fish passage

in new zealand rivers

Understanding fish habitat and simple solutions to allow fish passage over weirs, fords, bridge aprons and through culverts.

Valuing our freshwater fishes

New Zealand's freshwater fishes are a significant part of our country's biodiversity, each with its own story. Fish like the koaro, kokopu and kanakana are considered by some to be as important as the kiwi, kakapo, kauri and kahikatea. Their origins and relationships are part of our country's evolutionary history. Some of these fish are important traditional foods for Maori and are regarded as taonga. Trout, eels and whitebait form significant sport and commercial fisheries, while others are an important food base for fish and birds. To those who have learned to find them, they are also both beautiful to look at and fascinating to study. We rob both our aquatic ecosystems and our natural history heritage if we do not look after them so that they can be passed on for future generations.

Dr R M McDowall
NZ's leading authority on freshwater fish

Banded kokopu (Galaxius fasciatus) are one of the five species that make up the whitebait catch.

Where there is water there are fish

It is surprising where freshwater fish can sometimes be found in New Zealand – from small stream courses hardly big enough to wet your shoes, to steep mountain streams seemingly miles from anywhere. Few people realise that many of these fish have had to journey all the way from the sea at some stage in their life cycle.

Freshwater fish have varying abilities for making their way inland from the sea. Some fish only inhabit streams and wetlands within our coastal lowlands. Other fish are able to penetrate great distances inland, some climbing steep waterfalls in their quest for the ideal place to live. Yet the same species can often be simply prevented from moving upstream by an incorrectly placed road culvert.

In this brochure we look at where migratory freshwater fish are typically found and at ways we can ensure that man-made structures in waterways do not prevent them from reaching these habitats.

Brown trout (Salmo trutta) juvenile takes shelter in a small shallow tributary.

Even small streams are used by fish

This small stream is home to at least five species of fish.

For fish, small streams are as important as large rivers. Streams that some fish choose to live in are so small they can be easily overlooked as habitat for fish. These smaller streams are the usual domain of most New Zealand native freshwater fish, but are also often used by juvenile trout. When viewed collectively, the myriad of small streams throughout New Zealand are house and home to millions of fish. The fish produced and reared in these small streams are the source of valuable fisheries in the rivers downstream.

Barriers to fish passage limit habitat choice

If barriers are placed in the way of migrating fish, their choice of habitat becomes limited and this in turn causes a decline in their number. Anytime a simple structure such as a culvert is placed in a stream, there is potential for it to impede fish passage. Bridges generally have the least impact on fish passage because their construction usually does not alter the natural characteristics of the stream. However, even a bridge can impede fish passage if it is boxed or has a concrete apron. Concrete aprons are often left to form overhangs or small falls, which prevent most fish swimming past this point.

The overhang and level positioning of this concrete bridge apron will prevent most fish from swimming upstream.

A means of ensuring structures of this sort do not become a problem for fish is shown later in this brochure. Another problem with concrete aprons is that they are usually made level, which means that during low flows there is seldom enough depth of water for fish to swim. Sloping the apron to one side or providing a channel for low flows will allow fish easier passage.

How can we help fish?

The best time to consider fish passage is before a structure, such as a culvert, is built or placed in a stream. At this stage, the most important consideration is ensuring the structure has a minimum effect on the natural characteristics of the stream. This is done best by choosing a design that does not create a physical feature in the stream course not there previously. For example, the structure should not create a waterfall where there was previously a gentle meander. If this rule of thumb is followed, there is a much better chance that fish will cope with passage past the structure. Of course this is not always possible because some structures such as dams and weirs are purposely designed to alter a stream's character.

The culvert overhang (at right) will prevent fish passsage. The culvert placed at streambed level (left) provides closer to natural conditions all through its length and allows unrestricted access for fish at most flows.

There are all kinds of designs and solutions for providing fish passage at existing structures. In this brochure we present a simple design that can be adapted to a wide range of existing structures. This is not only a proven design but is one that can be easily built without elaborate engineering detail. Because the design is an adaptation of natural stream features it blends well in all surrounds. See details in the final section.

Some New Zealand freshwater fish begin their life cycle in the sea. For others, the sea is where they complete their life cycle. This relationship with the sea can result in long and difficult journeys through the ocean as well as up and down rivers. Not all fish found in freshwater have such a complicated life, but in this section we follow the journey of some that do. We also look at some of the human impacts that further complicate the lives of these fish.

INLAND FROM THE SEA

the journey and destination of freshwater fish in a typical New Zealand river system

There are about 60 species of freshwater fish in New Zealand. The 12 fish shown here are typical of those that can be found in most rivers and have been divided into the three reaches of the river that they would most typically be found.

Lower Reaches

1 Lamprey, kanakana *(Geotria Australis)*
2 Shortfin eel *(Anguilla australis)*
3 Giant kokopu *(Galaxius argenteus)*
4 Banded kokopu *(Galaxius fasciatus)*
5 Inanga *(Galaxius maculatus)*

Middle Reaches

6 Common bully *(Gobiomorphus cotidianus)*
7 Redfin bully *(Gobiomorphus huttoni)*
8 Torrentfish *(Cheimarrichthys fosteri)*
9 Common smelt *(Retropinna retropinna)*

Upper Reaches

10 Rainbow trout *(Oncorhynchus mykiss)*
11 Longfin eel *(Anguilla dieffenbachii)*
12 Koaro *(Galaxius brevipinnis)*

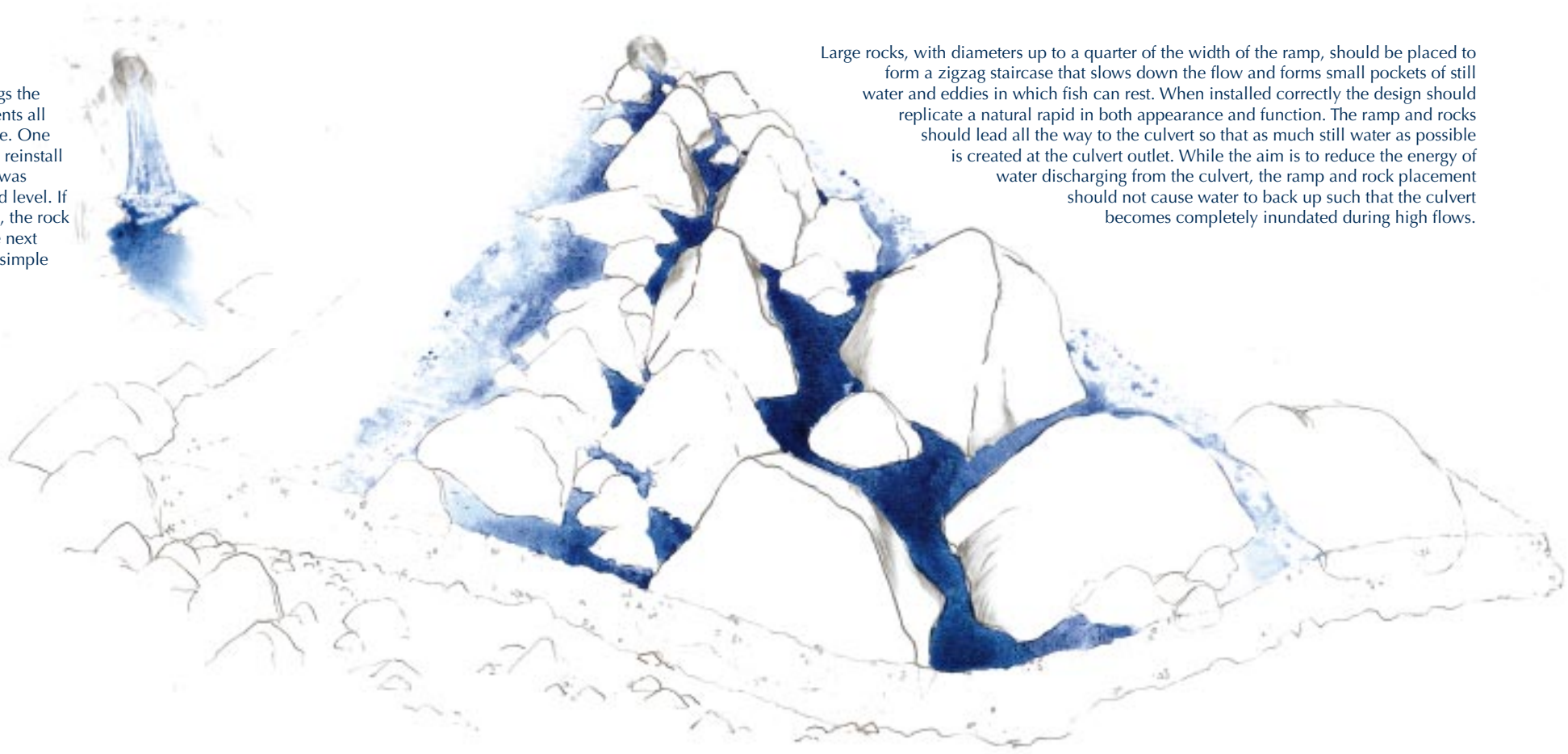
Follow the symbols for each group of fish to discover their final destination.

Floodgate A
Farm Culvert B
Bridge Apron C
Farm Water Supply Weir D
Forestry Culvert E
Town Water Supply Weir F

The Rock Ramp Fish Pass

A multipurpose solution for providing fish passage over low obstructions

This culvert overhangs the streambed and prevents all upstream fish passage. One solution would be to reinstall the culvert so that it was lowered to streambed level. If this was not possible, the rock ramp depicted in the next drawing would be a simple alternative solution.



Large rocks, with diameters up to a quarter of the width of the ramp, should be placed to form a zigzag staircase that slows down the flow and forms small pockets of still water and eddies in which fish can rest. When installed correctly the design should replicate a natural rapid in both appearance and function. The ramp and rocks should lead all the way to the culvert so that as much still water as possible is created at the culvert outlet. While the aim is to reduce the energy of water discharging from the culvert, the ramp and rock placement should not cause water to back up such that the culvert becomes completely inundated during high flows.

The cross-section of the concrete ramp should be dished into a shallow v shape. This will ensure that during low flows the confined channel will provide a suitable depth of water for fish to swim. During high flows the dished shape of the ramp will provide low velocity shallows and a splash zone along its outer edges that fish will be able to utilise to swim upstream.

Aim for a slope of 1:20. For ramps at structures less than 0.75 m, a ramp slope up to 1:15 can be considered.

Culvert Improvement

The ramp structure at culverts should be built to the full width of the natural stream course. At other structures, such as weirs, a ramp that is narrower than the natural stream channel may need to be considered. In these cases the rock ramp is modified into a fan shape (Weir Improvement drawing). The rock ramp is usually lead out from a slot or depression in the structure designed to allow water to pass down the ramp at any flow. The ramp is extended across the face of the structure as well as downstream. The construction should create numerous channels with varying flow. This will allow a greater chance for fish to find a way onto the ramp and provide a range of flows to suit their various swimming capabilities.

Benefits or uses of the design – easily adapted for culverts, weirs, bridge aprons and virtually any structure in a river up to about 1.5 m in height.

Weir Improvement

Guidelines for installation of new culverts

- Choose sites with a minimum of streambed slope
- Culvert width should be as wide or greater than the streambed
- Culvert slope should conform with the natural streambed slope
- Culvert alignment should conform with the natural stream channel
- Embed culvert below the normal streambed
- Allow natural streambed material to settle throughout the culvert length
- Armour the inlet and outlet with rock or other suitable material
- Ensure maintenance and monitoring

Further Information

Before altering or constructing structures in waterways,
you should consult your local offices of the:

Regional Council
Department of Conservation
Fish & Game New Zealand

The material in this brochure is based on the research of Rowan Strickland, Cawthron Institute

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