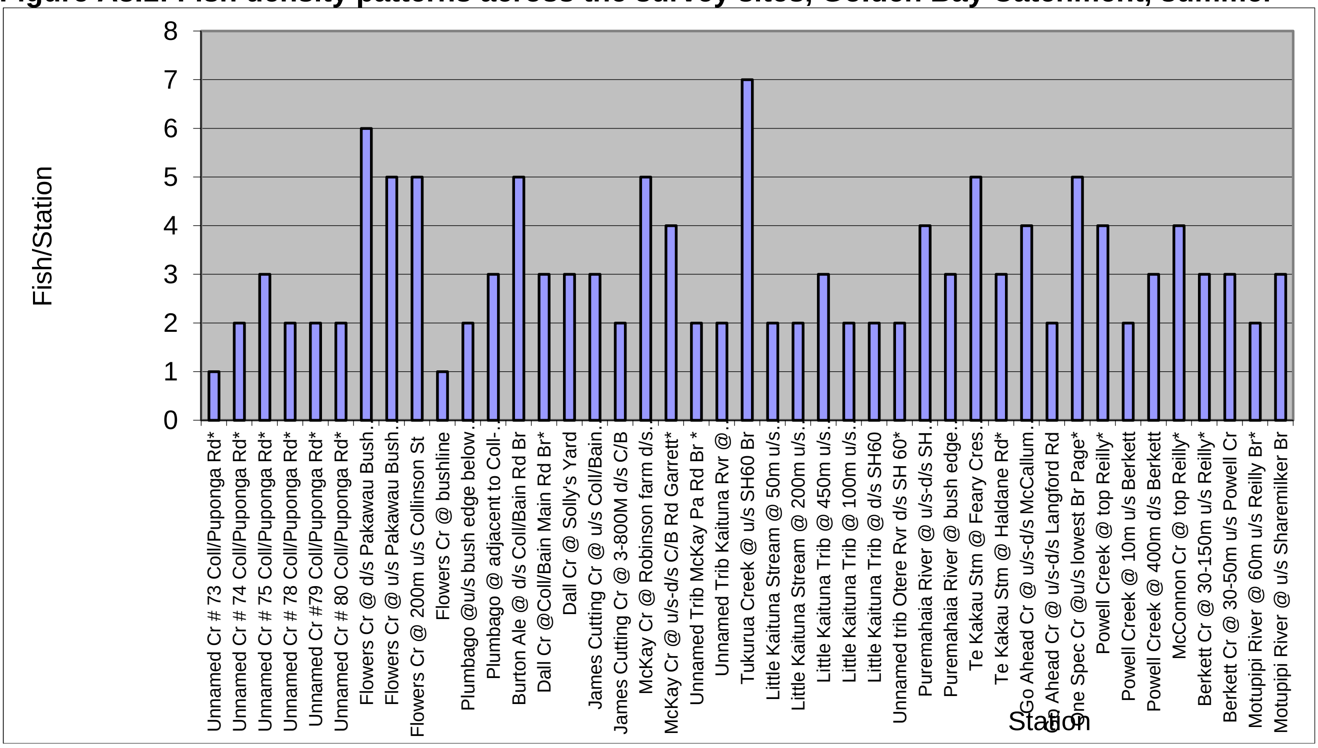


Figure A3.2: Fish density patterns across the survey sites, Golden Bay Catchment, spring

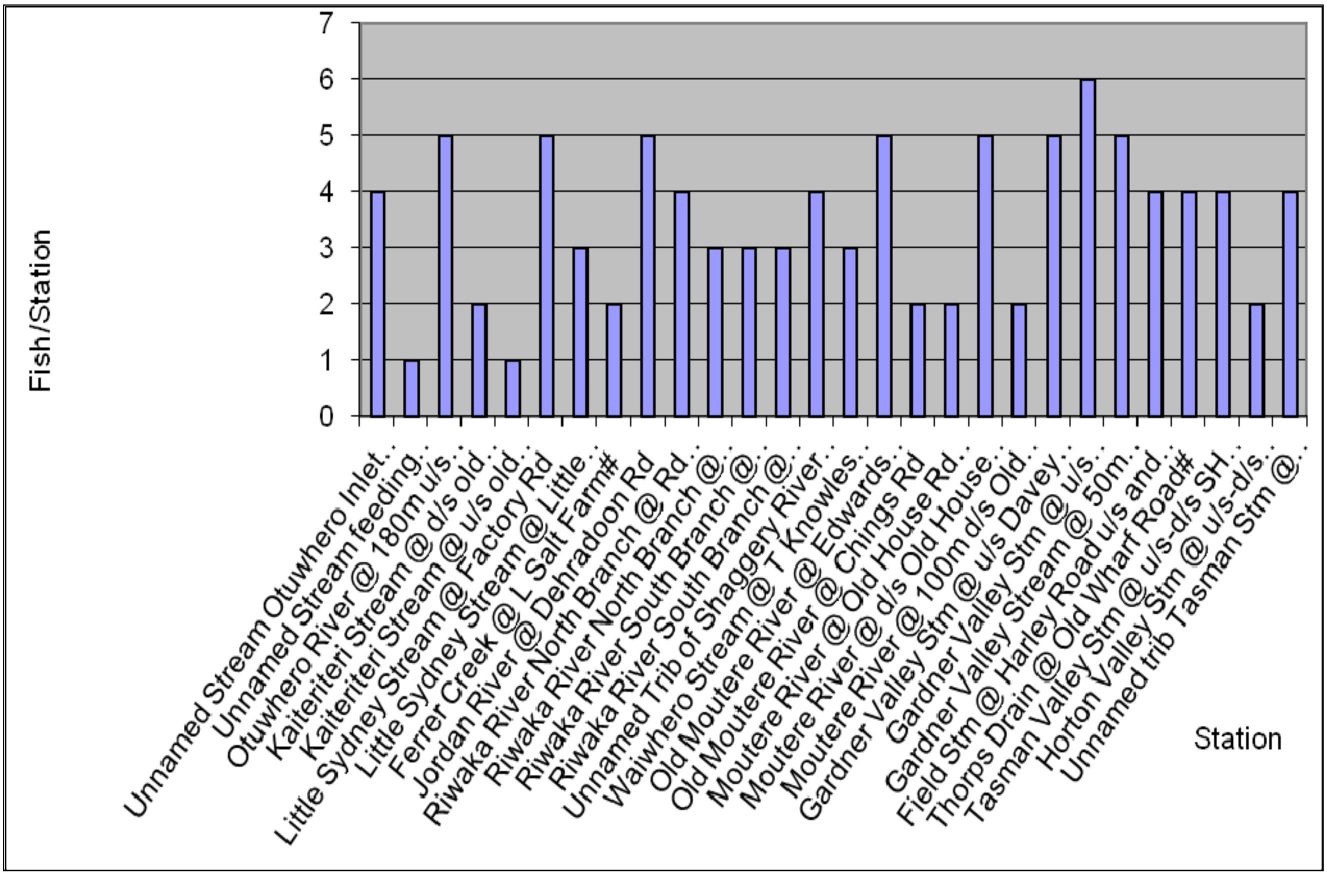


Figure A3.3: Fish density patterns across the survey sites, Motueka-Riwaka Area/Catchment, summer

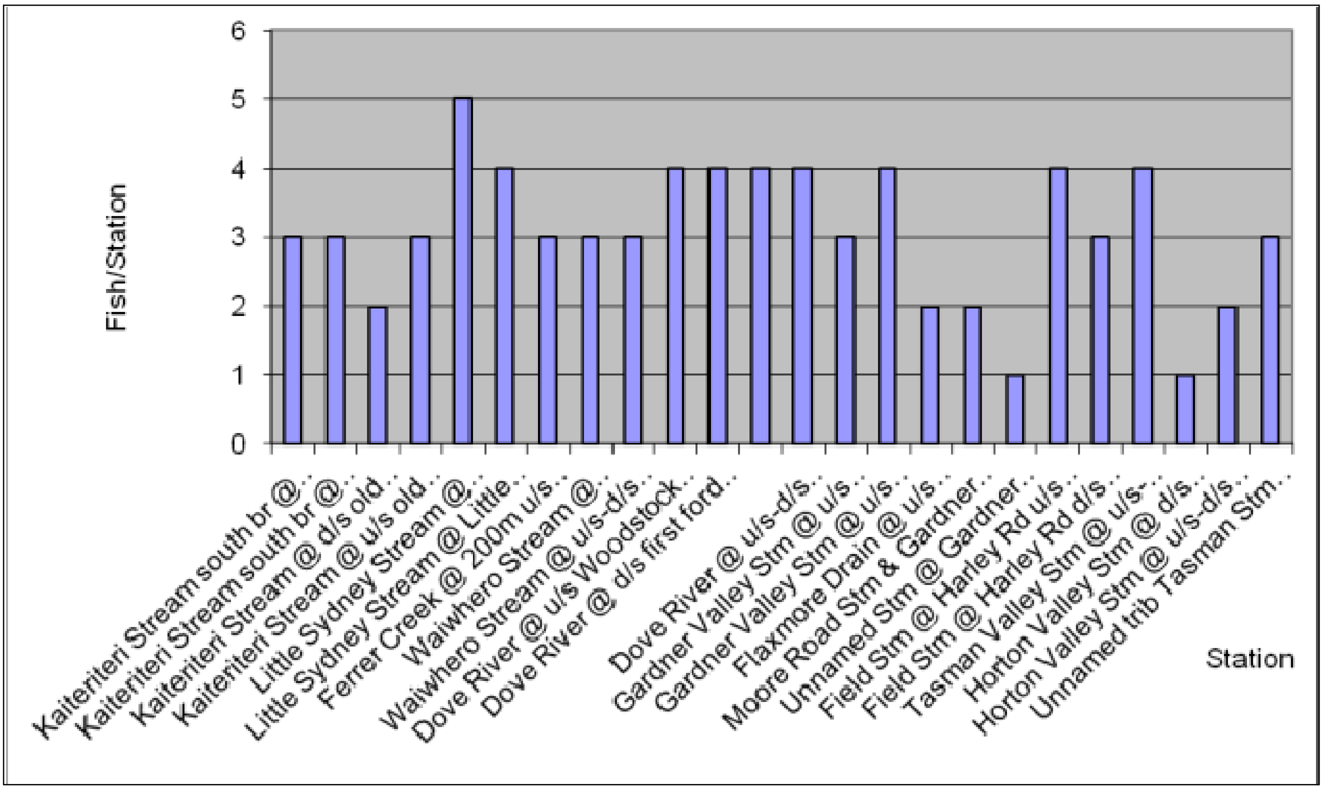


Figure A3.4: Fish density patterns across the survey sites, Motueka-Riwaka area/catchment, spring

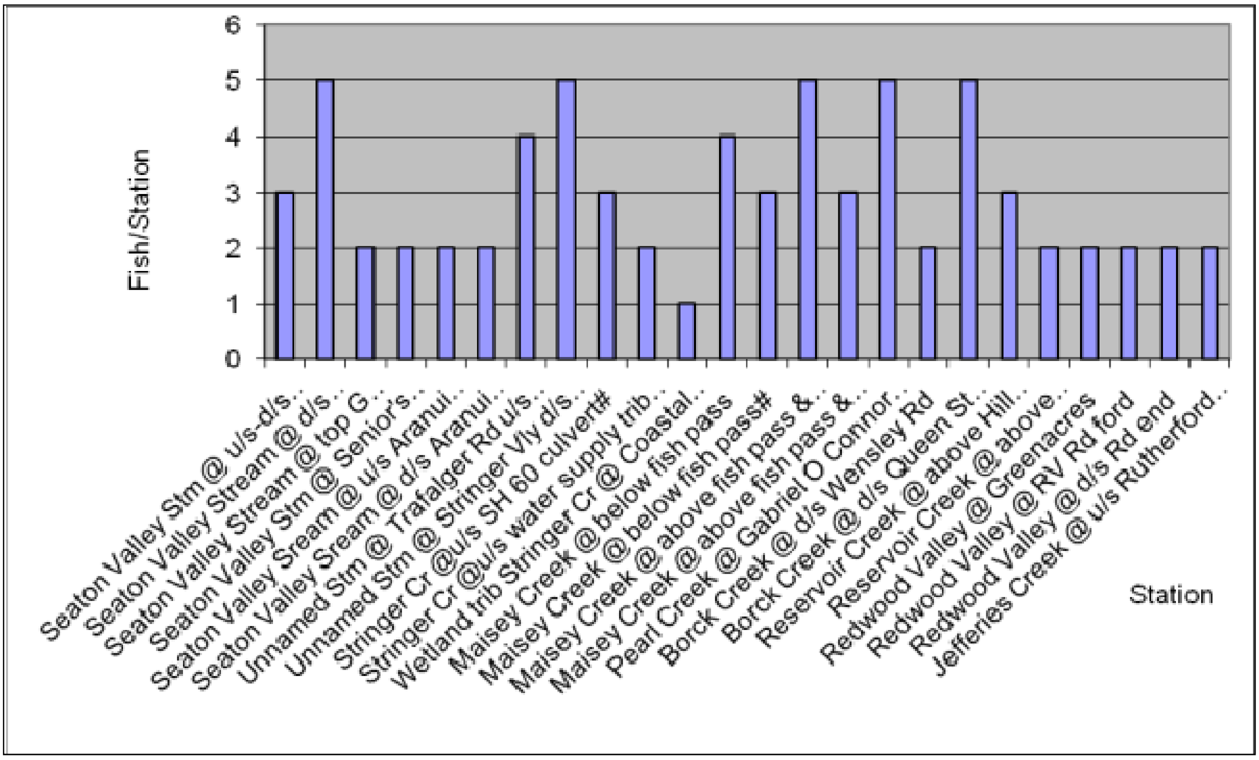


Figure A3.6: Fish density patterns across the survey sites, Waimea Catchment, summer

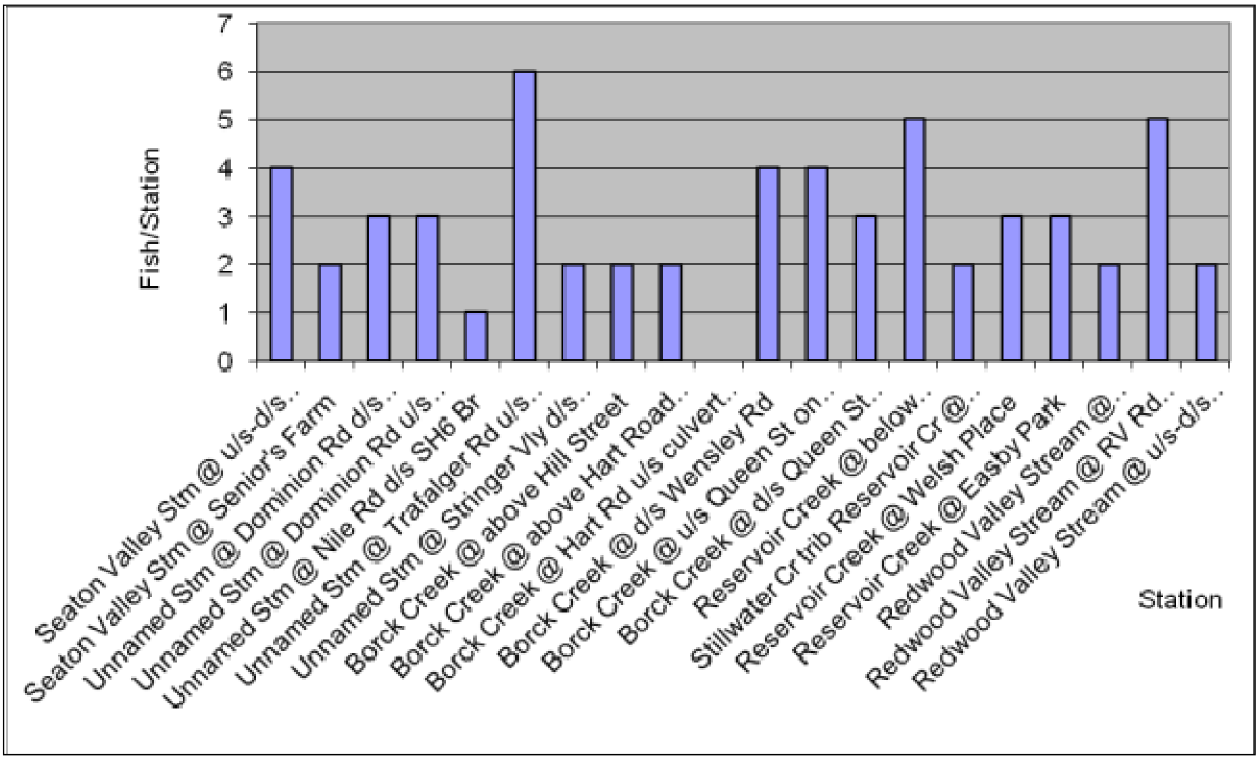


Figure A3.7: Fish density patterns across the survey sites, Waimea Catchment, spring

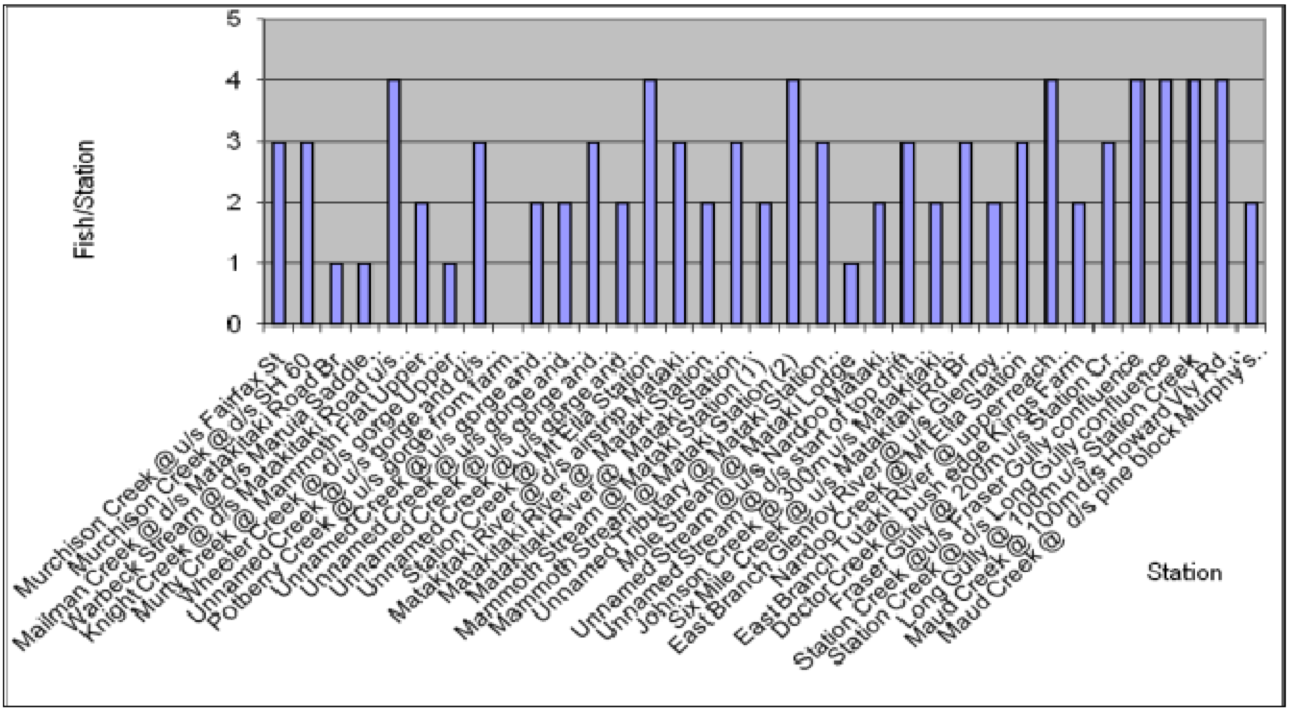


Figure A3.8: Fish density patterns across the survey sites, Buller Catchment, summer 2010

APPENDIX 4: SITES WITH MORE THAN ONE SAMPLING RECORD (2006, 2008 AND 2010)

Site name	2006	2008	2010	TOTAL
Borck Creek @ d/s Queen St along Headingly Lane		1	1	2
Borck Creek @ d/s Wensley Rd		1	1	2
Dall Cr @Coll/Bain Main Rd Br	1	1		2
Field Stm @ Harley Rd u/s bypass culvert site		1	1	2
Flowers Cr @ 200m u/s Collinson St		1	1	2
Flowers Cr @ bushline		1	1	2
Gardner Valley Stm @ u/s Davey Rd Mission Br		1	1	2
Gardner Valley Stm @ u/s Flaxmore drain Kaltenstadler		1	1	2
Horton Valley Stm @ u/s-d/s Preece (Sebastien)	1	1		2
James Cutting Cr @ u/s Coll/Bain Br	1	1		2
Kaiteriteri Stream @ d/s old watersupply weir		2		2
Kaiteriteri Stream @ u/s old watersupply weir		2		2
Little Kaituna Stream @ 200m u/s SH60		1	1	2
Little Kaituna Stream @ 50m u/s SH60		1	1	2
Little Kaituna Trib @ 100m u/s dairy shed Bennett farm		1	1	2
Little Kaituna Trib @ 450m u/s SH60 d/s dairy shed		1	1	2
Little Sydney Stream @ Factory Rd	1	1		2
Little Sydney Stream @ Little Sydney Rd	1	1		2
Maisey Creek @ above fish pass & pond		1	1	2
Maisey Creek @ below fish pass		1	1	2
McKay Cr @ u/s-d/s C/B Rd Garrett	1	1		2
Motupipi River @ u/s Sharemilker Br	1	1		2
Plumbago @ adjacent to Coll-Puponga Rd		2		2
Powell Creek @ 10m u/s Berkett	1	1		2
Puremahaia River @ bush edge Avery	1	1		2
Puremahaia River @ u/s-d/s SH 60 Br	1	1		2
Redwood Valley @ Greenacres	1	1		2
Redwood Valley Stream @ RV Rd ford	1	1		2
Seaton Valley Stm @ u/s-d/s Renwick	1	1		2
Tasman Valley Stm @ u/s-d/s SH 60 Br	1	1		2
Te Kakau Stm @ Feary Cres Reserve	1	1		2
Te Kakau Stm @ Haldane Rd	1	1		2
Tui Stream @ u/s culvert 25# McShane Rd		1	1	2
Unnamed Cr # 74 Coll/Puponga Rd	1	1		2
Unnamed Cr # 75 Coll/Puponga Rd	1	1		2
Unnamed Cr # 78 Coll/Puponga Rd	1	1		2
Unnamed Cr # 80 Coll/Puponga Rd	1	1	1	3
Unnamed Cr #79 Coll/Puponga Rd	1	1	1	3
Unnamed Stm @ Stringer Vly d/s Coastal Hwy		1	1	2
Unnamed Stm @ Trafalger Rd u/s SH6 Br		1	1	2
Unnamed Stream @ d/s culvert 4 McShane Rd.		1	1	2
Unnamed Stream @ u/s culvert 4 McShane Rd.		1	1	2
Unnamed Stream @ u/s culvert 9 McShane Rd.		1	1	2
TOTAL	**21**	**46**	**21**	

APPENDIX 5: WATER CHEMISTRY AT SELECTED SITES WHERE WATER CHEMISTRY WAS THOUGHT TO BE LIMITING FISH DISTRIBUTION

Site	Acidity (g/m^3 as $CaCO_3$)	Alkalinity (g/m^3 as $CaCO_3$)	Hardness (g/m^3 as $CaCO_3$)	pH (Field)	Ca (g/m^3)	Cl (g/m^3)	Cond (Field) (µS/cm)	DO Conc (Field) (g/m^3)	DO Sat (Field) (%)	Fe (g/m^3)	Mg (g/m^3)
Dall Ck @ u-s Sollys Yard	29.0	41	43	6.90	13.0	7.2	147	8.78	82.1	0.13	2.6
Flowers Ck @ Pakawau Bush Rd	7.9	20	22	7.50	4.4	23.0	130	9.19	98.8	0.92	2.6
James Cutting @ Collingwood-Bainham Rd	31.0	19	19	6.13	4.7	15.0	391	4.68	48.5	0.19	1.8
MacKay Ck @ 50m u-s Kaituna	-	-	-	6.75	-	-	63	7.72	82.6	-	-
Plumbago Ck @ Coll-Puponga Rd	9.4	140	118	6.52	42.0	11.0	275	6.38	75.1	0.34	3.1
Guideline Value (where one exists)		>20	20-100	5-9					>80%	0.5	