Freshwater Ecological Values

of the Waitaki Catchment

September 2004

Prepared for

Ministry for the Environment

By

Kingett Mitchell Limited

Report commissioned by the Ministry for the Environment
for consideration by the Waitaki Catchment Water Allocation Board.

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Published in November 2004 by the
Ministry for the Environment
Manatū Mō Te Taiao
PO Box 10-362, Wellington, New Zealand

ISBN: 0-478-18971-0
ME number: 556

This document is available on the Ministry for the Environment's website:
www.waitaki.mfe.govt.nz

Table of Contents

1. Introduction

The Waitaki River is one of New Zealand's largest braided rivers and has a wide range of ecological, economic, social, and cultural values (Fig. 1 shows the Catchment boundary). The Resource Management (Waitaki Catchment) Amendment Act provides for the establishment of a Board to develop a water allocation plan for the Waitaki River Catchment. The Board has 12 months from September 2004 to develop and implement a water allocation plan for the Waitaki River Catchment. Environment Canterbury will administer the plan when it is operative.

The Ministry for the Environment is drawing together a range of information on the Waitaki Catchment for the Board to use when developing the water allocation plan. Catchment information being collated at the time of writing this report included reports on hydrology, recreational values, water demand, and freshwater ecological values. Kingett Mitchell was engaged by Ministry for the Environment to collate the freshwater ecological data and present it in a Geographical Information System (GIS) format. The objectives of this investigation were to:

- develop an understanding of the range of freshwater flora and fauna associated with the rivers and beds, banks, margins, tributaries, lakes, islands, wetlands and aquifers of the Waitaki Catchment.
- develop a graphic presentation that identifies their location including the location/s where different lifecycle stages of fauna species that may be related to or influenced by flow occur e.g., fish spawning and bird nesting.
- highlight areas of the Catchment where there is insufficient information to make an assessment of freshwater ecological values.

It is important to note that this project was an information collection and presentation exercise. Therefore, no assumptions regarding the relative importance of the various freshwater ecological values shown in the GIS have been made beyond the Department of Conservation's (DoC) threatened species classification system (Molloy *et al*., 2002).

This report is a companion to the freshwater ecology data collected, collated and presented in a GIS format by Kingett Mitchell for Ministry for the Environment. The purpose of this report is to:

- briefly summarise coverage of the Catchment with ecological values data and compare to known water allocation pressure areas.
- provide support to the freshwater ecology data in the GIS provided to Ministry for the Environment (herein referred to as "GIS data").
- describe for each group of GIS data its age, source, strengths/weaknesses, geographic spread within the Catchment, and any caveats on the use or coverage of the data.
- identify where there are gaps in ecological information – both in terms of spatial coverage, and in terms taxonomic groups.

- develop a GIS-based tool for (fish) ecological values mapping, using the River Environment Classification (see explanation in Section 4 below).

This report starts with a summary of freshwater ecological values in the Waitaki River Catchment, and then discusses the data sources in detail. Section 2 provides an overview of the GIS outputs and describes biological groups, life stages represented the spatial distribution of ecological values and assesses ecological values within the Catchment. Section 3 describes the various sources of the GIS data used, and discusses additional sources of ecological information not used for this project. Section 4 describes the attributes of each of the GIS layers, and includes methods on how the River Environment Classification (REC) was used to model freshwater fish distributions within the Catchment. Sections 5, 6 and 7 include acknowledgements, literature referred to in the body of the report and a bibliography of additional related literature not referred to in the report.

2. Freshwater ecological values in the Waitaki Catchment

2.1 Overview

2.1.1 Biological groups covered in GIS layers

The coverage of GIS data for the diversity of biological groups is generally very good for the Waitaki River Catchment and the freshwater ecology GIS layers include species records and habitat data for freshwater invertebrates, freshwater fish, lizards, birds, threatened plants and weed plants. Description of the diversity and spatial extent of these groups is given in the following sections. While many of the major taxonomic groups are represented in the GIS layers, groups not represented include algae, bryophytes (mosses and liverworts), fungi, frogs and bats.

There is little spatial information available for freshwater algae, bryophytes or fungi in New Zealand in general, or in the Waitaki River Catchment in particular. At the time of writing, Landcare Research (a Crown Research Institute) was preparing a "Moss Flora of New Zealand" publication as part of their Moss Flora project, but this information was not readily available at the time of writing. Most up-to-date information for the lower catchment on freshwater algae is held by the National Institute of Water and Atmospheric Research (NIWA). Although there is the potential for rare algal taxa to be present, the Project Aqua field surveys and literature review found no rare taxa in the lower catchment (Biggs *et al.*, 2003). In general, understanding of taxonomy and biodiversity of freshwater algae in New Zealand is still poorly developed. Little is known of freshwater fungi in New Zealand.

None of the three native frog species found on mainland New Zealand (all belonging to the genus *Leiopelma*) are found within the Waitaki River Catchment (Hitchmough,

2002). There are no historic or recent records of either long-tailed bats (*Chalinolobus* spp.) or short-tailed bats (*Mystacina* spp.) occurring within the Waitaki River Catchment (O'Donnell, 2001; Lloyd, 2001).

2.1.2 Life stages represented in GIS layers

The importance of a given freshwater body to species of interest may vary according to whether it is used for feeding, dispersal, breeding, or over-wintering. Freshwater fish, numerous native bird species, and many insects with aquatic larval stages depend on freshwaters to complete important parts of their life history.

Life history information is presented in GIS format for salmonid fish (introduced salmon, trout and charr) and native birds. The New Zealand Freshwater Fish Database (NZFFD) records information of native and introduced fish, however information on the life history status is patchy, so was not used as part of this project. O'Donnell (2000) identified the locations of significant feeding, breeding, roosting and over-wintering habitat for native birds (including riparian areas, lakes and rivers) in Canterbury in a GIS format. In the Waitaki River Catchment, there are large areas of open water and braided riverbed that form important habitat to a variety of native birds. For example, Fig. 2 shows that the braided riverbeds and deltas of the upper Waitaki catchment are primary breeding habitat for one of New Zealand's rarest birds, the black stilt (*Himantopus novaezelandiae*). The GIS layer from O'Donnell (2000) includes similar life history and habitat information for seven bird guilds and seven threatened bird species found within the Waitaki River Catchment.

Most salmonid fish species undertake migrations associated with spawning or downstream migration of juveniles within river catchments. The timing and habitat requirements of migrating salmonids depend on the developmental stage and species of interest. Langlands and Elley (2000) summarised salmonid habitat values, including spawning habitats, in the Canterbury region (including the Waitaki Catchment) in a GIS format. For example, Fig. 3 shows that brown trout spawning habitat occurs throughout the Waitaki Catchment, from the mainstem and tributaries below Lake Benmore, to the glacial lake tributaries in the upper catchment. The relative value of salmonid habitats, based on the assessment of Langlands (2000), is also presented in the GIS layer.

2.1.3 Spatial distribution of ecological information and values within the Waitaki River Catchment

Overall, the spatial coverage of the Waitaki Catchment with freshwater ecological GIS data is variable, and depends on the biological group of interest (see discussion below). All sub-catchments and major tributaries have some ecological information included in the GIS data, however the upper catchment (above Lake Waitaki) has a greater proportion of ecological data than the lower catchment, reflecting either greater ecological values or greater sampling effort in the upper catchment.

One of the major constraints in using the GIS data provided is that it will not be updated automatically when new records are added to the original data source. This will not greatly affect GIS layers such as the Department of Conservation Natural Significance layer, where much of the information is based on historic surveys. However, for groups such as the freshwater fish, new records are constantly being added, such that the spatial distribution of fish in the GIS layers may be misleading if the data is not updated regularly. Therefore, the 'life' of the ecological data presented in this report and associated GIS layers may be as short as 12 months for groups such as the freshwater fish, but will be longer for other layers.

There is a greater amount of ecological data available for the larger tributaries and sub-catchments within the Waitaki Catchment compared to the smaller headwater streams. The greatest diversity of stoneflies (Plecoptera) in New Zealand is typically found in small headwater streams (Quinn and Hickey, 1990). However, there is little ecological information for small headwater streams in the Waitaki. Thus, there are pockets of biodiversity, such as headwater streams, that are not covered in the GIS layers. Generalised Environment Canterbury GIS data coverage of wetland bird, vegetation, and salmonid habitat is restricted to the larger rivers and lakes such as the Hakataramea River. Similarly, information on distribution of threatened plants, lizards and birds is biased, as records do not include where threatened species were searched for and not found. The NZFFD is good in this regard, as records include sites where fish sampling occurred but no species were found. For example, in the upper Maraewhenua River Catchment (Fig. 4) and the headwaters of the Otematata River no fish have been recorded at some sampling locations.

The NZFFD has the best spatial coverage and most up-to-date records for any of the biological groups considered. Based on a search of the NZFFD in October 2004, there are 712 freshwater fish records, including 26 species in the Waitaki Catchment. Although the Department of Conservation threatened plant GIS data indicated that there were a total of 714 threatened plant species, including 78 species, within the Catchment, no distinction is made between terrestrial and aquatic species, so the actual number of threatened wetland plants is likely to be considerably less than this.

The distribution of threatened native fish and salmonids within the Catchment were modeled, in an effort to fill gaps where ecological data may be scarce. Fish distributions were modeled by combining fish species location records from the NZFFD with habitat information contained in the REC, a GIS-based river management tool created by NIWA. Details of the modeling process are described later in this report. However, in general, the modeling process was successful in extrapolating the potential locations of certain fish species throughout the Catchment.

2.2 Assessing ecological values within the Catchment

2.2.1 Overview

In general, ecological values include measures of biodiversity, habitat quality/integrity, and the presence of key species of interest, such as rare and endangered species or species

of recreational interest (eg, trout and salmon). This section provides an assessment of the freshwater ecological values of the Waitaki River Catchment, under the categories of threat status, biodiversity, salmonid habitat and habitat quality and ecological pressures. Where species are described as being threatened with extinction, the threat classification follows that of Molloy *et al.* (2002), as shown in Table 2.1 below.

Table 2.1 Classification of New Zealand native resident species according to threat of extinction (after Molloy *et al.*, 2002)

Degree of threat of extinction	Threat category
Acutely threatened	Nationally critical Nationally endangered Nationally vulnerable
Chronically threatened	Serious decline Gradual decline
At risk	Range restricted Sparse

Threatened species

Threatened plant and animal species occur throughout the Waitaki Catchment, as shown in Fig. 5. Appendix 2 lists the species recorded in the GIS data layers. Differences amongst groups in their spatial representation most likely reflect historic differences in sampling effort and reporting for the groups. Thus, the distribution of threatened species depicted in the GIS layers is probably quite accurate for birds and plants, patchy for lizards and native fish, and poor for freshwater invertebrates.

One of the three gecko species and four of the six skink species recorded in the Waitaki are threatened. Of these threatened lizards, only the jewelled gecko (*Naultinus gemmeus*), the green skink (*Oligosoma chloronoton*) and the long-toed skink (*O. longipes*) are commonly found in riparian areas, river terraces, or river islands. Threatened lizards are sparsely distributed mainly throughout the upper catchment

There are 714 records of threatened plants, including 78 species, within the Waitaki River Catchment. The most threatened wetland plant species recorded in the catchment is sneezeweed (*Centipeda minima*), which has a nationally critical threat status. Sneezeweed is a small herb typically found at the margins of wetlands and lakes, and has been recorded in the upper Waitaki catchment in the Ben Omar Swamp (near the Ahuriri River), on the southern shore of Lake Pukaki, and from an unnamed tributary of the Pukaki River. Two species of native broom, *Carmichaelia kirkii* (nationally endangered) and *C. vexillata* (in serious decline), are the most commonly recorded threatened plant species in the Waitaki Catchment. Both broom species are sparsely distributed throughout the upper catchment, although there are a cluster of *C. kirkii* records from tributaries of Lake Benmore in the Ben More range. Both *C. kirkii* and *C. vexillata* occur

on river banks and terraces, and recent alluvium, and *C. kirkii* is sometimes found in wetlands.

Six of the 26 freshwater fish species recorded from the Waitaki River Catchment are threatened with extinction. The most threatened of these fish taxa are the lowland longjaw galaxias (*Galaxias cobitinus*), whose threat status is regarded as nationally critical, and Canterbury mudfish (*Neochanna burrowsius*), which is nationally endangered (Hitchmough, 2002). Lowland longjaw galaxias are typically found at river margins and most records are from the upper catchment (although there is a single record from the Hakataramea River). In contrast, Canterbury mudfish are typically found in still or sluggish waters, with plenty of aquatic weeds, and have only been found in small tributaries close to the mouth of the Waitaki River. The Waitaki River marks the southern limit of Canterbury mudfish records in New Zealand.

Four or five species of threatened native birds are known to occur at any one time on the Waitaki River mainstem, Lake Benmore, Ahuriri River, and the glacial lakes and their major tributary inflows, outflows and deltas (O'Donnell, 2000). The black stilt (*Himantopus novaezelandiae*) is the most threatened bird species within the Catchment, and only about 100 individual black stilts exist. Black stilts feed and breed along braided rivers and river deltas (Fig. 2), and the Waitaki River Catchment is their principal habitat. Crested grebe (*Podiceps cristatus australis*), which are also listed as nationally critical, breed and feed on the glacial lakes in the upper catchment, and on Lakes Benmore, Aviemore, and Waitaki further down the Catchment.

Biodiversity

Biodiversity can be measured in the Waitaki Catchment at a variety of taxonomic levels. For example, by overlaying all the freshwater ecological GIS layers, it is clear that there is a diverse assemblage of biological groups (e.g., plants, birds and fish) within the Catchment. Clusters of ecological data coincide with areas where more intensive research has been carried out, such as the Department of Conservation Project River Recovery area in the Mackenzie Basin area and around Mount Cook village in the upper catchment.

Species richness (the number of species found at a given location) is a commonly used measure of biodiversity within a given habitat type or location. Fig. 6 shows that while there are many records of threatened fish species throughout the Catchment, there are only six sites (all below the glacial lakes) where more than one threatened fish species has been found at a site. In contrast, four or five threatened bird species are known to co-occur throughout the Catchment, including most of the large lakes and braided river habitat. Similarly, freshwater invertebrate data, while limited in its spatial extent, shows relatively high species richness (over 20 taxa per site) at a number of sites throughout the Catchment. Caddiflies (Trichoptera) have the greatest diversity within an individual taxon in the Catchment.

Salmonids

There are approximately 350 individual NZFFD records of brown trout (*Salmo trutta*) from the Waitaki Catchment, making it the most commonly recorded fish species within the Catchment (total of 1851 records, from October 2004 search of the NZFFD). Rainbow trout (*Oncorhynchus mykiss*) and chinook (or quinnat) salmon (*Oncorhynchus tshawytscha*) are also commonly found within the catchment. While rainbow trout and brown trout occur throughout the Waitaki Catchment chinook salmon are mostly found downstream of the Waitaki dam in the mainstem and in tributaries such as the Hakataramea River. Chinook salmon, brown trout and rainbow trout, are all important sports fish within the Catchment. The only New Zealand records of sockeye salmon (*O. nerka*) are from the upper Waitaki catchment, upstream of the Waitaki dam. Although sockeye salmon are virtually extinct within New Zealand outside of commercial salmon farms, they are known to spawn in Larch Stream at the head of Lake Ohau (Mark Webb, Fish and Game, *pers comm.*).

Habitat quality and ecological pressures

Fields in the salmonid, bird and vegetation GIS layers include information on habitat intactness and threats to the biological groups of interest. For example, Fig. 7 shows that a significant proportion of native bird habitat within the Catchment is threatened by a variety of factors such as introduced predators and reduced water quality.

The location and density of permits to abstract water provide an additional measure of pressure (water abstraction) on freshwater ecosystems. For example, there is a greater amount of ecological data (considering all point data combined) and fewer water permits in the upper catchment compared to the lower catchment, where there are more water permits and less ecological data (Fig. 8). However, two points must be made before making inferences from this pattern. First, while some layers indicate whether a species was present or absent (e.g., the fish layers), others do not. Therefore, the absence of data does not necessarily infer that the ecological values are low. It may simply mean that no detailed collections have been made in the location. Secondly, it is likely that there is additional ecological value information contained in the ecology polygon layers (e.g., the bird or salmonid layers) and the REC fish layers.

2.2.2 Examples

To show how GIS data can be used to help assess different freshwater ecological values against water demand, an example is given from the Hakataramea River Catchment. Fig. 9 shows that while there are water permits throughout the Hakataramea River Catchment, including the mainstem and tributaries, most threatened species records are concentrated along the mainstem. In contrast to threatened species records, brown trout are found both within the mainstem and tributaries of the Hakataramea River (Fig. 10). Because threatened species and brown trout distributions differ within the Hakataramea River, management of freshwater resources for instream habitat will vary depending on whether the focus is on tributaries (where brown trout have been found, but threatened species

records are uncommon) or on the mainstem (where trout, other salmonids, and threatened species occur).

3. Sources of ecological information

3.1 Data used in GIS

The Department of Conservation provided GIS data for threatened and weed plants, lizards (geckos and skinks), and threatened birds. In addition, Department of Conservation provided a "Sites of Natural Significance" GIS layer, which is a compilation of data from the following Department of Conservation databases: Recommended Areas for Protection; Special Sites of Significance to Wildlife; and Wetlands of Ecological and Representative Importance.

Freshwater invertebrate data was obtained from Environment Canterbury, and records of adult caddisflies (Trichoptera), which have aquatic larvae, were obtained from John Ward at the Canterbury Museum.

Data on the habitats and threats of salmonid fish (trout, salmon and charr), and wetland birds and plants were obtained from Environment Canterbury's GIS database.

Freshwater fish records were obtained from the NZFFD, which is administered by NIWA. Additional fields were added to the NZFFD records, including classifications according to threatened species status, whether or not the species is diadromous (with freshwater and marine life history stages), and whether or not the species were salmonids. Threatened species rankings followed the Department of Conservation classification of Molloy *et al.* (2002), as outlined in Table 2.1. Where additional potential sources of fish data were identified (see below) records were compared with the NZFFD, which was always found to contain the additional data source entries.

The River Environment Classification (REC) is a system that classifies New Zealand's rivers at six hierarchical levels (Snelder *et al.* 2004). The REC was produced for Ministry for the Environment by NIWA. The classification hierarchy includes information on climate, source-of-flow, geology, landcover, stream order (or size), and valley slope for stream reaches. For this project REC reach attributes were joined to the nearest NZFFD record, imparting habitat information to the NZFFD records and enabling predictions on the likelihood of fish occurrence to be made based on the REC. A more complete discussion of this process is provided in Section 4.3.

3.2 Additional data sources

Central South Island Fish and Game provided a range of useful data following a meeting with Kingett Mitchell staff in early October. The data provided by Central South Island Fish and Game included:

- chinook salmon spawning count and redd count data for the Hakataramea River.
- description of the sockeye salmon population.
- trout spawning data for the Maryburn, Forks Stream, Irishman Stream, Black Forest Stream, Ahuriri River, Ohau River and the Awakino River.
- description of trout population data for Lake Alexandrina, Ohau and Middleton.
- trout population data for Mistake River.

The Environment Canterbury salmonid habitat GIS layer included descriptions of salmonid habitat and values at all of the sites listed above, and were constructed in consultation with Central South Island Fish and Game Council. However, while the Central South Island Fish and Game Council data is included in the Environment Canterbury salmonid layer, it also contains information on population trends over time that is not easily represented in GIS. This information is held by Ministry for the Environment and may be of use to the Board when assessing long term trends in salmonid populations.

Information on the habitats and locations of native freshwater fish in the upper catchment (above the Waitaki dam) is included in Mitchell and Davis-Te Maire (1993), and in draft Department of Conservation reports by Bowie (2004) and Elkington and Charteris (2004), plus several other sources identified in the bibliography. In all cases, fish records and associated habitat data was found to have been included in the NZFFD records obtained for this project. However, the reports do provide some additional insight into the ecology of native and introduced fish species in the Catchment that is not easily represented in GIS.

Additional data contained within the Project Aqua invertebrate report (Stark and Suren, 2003) would have improved the coverage of invertebrate ecological values data for the Waitaki River mainstem and tributaries in the lower catchment. This data was not able to be obtained from Meridian Energy Ltd during the preparation of this report, but may become available to the Board in the near future.

The New Zealand mayfly database is administered by Canterbury Museum. Mayflies (Ephemeroptera) have aquatic larvae and flying adult stages, and are important food to many native and introduced freshwater fish species. The mayfly data was not obtained because the Environment Canterbury invertebrate and caddisfly GIS layers are considered sufficient, without the need for this additional data source.

The National Vegetation Survey database is administered by Landcare Research. Vegetation Survey data for the Waitaki Catchment was obtained, but it was not entered into the GIS due to uncertainty regarding its usefulness. Most of the information on significant vegetation and threatened plant species is captured in the GIS data obtained from Department of Conservation and Environment Canterbury, and the National Vegetation Survey data is unlikely to add significant value to the existing GIS layers.

At the time of writing, ecological data from Department of Conservation's Tenure Review process was patchy and much of it had not been entered into databases.

However, most of the fish records have been entered into the NZFFD (Sjaan Charteris, Department of Conservation, *pers comm.*). Given the generally good coverage of ecological GIS data obtained for the Catchment, and the recent freshwater fish sampling efforts by Department of Conservation, the unclassified Tenure Review data is unlikely to add significant value to this project.

Resource consent applications often contain assessments of freshwater bodies, and there have been many relatively recent applications in the Waitaki River Catchment. However, ecological data obtained from consent applications was not in electronic format, and had varying degrees of data quality. Given the questionable value of the ecological assessment information, and the difficulty in extracting information from individual consent files, resource consent information was limited to that already entered into the NZFFD.

Data from reports on the significance of wetlands (Davis, 1999) and aquatic habitats (Taylor *et al*., 1998) were not included as GIS layers, as the more recent plant, bird, and salmonid Environment Canterbury GIS layers were considered more up to date.

Bibliographies including information regarding Project River Recovery (from Department of Conservation) and the Waitaki River in general (from Ministry for the Environment) were inspected for additional information sources of value to this project. While these reviews included a wealth of reports, most of it was already captured in the ecology GIS layers discussed above and was therefore not included in this assessment.

Information on terrestrial insects (e.g., Sinclair, 1995) was excluded from the GIS layers, due to the aquatic focus of this report.

The GIS data did not include the fauna of groundwaters or hyporheic zones (shallow groundwater where groundwaters and surface waters interact). Although research on the ecology of subsurface environments has grown in recent years, and sampling in most stony-bedded rivers and streams have revealed an abundant subsurface fauna (Burrell and Scarsbrook, 2004), there has been only limited sampling of subsurface communities in most river systems, including the Waitaki River Catchment. However, sampling in the Otematata River has revealed an abundant hyporheic fauna (termed the "hyporheos"), while crustaceans and other groundwater fauna have been collected from groundwater wells around Otematata and in the lower reaches of the Catchment, near Glenavy (Graham Fenwick, NIWA, *pers comm.*). Groundwater and hyporheic fauna records will be entered into NIWA's Freshwater Biota Information System database in the future, but were not available at the time of writing.

4. Description of individual GIS data layers

This section provides a breakdown summary of the all the GIS data provided to Ministry for the Environment as part of this project. Each GIS layer or layer group is listed in bold, along with the shape file name and the following descriptors (where known):

- description of what information the layer contains.

- classifications of data (where relevant).
- data source.
- data age.
- geographic coverage of the Catchment.
- any caveats on use of the data.
- related layers.
- ecological values (for ecological layers).

4.1 Background GIS layers

Topographical maps: NZMS_262_Topo

Description: New Zealand Map Series (NZMS) 262 1:250,000 topographical map.

Classes: None.

Data source: Land Information New Zealand.

Data age: Unknown.

Coverage: Entire catchment.

Caveats: None.

Related: Rivers_250 layer.

Waitaki Catchment outline: Waitaki_Catch

Description: Outline of the Waitaki River Catchment.

Classes: None.

Data source: Ministry for the Environment.

Data age: Unknown.

Coverage: Entire Catchment.

Caveats: None.

Related: None.

Hill shading relief: Hillshade

Description: Hill shading from 1:250,000 GIS data. Used as a base layer for all ecological GIS plots.

Classes: None.

Data source: Land Information New Zealand.

Data age: Unknown.

Coverage: Entire Catchment.

Caveats: None.

Related: NZMS_262_Topo.

River Environment Classification: REC

Description: Streamlines classified according to the River Ecosystem Classification (REC).

Classes: Length of stream reach (m), stream order, climate, source of flow, geology, landcover, network position, valley landform.

Data source: REC from NIWA. Details of use of the REC can be found in Snelder et al. (2004).

Data age: Recent – 2004.

Coverage: Coverage of all Catchment.

Caveats: Does not include lakes and excludes a number of small tributaries shown on 1:50,000 topographical maps.

Related: REC_Fish species layers and REC_highorder layer.

REC excluding small streams: REC_highorder

Description: REC layers, excluding first and second order streams (smallest streams). Good river base layer. Used as a base layer for all ecological GIS plots.

Classes: Length of stream reach (m), stream order, climate, source of flow, geology, landcover, network position, valley landform.

Data source: REC from NIWA. Details of use of the REC can be found in Snelder et al. (2004).

Data age: Recent – 2004.

Coverage: Coverage of all Catchment.

Caveats: Does not include lakes and excludes a number of small tributaries shown on 1:50,000 topographical maps. Excludes REC first and second.

Related: REC_Fish species layers and REC.

Lakes

Description: Polygons showing location of lakes. Used as a base layer for all ecological GIS plots.

Classes: Lake name, lake area.

Data source: Environment Canterbury "Lakes" layer.

Data age: Unknown.

Coverage: Major lakes shown on NZMS 262 series maps.

Caveats: Some small unnamed lakes not shown.

Related: NZMS_262_Topo.

Water permits from Otago and Canterbury: Consents

Description: Records and associated information for water permits and certificates of compliance within the Catchment.

Classes: Source (water permit or certificate of compliance), record type (eg, existing or new application), state of application, client name and address, compliance monitoring details, water use, maximum consented rate of abstraction, sub-catchment.

Data source: Environment Canterbury and Otago Regional Council Consents database.

Data age: September – 2004.

Coverage: There is coverage of the whole Catchment, but water permits are concentrated in the lower catchment, especially the Waitaki River mainstem and the Hakataramea River. There are also numerous records around the Twizel-Ahuriri-Ohau area, and tributaries of the Tekapo River.

Caveats: Limited to coverage of Otago Regional Council and Environment Canterbury Consents database in September 2004; more recent applications will not be shown.

Related: None in particular, but of interest in relation to proximity of GIS layers showing ecological values.

4.2 Ecological data

Department of Conservation provided conservation status and threatened species data from their national "Bioweb" database. Bioweb is a database administered by Department of Conservation that holds data about New Zealand's natural and historic heritage that is of importance to Department of Conservation. The following caveats were provided by Deb Zanders (Department of Conservation Canterbury) and are relevant to all the Lizards, Threat_Plants, and Birds_Pt DoC layers that follow:

- data was extracted from the Bioweb database in October 2004.

- non 7-figure NZMS grid references were excluded (by Department of Conservation), because of the extra time required to convert them.
- Bioweb was still being populated at the time of writing and so the data does not include information from Tenure Review inspections in Canterbury and includes only some Otago records.
- fish, rock wren, and plant data is considered to have reasonable coverage.
- invertebrate and some bird data is the weakest, and there is no data for many threatened species.
- within pastoral leases that have not been field-inspected by Department of Conservation, an absence of threatened species may be misleading.
- the data represents the best at the time of writing, and was drawn together from a variety of databases (some not held by Department of Conservation).

Geckos and skinks: Lizards

Description: Combined lizard (herpetofauna) data records from Otago and Canterbury.

Classes: Includes threat status, locality, habitat and collector notes.

Data source: Department of Conservation Bioweb.

Data age: Unknown.

Coverage: Best coverage around Twizel, Lakes Pukaki, Tekapo and Benmore, and the upper reaches of the Otematata River (tributary of Lake Aviemore). Few records form the lower catchment, especially the Hakataramea River and Waitaki River mainstem.

Caveats: Records do not include sites where lizards were searched for and not found.

Related: None.

Values: Many occur in riparian habitats and there are many threatened species.

Threatened native plants: Threat_Plants

Description: Threatened plants collected by Department of Conservation botanists.

Classes: Species names, threat status.

Data source: Department of Conservation "Biotheme" GIS data layer.

Additional data from Otago and Southland pastoral lease inspections.

Data age: Obtained from Department of Conservation in September 2004; variable original data age.

Coverage: Good coverage around the lakes and the tributaries of Lake Ohau. Patchy for the remainder of the upper catchment. Little data for the lower catchment.

Caveats: Records do not include sites where plants were searched for and not found.

Multiple species records occur on individual points.

Related: None.

Values: All records are for threatened species, suggesting high ecological value.

Weed plant species: Weeds_Poly and Weeds_Pt

Description: Areas (Weeds_Poly) and points (Weeds_Pt) where weed pest plant species have been recorded by Department of Conservation.

Classes: Species names, abundance, area (for Weeds_Poly).

Data source: Department of Conservation "Bioweed" GIS data layers.

Data age: Obtained from Department of Conservation in September 2004; variable original data age.

Coverage: Very sparse and patchy data, and no data for the lower catchment.

Caveats: Records do not include sites where plants were searched for and not found.

Multiple species records occur on individual points.

Related: None.

Values: Weed species may exclude native species.

Areas of Department of Conservation Natural Significance: Nat_Signif

Description: A compilation of Department of Conservation data, including historic Recommended Areas for Protection (RAP), Wetlands of Ecological and Representative Interest (WERI) and Special Sites of Wildlife Importance (SSWI) data. In polygons, rather than point format.

Classes: Area (m^2 and ha), name of area, Department of Conservation identifier, ecological district, extensive descriptive notes on ecological values.

Data source: Department of Conservation "Nat_sig" GIS data layer.

Data age: Obtained from Department of Conservation in September 2004. Original data ranges from 1980s to 2000s.

Coverage: Extensive coverage throughout the Catchment.

Caveats: Unknown data age.

Related: Overlap with numerous ecology layers.

Values: All areas of natural significance shown are of high ecological value.

Threatened birds: Birds_Pt

Description: Locations of threatened bird sightings from Department of Conservation and Ornithological Society staff.

Classes: Species name, threat status, Department of Conservation source of data.

Data source: Department of Conservation "Biotheme" GIS data layer.

Data age: Obtained from Department of Conservation in September 2004; variable original data age.

Coverage: Extensive coverage throughout the Catchment.

Caveats: Due to the mobility of birds, this point data layer is not as useful as the Birds_Poly layer.

Mohua sightings and some other sightings were excluded, as they lacked point data.

Related: Birds_Poly layer.

Values: All records are for threatened species, indicating high ecological value.

Wetland bird habitat: Birds_Poly

Description: Polygons showing the locations and significance of indigenous bird habitats of rivers and open waters.

Classes: Location name, water body type, wetland bird guilds and their key habitats, threatened species and their key habitats, habitat ranking and significance, threats (actual and potential), information sources, comments, data quality.

Data source: Environment Canterbury Report U00/37 (O'Donnell, 2000) and associated Environment Canterbury GIS data.

Data age: Variable age of original sources, although Department of Conservation still consider this reference and GIS data to have good coverage of information for the area.

Coverage: Excellent coverage of lakes and mainstem of major rivers. Poor coverage of tributaries.

Caveats: None.

Related: Birds_Pt layer.

Values: All locations denote areas of high ecological value, mainly due to the presence of habitat for threatened bird species.

Wetland vegetation: NatVeg_Poly

Description: Polygons showing the locations of significant indigenous vegetation associated with water bodies.

Classes: Name of water body and ecological district, water type, altitude, presence/absence of 10 plant community classes, presence/absence of 508 listed plant species, presence/absence of threatened and uncommon plants, criteria for conservation significance, threats, reserve status, information sources, weed presence/absence.

Data source: Environment Canterbury Report U01/45 (Allen, 2001) and associated Environment Canterbury GIS data.

Data age: 1972 – 2000.

Coverage: Restricted to Waitaki mainstem (from Lake Waitaki downstream), Ahuriri River and delta, and the Tekapo River.

Caveats: None.

Related: Threat_Plants layer.

Values: All records are for threatened species, indicating high ecological value.

Salmonid habitat: Salmonid_Poly

Description: Polygons with data fields describing salmonid habitat values and threats.

Classes: Name of water body, salmonid habitats present (for each of six salmonid species), salmonid habitat value (low, medium, high), threats (actual and potential), data source and age, site comments.

Data source: Environment Canterbury Report U00/31 (Langlands and Elley, 2000) and associated Environment Canterbury GIS data.

Data age: 1980s – 2000.

Coverage: Excellent coverage of lakes and mainstem of major rivers. Poor coverage of tributaries.

Caveats: None.

Related: Fish layer.

Values: Ecological values are determined by selecting appropriate fields, the presence of the layer in an area does not automatically infer high values.

Freshwater fish: Fish

Description: New Zealand Freshwater Fish Database (NZFFD) records, with additional information added.

Classes: Fish species collected, NZFFD card number, catchment and locality name, native (vs introduced or marine wanderer), migratory status (diadromous, non-diadromous, marine wanderer), salmonid (vs non-salmonid), threat status and category, plus numerous NZFFD attributes.

Data source: NZFFD search of Waitaki Catchment records in October 2004.

Data courtesy of the National Institute of Water and Atmospheric Research (NIWA).

Summary fields (eg, threat status) added by Kingett Mitchell.

Data age: Based on a search of the database in October 2004.

Individual records range from 1952 to 2004.

Coverage: Excellent coverage throughout catchment.

Probably best coverage of all the freshwater ecological data available.

Caveats: NZFFD is provided by NIWA on the assumption that it is for non-commercial use.

Related: REC, REC_Fish and Salmonid layers.

Values: Not all fish species necessarily have high ecological value. However, ecological values can be determined by looking at fields such as threat status.

Caddisflies (Trichoptera): Caddisflies

Description: New Zealand Caddisfly (freshwater invertebrates in the order Trichoptera) Database records.

Classes: Species collected, altitude, collector, location of type specimens, ecoregion, locality, number of adults, larvae, and pupae collected.

Data source: Database held by John Ward (Canterbury Museum).

Data age: Last updated in May 2004.

Coverage: Sparse catchment-wide coverage.

Caveats: None.

Related: SoE_Inverts layer.

Values: Many larval caddisflies (which are aquatic) are sensitive to pollution, plus they are important food for many freshwater fish species.

Freshwater invertebrates: SoE_Inverts

Description: Freshwater invertebrate values data.

Classes: Number of taxa collected, percentage abundance comprised of pollution-sensitive Ephemeroptera, Plecoptera, and Trichoptera (%EPT), percent dominance of the most abundant taxa (a diversity measure), site name, comments, land use.

Data source: Raw invertebrate data provided by Environment Canterbury, collected as part of their regional State of the Environment (SoE) monitoring.

Invertebrate summary data calculated by Kingett Mitchell.

Data age: Field sampling from 1999 to 2003.

Coverage: 24 records from a good range of localities throughout the Catchment. Good coverage in areas where most water permit records occur.

Caveats: None.

Related: Caddisfly layer.

Values: A combination of high %EPT and high taxa richness often indicates high ecological values. Freshwater invertebrates are also important fish food.

Modeled fish locations: REC _ Fish genus and species

Description: REC streamlines classified according to the likelihood of threatened native fish (four species layers) and introduced sports fish (three species layers) occurring there.

Classes: Likelihood of selected threatened and sports fish occurring, expressed as a percentage (and rank) of all NZFFD records falling in REC classes.

Data source: Created by Kingett Mitchell in October 2004, by combining NZFFD data (see Fish layer above) and REC data. Details of this process are described below.

Data age: Recent – 2004.

Coverage: Coverage depends on the species (see Figs. 11 and 12 for examples). Purpose of the layer was to extrapolate fish values throughout the Catchment.

Caveats: Excluded fish records from lakes and where it was difficult to assign a fish record to an REC reach (eg, records >100m from an REC reach that fell between differing REC classes).

This layer was a trial and has not been field-validated. The values are intended to provide an indication of the likelihood of fish occurring – numerous factors other than the coarse REC classes used could influence fish distribution.

Related: REC and REC_highorder layers.

Values: High percentage likelihood of species occurrence indicates there is potential for high fish values in the reach.

4.3 Modelling freshwater fish values using the REC

4.3.1 Background

The REC contains a great deal of environmental data of relevance to freshwater biological communities. For example, the REC can be used to determine the proportion of the catchment with pasture, forest, and urban land cover for each stream reach, and it is well understood that land cover and river habitat quality are closely related (Quinn *et al*, 1997). Most recently, Joy and Death (2004) combined REC data with additional habitat

data and freshwater records to predict fish species occurrence in the Wellington region. Freshwater fish are good species to model, because of the wealth of location and habitat data stored in the NZFFD. The value of ecological modeling is that information can be extrapolated from areas where data is present into areas where data is sparse.

In an attempt to improve the geographic spread of freshwater ecological values in the Waitaki Catchment, Kingett Mitchell created new REC layers with freshwater fish attributes. The REC fish layers were limited to five threatened species and the three most common salmonid sports fish in the catchment. These species were chosen because of their conservation and sports fishery values, respectively. Lamprey (*Geotria australis*) and Canterbury mudfish (*Neochanna burrowsius*) have a threatened status but were excluded from the REC analysis, as they had too few records in the Catchment to be able to reliably extrapolate data from. It is worth noting that sampling by Department of Conservation may increase the number of Canterbury mudfish records in the near future (Leanne O'Brien, University of Canterbury, *pers comm*.).

What follows below is a description of how the REC_Fish layers were created and a brief discussion of the results of the modeling and use of the data.

4.3.2 Methods

1. REC reach attributes were joined to the nearest NZFFD record, using a 'spatial join' GIS grouping command.

2. All lake records were removed, as the REC is only for rivers. This required some checking of original NZFFD cards to confirm whether fish records were from lakes or rivers.

3. For all NZFFD records >100 m from an REC reach, points were excluded if it was unclear which REC reach to assign them to (eg, if the record fell between two REC reaches with different classes). For clarity, we refer to these excluded records as 'ambiguous' points.

4. The remaining NZFFD records with REC attributes were used for the next stage of extrapolating throughout the Catchment. The total number of NZFFD records (cards) for the Catchment dropped from 712 to 597, and individual species records dropped from 1851 to 1544 after this data editing stage. Thus, 83% of original NZFFD data remained, which is a reasonable proportion. Between 78 and 100% of records remained for the seven 'target' fish species being used for subsequent modeling.

5. For each of the seven target fish species, record counts were tabulated and plotted against all permutations of the climate, source-of-flow, geology, and land-cover REC categories (see example figures attached). The percent frequency and rank occurrence of each target fish species in each of the REC classes was then calculated.

6. An REC fish layer was then created for each target fish species by adding a field to the REC layer stating the percent occurrence of the fish species within the REC category. REC categories sharing the same percent fish occurrence value were given the same classification in the percent occurrence field. Where the number of percent occurrence classifications exceeded 10, they were truncated to 10.

4.3.3 Results

Fig. 11 and Fig. 12 are sample GIS plots showing the REC fish data for chinook salmon and longfin eels, respectively, overlain with actual NZFFD records for each species. These layers illustrate how chinook salmon records, and by inference their likelihood of occurrence (displayed using the REC_*Oncorhynchus_tshawytscha* layer), are mostly restricted to the lower catchment (Fig. 11). This reflects the effect of the hydroelectric dams on upstream salmonid migration.

The REC fish layers will be most reliable for those fish species with the greatest number of records, due to the greater REC environmental data and spatial data available. Thus, while REC predictions for rainbow trout (*Oncorhynchus mykiss*) are considered reasonable, records for less common threatened galaxiid species should be treated with caution and regarded as being indicative only.

Initial examination of the data indicates that the REC fish layers may help fill gaps where ecological data is sparse, thus fulfilling the objective of the exercise. However, there has been no field validation of the data, and therefore the absence of a high percentage REC fish ranking in a given area will not necessarily mean the species will not be found there. Field data would still need to be collected, or local experts consulted, to fill ecological data gaps in areas where water demands are high.

5. Acknowledgements

Many individuals from a wide variety of organisations provided helpful advice and useful data for this project. Many thanks to Department of Conservation, Environment Canterbury, NIWA, Landcare, and Fish and Game for providing advice and access to datasets they administer. Special thanks are due to: Norm Thornley and Deb Zanders (Department of Conservation Christchurch) for providing GIS data; Herb Familton (Department of Conservation Christchurch) for helpful discussions; Chris Wilmore (Department of Conservation Twizel) for discussions and local data; Ryan Elley (Environment Canterbury Christchurch) for GIS data and discussions; Jay Graybill, Bridgette Pringle and Mark Webb (Central South Island Fish and Game Council) for helpful discussions and numerous reports; Michelle Breach (Landcare) for access to National Vegetation Survey data; Brian Smith (NIWA) and John Ward (Canterbury Museum) for caddisfly data.

6. References

Allen RB 2001. Significant indigenous aquatic, littoral and riparian vegetation of Canterbury water bodies, and factors that affect composition and condition. *Environment Canterbury Report* U01/45.

Biggs B, Riis T, Larned S, Flanagan M, Suren A 2003. Project Aqua: environmental study – aquatic ecosystems: periphyton and macrophytes. Appendix E to Project Aqua: assessment of effects on the environment. CHC01/110.

Bowie S 2004. Bignose galaxias (*Galaxias macronasus*) survey in the Mackenzie Basin, Canterbury, New Zealand. *Department of Conservation Report - Draft*.

Burrell GP, Scarsbrook M 2004. Hyporheic zones. *In*: Harding J, Mosley P, Pearson C, Sorrell B (eds.) *Freshwaters of New Zealand.* New Zealand Hydrological Society and New Zealand Limnological Society: Christchurch.

Davis M 1999. Canterbury region wetlands: report and preliminary inventory. Part one: desktop review. *Canterbury Regional Council Report* U99/64.

Elkington S, Charteris SC 2004. Species and distribution of freshwater fish of the Upper Waitaki River, South Island, New Zealand. *Department of Conservation Report - Draft*.

Hitchmough R 2002. New Zealand Threat Classification System lists. *Department of Conservation threatened Species Occasional Publication* 23.

Joy MK, Death RG 2004. Predictive modeling and spatial mapping of freshwater fish and decapod assemblages using GIS and neural networks. *New Zealand Journal of Marine and Freshwater Research* 49: 1036-1052.

Langlands P, Elley R 2000. Survey of salmonid distribution and habitats in the Canterbury Region. *Environment Canterbury Report* U00/31.

Lloyd BD 2001. Advances in New Zealand mammalogy 1990-2000: Short-tailed bats. *Journal of the Royal Society of New Zealand* 31: 59-81.

Mitchell C, Davies-Te Maire KTA 1993. Mahinga kai survey of the upper Waitaki. *Report prepared for Ngai Tahu and ECNZ.*

Molloy J, Bell B, Clout M, de Lange P, Gibbs G, Given D, Norton D, Smith N, Stephens T 2002. Classifying species according to threat of extinction: a system for New Zealand. *Department of Conservation Threatened Species Occasional Publication* 22.

O'Donnell CFJ 2000. The significance of river and open water habitats for indigenous birds in Canterbury, New Zealand. *Environment Canterbury Report* U00/37.

O'Donnell CFJ 2001. Advances in New Zealand mammalogy 1990-2000: Long-tailed bat. *Journal of the Royal Society of New Zealand* 31: 43-57.

Quinn, JM., Cooper AB, Davies-Colley RJ, Rutherford JC, Williamson RB 1997. Land use effects on habitat, water quality, periphyton, and benthic invertebrates in Waikato, New Zealand, hill-country streams. *New Zealand Journal of Marine and Freshwater Research* 31: 579-597.

Quinn JM, Hickey CW 1990. Characterisation and classification of benthic invertebrate communities in 88 New Zealand rivers in relation to environmental factors. *New Zealand Journal of Marine and Freshwater Research* 24: 387-409.

Sinclair L 1995. *The detection of biotic changes in the Tekapo riverbed after habitat restoration*. Unpublished MSc thesis, Zoology Department, University of Canterbury.

Snelder T, Biggs B, Weatherhead M 2004. *New Zealand River Environment Classification user guide*. Ministry for the Environment: Wellington.

Stark JD, Suren AM 2003. Project Aqua: environmental study - aquatic ecosystems: macroinvertebrates. Appendix F to Project Aqua assessment of effects on the environment. *NIWA Client Report* CHC02/59.

Taylor MJ, Champion P, Main MR 1998. Aquatic habitats with indigenous floristic or faunistic value in the Canterbury region. *Environment Canterbury Report* U98/63.

7. Bibliography

Daly A 2004. Inventory of instream values for rivers and lakes of Canterbury New Zealand: a desktop review. *Environment Canterbury Report* U04/13.

Graynoth E, James G, Hayes J, Bonnett M 2003. Project Aqua: environmental study - aquatic ecosystems: salmon and trout. Appendix H to Project Aqua assessment of effects on the environment. *NIWA Client Report* CHC01/32.

Jellyman D, Bonnett M, Boubée J, Taylor MJ 2003. Project Aqua: environmental study - aquatic ecosystems: native fish. Appendix G to Project Aqua assessment of environmental effects. *NIWA Client Report* CHC01/113.

Lavender R 2001. Analysis of the New Zealand Freshwater Fish Database and the distribution of native fish in Canterbury. *Environment Canterbury Report* U01/25.

Venus, G 2003. *Ministry for the Environment Waitaki data review*. Ministry for the Environment: Wellington.

Wilson GA 2000. *Historical changes and present status of the rivers and adjoining wetlands in the Upper Waitaki Basin*. Unpublished MSc thesis, Departments of Earth Sciences and Resource and Environmental Planning, University of Waikato.