River life

Explore the ecology of braided rivers
in the Mackenzie Basin

EDUCATION RESOURCE 2010

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Te Papa Atawhai

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CONTENTS

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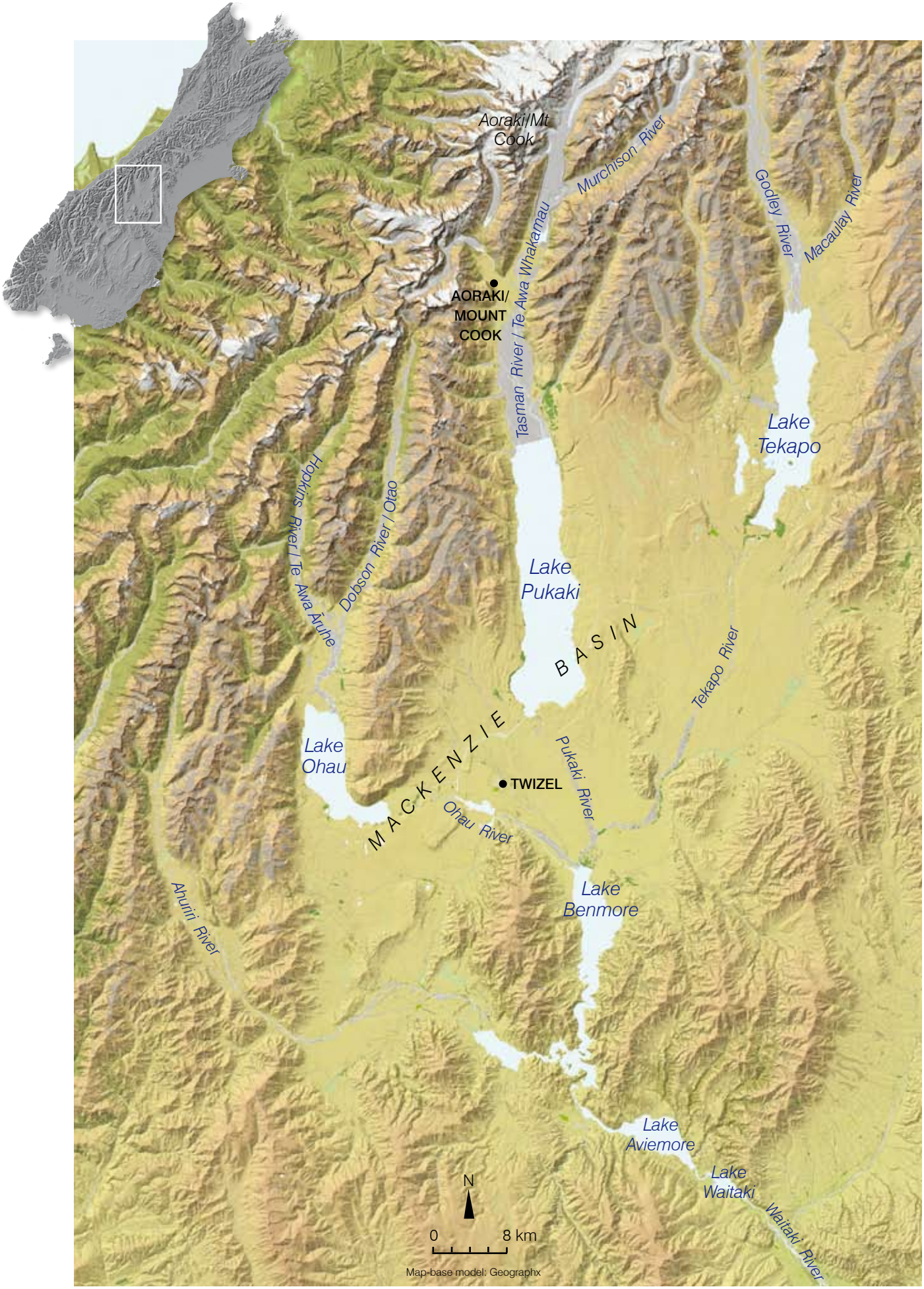

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Wrybill

Introduction

Gravel-based braided river systems are found in only a few places around the world; Alaska, Canada, the Himalayan region and New Zealand's South Island have excellent examples. They all flow from geologically young, rapidly eroding mountain systems and are characterised by wide gravel or alluvial beds, many winding channels, and highly variable water flows.

In the South Island, the largest braided rivers are found on the eastern side of the Southern Alps/Kā Tiritiri o te Moana, especially in Canterbury. By the end of the last glaciation, 10,000 years ago, rivers carrying alluvium down the valleys of the east coast had spread it amongst glacial deposits to form flat basins between the mountains and the coastal plains. The floor of the Mackenzie Basin has been formed from sediments deposited by the Tekapo, Tasman/Te Awa Whakamau, Ohau, Hopkins/Te Awa Āruhe, Dobson/Otao, Cass, Pukaki, Macaulay and Ahuriri rivers. The process of geological uplift, erosion, and alluvial transport continues to maintain the braided rivers today.

New Zealand's braided rivers are distinctive, dynamic environments with specialised plant and animal communities. During spring and summer, at least 26 species of water birds feed or nest on braided rivers. Some of these birds are now threatened or critically endangered. In addition to birds, braided rivers provide important habitats for numerous plants and other native animals.

Some of these species such as the kakī/black stilt, wrybill/ngutu pare, McCann's skink/mokomoko, native fish and insects will be profiled in this resource, and are each interesting to study in themselves.

For more on the Waitaki braided river system visit: www.doc.govt.nz – conservation – land and freshwater – freshwater – upper Waitaki braided rivers

Unfortunately, the braided river habitat and surrounding wetlands of the Mackenzie Basin are under threat – from introduced species, habitat loss and the development of hydro-power schemes, as well as agriculture. These issues are discussed throughout this resource.

A programme called Project River Recovery was created in 1990 in recognition of the importance of braided river and wetland ecosystems in the Mackenzie Basin. Its focus is to enhance braided river and wetland ecosystems in this area, and to maintain populations of native plants and animals. This project will also be profiled in this resource.

Murchison River Photo: C Woolmore

Black-fronted terns

Section A: The braided river environment

Waitaki River catchment

The extensive catchment of the Waitaki River system begins in the snow and icefields of the Southern Alps/Kā Tiritiri o te Moana. Preceding hydro-power production, the waters of the Pukaki and Tekapo rivers, augmented by the Ohau River, combined with the waters of the Ahuriri River to form the Waitaki River, one of New Zealand's largest rivers. From its snow-fed headwater tributaries to the sea, over 200 kilometres of river traversed a variety of landscapes. The upper Waitaki catchment, sometimes referred to as the Upper Waitaki Basin, forms part of the larger Mackenzie Basin.

Ecosystem overview

The cover illustration demonstrates the dynamic ecosystem of braided rivers. You can use this to guide you through the different sections of this resource or just select the aspects most relevant to you, e.g. plants and animals, fluvial processes.

The Mackenzie Basin provides a magnificent landscape for a geologist or a glacial geomorphologist. Many of the geological processes that created its braided rivers 10,000 years ago can still be observed today. Geological uplift, erosion and water carrying sediments downstream are all important features of New Zealand's braided river systems. A braided river floodplain is in constant movement – with small shingle bars appearing and disappearing, river channels shifting and water flows varying. All of this movement is actually part of the reason the rivers are such productive ecosystems, providing great feeding opportunities for native birds. Braided rivers and their surrounding wetlands are also specialised and sensitive environments. They support an abundance of small native fish and birds. Grasshoppers, lizards, wētā and insects also depend on the braided river habitat characteristics.

Godley River Photo: C Woolmore

Wetlands

Wetlands are among the world's most productive environments and are very important ecosystems. They are cradles of biological diversity, providing the water and primary productivity upon which countless species of plants and animals depend for survival. Many of these plants and animals are specially adapted to living in wet places.

Did you know?

Wetlands were a treasure trove for early Māori, providing abundant supplies of flax/harakeke for clothing, mats, kits and ropes; raupō for thatching and dried moss for bedding; and the eels/tuna, fish and birds living in wetlands were a good food source. Waterways were also an important means of access by waka/canoe.

Until about 1850 the wetlands and riversides of the Mackenzie Basin were densely vegetated, largely by a small group of sedge and sward-forming wetland plants.

The distribution of wetlands and braided river systems divided the area into a mosaic of wetland and non-wetland areas and provided secure wildlife corridors and habitats. At this time, the wetlands and braided rivers of the area had an abundance of native bird life.
After 1850, human activities particularly those associated with pastoral farming, took effect. Stock grazing, drainage, fires and pasture development drastically altered and reduced wetland areas. There is now some restoration taking place (refer to section *What is DOC doing?* page 23)

Wetlands are areas where water is the primary factor controlling the environment and its associated plant and animal life. They occur where the water table is at or near the surface of the land, or where the land is covered by water, either permanently or temporarily. They come in many different forms, including streams, swamps, bogs, lakes, lagoons, estuaries, mudflats and flood plains.

Braided rivers under threat

As a result of the introduction and invasion of weeds, predators, exotic fish, and other human activities, this special environment is under threat. Dams, water diversion and drainage have led to changes in the natural flow of water. The filling of lakes behind the hydroelectric dams has flooded habitat; water is diverted from rivers to canals for electricity generation; and drainage of land has removed water from wetland areas.

Wetland environments are closely linked to braided rivers. Prior to any development these areas surrounded the edges of braided rivers, acting as a natural flood control as well as providing habitat for a range of native fish and insects. Many of these wetland areas have been drained or lost completely due to inundation so can no longer support the same levels of biodiversity.

The Mackenzie Basin braided river environment has adapted to significant modifications from hydroelectric development and land-use changes. The two main examples are reduced water flow and the increased spread of weeds over river gravels and islands. Animal communities have also had to adapt to these changes, e.g. birds have fewer nesting areas available or they nest in areas more prone to flooding. Limited nesting areas are a major issue for specialist braided-river wading bird survival.

Along with habitat loss, predation by introduced mammals is a major threat to braided-river birds and is one of the main contributors to population decline. Predators of riverbed nesting birds include feral cats, stoats, ferrets and hedgehogs.

These special ecosystems are also under threat from agriculture as farm edges often surround braided rivers and the rivers are actively controlled to reduce the risk of flooding. Recreation and driving can also disturb the riverbed habitat and nesting areas for birds.
All activities that take place both on and around this environment have an impact. The challenge is to try to balance the environmental needs (the ecosystem and its inhabitants) with the economic and social needs of those living and working in braided river environments.

Because of significant modifications, both in the past and continuing today, some braided river environments of the upper Waitaki River and the Mackenzie Basin are no longer 'true' braided river systems. In general, the Tasman/Te Awa Whakamau, Murchison, Godley, Hopkins/Te Awa Āruhe and Dobson/Otao rivers situated above the glacial lakes are least modified, while the Tekapo, Ohau and Pukaki rivers are more affected by weed invasions and hydrological changes.

Meridian Energy Limited and Project River Recovery

Construction and commissioning of the upper Waitaki hydroelectric power scheme in the 1970s required a number of consents for building the structures and taking the water needed for power generation. When these rights were due for renewal in 1990, a working party was established to assess the concerns and proposals of water users resulting from operation of the hydro scheme. As a result of this process, several compensatory agreements between the power company and individual user groups were drawn up.

One of these was the Compensatory Funding Agreement with the Department of Conservation that established Project River Recovery (PRR) and explicitly recognised the impacts of hydroelectric power generation on braided rivers and wetlands. PRR began operation in late 1991, undertaking a range of activities to enhance and restore braided river and wetland systems. PRR currently implements the agreement with Meridian Energy Limited as the current power provider. The term of the agreement with PRR is tied to the term of Meridian Energy's resource consents, which expire in 2025.

What do you think?

Is it fair to try and achieve this kind of balance or are the needs of one system more important than the other?

Section B: Geology and geomorphology

The Mackenzie Basin is a gravel-filled intermontane depression of tectonic origin that covers an area of about 30 km by 50 km, and is surrounded by mountains ranging in height up to about 2500 m.

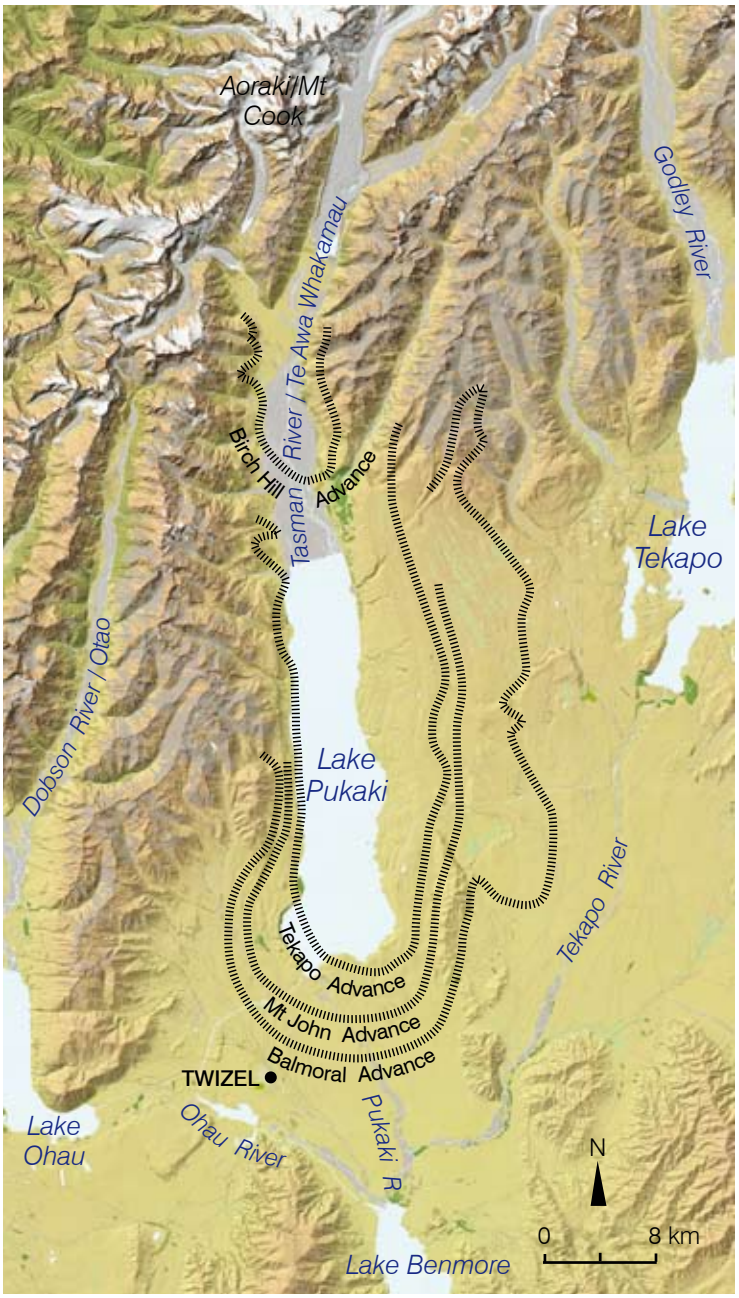
Formation of the Mackenzie Basin

The beginnings of the present basin can be traced to the start of the Kaikoura Orogeny in which active plate boundary movements starting some 10 Ma (10 million years) ago caused substantial uplift of the basement greywacke-argillite rocks of the Torlesse Supergroup. This resulted in the 'stripping' of older Tertiary cover rocks (65–5 Ma old), such as the extensive limestone that characterises the Oamaru area further to the east; and with fault movements, downwarping created an irregular depression between the uplifted greywacke mountains to the east and to the west.

Infilling of the basin by sediments of the Glentanner Formation, which are exposed in the well-known 'Clay Cliffs' to the west of Omarama, began more than 5 Ma ago as a sequence of major gravel fan-like deposits and accompanying ponded areas in which freshwater lacustrine beds (of clay, silt and sand) also accumulated. Continuing uplift on the western side of the basin along the foot of the Ben Ohau Range/Ruataniwha provided further sediment sources, and the maximum thickness of these 'piedmont fan sequences' is estimated at about 700–800 m. Where now exposed, for example in the Fraser Stream section near Twizel or at the 'Clay Cliffs' site, the beds of the Glentanner Formation are typically tilted to around 30–50 degrees that reflects the ongoing tectonic activity on the western basin-margin faults in the last few million years.

The present-day landscape of the Mackenzie Basin is dominated by the uplifted bounding mountains to the west, by hummocky ground reflecting glacial deposition by ice lobes and sheets from western source areas, and extensive flat plains that slope gently towards the well-developed basin outlet now occupied by the Waitaki River and its tributaries. From about 2 Ma ago the earth's climate has been punctuated by episodic cooling with accompanying ice-sheet and glacier development, and periods of warming (to present-day temperatures) in the intervening interglacials.

Photo: A Thompson



Map-base model: Geographx

Timeline

Older glacial deposits are undoubtedly concealed beneath the present landscape, but only four main periods of ice advance are presently recognised within the basin and these reflect glacier generation within each of the Tekapo, Pukaki and Ohau catchments, as follows:

- **135,000 years BP** (before present) – The Wolds Advance and the remnants of what was almost certainly a piedmont ice sheet are preserved between Lakes Tekapo and Pukaki near Irishmans Creek.
- **60–70,000 years BP** – The **Balmoral Advance** formed well-preserved deposits from glacier advance to both the north and south of the Mary Range, as well as elsewhere in the basin.
- **25,000 and 18,000 years BP** – The **Mt John Advance** formed the major moraines impounding Lakes Tekapo, Pukaki and Ohau. Associated ice lateral features can be traced up each valley together with extensive outwash plains extending well to the east within the basin.
- **15,000 and 12,000 years BP** – The main glaciers re-advanced to form the **Tekapo and Mt John deposits**.
- **8,000 years ago** – The ice retreated rapidly with local evidence for re-advance in the upper valleys to form the **Birch Hill** deposits near Glentanner (at the head of Lake Pukaki). The major glaciers have continued to retreat as global warming led to sea-level rise and climate amelioration.

Fault activity

The other important landscape element in the Mackenzie Basin is the continuing activity of major faults, of which the Ostler Fault is the principal feature with its well-developed scarps extending from near Aoraki/Mt Cook for some 60 km southwards towards the Lindis Pass.

There is clear geomorphic evidence near Lake Ruataniwha for offsets on both the Tekapo and Mt John outwash surfaces, and, in fact, continuing ground deformation in the vicinity of the Ohau A power station has caused differential tilting of the structure necessitating turbine-stator realignment.

Photo: C Woolmore

Research carried out both for and since construction of the upper Waitaki power scheme has confirmed that the Ostler Fault, a steep west-facing structure extending beneath the range front, has ruptured at least three times in the last 10,000 years, the most recent event occurring about 3,000 years BP. Earthquakes generated from such sudden ground movements are likely to have magnitudes of about 7.0–7.5, and to produce both horizontal and vertical accelerations of about 0.5 g.

The Mackenzie Basin is, therefore, a feature that has been formed by active tectonic movements associated with the plate boundary that passes through the western part of the central South Island. This has caused repeated fault ruptures and continuing localised ground warping that has left a clear imprint on the landscape. Alongside the tectonic activity has been erosion of uplifted land areas, and the climatically-controlled advance (and retreat) of ice sheets and glaciers during the last 2 Ma.

Today new geological processes and environmental changes have been introduced by the construction of hydroelectricity infrastructure. Shoreline erosion on Lake Pukaki, and changed flow conditions in the main river systems continuing to alter ecological processes, are examples.

Kakī

Section C: Biodiversity

Threatened birds

Black stilt/kakī

Status: Threatened – nationally critical

The kakī (*Himantopus novaezelandiae*) is regarded by Ngāi Tahu as a taonga species. Now confined to the Mackenzie Basin, kakī are one of the rarest waders in the world. The braided riverbeds, swamps and tarns of the Mackenzie Basin are its last feeding and breeding grounds.

Most riverbed birds migrate to warmer coastal environments in winter, but kakī usually stay in the Mackenzie Basin and feed on the parts of river and delta that do not freeze over. Kakī can wade out into deeper, slower-moving water than most riverbed birds. They reach down to catch insects, such as mayfly and caddisfly larvae, on the river bottom. Sometimes they dart at insects and small fish in shallow rapids or muddy areas. Unlike pied stilts and other waders, kakī can also feed by 'feeling' insects under stones.

If kakī cannot find a kakī mate, they tend to breed with the pied stilt, a close relative. Each pair of kakī defends a territory, and nests alone. They rely on camouflage to protect their eggs and chicks and actively defend their nests. Within hours, newly hatched chicks can hunt for food and swim if necessary.

The Department of Conservation has a management programme based in Twizel to increase kakī numbers. This programme has been successful and kakī numbers have increased significantly from 31 adult birds in 1999 to 93 in 2008.

Black-fronted tern/tarapirohe

Status: Threatened – nationally endangered

Most terns are sea birds, but the black-fronted tern (*Chlidonias albostriatus*) lives and breeds inland, only visiting the coast to feed in autumn and winter. Black-fronted terns feed on the wing over main channels, catching insects in the air, or swooping down on fish and insects at the water's surface. They sometimes feed on insects and lizards from surrounding farmland, especially in ploughed fields.

Photo: D Veitch

Black-fronted terns nest in loose colonies on open shingle, often on river islands. Their eggs and chicks are well camouflaged. Unlike many other river birds, young terns must remain near the nest, relying on parents to bring them food. To defend their eggs and chicks from intruders, they dart at them, calling loudly while swooping past. Terns often desert their nests if people or predators disturb them.

Of the remaining 5,000 black-fronted terns, 60 percent nest on the rivers and wetlands of the Mackenzie Basin. In the 2008–09 breeding season 762 black-fronted terns were counted in the Tekapo and Ohau riverbeds. At present they are declining in numbers because of loss of suitable habitat and high levels of predation.

Black-billed gull/tarāpuka

Status: Threatened – nationally endangered

Photo: R Morris

Unlike the common coastal red-billed gull, the endangered black-billed gull (*Larus bulleri*) visits the coast only in the winter after the breeding season. During the rest of the year, the black-billed gull is found inland, breeding and feeding in colonies on shingle islands in rivers. Nests are found on open shingle areas.

Colonies vary in size and location, because the gulls do not choose the same sites or the same rivers for breeding each year. Young gulls, like terns, rely on their parents to bring food until they can fly and hunt for themselves. Black-billed gulls feed on the wing over the main river channels, catching insects in the air, or scooping fish and insects from the water's surface. They sometimes feed on insects from surrounding farmland.

Wrybill/ngutu pare

Status: Threatened – nationally vulnerable

Photo: D Veitch

Wrybills (*Anarhynchus frontalis*) are small birds that are well camouflaged amongst the stones of braided riverbeds. They are probably the most specialized braided river wading bird, but sadly, wrybill numbers continue to decline as they are affected by high levels of predation and habitat loss. Wrybills require open shingle habitat to nest in, and feed along the shallow margins of braid channels. Aggressive colonising weeds occupy nesting habitat and stabilise the braids

Photo: R Morris

making channel margins too deep for feeding. Reduction in river flows compounds the weed encroachment problem and can make nesting and feeding sites more accessible to predators. Of the remaining 5000 wrybills, approximately 15 percent nest in the Mackenzie Basin. In the 2008–09 breeding season 143 wrybill were counted in the Tasman riverbed.

Wrybill pairs defend a territory and nest alone. They will nest only on flat expanses of gravel, bare of vegetation. They rely on camouflage and distraction behaviours to protect their nest, eggs and chicks. Chicks are active soon after hatching.

Wrybills feed in shallow channels, shallow rapids, and the edges of pools. They are the only bird in the world with a bill that curves to the right. The bill is specially adapted to reach under stones for mayfly larvae. In winter, they migrate to North Island harbours and feed in flocks on the mudflats.

Photo: P Morrison

Banded dotterel/turiwhatu

Status: Threatened – nationally vulnerable

In the North Island, banded dotterel (*Charadrius bicinctus bicinctus*) breed mostly on harbours and coastal beaches. However, in the South Island, many live inland on braided rivers and sparsely vegetated river terraces, where they are the most numerous wading bird. While some South Island banded dotterels move to the coasts of both islands during winter, many migrate to the warmer climate of Australia.

Banded dotterels feed on moths, flies and beetles found among scattered low vegetation on the high parts of the riverbed and along the muddy edges of lakes and rivers. While feeding, they show a distinctive run-stop-peck-run movement.

Each banded dotterel pair defends a territory and nests alone. Chicks can leave the nest soon after hatching to follow parents as they forage for food. In the 2008–09 breeding season 847 banded dotterel were counted in the Tasman riverbed.

Photo: D Veitch

South Island pied oystercatcher/tōrea

Status: At risk – declining

South Island pied oystercatchers (*Haematopus ostralegus*) establish territories in South Island riverbeds and surrounding farmland in late July. Between September and January the birds breed. Breeding pairs are very territorial and display with shrill piping calls when other birds or people come too close to their nests.

The pied oystercatcher's long bill allows it to probe deep into mud, sand or under pebbles, to find worms and insects in riverbeds, pasture and ploughed land. During the winter they flock to harbours of both the North and South Islands to feed.

Pied stilt Photo: J L Kendrick

Other braided river birds

Caspian terns/tarānui (Threatened – nationally vulnerable), and pied stilts/poaka (At risk – declining), also breed on braided rivers and their side channels and wetlands. Caspian terns are infrequent visitors to upper Waitaki rivers, but pied stilts often make use of shallow braid channels or ponds with low vegetation in rivers and wetlands for feeding and nesting. At least sixteen other bird species, including various shags/kawau, gulls, terns/tara, and herons/matuku, breed and forage in Canterbury's braided rivers and adjacent wetlands.

Lizards

New Zealand has two main types of native lizards/ngarara – skinks and geckos. However, there are many different species within these two groups. A number can be found throughout the Mackenzie Basin, each living it its own habitat niche. Several make use of river-terrace boulder habitat to live and breed.

Long-toed skink Photo: B W Thomas

Southern Alps gecko Photo: R Morris

McCann's skink/mokomoko, long-toed skink, common skink/mokomoko, scree skink and spotted skink have been recorded at various locations throughout the Mackenzie Basin, as have jewelled gecko/moko-kākāriki and Southern Alps gecko.

McCann's skink (*Oligosoma maccanni*) is the most widespread, and probably the most abundant skink in the Mackenzie Basin. It is usually found in dry, rocky and grassland areas. The common skink (*Oligosoma polychroma*) lives mostly in densely vegetated grassland or shrubland.

The long-toed skink (*Oligosoma longipes*) is more like to be found in dry rocky areas, screes and boulder tumbles; the spotted skink (*Oligosoma lineoocellatum*) is found in dry scrubby and rocky areas; and the scree skink (*Oligosoma waimatense*) is found mostly on active (moving) scree slopes.

The Southern Alps gecko (*Hoplodactylus* aff. *maculatus* 'Southern Alps') lives near rocky outcrops, screes, boulder banks and rock tumbles. The jewelled gecko (*Naultinus gemmeus*) lives in forest and shrubland.

Long-toed skink, scree skink, spotted skink and jewelled gecko all have threatened species classifications.

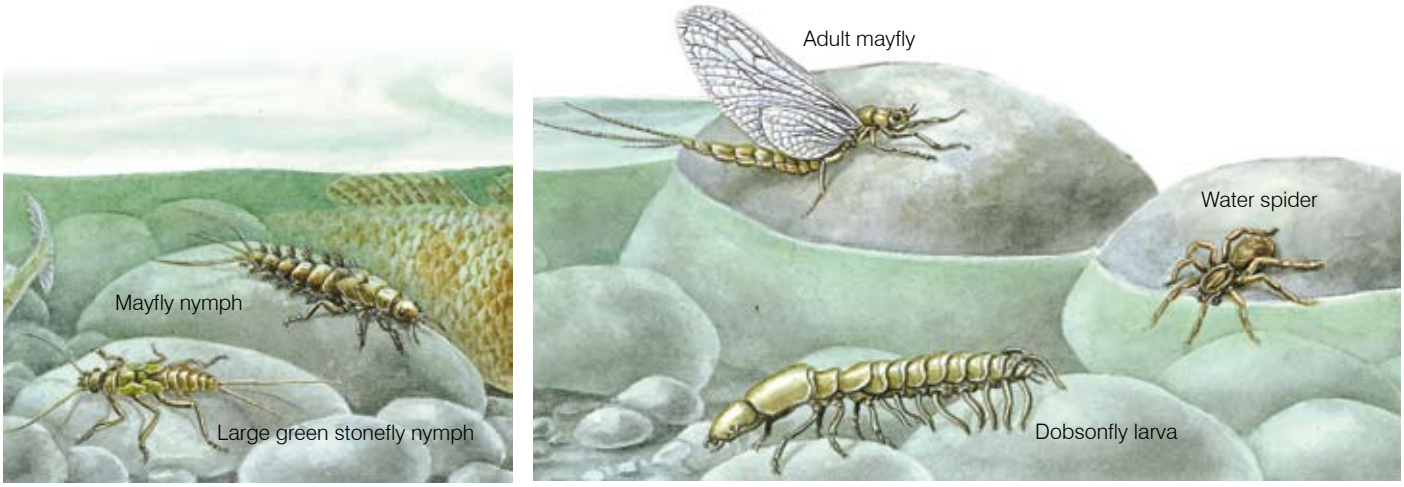
Insects

Fresh water insects

The rivers and wetlands of the Mackenzie Basin are home to many aquatic invertebrates including dobsonflies, mayflies, stoneflies, caddisflies, waterboatmen, red coat damselflies, and sandflies. Recent studies have found that small springs associated with the margins of large braided rivers support their own distinctive aquatic invertebrate fauna. Similarly, wetlands have other characteristic invertebrates, such as the spectacular giant mountain and yellow-spotted dragonflies.

Giant dragonfly

Illustrations: Simone End



Many kinds of freshwater insects inhabit riverbeds. Wingless larvae live beneath rocks and once they have become adults with wings, most species leave the riverbed and take to the air.

The Tasman River/Te Awa Whakamau is one of only a few sites where the uncommon aquatic caddisfly, *Psilochorema folioharpax*, has been found. All of these insects are also a food source for native and introduced
fish, and birds.

Terrestrial insects

Unfortunately very little is known about terrestrial invertebrates living in braided rivers, although on a warm summer day myriads of small insects and bugs can be seen swarming over low growing cushion plants in river floodplains. These insects probably play important roles in pollination of riverbed plants and are vital foundations of food webs.

Robust grasshopper Photo: R Smith

The cryptic minute grasshopper

One unusual insect you may see in the Mackenzie Basin is the indigenous robust grasshopper (*Brachaspis robustus*). This chunky, grey, rough-skinned grasshopper is found along only a few sites on riverbeds of the Mackenzie Basin, preferring to live on the newly disturbed gravels of riverbeds and outwash terraces. To avoid predators, the robust grasshopper relies on its cryptic coloration and remains quite still, rather than actively escaping by hopping away. It is an endangered species.

Another species endemic to riverbeds and outwash gravels of the Mackenzie Basin is the short-horned grasshopper (*Sigaus minutus*). It is also a threatened species, preferring to live on more stable gravels where encrusting lichens provide food and excellent opportunities for camouflage.

Other insects found in the Mackenzie Basin include boulder butterfly, cicada, tiger beetle, Tekapo ground wētā, grass moth, and chafer beetle.

Did you know?

Hydroelectric development has had a significant impact on eel migration and populations. Dam construction has affected the ability of longfin eel and kōaro to move freely between inland rivers and the coast where they spawn. Longfin eels are becoming uncommon in the upper catchment of the Mackenzie Basin, whereas kōaro have adapted and formed land-locked populations, probably using the lakes instead of the sea to spawn.

Native fish

Braided rivers and their associated wetlands are important habitat for several native fish. Two migratory and eight non-migratory native freshwater fish are found in rivers and streams of the Mackenzie Basin.

The non-migratory bignose galaxiid is found only in streams in this region. Two other endangered non-migratory species are also present – the nationally threatened lowland longjaw and upland longjaw galaxias. Lowland longjaws are unusual in that they are known to burrow into gravels and spawn underground. Other non-migratory fish include upland and common bullies, and alpine galaxias. Longfin eel and kōaro (whitebait species) are the only native fish in the upper Waitaki that normally migrate to the sea to spawn. Longfin eel are also classified as threatened. They are a long-lived fish, which spawn once in their lifetime, and their numbers are declining due to the combined effects of commercial harvest and loss of habitat.

The protection of waterways inhabited by native fish in the upper Waitaki catchment is an important priority. We need to find out more about the ecology of non-migratory fish, in particular, so we can understand their requirements and likely responses to change. The increasing number of threats facing streams in the catchment, including resource consent applications to extract water and changes to water quality as land uses intensify, emphasises the urgency of this work.

Habitat requirements

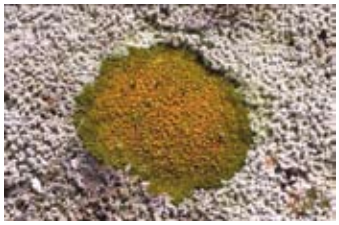
Instream cover, such as vegetation, rocks and boulders, is a major habitat requirement of these fish. Larger fish spend most of their time concealed amongst instream cover, venturing out into the open only to hunt for food. These hunting forays may occur only at first light, in the evening or during the hours of darkness. This is how they grow so large, and are seldom seen or caught.

New Zealand native freshwater fish and insects have adapted to cooler waters, which have higher oxygen levels. Once water reaches 16° C the oxygen levels are significantly reduced. A vegetation canopy can provide cover and shading, which helps to regulate water temperature. Leaves and other debris provide habitat for a myriad of insects both aquatic and terrestrial, many of which either fall or fly onto the water surface. This provides an important food source for native fish species as well as sports fish and wading birds.

For more information about native fish visit www.doc.govt.nz click on conservation – native animals – freshwater fish

A selection of cushion plants and lichens

All plant photos: C Woolmore



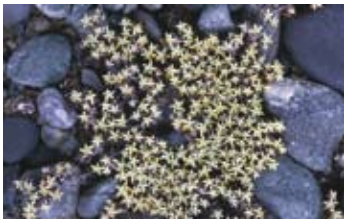
Native plants

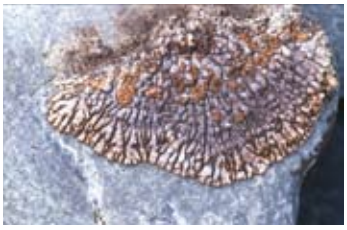
Despite the apparent sparseness of riverbeds, a recent survey found over 300 hardy yet beautiful native plant species, 35 mosses and liverworts and 41 lichens, forming mosaics of distinctive communities in the riverbeds and adjoining wetlands of the Mackenzie Basin braided rivers. Twenty three different threatened plants were recorded from upper Waitaki riverbeds and wetlands in this same survey. Prior to this work the riverbeds were not thought to contain any rare or endangered plants.

Typical early pioneer species include various encrusting lichens, mosses, tiny cushion plants, willow herbs and wispy native grasses.

With time these plants form blankets of plant cover and other tussocks and woody shrubs slowly establish, in turn becoming the dominant plants. The whole process is dynamic, often being disrupted by changing river channels and scouring floods resulting in the mosaic of vegetation development typical of braided riverbeds.

Some eye-catching species include the prostrate shrub, *Helichrysum depressum*, with its cryptic grey foliage and contrasting white fluffy seed heads, *Pimelea prostrata*, a native daphne with a





profusion of small white scented flowers and the cushion plant *Myosotis uniflora* with tight cushions of delicate white or lemon flowers.

Distinctive species

This riverbed environment is unusual for its combination of wetland and almost desert conditions. The plants that grow here have adapted to extremes of both wet and dry, and hot and cold. A number of plants hug the ground and form dense mats and cushions on the shingle river flats. Many riverbed plants have adapted and become specialised for living in a riverbed environment. They are often low growing and cushion forming, with reduced leaves and deep root systems.

Within the wetland and tarn edge areas of the Mackenzie Basin, there are a number of rare and threatened wetland plant species. These plants are usually small, and easily overlooked. The habitats are very vulnerable as they are subject to flooding, stock grazing, pests, development or drainage. Protection is vital if they are to survive.

The eastern South Island is unique within New Zealand. Climatically, the rainfall is lower and its annual temperature range is probably greater than most other areas in the country. The dry, gale force nor'westers are common and summer temperatures can be very hot, while in winter heavy snow falls are frequent and frosts severe. The extremes of temperature seem to agree with many native shrubs, especially along the river terraces, gullies and fans where disturbance is a regular occurrence.

Recovery plans are prepared for many threatened plants and animals, which provide a working document for the long-term survival of each species. They look at research needs, protection requirements, and cover all aspects of the management of each plant or animal.

Ecosystem links

While each of these species groups has its own habitat requirements it also interacts with and depends on other organisms. These interrelationships help build the incredibly diverse and interdependent braided river ecosystems of the Mackenzie Basin. It is important to emphasise that braided rivers are recognised as rare ecosystems in their own right, as are many of the plants and animals that interact within them.

Photo: C Woolmore

Section D: Human impact

Since their arrival, humans have certainly made their mark on the Mackenzie Basin. The natural environment has been greatly modified, with changes accelerating in the last 150 years. Humans have had regular contact with the Mackenzie Basin since the time of the moa, when forests were burnt to aid hunting, to the massive hydroelectric developments of today.

Māori history

Illustration: Brian Flintoff

Māori tribal ancestor Rākaihautū was captain of the canoe,Uruao, which brought the Waitaha tribe, the predecessors of modern Ngāi Tahu, to the South Island of New Zealand. Rākaihautū beached his waka/canoe near Nelson and then travelled southwards following the Alps along an inland route.

Māori occupation of the Mackenzie and Waitaki basins is difficult to accurately date, but their arrival has been placed between 750–1300 AD. Waitaha, lead by Rākaihautū, is credited with naming much of the landscape, particularly the lakes of the interior. Waitaha were also referred to as Kahuitipua. Te Rapawai – sometimes referred to as the 'moa hunters', established a pā site on Motuariki, the large island in Lake Tekapo. It was used for some time as a permanent living base.

A number of migrations into the area occurred throughout the subsequent centuries including Ngati Mamoe and lastly Ngāi Tahu in the seventeenth century. Today it is Ngāi Tahu who hold mana whenua, or customary authority, over the lands of the Mackenzie Basin.

Weka Photo: Copyright Nga Manu Images

Moa hunters hunted in the Mackenzie Basin before the thirteenth century, when moa were fairly plentiful. Village and camp sites have been discovered right up to the Ohau River. Fish and moa, and foraged berries and roots made up their diet. Tamatea, a legendary Māori explorer who came from the Takitimu canoe, is said to have explored the South Island in the fourteenth century. On one of his trips he apparently visited the Mackenzie Basin, travelling from Lake Ohau to the West Coast via Broderick Pass/Te Tarahaka.

Until the mid-nineteenth century, large parties of Māori used to come to the Mackenzie for three to four months each year to forage and collect food for trade. The Mackenzie was known for its many weka, NZ quail/koreke, fernroot/aruhe, eel/tuna and lamprey/kanakana. Raupō roots were also harvested for food, and their leaves and stems for making reed rafts (mōkihi). Haumata (snowgrass) was used for thatching huts. Quartzite (flint) was mined at a quarry in the upper Waitaki catchment. The last recorded expedition into the upper Waitaki catchment was in 1889 when three tons of birds were reported to have been captured.

When Europeans arrived in the Mackenzie Basin there was little forest cover. There is some evidence to suggest that Māori may have burned forest during moa hunting expeditions as the remains of former tōtara forests up to 1220 metres above sea level have been found. As important mahinga kai sites, the wetlands of the Mackenzie Basin were intact.

At the time of European colonisation of New Zealand, the Māori population of South Canterbury was small because it had been depleted by a measles epidemic. The tribe of Te Puna-o-Maru had settlements at several sites on the Otago side of the Waitaki River. On the Canterbury side, there were small settlements at Tauhinu and Te Kapa.

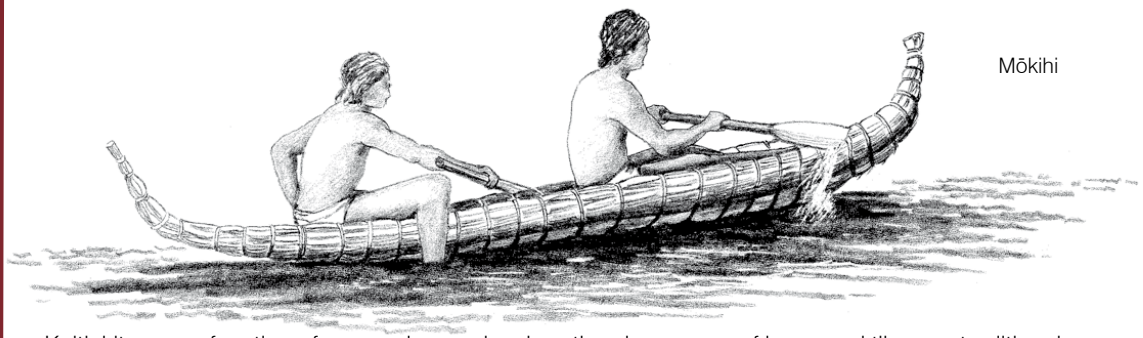
Significance to Ngāi Tahu

Waitaki is the ancestral river of Ngāi Tahu, fed by the sacred waters of Aoraki and the tears of Raki (Sky Father). The life-giving waters flow to the sea passing through the valleys and plains of Papatūānuku (Earth Mother). The river is a symbol of permanence and source of spiritual meaning to tangata whenua. The creation traditions tell of the interconnection between earth, sky and the natural elements, the source of life or mauri that emerged from the primordial waters, and the realm of the gods who made Te Waipounamu habitable for humans.

Tribal whakapapa links the cosmological world of the gods and present generations, giving rise to a spiritual relationship and respect for the mauri evident in the tribal landscape. The Waitaki River is a central element of the tribal identity and mana, a taonga derived from the gods, which requires a reciprocal duty to protect the Waitaki and the associated natural resources now and for future generations.

Some information from Prehistoric New Zealand and its people, *Beverley McCulloch and National Library website*

Wāhi tapu and wāhi taonga are cultural anchors associated with the Waitaki catchment. These include sites linked to the creation traditions, burial sites and areas where important historical events have occurred. The relationship with the Waitaki catchment is recalled in traditions, place names, songs and whakapapa. The practice of mahinga kai was a cornerstone of Ngāi Tahu existence and culture, a seasonal food and resource-gathering activity requiring intimate knowledge of the catchment, seasons and methods of procurement. The Waitaki catchment was a prime provider of mahinga kai resources and a means of travel by reed raft (mōkihi).



Mōkihi

Kaitiakitanga, a function of mana whenua, involves the observance of kawa and tikanga, traditional rules applied to protect the mauri from harm by human actions, to ensure that the health and spirit of the Waitaki remains intact and the principle of sustainable use of the natural resources is observed. Te Rūnanga o Ngāi Tahu is the iwi authority vested with statutory functions to act in the interests of Ngāi Tahu in matters of natural resource management.

Waitaki River – route to the West Coast

The Waitaki River derives its name from the Māori words wai (water) and taki (a sounding or weeping). The route up the river was frequently travelled by Māori parties on their way to the West Coast in search of the coveted pounamu (greenstone).

European history

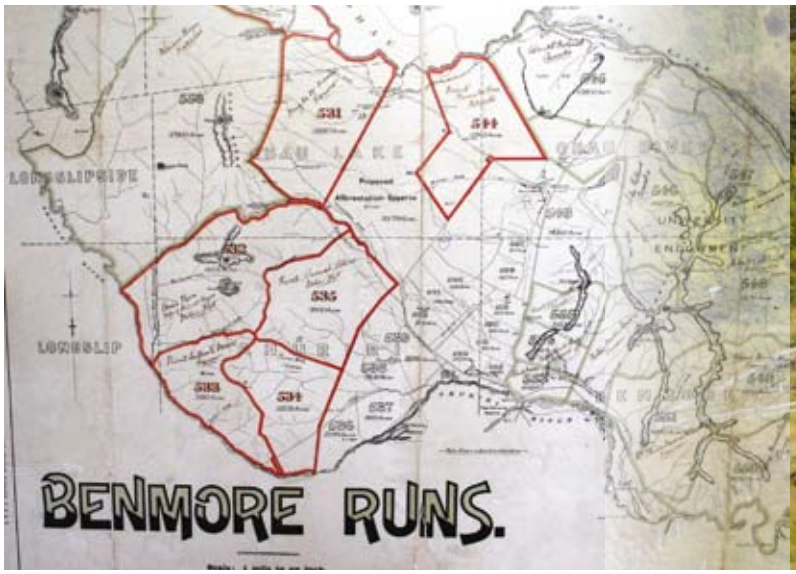
During the1850s land was opened up for pastoralists and development of the high country by runholders. This saw the introduction of cattle, horses and sheep, and by 1861 most of the land in the Mackenzie Basin was taken up by runholders. It was around this time that sport hunting began with the release of 12 rabbits on an island in the Ohau River. More introduced species were released in the late 1860s; deer in 1867 followed by the first planting of broom and gorse in 1868. The rabbit population grew and became a problem, so in an attempt to control numbers cats were released on runs during the 1870s.

By 1875 the practice of burning by runholders was condemned, but this had little effect. Continued burning, as well as the effects of rabbits, caused acceleration of erosion throughout the Mackenzie Basin.

In 1877 the Waitaki County Acclimatisation Society was formed to introduce and acclimatise all manner of animals, birds, fish, insects and vegetables. This included ferrets, which were kept on Kowhai Island in Lake Pukaki for release by farmers for rabbit control.

During the early 1900s quinnat and sockeye salmon were introduced into Lake Ohau and in 1916 rainbow trout were introduced to New Zealand in the Hakataramea hatchery. Russell lupins were then introduced to the Mackenzie Basin in 1930.

In 1934 the Waitaki Power Station opened. Since this time, hydroelectric power development has had a significant impact on the region.



Habitat loss and development

Braided rivers of the Mackenzie Basin and the plants and animals they support face a variety of impacts. Unfortunately, very few river systems in New Zealand remain unmodified and free of introduced species. With a mounting demand for water use, for both electricity and agriculture, regional water resources are facing increased pressure.

The arrival of Europeans, introduced species, development of agriculture, and later the Waitaki Power scheme, has had a significant impact on braided river ecosystems. Much of this habitat loss and modification has been incremental, but the overall impact on native species has been significant.

Introduced animals

Mammalian predators

With the Europeans came numerous introduced animals, either as new economic business opportunities (fur industry), agents to control farm pests (starlings, hedgehogs), as pets, to deal with other introduced animals that had got out of hand (ferrets, stoats, weasels) or simply by accident (rats). Many of these mammals turned their attentions to unforeseen activities and became predators of native fauna. While native animals always had some natural predation to contend with, the scale of predation by mammalian predators is massive in comparison.

In the absence of any mammals other than bats, most New Zealand riverbed fauna has evolved traits and behaviour, such as well camouflaged eggs and chicks, to deal with avian predation. Hunting by fast, nocturnal ground-based mammals that locate prey through scent, negate these protective strategies and they are now a major threat to many braided river birds, reptiles and macro invertebrates. Predation is a significant factor in many species population decline, and effective predator-control techniques will be essential to maintain viable populations of many threatened native animals.

Predators may eat eggs, chicks and even adult birds, which are particularly vulnerable during the nesting period. Mammalian predators of riverbed nesting birds include feral cats, rats, weasels, ferrets, stoats and hedgehogs. Breeding colonies can face dangers from the sky too, with Australasian harriers, black-backed gulls and magpies known to eat eggs and chicks.

Over a five-year study, video cameras recorded the causes of nest failure at 137 nests of kakī, black-fronted tern and banded dotterel in the Ohau and Tekapo rivers. Cats, ferrets and hedgehogs caused 89 percent of predation. All except one raid occurred at night.

Unfortunately, these predators cannot be eliminated because of constant reinvasion from surrounding land. Research aims to identify effective methods and intensity of predator control needed to enable threatened birds to recover. In some areas, such as wetlands, specially designed fences can be used to exclude predators, as an alternative to trapping. These fences are very expensive to build and opportunities to use predator-exclusion fences in braided rivers are limited due to the constantly changing nature of river floodplains.

Combined predator-control research projects between Landcare Research, Department of Conservation (DOC) and university students have taken place in the past. DOC supports and encourages these projects, where appropriate.

Cat with adult bird (left), ferret (centre) and hedgehog (right) raiding riverbed nests.

Video footage of predators attacking bird nests can be viewed on the teacher's resource CD.

Ferret Photo: R Morris

Banded dotterels, black-fronted terns, and stilts combined

Cause of event	Clutches - eggs killed	Clutches - eggs deserted	Clutches (%)	Chicks	Adults	Total	Total (%)
Cat	16	3	34	5	3	25*	40
Ferret	14	0	25	0	0	14	22
Hedgehog	12	0	21	0	0	12	19
Stoat	3	0	5	0	0	3	5
Sheep	2	0	4	0	0	2	3
Magpie	0	0	0	1	0	1	2
Harrier	1	0	2	1	0	1*	2
Black-fronted tern	1	0	2	0	0	1	2
Banded dotterel	1	0	2	0	0	1	2
Flood	3	0	5	0	0	3	5
Total	**53**	**3**	**100**	**7**	**3**	**63**	**100**
Human	0	3	-	0	0	3**	-
Unknown cause	1**	2	-	1	0	4	-

*Some events involved deaths of more than one of deaths of clutches, chicks, eggs, and adults, and desertions, hence these totals are less than the sum of number of deaths in each of these categories.
**These four events occurred at videoed nests but were not recorded on tape

CAUSES OF LETHAL EVENTS AT VIDEOED NESTS OF BANDED DOTTERELS, BLACK-FRONTED TERNS AND STILTS 1994–1998.

Constructing a rabbit-proof fence

Rabbits

Rabbits, introduced to New Zealand in the 1800s as game, became a serious pest, especially in Central Otago, the Mackenzie Basin, North Canterbury and Marlborough. Where they occur in large numbers, rabbits compete with stock for grazing, threaten plant cover, and accelerate soil erosion. They also damage commercial crops and plantings of young trees. Rabbit numbers often become so high that landowners have to undertake expensive, large-scale control programmes using poisons.

In August 1997, rabbit haemorrhagic disease (RHD) was illegally introduced into New Zealand by a group of South Island farmers. RHD is a highly infectious disease that attacks the liver and spleen of rabbits and kills them within three days. Because of the introduction of RHD, rabbit numbers declined rapidly in most places, but numbers are again increasing.

The rabbits' main predators are the Australasian harrier, wild cats, ferrets, stoats and weasels. Unfortunately these animals not only prey upon rabbits, but also on native birds. When rabbit populations rapidly decline due to poisoning operations or introduction of control agents, such as RHD, these predators switch their attention almost entirely to native prey.

Sport fish

Yellow tree lupin

Acclimatisation Societies introduced brown trout to the Mackenzie Basin during the 1870s and 1880s. These introductions were soon followed by releases of rainbow trout, sockeye salmon and quinnat salmon in the early 1900s. The trout populations flourished and rapidly spread throughout the catchment. These fish now form the foundation of an internationally recognised sport fishery in upper Waitaki rivers. Unfortunately native fish have contributed to the success of the sport fishery by becoming food items for the larger trout and salmon. Trout are significant predators of native fish and invertebrates, becoming aggressive competitors for territorial space and food resources. While no native fish are known to have become extinct as a result of sport fish introductions (except perhaps the early disappearance of grayling) it is now being increasingly recognised that they play a role in the marginalisation of available habitat for native fish and may be a significant agent in the continued decline of some species.

Introduced plants and habitat modification

Extensive burning in the Mackenzie Basin, particularly among flammable shrubs and trees, such as bog pine and tōtara, has caused major change. As a result, much of the original habitat has disappeared or been modified. In the upper valleys a similar occurrence has taken place within the beech forest, where small remnants are all that remains of more widespread forest.

European settlers also brought many plant species to New Zealand. Some of these plants, e.g. willow, lupin, gorse, sweet brier and broom, have invaded braided rivers and become weeds. The influx of introduced plants continues as they are imported for ornamental or economic use. It is estimated that over 20,000 species of introduced plant are now present in New Zealand gardens and farms. Of these some 2,500 have escaped and are spreading by themselves in the wild, with around ten percent becoming serious conservation threats. Compare this to the 2300 plants in our native flora.

In riverbeds, invasive plants out-compete natives and quickly establish on gravel bars and islands, covering feeding and breeding areas and so limiting available nesting sites for birds. Silt and debris are also trapped by weeds, raising the height of the islands. This leads to deeper, more stable channels, which means fewer shallow feeding areas for wading birds. Continued channelisation and narrowing of the floodplain can completely change the function and natural character of a braided river, making it no longer suitable for native plants and animals that previously lived there.

Weeds also provide habitat and cover for predators, such as cats and ferrets, which prey upon native fauna. Braided-riverbed birds need exposed riverbed gravel with little or no vegetation in order to breed, and shallow edges at which to feed. Black-fronted terns and black-billed gulls are at particular risk. Forced to nest closer to the water, their nests are much more vulnerable to being swept away by the river.

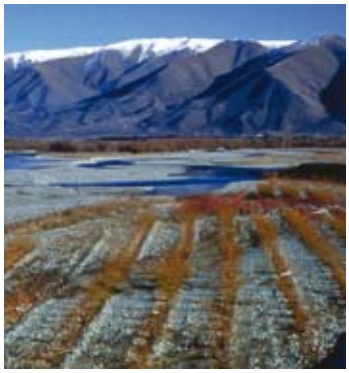
Didymo

Didymo

Didymo (also known as rock snot) is an invasive species of algae that threatens the health of all waterways in New Zealand. It attaches itself to streambeds by stalks. Thick growths of didymo can reduce the amount and quality of habitat available to freshwater fish, plants and invertebrates. Didymo is present in the Mackenzie Basin.

Willow

Willows are often found on river banks. Crack willow (*Salix fragilis*) was used by early runholders to provide shelter from the winds sweeping down the plains. Crack willow is very good at growing from small branches and twigs that break off and take root in the ground. Because stems are very brittle, they break easily and in a river environment can be washed long distances to then take root and grow. Willows spreading this way have gradually covered the open gravels of the Tekapo River delta and trapped silt, forming ever-growing silt islands. Willows have also invaded the riverbed of the lower Ahuriri River. Lake edge deltas provide an important habitat for native river birds, particularly as a feeding ground in the lean winter months, and open riverbeds are important nesting sites.



Planted willows

To restore and maintain open gravel riverbed, willows are removed. Young willows, and later willow regrowth, are sprayed with herbicides containing glyphosate. Strict ecological monitoring is carried out when sprays are used and no negative impacts on native or introduced fish, insects, birds or water quality have been found.

Willows are left where they are important in preventing river bank erosion. Environment Canterbury is responsible for protecting farmland and as part of this they plant willows along river banks to stabilise them. While this protects farmland and, therefore, farmers' livelihoods, it is not natural for braided riverbeds and so prevents the river from moving and changing as it would naturally do. This creates a possible conflict between the need for human protection and the natural balance of the braided river ecosystem.

Russell lupins

Russell lupins (*Lupinus polyphyllus*) are a familiar feature of roadsides in the Mackenzie Basin. They grow well in damp, gravel soils and tolerate low nitrogen levels – conditions most other plants find unsuitable. They can also withstand hot, dry winds and hard frosts. The gravel roadsides and braided riverbeds are, therefore, ideal lupin habitat.

Russell lupins

Nitrogen is an essential nutrient for plant growth. It is usually made available for plants in soils through the process of breakdown and decomposition of organic material. On fresh gravel surfaces, like those found in braided rivers, this process has not had enough time or plant material to start working. Nitrogen fixing plants like lupins and broom get around this problem by creating small nodules in their roots in which special bacteria transform nitrogen the plant takes from the air into a form useable by the plant. Because of this, they are able to rapidly colonise open, gravel surfaces, quickly forming tall, dense stands, which displace the low growing native plants, reducing all-round visibility wading birds need for nesting.

Most people do not realise the impact lupins have on the braided river environment and the intensive control measures that take place. For example, in the Ahuriri River the spread of lupins is so extensive that Project River Recovery cannot afford to manage them. In places like the Tasman /Te Awa Whakamau River where lupins are just establishing, control programmes are showing positive reduction rates.

For more information about weeds in the Upper Waitaki visit: www.doc.govt.nz – conservation – land and freshwater – freshwater – Upper Waitaki braided rivers - threats

Did you know?

Before lupins were identified as an invasive weed, the New Zealand Tourism Board issued visitors with lupin seeds and encouraged people to spread the seeds around road edges.

Recreation

More people are choosing to visit or live in the Mackenzie Basin for its recreation opportunities. However, recreational activities in riverbeds can have unintended impacts on fragile vegetation or disrupt nesting birds and other animals, especially as demand for these activities increases.

People use braided rivers for activities such as fishing, camping, boating, kayaking and wildlife watching. Recreational vehicle use of braided rivers is increasing as 4WD vehicles become more common. The tourism industry in the Mackenzie Basin includes activities like fishing tours, home-stays, and eco-tourism.

Braided river birds are very vulnerable to disturbance by human activity. Off-road vehicle use, fishing and even picnicking can disturb nesting birds. If riverbed birds are disturbed from their nests, eggs and chicks can be cooked by high temperatures or chilled in low temperatures; they can be run over or be eaten by pet dogs and cats. Beyond the physical threats of accidentally stepping on or turning over eggs or chicks, prolonged disturbances may cause breeding adults to desert their nests.

DOC works with 4WD clubs to minimise the impact of 4WD activity on the river beds. The Regional Council is also currently looking into restricting 4WD activity in some river systems.

Recreational users can minimise the risk to nesting birds by driving on marked tracks, learning about bird behaviours and responding appropriately, keeping pets off riverbeds or keeping dogs on a leash. Most riverbed-nesting birds breed between August and February. Visitors to these areas should be aware of nesting birds and keep their distance from breeding colonies and individual nests.

Hydroelectricity

The Waitaki catchment is of national importance for power generation. Meridian Energy operates eight power stations on the Waitaki River system. The network of dams, storage lakes, canals, spillways, pipelines and power stations in the Waitaki catchment contributes nearly 30 per cent of New Zealand's electricity requirements.

Benmore Dam

Between 1935 and 1985 the three main glacial lakes – Tekapo, Pukaki and Ohau – were dammed and the lake levels raised. The braided rivers of the Mackenzie Basin were diverted into canals, and the river in the upper Waitaki was dammed to create the artificial lakes of Benmore, Aviemore and Waitaki. Five power stations were built at the dams.

Depending on inflows, the Waitaki hydroelectricity scheme generates approximately 30 percent of New Zealand's electricity annually, with Lakes Tekapo and Pukaki providing around 65 percent of the nation's hydroelectricity storage capacity. This storage is critically important to the nation's energy system, especially for security of supply in the South Island in dry years. Water is also used in micro-hydroelectricity generation for localised use such as ski fields and high-country stations.

The development of this hydro scheme has had an enormous impact on the biodiversity of the Waitaki catchment. Parts of rivers have been dewatered and, in other areas, habitat has been drowned to form lakes to provide water storage.

Water control (i.e. abstraction and damming) for hydroelectric power generation has caused a major reduction in the amount and quality of braided river habitat and associated stable side channels and wetlands in the Tekapo, Pukaki and Ohau rivers. Raising natural lake levels or creating artificial lakes has inundated a further 7400 hectares of braided riverbed and 3900 hectares of wetlands. Water control has also reduced the size and frequency of floods, and changed the timing of floods in affected rivers, reducing substrate disturbance and allowing vegetation to establish more quickly.

However, it is important to remember that these power developments have also created a significant renewable energy resource that provides New Zealand with much of its electricity. Renewable energy is the way to power our future, but at what cost?

Other issues – agriculture and irrigation

The Upper Waitaki Irrigation Scheme takes water upstream of the Waitaki dam. Water for this area is drawn from both river sources and hydro-canals, with approximately two-thirds currently drawn from river sources. The water irrigates approximately 54,600 hectares of land, which amounts to about 10 percent of New Zealand's irrigated land. About 8,600 hectares are currently irrigated from takes in the upper catchment.

Any additional extraction from the streams and rivers will put further pressure on these waterways

Agricultural irrigation

and the surrounding ecosystems. One significant issue that already exists is the reduced flow effects on braided river morphology.

Historically, the agricultural sector consisted of mainly dryland grazing in the Mackenzie and Ahuriri basins, with more intensive agriculture in the Hakataramea and lower Waitaki valleys. Water from the upper Waitaki catchment was used for stock drinking-water and minor irrigation.

The productive use of land is now rapidly changing in the Mackenzie Basin; pastoral practices are moving away from extensive grazing to more intensive management systems reliant on water abstraction for irrigation. Over time, land-use intensification and pastoral development has resulted in an estimated loss of 90% of wetlands in Canterbury, a process that continues as wetlands are drained, damaged by stock, or the natural hydrology impacted by groundwater abstraction and vegetation clearance. Similarly, pastoral development has displaced whole sections of alluvial riverbed succession sequences. Of particular concern is the displacement of indigenous communities by pasture grasses on more fertile alluvial surfaces and the trampling effects of stock in wetlands.

The high costs of irrigation and operational costs mean farmers often need to use fertiliser and other inputs to remain productive. Fertiliser from run-off can leach into the soil and waterways. Increasing the stock capacity of land also increases the amounts of nitrates and phosphates being produced. This intensifies the risk of contamination of ground and surface waters. Increased nutrient loading in water in the Mackenzie Basin is an issue, particularly given the high water quality that is there now.

River engineering works are commonly used to protect economically productive land uses or important infrastructure within or adjoining braided riverbeds. The effect of these works is to constrain the river, either by stabilising banks or narrowing the floodplain available for peak flows to spread across. This can affect river flows, change the way braid channels erode and reform, or alter the floodplain sediment supply. The use of exotic trees, such as willow, in engineering works can also act as sources for further spread of problem plants into the floodplain.

Stock pugging in wetland

Water abstraction can adversely affect the quality and quantity of habitat available for plants and animals as well as the physical functioning of braided river systems. Changes in water flow alter the insect food supply for birds. Rivers with less water around islands and narrower channels are more at risk from predator invasion. Seasonal floods are needed to prevent weeds from gaining a foothold in the riverbed, or to wash away newly established weeds.

Stock intensification can also affect quality of habitat by increasing the levels of nutrients entering waterways from fertilisers or animal effluent.

As previously discussed, the Mackenzie Basin is a highly modified habitat. The more land development for farming and thus irrigation that takes place, the greater the demand for water, and the more pressure that will be put on this already modified and fragile environment. This situation clearly demonstrates that an integrated irrigation/land management programme is essential if future problems are to be avoided.

Information adapted from www.mfe.govt.nz

A damaging combination

All of these threats significantly reduce the amount and quality of braided river habitat. Their adverse effects are often inter-related, complex, and more than additive in their cumulative impact. For example, a reduction in river flow can reduce quantity and quality of feeding habitat for wading birds, as well as allowing predators access to islands previously safe for animals. Lower flows also lead to increases in vegetation cover which in turn destroys open-gravel nesting habitat and provides better cover for predators.

Section E: What is DOC doing?

Sustaining ecosystems

Human actions can have both positive and negative impacts on the environment. Part of this is due to the intrinsic need humans have to interact with nature and it is often what motivates groups to restore or conserve natural environments and ecosystems.

The Mackenzie Basin is a distinctive and diverse ecosystem that supports a variety of rare and special plants and animals. It is worthy of protection and restoration both for this reason and for the deep connection people have with the region. It has strong emotional, spiritual, aesthetic, cultural, social and economic value for people who live in, make their livelihood from, holiday in and travel through it.

The scenery, setting and its landforms, along with its sparse population – mostly concentrated in small towns – provide a distinctive rural lifestyle and holiday destination. In many places the development of the community infrastructure has been linked to hydro-construction.

Sustaining this environment and the ecosystems within it requires focusing on biodiversity and, therefore, the interrelationships between species and their surroundings. In order to achieve more complex and intensive conservation goals, it is important people enhance their understanding of ecological processes and how ecosystems respond to management.

Project River Recovery

In 1989, a number of organisations began talks to find ways to meet the needs of all Waitaki water users, while recognising the national importance of the area for power generation. These talks led to The ECNZ Waitaki Water Rights Working Party Agreement, signed in 1990.

The ECNZ Waitaki Water Rights Working Party included DOC, ECNZ, Ngāi Tahu, The Royal Forest and Bird Protection Society, New Zealand Salmon Anglers Association, Central South Island Fish and Game Council, Federated Farmers, and various community, recreational and irrigation groups. As well as the main agreement, ECNZ signed separate agreements with each party.

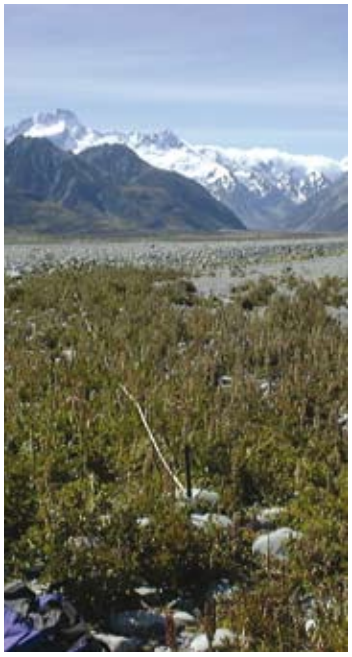
The recognition by ECNZ of the impact of hydro development on wildlife habitat, led to an agreement between DOC and ECNZ to create Project River Recovery (PRR).

PRR is managed by DOC and funded by Meridian Energy. The project aims to restore braided rivers and wetlands in the Mackenzie Basin (above Lake Benmore), mostly via weed control, but it also includes research on riverbed predators, ecological monitoring, advocacy, and the construction of new wetlands and encouragement for native birds to nest in these wetlands.

PRR is a restoration programme for the wildlife and plants of the braided rivers and the wetlands that have lost part of their natural habitat due to introduced vegetation and changes to the natural flow of water, as a result of the Waitaki hydro scheme.

PRR's current objectives are to:

- Maintain indigenous vegetation and protect or restore riverbed and wetland habitat by removing problem weeds
- Explore opportunities to enhance wetland protection in the upper Waitaki Basin
- Continue to build knowledge of natural heritage in braided river ecosystems
- Test the effectiveness of large-scale predator control for population recovery of braided river fauna
- Facilitate research by external agencies to improve our understanding of the ecology of braided river systems
- Increase public awareness of braided rivers and associated wetlands.



Weed transects in Tasman valley–2004 (above) and 2008 (below)

Weed control

Maintaining and restoring braided river habitat through weed control is PRR's core work. Targeted application of herbicides to a range of weeds using handheld methods is the main approach used, with occasional spot spraying by helicopter. Non-chemical methods of control have been trialled, but they have not been successful to date.

The project faces weed invasions in the braided rivers and wetlands it manages on a scale far beyond its resource capabilities to deal with. Because of this, three strategic approaches to weed control have been adopted.

The first approach is to prevent weeds known to cause problems in other river and wetland systems from becoming established in the Mackenzie basin. This is achieved through an active surveillance programme in which staff and associates are trained to recognise potential problem weeds, such as false tamarisk (*Myricaria germanica*) and purple loosestrife (*Lythrum salicaria*), and report them if they are seen. Controlling weeds at the time of establishment, before they widely disperse is the most cost effective weed control approach available. (See *Wicked weed* booklet for more information.) PRR has two active control programmes for newly establishing weeds – yellow tree lupins (*Lupinus arboreus*) and buddleia (*Buddleja davidii*) – and is making excellent progress at maintaining them at zero density within the upper Waitaki basin.

The second approach is to deal with weeds that have already dispersed widely into some rivers but are only just establishing or yet to establish in others. By removing these scattered infestations in the 'pristine' rivers the project can be very effective at maintaining the high-quality habitats that still remain. PRR is achieving very good results using this strategy. Examples are removal of Russell lupins (*Lupinus polyphyllus*) from the Tasman/Te Awa Whakamau and Godley rivers and crack willow from the upper Ahuriri, Tasman/Te Awa Whakamau, and Godley rivers.

The last approach is to remove dense infestations of weeds at targeted locations within a river to protect important plants or animals. This approach is challenging, not only because of high costs of widespread herbicide use but also because of potential unintended impacts on native plants and animals. PRR has taken a number of measures to ensure it minimises these impacts, including monitoring of water quality and aquatic invertebrate numbers before and after spraying, choosing to use targeted, hand-held herbicide application methods rather than blanket spraying, choosing to use herbicides which have the least environmental impact on aquatic systems, and undertaking trials to establish minimum effective application rates for target weeds. Places where this approach has been used include removal of dense willow stands on the Ahuriri and Tekapo lake deltas to restore important feeding habitat for native birds, and, in the upper Tekapo River where broom and lupins threaten to displace a range of threatened plants, invertebrates and birds that can't be found in other less weedy river systems.

Measuring the benefits of weed control is not easy or cheap. PRR quantitatively monitors success at selected sites, with visual assessments of contractor performance at others. In the Tasman/Te Awa Whakamau River 15 permanently marked transects are assessed annually to record progress with control of Russell lupins. In the Ahuriri River permanent photo points and aerial photography are being used to examine long-term changes in weed infestations and amounts of open-gravel nesting habitat available for threatened birds. Short-term monitoring associated with specific projects is also undertaken. For example, breeding birds monitored in the Tekapo and Ahuriri deltas immediately after willow removal, showed kakī, black fronted tern and many other species nested in the restored habitat.

Resource information

PRR is steadily building knowledge about braided river ecosystems to better inform its management. Important findings so far have included using infrared video equipment to identify causes of nest failure in threatened birds; this study in the 1990s clearly identified predation by hedgehogs, feral cats and ferrets as the main causes of nest failure. Surveys of threatened plants and plant communities have identified the importance of braided rivers as habitat for a range of threatened plants and highlighted the diversity of plant communities present. Current work is looking at the range and diversity of terrestrial invertebrates in braided river floodplains.

The project also does a number of trials to improve management practice. Examples are establishing effective application rates for riverbed weeds as new, lower-impact herbicides become available; establishing effective timing of herbicide application for lupin control; and trialling predator-control techniques to benefit colonial nesting birds.

Creation of wetlands

Several wetlands have been created or enhanced and protected by predator-exclusion fences. The aim of these areas is to demonstrate the creation of wetlands suitable for a variety of wading birds, including threatened braided river species, such as black-fronted tern, banded dotterel and kakī.

The creation of the Ruataniwha wetland complex (left) adjacent to the Ohau River is a major achievement of PRR. So far, about 100 hectares of shallow wetland and surrounding breeding areas have been created. Stop-log weirs control water levels through the season. During winter, exposed margins and vegetation are flooded to boost aquatic invertebrate production. As summer advances, the wetlands are progressively lowered, exposing invertebrate-rich areas of the bottom for birds to feed on.

Wetland enhancement and creation has already proved highly successful, with a variety of birds making immediate use of them. Some wetlands have been used as sites to release kakī reared in captivity. A colony of 80 black-fronted terns nested in the new Ruataniwha wetlands soon after they were constructed.

Communication and education

PRR has many methods of communicating the importance of its work to people. Some of these include:

- Newsletters, web information and video footage
- Open days, talks and fieldtrips and scientific papers
- Consultation with stakeholders
- Newspaper articles and other media releases
- Riverbed signage and field guides
- Brochures, posters and factsheets on braided river ecology
- Placement of *Braided River Care Code* in all new 4WDs in Canterbury and Otago
- Provision of *Braided River Care Code* to fishing outlets to be handed out with fishing licences
- Book on braided rivers, education resources and talks to schools.

For more information visit www.doc.govt.nz – conservation – land and freshwater – freshwater – upper Waitaki braided rivers – Project River Recovery's work

Kakī recovery programme

Kakī are so critically endangered that the Department of Conservation has set up a team of people to manage their recovery. This conservation programme was set up specifically to assist the recovery of kakī population numbers and is managed separately from Project River Recovery. Kakī have been intensively managed since 1981, when their population declined to a critically low number of just 23 birds. The wild adult kakī population currently stands at 93 (February 2008).

DOC's captive breeding centre (left) is located near Twizel in the Mackenzie Basin. A number of kakī pairs are held at the centre for captive breeding, and eggs are also collected from birds nesting in the wild. All kakī eggs are artificially incubated and the young chicks are raised in captivity. Once juveniles are ready to leave the nest they are put into outside aviaries, where they learn to feed themselves from small streams but still get artificial food.

Kakī chicks are released into the wild when they are between 2–9 months old. Some chicks are released in January and others are kept over winter. Rearing them in captivity significantly increases their chances of survival by preventing predation when they are most vulnerable (as chicks and eggs). The survival rate for these birds can be very high.

A key research aspect of the kakī recovery plan is to identify what happens after captive-reared birds are released and why they die. This research involves large-scale attachment of transmitters to released sub-adult birds. Thirty-nine sub-adults were released on the Tasman/Te Awa Whakamau River delta in September 2007. Transmitters have also been attached to wild-caught adult kakī. Trials have shown no major issues with transmitter attachment methods. Fitting birds

What do you think?

Should hybridisation of kakī with pied stilts be allowed to take place? What do you think might happen to the current population?

with transmitters helps make nest-finding easier, and helps determine the location and timing of adult deaths.

As part of the recovery programme, no cross-breeding (hybridisation) is allowed between kakī and their close relative the pied silt. Although kakī preferentially mate with kakī, if no other kaki are available they will mate with pied stilts. This kind of hybridisation would influence and change the existing kakī population significantly. If hybridisation did occur, some kakī would still come from this population as the kakī genes would still be present in the population.

Kakī hide

The kakī visitor hide (left) is next to the captive-breeding centre. It overlooks aviaries where kakī pairs are held and a display aviary next to the hide enables a close-up kakī encounter. The hide is a great place to see these rare birds up close and is used by many South Island schools on field trips to both Twizel and Aoraki/Mt Cook.

Regular guided tours of the kakī visitor hide are run by DOC staff and local volunteers during spring and summer. The tours offer a great opportunity to see kakī and learn about their ecology and conservation. Bookings are essential.

For school bookings contact the Twizel Area Office on (03) 435 0802 or email KakiVisitorHide@doc.govt.nz

Captive-reared kakī being released

Tasman predator control project

Checking traps

The Tasman Predator Control Project is a five-year project jointly funded by PRR and the kakī recovery team to test the effectiveness of large-scale predator control at improving the breeding success of a range of native riverbed fauna, including threatened wading birds.

Long-term and large-scale predator control began in the Tasman/Te Awa Whakamau River valley in 2005 and was fully operational by the beginning of the 2006/07 river-bird breeding season. Predator control is carried out all year round and uses a combination of live-capture and kill traps. The main predators targeted are feral cats, stoats, ferrets, weasels, and hedgehogs. Possums also occur in the area and are caught in the traps.

Trapped ferret

In addition to pest control, pest monitoring and tracking is also carried out in order to determine the effectiveness of predator control as well as predator numbers in an area. The long-term aim of this programme is to reduce predator numbers to a level where threatened wading bird survival rates increase and can be sustained. The breeding success of wrybill, banded dotterel and black-fronted tern is being monitored over five years to assess whether this level of predator control is helping these birds.

A second smaller predator-control programme was also set up in the upper Ahuriri River valley by the kakī recovery team. The aim of this programme is to provide protection for kakī wild-breeding pairs as well as recently released aviary birds from the kakī captive-breeding programme.

Trap building – at school

What can you do?

There are a variety of action projects you and your school may be able to get involved in, in the Mackenzie Basin. Tours of the Kakī Visitor Hide and constructed wetlands are also possible. For more information contact the Twizel Area Office on (03) 435 0802 or email TwizelAO@doc.govt.nz.

Looking to the future

There is no doubt that the Mackenzie Basin is a spectacular environment, worthy of both respect and protection. Within this environment the actions of humans form a major part, be it through farming, forestry, power generation, conservation or recreation. This is a place with many natural resources. Should these resources be used? Can they be managed properly and carefully?

The braided rivers and associated wetlands of the Mackenzie Basin, with their unique plants

and animals, are precious parts of New Zealand's natural heritage that are worth protecting. The challenge is to retain this heritage while accommodating the varied uses and economic demands we place on braided river systems.

This special environment is also a reminder that humans need to live in harmony with nature and that we cannot and must not destroy our heritage and our future. Do you think this is possible?

Glossary

Competition – the struggle among organisms, both of the same and of different species, for food, space, and other vital requirements.

Community – an assemblage of interacting populations occupying a given area

Co-operation – mutually beneficial interaction among organisms living in a limited area

Ecosystem – a system formed by the interaction of a community of organisms with their environment

Endemic – natural to, or characteristic of, a specific people or place; native; indigenous

Habitats – the places/environments where plants and animals live. In a healthy habitat there is more diversity (variety) of species.

Niche – the position or function of an organism in a community of plants and animals.

Organisms – forms of life considered as an entity; an animal, plant, fungus, protistan, or moneran

Populations – a. The assemblage of a specific type of organism living in a given area

b. All the individuals of one species in a given area

Predation – a relation between animals in which one organism captures and feeds on others

Symbiosis – any interdependent or mutually beneficial relationship between living entities; the living together of two dissimilar organisms

Trade-offs – an exchange of one thing in return for another, especially relinquishment of one benefit or advantage for another regarded as more desirable

Values – the ideals, customs, institutions etc. of a society toward which the people of the group have an affective regard, i.e. freedom, or education; any object or quality desirable as a means or as an end in itself.

Biodiversity – the variety of all life on earth. Biodiversity of species is the diversity/variety of all plants and animals.

Flora – plants

Fauna – animals

Contacts

The following is a list of useful organisations and agencies you can contact for further information:

Project River Recovery, Department of Conservation,
Twizel Area Office
(03) 435 0802, TwizelAO@doc.govt.nz

Chief Executive, Central South Island Fish and Game
(03) 615 8400, csi@fishandgame.org.nz, www.fishandgame.org.nz

Government agencies

Department of Conservation www.doc.govt.nz
and search for Project River Recovery

Ministry of Agriculture and Fisheries Information Bureau
www.maf.govt.nz

Ministry for the Environment www.mfe.govt.nz

Crown Research Institutes

Institute of Environmental Science and Research Ltd (ESR)
www.esr.cri.nz

Landcare Research New Zealand Ltd www.landcareresearch.co.nz

National Institute of Water and Atmospheric Research Ltd
www.niwa.cri.nz

New Zealand Pastoral Agriculture Research Institute Ltd (AgResearch)
www.agresearch.co.nz

Local, regional and city councils

Environment Canterbury www.ecan.govt.nz

Mackenzie District Council www.mackenzie.govt.nz

Christchurch City Council www.ccc.govt.nz

Other organisations

Royal Forest and Bird Protection Society of New Zealand
www.forest-bird.org.nz

Greenpeace www.greenpeace.org.nz

Meridian Energy www.meridianenergy.co.nz

New Zealand Conservation Authority www.doc.govt.nz (search for New Zealand Conservation Authority)

World Wide Fund (WWF) for Nature New Zealand, www.wwf.org.nz

Education for Sustainability New Zealand www.efs.tki.org.nz

Many other organisations can help out with advice and resources.

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New Zealand Government