

OTAGO CONSERVANCY

Sutton Salt Lake (67)

Location: 45°34'S, 170°05'E. 2.7 km from Sutton and 8 km from Middlemarch, Straith-Tari area, Otago Region, South Island.

Area: 3.7 ha.

Altitude: 250 m.

Overview: Sutton Salt Lake is a valuable example of an inland or athalassic saline lake, with a considerable variety of saline habitats around its margin and in adjacent slightly saline boggy depressions. The lake is situated in one of the few areas in New Zealand where conditions favour saline lakes (*i.e.* where precipitation is lower than evaporation). An endemic aquatic animal, *Ephydrella novaezealandiae*, is present, and there is an interesting pattern of vegetation zonation.

Physical features: Sutton Salt Lake is a natural, inland or athalassic saline lake with an average depth of 30 cm and a salinity of 15%. The lake has no known inflow or outflow. The soils are saline and alkaline at the lake margin (sodium-saturated clays), and surrounded by yellow-grey earths and dry subdygrous Matarae. The parent material is loess. Shallow boggy depressions exist near the lake, and there is a narrow fringe of salt tolerant vegetation at the lake margin. Algal communities are present, and often submerged by lake water. The average annual rainfall is about 480 mm, while annual evaporation is about 710 mm.

Ecological features: Sutton Salt Lake is one of only five examples of inland saline habitats of botanical value in Central Otago. This is the only area in New Zealand which is suitable for the existence of this habitat, since in general rainfall is high, evaporation is low, and endorheic drainage systems are absent. Five main vegetation zones have been identified at the lake:

- A narrow fringe of salt-tolerant vegetation at the margin of the lake. This zone has three sub-components: a zone dominated by *Lilaeopsis* sp., generally occupying the lowermost zone; a zone dominated by *Selliera* sp., generally merging with and continuing above the *Lilaeopsis* zone; and a zone of pure salt grass *Puccinellia fasciculata*, with *P. stricta* occupying the lowermost zone along the northern edge of the lake. This salt-tolerant vegetation extends about three metres back from the high water mark along the northern edge of the lake, and about two metres back at the southern end. Generally, however, it is a narrow fringe less than 50 cm wide.
- Algal zones, submerged in winter or when the lake is full.
- Rough pasture with exotic grasses, hard tussock and a few shrubs, abutting the salt-tolerant vegetation.
- Communities on the rock outcrops that surround parts of the lake edge and emerge from the adjacent rough pasture.
- Shallow boggy depressions near the lake. These are generally dominated by *Eleocharis acuta* and *Juncus articulatus*, with clumps of *J. effusus*. Amongst these plants are *Selliera radicans*, *Myriophyllum propinquum*, *Pratia perpusilla* and *Lythrum portula*. Forget-me-not grows in the drier areas and adjacent to rock outcrops. In the wettest areas, floating Sweet Grass dominates, with *Potamogeton cheesemanii* and the floating fern *Azolla rubra*. *Ranunculus glabrifolius*, with exotic grasses and clovers, dominates in places between boggy depressions. *Carex dipsaosa*, *C. flagellifera* and *C. ovulis* occur at the edge of boggy patches.

A dense mat of *Selliera*, native celery, *Leontodon taraxicoides* and *Scirpus antarcticus* occurs just north of the northern large bog. It is surrounded by rough pasture with scattered hard tussock.

Land tenure: The lake is freehold land under a Queen Elizabeth the Second National Trust Conservation Covenant. Surrounding areas are freehold.

Conservation measures taken: The salt lake is covered by a Queen Elizabeth the Second National Trust Conservation Covenant. An enclosure at the north end of the lake is fenced.

Conservation measures proposed: The boundary of the wetland is to be fenced. It has been recommended that restrictions be imposed on grazing by domestic livestock, and that a ban be imposed on the burning of plant communities adjacent to the lake.

Land use: Livestock grazing (cattle) and some waterfowl hunting.

Possible changes in land use: None.

Disturbances and threats: The principal threats are grazing and extensive trampling by cattle, and repeated burning of plant communities adjacent to the lake. The condition of the wetland is poor due to this lake edge trampling by cattle. Over-sowing and top-dressing may alter the natural condition of the plant communities. Littering and the construction of "maimai" also create problems and should be halted.

Hydrological and biophysical values: Sutton Salt Lake is one of only five examples of inland saline habitats of botanical value in Central Otago.

Social and cultural values: None known.

Noteworthy fauna: The lake supports a variety of waterfowl including White-faced Heron *Egretta novaehollandiae*, Black Swan *Cygnus atratus*, Paradise Shelduck *Tadorna variegata*, Mallard *Anas platyrhynchos*, New Zealand Shoveler *A. rhynchotis variegata*, South Island Pied Oystercatcher *Haematopus finschi* and Southern Black-backed Gull *Larus dominicanus*.

The aquatic fauna includes *Brachionus plicatilis* (very abundant), *Microcyclops (Metacyclops) monacanthus* (scarce), *Diacypis* spp. (abundant) and *Ephydrella* spp. (scarce). An endemic species of *Ephydrella*, *E. novaezealandiae*, is of particular interest.

Noteworthy flora: The inland saline (alkaline) vegetation is of considerable scientific interest. This is an uncommon type of vegetation in New Zealand.

Scientific research and facilities: Bayly (1967) studied the fauna and chemical composition of the lake, while Murray (1972) studied the zonation of the vegetation.

Conservation education: None.

Recreation and tourism: There is some game-bird hunting in the area.

Management authority: The Queen Elizabeth the Second National Trust is responsible for administration of the Conservation Covenant. The Department of Conservation (Otago Conservancy) is responsible for the management of Crown land and wildlife. The Otago Regional Council has statutory responsibilities for water resources under the Resource Management Act 1991.

Jurisdiction: Territorial: Otago Regional Council. Functional: Queen Elizabeth the Second National Trust and Department of Conservation.

References: Bayly (1967); Murray (1972).

Reasons for inclusion:

1d Sutton Salt Lake is an example of inland or athalassic saline water, a wetland type rare in New Zealand (*i.e.* found only in Central Otago).

Source: J.M. Neilson and Pam Cromarty.

Lake Waipori, Lake Waiholo and Associated Wetlands (68)

Location: 46°00'S, 170°06'E. On the Lower Taieri Plain, adjacent, in places, to State Highway No.1, 30 km southwest of Dunedin City, Otago. The wetlands are 10 km from the sea, on the

east coast of South Island. Within Tokomairiro Ecological District.

Area: Total area c.1,625 ha. Lake area: Waipori, 220 ha; Waihola, 640 ha.

Altitude: Sea level to 5 m.

Overview: Lake Waipori, Lake Waihola and their associated wetlands are the most significant waterfowl habitat in Otago. The wetlands are of national and international significance for several reasons: they are large and ecologically diverse; they support uncommon endemic species, notably South Island Fernbird *Bowdleria punctata punctata* and Giant Kokopu *Galaxias argenteus*; and they regularly support large populations of Anatidae (Department of Conservation, 1993b).

The wetlands comprise two shallow lakes, Waipori and Waihola, both of which drain through an extensive swamp into the Waipori River, then the Taieri River. The swampland includes vegetated islands, lagoons, shallow pools, meandering channels and backswamps. The lower lake, Waihola, is influenced by saltwater from tidal flows up the Taieri River. Both lakes are considered eutrophic, even though the mean residence time of water in the lakes is less than two days. Peat is accumulating in the backswamps. Silt from floods in the Taieri and Waipori Rivers is also infilling parts of the wetlands. Despite the current ability of the lakes to support large numbers of birds, the lake waters are of low quality, particularly because of sewage, stormwater, dairy shed and farmland discharges. Drainage schemes have modified the wetlands, with the loss of over 180 ha of swampland. The Sinclair Wetlands, between the lakes, survive because attempts to drain these wetlands failed. The area has ongoing and historical value to the Maori people, particularly because of the traditional food resources and location of sacred sites and former settlements. The wetlands are a regionally important recreational game-bird hunting area, as well as a recreational and commercial fishery. The wetlands are valued as a buffer to floodwaters on the Taieri Plain, an area highly susceptible to flooding. The ecological and scientific values of the wetlands are now being recognised. Much of the area is either reserved or designated to become reserve. Sinclair Wetlands, between the lakes, are protected under a Queen Elizabeth the Second National Trust Open Space Covenant. This area was gifted by the previous owner to a non-profit organisation, Ducks Unlimited. The wetlands and newly-developed visitor centre have been visited by over 5,000 people since 1988, a fact which highlights the strong public interest in these wetlands.

Physical features: The Department of Conservation (1993b) has compiled a detailed natural resource inventory on Lake Waipori, Lake Waihola and their associated wetlands. Much of the following information is taken from this report.

Lake Waipori and Lake Waihola are shallow lakes (with mean depths of 0.75 m and 1.0 m, respectively) connected by a system of swamp landforms, *i.e.* delta, levee, island, backswamp, mudflat and channel. The wetlands are situated on the low-lying down-faulted Taieri Plain. Waipori River, small streams and several drainage channels enter the central swamp. Outflow is via Waipori River into the Taieri River. Tidal flow in the Taieri River brings saline water into Lake Waihola.

The area experiences a cool temperate climate, typical of its coastal and southern location. There are moderate sunshine hours, occasional fog, frequent frosts, an average rainfall of 734 mm per year, and relatively strong winds for a low altitude site. Occasional high summer temperatures and calm conditions can cause the shallow lakes to heat rapidly.

Ecological features: The wetland complex is highly diverse and productive. It is characterised by distinct soil-landform-vegetation relationships as a result of interaction between water table height, flood patterns, sedimentation rates, landform age and human disturbance.

The accessible but often flooded levees are capped with silt loams, with little peat development. Manuka *Leptospermum scoparium* shrubland and *Carex secta* sedgelands have been replaced by associations of weedy shrubs and willows *Salix fragilis*.

Backswamps are the largest areas of land in the wetlands. The water table is at or above the surface. Organic peat soils up to 50 cm deep have formed on top of fine alluvium. Vegetation here is little-modified tall sedgeland, dominated by *Carex secta*. Willows are expected to spread into the backswamps.

Tidal mudflats have deep, fine to medium sand deposits, with little or no soil development and sparse vegetation. Island margins in the Lake Waihola delta support dense stands of the saltmarsh plant Jointed Wire Rush *Leptocarpus similis*. Other species include *Carex secta*, *Juncus gregiflorus*, New Zealand Flax *Phormium tenax* and Mingimingi *Coprosma propinqua*. Aquatic plants, extensive in sheltered ponds and at the northern end of Lake Waihola, include *Potamogeton ochreatus*, *P. cheesemanii*, *Myriophyllum triphyllum* and the turfland plants, *Lilaeopsis novae-zelandiae* and *Glossostigma elatinooides*. Ponds with floating mats of Spike Rush *Eleocharis acuta* and *Juncus articulatis* are indicative of an in-filling backswamp. Extensive stands of Raupo *Typha orientalis* occur in sheltered pond margins, in channels and along the Waipori River banks.

Raised levees support Ti *Cordyline australis*, emergent over dense shrubs of Mingimingi, Manuka, Saltmarsh Ribbonwood *Plagianthus divaricatus*, New Zealand Flax, Jointed Wire Rush and a climber *Muehlenbeckia complexa*. Willow trees have also invaded this habitat.

Gleyed silt loam soils occur on fans bordering the wetlands. Downlands beside the wetlands and several rocky islands are covered with yellow grey earths with silt loam or silty clay loam, textured loess and a brittle (when dry) fragipan in the B horizon. Originally, these soils may have supported mixed broad-leaved podocarp forest. A remnant of mixed shrub and Kanuka *Kunzea ericoides* forest still survives. Shrub species include *Coprosma crassifolia*, Korokio *Corokia cotoneaster* and the fast-growing introduced species, Broom *Cytisus scoparius* and Gorse *Ulex europaeus*.

The lakes are in a eutrophic state. Natural and human-induced changes in lake chemistry cause complex changes in biological character. Warm water and high nutrient levels can increase the concentration of suspended algae (especially *Anabaena* spp.), causing loss of water clarity and depletion of dissolved oxygen. Algal blooms were recorded in the lakes seven times between 1980 and 1990. Faecal coliform counts suggest the water is not of sufficient quality for human bathing. Total phosphorus content reaches levels which cause a still water body to become extremely productive. Wind-induced turbulence in the shallow water re-suspends sediment, maintaining high phosphorus levels. Phosphorus is then available for algal growth. Stirring of sediment and large silt inflows during floods reduce water clarity and aesthetic values.

Land tenure: The lake beds (860 ha) and 640 ha of swampland are vested in the Otago Regional Council as an endowment of the Taieri River Improvement Act 1920. A further 35 ha of islands at the northern end of Lake Waihola are vested in the Council. Small areas are unalienated Crown land and leasehold Crown land (59 ha). The Department of Conservation administers 105 ha of Crown land protected as a Government Purpose (Wildlife Management) Reserve.

A large part of the land designated to become reserve is held under freehold tenure (580 ha). The largest area (315.4 ha) is owned by Ducks Unlimited (NZ) Inc. The land, situated between the two lakes, is protected private land, gifted by Mr H. Sinclair to Ducks Unlimited.

Most land surrounding the wetlands is held under freehold tenure. A large area of former State Forest land in the northwest of the Waipori catchment is now held by corporate owners.

Conservation measures taken: The land and wildlife of the Sinclair Wetlands are legally protected under a Queen Elizabeth the Second National Trust Open Space Covenant and Wildlife Refuge status. The area has been gifted to Ducks Unlimited, a non-profit organisation dedicated to the preservation, restoration and maintenance of wetland habitat and the propagation of rare indigenous waterfowl (Buxton, 1991). Wetland restoration work has been

undertaken since 1984, to repair the damage caused by previous drainage projects. An area of 105 ha of Crown land within the wetland complex is administered by the Department of Conservation as a Government Purpose (Wildlife Management) Reserve.

Conservation measures proposed: In 1981, New Zealand's Planning Tribunal confirmed an earlier ministerial directive that the wetlands, except for the central part of Lake Waihola, be designated as a proposed Government Purpose (Wildlife Management) Reserve. All works on the designated land, except daily management activities, require consent from the Minister of Conservation. Reserve status has not yet been formalised. The proposed reserve covers land vested in the Otago Regional Council, freehold land (580 ha) and a small area of Crown land.

Land use: The primary role of the wetlands is as wildlife habitat. A secondary use is as a recreational game-bird hunting area. The group Ducks Unlimited, owner of part of the wetlands, is active in its support of both of these land uses. Some sections of the wetlands and their margins are grazed. The two species of eel, *Anguilla dieffenbachii* and *A. australis*, are an important local fisheries resource, part of commercial, recreational and traditional Maori harvests.

Agriculture is the predominant land use on land surrounding the wetlands. Much of the lower Taieri Plain is farmed intensively for crops and dairying, whereas hill country to the northwest and southeast is grazed by sheep and cattle, or is under native vegetation cover or plantation forestry.

Possible changes in land use: None known. With the "proposed reserve" designation over the whole wetland area, it can be expected that any future developments at the wetlands will be for conservation and wetland enhancement purposes.

Disturbances and threats: Regardless of protection measures within the wetlands, water quality will continue to be affected by management of the surrounding farmland and the small housing settlement of Waihola. Human-induced pollution sources are upstream sewerage discharges, dairy-shed waste pumped into Main Drain (a lake tributary), and urban and farm stormwater run-off. The threat of wetland drainage has been lessened with the designation as proposed reserve. An ongoing problem is weed encroachment, especially by Crack Willow *Salix fragilis*, Gorse *Ulex europaeus*, Broom *Cytisus scoparius* and Reed Sweetgrass *Glyceria maxima*.

Hydrological and biophysical values: The wetland complex has been recognised as an area of national and regional importance for wildlife in general, fisheries and botany. The complex meets seven criteria for a "Wetland of National Importance to Fisheries" (listed below), and is rated as outstanding by the Ministry of Agriculture and Fisheries (Davis, 1987). The wetlands are:

- a habitat for rare or endangered fish species;
- a unique or diverse assemblage of fish species;
- a biologically or scientifically important fishery or fish habitat;
- an unmodified wetland habitat with significant endemic fisheries values;
- a particularly good example of a specific type of fishery or fish habitat;
- a remnant or regionally representative wetland with significant fisheries values;
- a habitat for fish species with a limited national distribution and/or declining numbers.

A survey for the Department of Conservation by Tangney (1987) states that the wetlands are of very high botanical significance within the Tokomairiro Ecological District and the wider Otago Coast Ecological Region. The wetlands also have important hydrological values. They play a valuable role as a buffer to flood flows in the Taieri River. Drainage of much of the plain hastens run-off and increases peak water discharges. The wetlands serve to absorb some of the flow and release water back into the Taieri River after the flood peak has past. The tidal component of the hydraulic system accounts for the short water-turnover time of less than two

days. The sediment flushing action is needed to maintain water-holding capacity of the lakes and channels. Tidal flows are also likely to have reduced the impact of past pollution discharges.

Social and cultural values: The area is of historical and current importance to the Maori, particularly to the Ngai Tahu "iwi" (tribe). Prior to drainage, this and other wetlands on the Taieri Plain provided many food and fibre resources, especially birds, fish, berries, flax and timber for "waka" (canoes). There have been several settlements by various "iwi" since the mid-1700s, but these are now uninhabited. The resources, however, remain highly valued by the Maori people.

Noteworthy fauna: The diverse wetland habitats support large numbers of ducks and swans (Anatidae) which use the area for breeding, feeding, loafing and moulting. As a major breeding site, the area serves as a regionally important centre of dispersal of young birds. Common Anatidae are Black Swan *Cygnus atratus*, Paradise Shelduck *Tadorna variegata*, Grey Teal *Anas gracilis*, Mallard *A. platyrhynchos*, Grey Duck *A. superciliosa*, New Zealand Shoveler *A. rhynchotis variegata* and New Zealand Scaup *Aythya novaeseelandiae*. The wetlands support a significant proportion of the national populations of Black Swan and New Zealand Shoveler, and are the most important moulting site for shoveler in Otago.

The wetlands also support good populations of swamp birds, including Australasian Bittern *Botaurus poiciloptilus*, Marsh Crake *Porzana pusilla affinis*, Pukeko *Porphyrio porphyrio melanotus* and South Island Fernbird *Bowdleria punctata punctata*. Australasian Bittern and Marsh Crake are present in much larger numbers than are usual in most New Zealand wetlands. The isolated population of South Island Fernbirds at the Lake Waipori and Lake Waihola wetlands is estimated at 170-230 pairs, and is one of only two populations of this species in Otago. The fernbird has long been extinct in Canterbury as a result of habitat destruction and predation.

Two species of shag *Phalacrocorax* spp., White-faced Heron *Egretta novaehollandiae* and Southern Black-backed Gull *Larus dominicanus* breed at the wetlands. Shorebirds include Pied Stilt *Himantopus leucocephalus*, South Island Pied Oystercatcher *Haematopus finschi*, the now common Spur-winged Plover *Vanellus miles* and small numbers of Banded Dotterel *Charadrius bicinctus*. Uncommon or rare visitors include Brown Teal *Anas aucklandica chlorotis* (one dead bird found), Banded Rail *Rallus philippensis assimilis* and Spotless Crake *Porzana tabuensis plumbea*. Four species of terns, all vagrants, have been recorded. Other visitors have included Cattle Egret *Bubulcus ibis*, Little Egret *Egretta garzetta*, Great Egret or White Heron *E. alba* and Royal Spoonbill *Platalea regia*, a recent addition to the local fauna.

There are 12 species of freshwater fish in the wetlands, many of which require access to the sea to complete their life cycle. Notable species are the Giant Kokopu *Galaxias argenteus*, the largest galaxiid species in the world, and Banded Kokopu *G. fasciatus*. Both species require forest cover, or entrenched streams with overhanging vegetation. They have been badly affected by the loss of forest cover and wetland drainage.

Little is known about the invertebrate fauna of the wetlands. Insects and crustaceans are prominent. The native freshwater mussel or "kakahi" *Hyridella menziesii* is present in both lakes and along edges of river channels.

Noteworthy flora: Although there are no records of threatened or unusual plant species or distributions, the wetlands are of high botanical interest. There are many different and little-modified wetland plant communities, largely made up of native species. The presence of a sequence of vegetation types, as drainage conditions vary, adds to the botanical value.

Scientific research and facilities: There are recently developed scientific research facilities at the Sinclair Wetlands. The nearest university is Otago University in Dunedin, approximately 30 km to the northeast.

Conservation education: Sinclair Wetlands are a focal point for wetland conservation

education. Interpretative displays, talks, viewing areas and other facilities are offered at a new on-site education centre. Schools and other groups based at the Otago Youth Adventure Trust lodge at Berwick settlement use the wetland for education and recreation.

Recreation and tourism: The Sinclair Wetlands have become a major tourist attraction in coastal Otago. The area has received approximately 5,000 visitors since it was opened to the public in 1988. Indoor facilities include an education centre with a lecture room, display room, research facilities, visitor accommodation, tea rooms and manager's house. Outside, there is a walkway to an elevated hide to overlook the wetland and a series of waterfowl enclosures for close viewing of most species of waterfowl present in New Zealand (Buxton, 1991).

The wetlands are also a valued game-bird hunting area. An estimated 322 hunters make regular annual use of the area. Lake Waihola is a centre for boating activities in Otago, especially for yachting (c.1,300 visitors per year in 1983), rowing, wind-surfing, power-boating and water-skiing. Recreational fishing is another popular activity at the wetlands. Target species are the introduced Brown Trout *Salmo trutta* and Perch *Perca fluviatilis*, the native eels *Anguilla dieffenbachii* and *A. australis*, and whitebait *Galaxias* spp. Easy road access and proximity to Dunedin City encourage passive activities, such as picnicking, camping and bird-watching. There is a camp and boat harbour on the shore of Lake Waihola.

Management authority: The Department of Conservation (Otago Conservancy) is responsible for management of some Crown land, reserves and wildlife. Otago Regional Council has management and policy responsibilities for natural resources under the Resource Management Act 1991. Ducks Unlimited (NZ) Inc. manages Sinclair Wetlands, in association with the Queen Elizabeth the Second National Trust. The wetland straddles the boundary between two local councils, Dunedin City Council and Clutha District Council. These agencies have resource consent responsibilities under the Resource Management Act 1991. The Otago Fish and Game Council manages sport fishing and game-bird hunting.

Jurisdiction: Functional: Department of Conservation, Queen Elizabeth the Second National Trust and Otago Fish and Game Council. Territorial: Otago Regional Council, Dunedin City Council and Clutha District Council.

References: Buxton (1991); Davis (1987); Department of Conservation (1993b); Otago Catchment Board and Regional Water Board (1983); Queen Elizabeth the Second National Trust (1988); Tangney (1987). A full reference list is found in Department of Conservation (1993b).

Reasons for inclusion:

- 1a Lake Waipori, Lake Waihola and their associated wetlands are a particularly good example of a lowland wetland complex including shallow lakes and swamplands, wetland types characteristic of the coastal lowlands of the east coast of New Zealand's South Island. The complex contains the best examples of wetlands in the Otago Coast Ecological Region.
- 2a The wetlands support populations of two threatened species of fish, *Galaxias argenteus* and *G. fasciatus*, and the globally threatened Australasian Bittern *Botaurus poiciloptilus*.
- 2b The wetlands are of special value for maintaining the genetic and ecological diversity of the region because of their role in waterfowl dispersal and the high diversity of species present.
- 2c The wetlands are of special value as breeding and moulting areas for waterfowl.
- 2d The wetlands are of special value for their endemic fish and bird species, notably *Galaxias argenteus*, *G. fasciatus*, *Tadorna variegata*, *Aythya novaeseelandiae*, *Haematopus finschi* and *Bowdleria punctata*.

- 3b The wetlands regularly support over 10,000 ducks, geese and swans. The high numbers and species diversity are indicative of a productive, diverse and valuable habitat.
- 3c The wetlands regularly support over 1% of the regional populations of *Anas rhynchos* and *Bowdleria punctata*.

Source: Jenny Steven.

Kawarau Catchment Wetland Complex (69)

Location: 45°02'S, 168°40'E (Queenstown). In Otago Region, east of the main divide, South Island. Approximately at the centre of the catchment area is the town of Queenstown, which is on the eastern edge of Lake Wakatipu.

Area: Unknown.

Altitude: 190-610

Overview: The Kawarau Catchment Wetland Complex consists of the Kawarau River and all its tributaries (major tributaries are the Shotover and Nevis Rivers), including Lake Wakatipu and its inflowing streams and rivers (*e.g.* Dart, Rees, Greenstone and Caples Rivers). It includes all rivers, streams, lakes, wetlands and other water bodies within the catchment. These water bodies have or contribute to one or more of the following outstanding characteristics:

- wild and scenic features and intrinsic worth;
- diversity of recreational resources;
- fisheries habitats and angling amenities;
- jet-boating, canoeing and rafting opportunities;
- important habitats for riverbed birds;
- wetlands of ecological value;
- lake flora that is of scientific interest and outstanding internationally;
- braided river landforms and processes;
- archaeological and historic features.

The Kawarau River is a large single channel river flowing through a deeply entrenched narrow channel cut into bedrock. It drains Lake Wakatipu from the head of the Frankton Arm, and flows east for 59 km to Cromwell where it joins the Clutha River. The river is swift and powerful, but the surface is generally unbroken except for the rapids which characterize the middle and lower reaches of the gorge. The river is joined by numerous tributaries, the most significant in terms of size of catchment and inflow are the Shotover and Nevis Rivers.

Lake Wakatipu is of glacial origin, and is one of only a few very clear water lakes that exist in New Zealand. Its clear water, relatively stable water levels and suitable substrates support extensive growth of tall plant cover and a high diversity of aquatic plants. Internationally, Wakatipu would rank as one of the most outstanding bryophyte lakes. The lake is 80 km long and has a surface area of 29,100 ha, making it one of the largest lakes in New Zealand. It lies at an altitude of 310 m, and has a maximum depth of 399 m, putting the lake floor below sea level. Important tributaries include the Dart, Rees, Greenstone and Caples Rivers. The lake offers a diversity of year-round fishing opportunities. The major sport fish include Rainbow Trout, Brown Trout and land-locked Quinnat (Chinook) Salmon.

The Shotover River is deeply entrenched in a steeply walled valley except for the uppermost and lowermost reaches which open out into wide shingle beaches.

The Kawarau River, the Greenstone and Caples Rivers, and the Dart and Rees Rivers are

described in greater detail as Sites 69a-c, respectively.

Physical features: The Kawarau catchment includes a number of impressive geological formations, with gorges, schist outcrops *etc.* For the first 12 km of the river, the geomorphology is glacial outwash and lacustrine terrace deposits. The river then flows through a rock-defended gorge. Detritus enters through its tributaries. Four tributaries, the Dart, Rees, Nevis and Shotover, include braided river habitat for part of their length. Braided rivers in New Zealand are specialised rivers derived from outwash gravels spreading out to create expansive river beds in which river flows can meander and break up into many small channels or "braids". They are found only in Canterbury, the Mackenzie Country and Otago. Elsewhere, braided rivers of this type are found only in Alaska and parts of Canada. Braided river habitat is unique in that it is created by a naturally unstable river substrate. A highly fluctuating river flow causes continuous motion of the riverbed substrate, preventing the establishment of vegetation. Braided rivers are sensitive to human alterations in flow because they are "closely in tune" with natural fluctuations.

Ecological features: The upper reaches of the Dart and the Rees are single channel rivers with a significantly different structure to the braided river found in the middle to lower reaches of these rivers. They are mountainous rivers with a steep gradient, large unsorted boulder substrate, and highly oxygenated water. The middle and lower reaches are braided rivers. Braided rivers are "multi-channelled" rivers having major and minor channels. The movement of the major channel causes the formation of additional habitats apart from the riffles (shallower, faster moving water) and edges of the pools. These include islands, low terraces, backwaters, seeps and disconnected pools. Braided rivers thus contain many different niches which provide a wide range of habitats for birds. Breeding habitats are usually on the active river bed where there are clean bars, flats, spits and islands; their height determines the degree of vegetation, and thus their use as breeding habitat. Feeding areas are usually associated with the aquatic component of the braided river. The food of the river beds is a range of aquatic insects and vertebrates which live on, in and under the pebbles, cobbles and boulders that make up the river bed.

For much of their length, the Greenstone and Caples Rivers are enclosed by beech forest, with the remainder bounded by pasture. Approximately half of the total vascular plants found in the Greenstone and Caples catchment area occur in the wet places; this is true of both native and naturalised species. Thus, for example, of a total vascular flora of 362 species (305 native and 57 naturalised) at the Elfin Bay, Greenstone and Routeburn Stations, 171 species (146 native and 25 naturalised) are wetland plants.

Wetlands occupy many different landforms, and are diverse and complex, reflecting a wide range of conditions of water fluctuations, fertility and aeration. Some of the vegetation types occupy more than one landform, and many of them grade into each other or form mosaics with the grasslands and scrub types. Nine principal wetland types are found in the Greenstone/Caples Valleys: floodplains; turf of flood channels and lake edges; swards of damp valley floors; aquatic vegetation; flushes of bog edges and hill toe slopes; sphagnum bogs; cushion bogs; Red Tussock grasslands; and Bog Pine wetland and heathland (Department of Conservation, 1993c).

Land tenure: See individual site accounts.

Conservation measures taken: See individual site accounts. In October 1990, the Minister of Conservation applied for a National Water Conservation Order over the Kawarau River and all contributing waters, in particular the Kawarau River upstream of the yet-to-be-formed Lake Dunstan, and the Shotover and Nevis tributaries. The Kawarau catchment area includes Lake Wakatipu and the Dart, Rees, Greenstone and Caples Rivers. It was envisaged that a National Water Conservation Order would protect as far as practical in their natural state the Kawarau and its tributaries, the Shotover and Nevis Rivers, and would provide recognition and

protection for their outstanding characteristics (scenic, recreational, fisheries and historic values). It could achieve this by not allowing damming of the Kawarau and its tributaries; by not allowing any damming, diversion, abstraction or discharge or other water rights that would interfere with the existing flows or levels or natural water or effect water quality within the Kawarau River systems; and by providing for Lake Wakatipu to continue to operate within its existing natural range. This application is being processed under provisions of the Resource Management Act 1991. On 7 February 1994, the Special Tribunal made its report on the Kawarau Water Conservation Order Application to the Minister of the Environment. The Special Tribunal recommended that a Water Conservation Order be made, and included a Draft Order in its Report. Five appeals have been lodged with the Planning Tribunal. None of these appeals opposes the making of an order in total. Efforts are being made to resolve the issues under appeal through negotiations.

Conservation measures proposed: As outlined above, the Kawarau River and its catchment are included in an application for a National Water Conservation Order over the Kawarau Catchment, made by the Minister of Conservation in October 1990.

Land use: In the vicinity of the Kawarau River, recreational uses can be divided into "passive" uses, such as enjoyment of wild and scenic views, and viewing historical sites (particularly those relating to gold mining and the Kawarau suspension bridge), and "active" uses, such as bungee-jumping, rafting, canoeing, kayaking, jet-boating, trout fishing and walking.

Within the protected areas on the Dart, Rees, Greenstone and Caples Rivers, the main uses are conservation of flora and fauna, protection of wildlife and recreational uses such as sport fishing, game-bird hunting, deer hunting and tramping (a major use in the summer months). On the unprotected area, uses include extensive livestock grazing (on pastoral leasehold land), mining (gold and scheelite), jet-boat tours, sport fishing, game-bird hunting, deer hunting and tramping (access to the protected areas is through former pastoral runs).

Possible changes in land use: Proposals for abstraction of water for irrigation, frost control and water supply are likely to be ongoing, as land surrounding the Kawarau River comes under more intensive development (*e.g.* from pastoral farming to viticulture). There are also proposals for damming of the rivers for hydro-electric power generation. Up to five hydro-electric schemes are proposed for the Kawarau River alone. These schemes contain up to three proposed dams as well as power-houses. Horticulture is planned on the banks of the river, and this will require irrigation.

Disturbances and threats: The massive numbers of jet-boats in the upper Kawarau River will increase siltation in certain areas, and may artificially alter the river's geological make-up. Untreated household sewage threatens the water quality, and the government controls on industrial waste should be strictly controlled to ensure minimum disturbance of water quality. The most important threat to the river is the proposed hydro-electrical development, which would permanently alter the river's character. Increased extraction of water for irrigation purposes, frost control and water supply would also disturb the river level.

The greatest threats to the braided river systems of the Dart and Rees are water resource developments, including abstraction, damming, and flood protection and channelisation. Other threats include livestock grazing on marginal strips and dunes in the river bed, increase in willow and scrub-weed growth on the river bed, drainage of swamp areas, and an increase in jet-boat traffic (causing disturbance to wildlife and increased mixing of sediments in the water).

Possible threats to the Greenstone and Caples Rivers include a proposed road through the Greenstone Valley and a road bridge over the Greenstone River. The road would improve access, and may result in an increase in the volume of trampers to a level which may be beyond the sustainability of this sensitive area. A jetty is proposed at the mouth of the

Greenstone River, and there is a proposal to install monorail transport up the valley and through the gorge. Helicopter landings at one of the huts threaten the very sensitive environment, and may lead to distress amongst bird communities in the immediate vicinity. An increase in the number of people fishing in the river could lead to over-fishing.

Hydrological and biophysical values: Groundwater recharge along the Kawarau River is achieved by the valley floor which is covered in very permeable glacial outwash gravels. Typically, the groundwater level falls gradually from the fans and terraces on the sides to the level of the river. The lowest gauged flow was 54 cubic metres per second. This is caused during winter by snow and ice trapping water. Flood control is achieved naturally by deep entrenchments in the upper river. The gorge section contains several considerable rises in level. The Dart, Rees, Greenstone and Caples Rivers are the major tributaries of Lake Wakatipu, which is one of three main feeder lakes for the Clutha River. The Clutha River carries the largest average flow of any river in New Zealand, and is important for hydro-electricity generation, urban, rural and industrial water supply, recreation and effluent dilution. Lake Wakatipu contributes slightly less than one third of the flow of the Clutha River. The waters of Lake Wakatipu are oligotrophic, of a very high quality, and have a diverse assemblage of aquatic species (predominantly native species). The Dart, Rees, Greenstone and Caples Rivers play a major role in the maintenance of water quality in the lake.

Social and cultural values: The Kawarau River is very important for outdoor recreation, including rafting, canoeing, kayaking, jet-boating, bungee-jumping, camping, picnicking, walking and trout fishing. The river itself has very high scenic values, and has been rated as "impressive", the second highest rating possible. The river has great economic importance; in 1989, commercial rafting and jet-boat operations on the river carried between 37,000 and 45,000 passengers.

Outstanding historical characteristics of the Kawarau River include the natural bridge, the Kawarau Suspension Bridge and the numerous relics of past gold-mining era scattered along its banks. The Goldfields centre is also on the river bank.

The Dart, Rees, Greenstone and Caples Rivers are also extremely important for outdoor recreation, especially sport fishing for introduced Brown Trout, Rainbow Trout and land-locked Quinnat Salmon, and waterfowl hunting for Mallard, Grey Duck, Paradise Shelduck and Canada Goose. The Greenstone River is known as Waipounamu by the Maori. The valley was used as an ancient trail for transporting greenstone from Lake Wakatipu to the villages of the Fiordland coast.

Noteworthy fauna: Lake Wakatipu and the Rees, Dart, Shotover and Nevis Rivers have been ranked as "outstanding" "Sites of Special Wildlife Interest" (SSWI). The SSWI system is a ranking system developed by the former Wildlife Service of New Zealand and recognised by the Department of Conservation. The braided rivers are not only unique in themselves, but also because they support certain species of birds which are specially adapted to the habitats of the braided rivers. These include South Island Pied Oystercatcher *Haematopus finschi*, Banded Dotterel *Charadrius bicinctus*, Wrybill *Anarhynchus frontalis*, Black-billed Gull *Larus bulleri* and Black-fronted Tern *Chlidonias albobristatus*, all of which breed along the rivers. The upper reaches of the Dart and Rees Rivers also provide habitat for Blue Duck *Hymenolaimus malacorhynchus*, a highly specialised riverine species which is adapted to living on mountainous rivers and streams.

The Kawarau River supports populations of both Brown Trout *Salmo trutta* and Rainbow Trout *Oncorhynchus mykiss* in its upper reaches. Below the confluence of the Shotover River, the turbulence of the river appears to make it uncongenial to fish.

A rich and diverse insect fauna is to be found on the Rees river bed, with some species not known elsewhere in Otago complemented by a fauna of more widespread species characteristic

of river beds. One moth species, typical of southern coastal turf areas, has its only inland occurrence on the Rees river bed.

Noteworthy flora: No plant species of note are associated with the braided rivers. At Lake Wakatipu, on the shores where finer sediments accumulate, especially shores of relatively gentle slope, in more sheltered sites, or near river or stream mouths, there is a zone of sward or turf vegetation tolerant of regular submergence and emergence. This plant cover grades into the more truly aquatic vegetation. Such semi-aquatic vegetation contains a large number of native plant species arrayed in zoned communities. This type of lakeshore vegetation has been lost from those large South Island lakes which have had their levels altered and/or range of fluctuations increased for hydro-electricity generation. Of those large lakes which retain their natural fluctuation patterns, semi-aquatic vegetation types are best developed at Lakes Manapouri and Te Anau, and moderately well represented at Lake Wanaka. The extent of semi-aquatic vegetation is somewhat less at Lake Wakatipu, where it has yet to be studied in any detail. The shores of Lake Wakatipu, both vegetated and non-vegetated, are in a condition which reflects the natural long history of lake processes and fluctuation. Accordingly, they have substantial scientific value.

Scientific research and facilities: A large amount of research went into the preparation of submission and objections on the National Water Conservation Order application. This research covered a wide range of topics and brought together a large amount of existing information. Topics covered included: landscape values, hydrology and sedimentation, wildlife associated with braided rivers, aquatic vegetation of Lake Wakatipu, wetland vegetation, archaeological and historical values, recreational/tourism use of water bodies, sport fishing, and hydro-electric development potential.

The Hydrology Centre of the former Department of Scientific and Industrial Research has gathered data on the hydrology and sediments of the Kawarau River. Wildlife surveys have been carried out on the Dart and Rees Rivers since at least 1967, and bird count data are available for the years 1967, 1982, 1984, 1990 and 1991. There are no specific scientific research facilities available in the area.

Conservation education: See individual site accounts.

Recreation and tourism: Queenstown and the surrounding area are a year-round resort destination, with an estimated 450,000 visitors in 1989/90. It is estimated that approximately 30% of all international travellers to New Zealand visit Queenstown (*i.e.* 300,000 in the year ending December 1991). The area offers almost 100 activities/excursions to these visitors throughout the year. There is a relationship between adventure tourism - the activities for which tourists come to Queenstown - and the geography of the region. Activities include skiing (incorporating heli-skiing), a wide range of rafting and jet-boating opportunities, boat cruises such as the trip to Walter Peak on the TSS Earnslaw, and bungee-jumping. Queenstown itself has a wide range of hotels, good facilities and a small-town atmosphere.

Recreational fishing ranks as one of the area's most popular activities. There are currently 18 resident fishing guides, numerous small boat rental facilities, and fishing tackle rental and sales outlets. The Otago Fish and Game Council have a full-time officer based in Queenstown. A large percentage of the anglers are non-local New Zealand residents or from overseas. Many of the waters of the catchment complex (Greenstone, Locky and Nevis Rivers and Lake Wakatipu) are outstanding in their own right, and form part of an exceptional river and lake fisheries system. The sport fishery consistently provides high catch rates of large trout, and is visited by sport fishing enthusiasts from all over the world. The fishery is based on self-sustaining stocks of salmon and trout.

The Kawarau River is ruggedly scenic, rich in historic associations, and flows through an arid landscape. It also offers outstanding recreational opportunities. A highway follows the course of the river and is part of the major tourist route to Queenstown. This makes the Kawarau one

of the few wild and scenic rivers in New Zealand that is easily seen throughout its length. It has an intrinsic recreational value as a scenic landscape and as the basis for a range of leisure pursuits such as rafting, kayaking, jet-boating, trout fishing, walking and bungee-jumping. Commercial rafting and jet-boating operations on the river carried 37,000-45,000 passengers in 1989. The Kawarau River is considered by canoeists to be the premier remaining big white-water river in New Zealand. There is still one rapid on the river of such ferocity that it has never been canoed during normal flows. Outstanding historical characteristics of the river include the natural bridge, the Kawarau Suspension Bridge and the numerous relics of past gold-mining era scattered along its banks. The Shotover River is internationally known for its jet-boating, Queenstown being the home of commercial jet-boating. The Shotover is one of the most commercially popular white-water rafting rivers in the South Island. The river has extremely challenging rapids and a unique feature in the 180 metre long historic Oxenbridge Tunnel. It is estimated that in 1989, 117,700 passengers were carried by commercial jet-boating and rafting operations on the Shotover River.

Management authority: The Department of Conservation (Otago Conservancy) is responsible for the management of Conservation Areas, National Parks, Scenic and Recreation Reserves and wildlife. The Commissioner of Crown Lands administers the Crown land that was formerly pastoral lease. The Otago Regional Council has statutory responsibilities for water resources under the Resource Management Act 1991. The Otago Fish and Game Council manages sport fishing (trout and salmon) and game-bird hunting.

Jurisdiction: Territorial: Otago Regional Council and Queenstown Lake District Council. Functional: Commissioner of Crown Lands, Department of Conservation and Otago Fish and Game Council.

References: See individual site accounts.

Reasons for inclusion:

- 1a The Kawarau Catchment Wetland Complex is a particularly good representative example of a river system characteristic of New Zealand.
- 1c The complex contains high quality wetlands which play a major hydrological, biological and ecological role in the natural functioning of a major river basin.
- 1d The braided river habitats found in the Dart and Rees Rivers are good examples of a wetland type that is uncommon on a global scale.
- 2a The complex supports substantial populations of three globally threatened species of birds, *Hymenolaimus malacorhynchus*, *Anarhynchus frontalis* and *Chlidonias albostratus*.
- 2b The Dart and Rees Rivers are largely unmodified ecosystems of large size containing populations of almost all of the species which are specially adapted to braided river habitats; they are thus of special value for maintaining the genetic and ecological diversity of the region.
- 2c The rivers are of special value as breeding habitat for a variety of waterfowl, including several threatened species.
- 2d The rivers are of special value for endemic bird species, notably *Hymenolaimus malacorhynchus*, *Haematopus finschi*, *Anarhynchus frontalis*, *Larus bulleri* and *Chlidonias albostratus*.

Source: Pam Cromarty.

Kawarau River (69a)

Location: 45°02'S, 169°00'E (approximately halfway between Lake Wakatipu and Cromwell). Approximately 5 km east of Queenstown, east of the main divide, Otago Region, South Island.

Area: Unknown.

Altitude: 195-308m

Overview: The Kawarau River is part of the Kawarau Catchment Wetland Complex. The river is ruggedly scenic, rich in historic associations, and flows through an arid landscape. It also offers outstanding recreational opportunities. The Kawarau is the most accessible wild river in New Zealand because of its proximity to a highway over much of its length. This highway is part of the major tourist route to Queenstown, one of the top three fastest growing tourist centres in New Zealand. Queenstown is a centre for both summer and winter activities (camping, tramping, sport fishing, hunting, jet-boating, rafting, canoeing and winter sports). The river flows into the Taieri River System which is a very important wetland ecosystem in its own right.

Physical features: The Kawarau River drains Lake Wakatipu from the head of the Frankton Arm and flows east for 59 km to Cromwell where it joins the Clutha River. Over most of its length, the Kawarau River flows through a deeply entrenched narrow channel. Impressive geological formations include gorges, schist outcrops *etc.* For the first 12 km of the river, the geomorphology is glacial outwash and lacustrine terrace deposits. The river then flows through a rock-defended gorge. Detritus enters through its tributaries. The water quality is affected by the following chemicals: ammonia $<0.04 \text{ gm}^{-3}$, dissolved reactive phosphate 0.053 gm^{-3} , total phosphate $0.006\text{-}0.095 \text{ gm}^{-3}$, and non-filterable residue $12\text{-}568 \text{ gm}^{-3}$. The average annual rainfall in the region is 405 mm and the mean annual temperature is 10.8°C .

Ecological features: No information.

Land tenure: Crown land, with no overlying protective status. Surrounding areas are in private ownership.

Conservation measures taken: In October 1990, the Minister of Conservation applied for a National Water Conservation Order over the Kawarau River and all contributing waters, in particular the Kawarau River upstream of the yet-to-be-formed Lake Dunstan, and the Shotover and Nevis tributaries. Further details are given in the general account of the Kawarau Catchment Wetland Complex.

Treated and other untreated effluent such as domestic sewage and waste from meat works and a dairy factor are pumped into the river. Both the meat works and dairy factory are legally bound to follow government regulations relating to discharge.

Conservation measures proposed: As outlined above, the Kawarau River and its catchment are included in an application for a National Water Conservation Order over the Kawarau Catchment, made by the Minister of Conservation in October 1990.

Land use: Recreational uses along the river can be divided into "passive" uses, such as enjoyment of wild and scenic views, and viewing historical sites (particularly those relating to gold mining and the Kawarau suspension bridge), and "active" uses, such as bungee-jumping, rafting, canoeing, kayaking, jet-boating, trout fishing and walking. The principal land-use activity in surrounding areas is intensive agriculture, including pastoral use (mainly sheep); there is also some viticulture.

Possible changes in land use: Proposals for abstraction of water for irrigation, frost control and water supply are likely to be ongoing, as land surrounding the Kawarau River comes under more intensive development (*e.g.* for pastoral farming and viticulture). Proposals have been made to dam the river for hydro-electric power generation. Up to five hydro-electric schemes

have been proposed, involving up to three dams as well as power-houses. Horticulture is planned on the banks of the river, and this will require irrigation.

Disturbances and threats: The massive numbers of jet-boats in the upper river area will increase siltation in certain areas and may artificially alter the river's geological make-up. Untreated household sewage threatens the water quality. Government controls on industrial waste should be strictly controlled to ensure minimum disturbance of water quality. The most important threat to the river is the proposed hydro-electrical development, which would permanently alter the river's character. Increased extraction of water for irrigation purposes, frost control and water supply would also disturb the river level.

Hydrological and biophysical values: Groundwater recharge along the Kawarau River is achieved by the valley floor which is covered in very permeable glacial outwash gravels. Typically, the groundwater level falls gradually from the fans and terraces on the sides to the level of the river. The lowest gauged flow was 54 cubic metres per second. This is caused during winter by snow and ice trapping water. Flood control is achieved naturally by deep entrenchments in the upper river. The gorge section contains several considerable rises in level.

Social and cultural values: The Kawarau River is of substantial socio-economic value and cultural value as a wild and scenic river, with important historical values and outstanding recreational opportunities. The river's high scenic values have been rated as "impressive", the second highest rating possible. The attributes of the Kawarau that contribute to its wild and scenic qualities are:

- impressive geological formations (gorges, schist outcrops *etc.*);
- occasional views to major peaks and ranges;
- a wilderness feeling that reflects the barren surroundings and deep gorge rather than the absence of development;
- powerful waters with stupendous rapids displaying an impressive energy;
- historical features.

Very large numbers of people enjoy the spectacular qualities of the river, and this adds greatly to its value. The river is very important for outdoor recreation, including rafting, canoeing, kayaking, jet-boating, bungee-jumping, picnicking, camping, walking and trout fishing. In 1989, commercial rafting and jet-boat operations on the river carried between 37,000 and 45,000 passengers. Outstanding historical characteristics of the Kawarau River include the natural bridge, the Kawarau Suspension Bridge, and the numerous relics of past gold-mining era scattered along its banks. The Goldfields centre is also on the riverbank.

Noteworthy fauna: Little information is available. Populations of both Brown Trout *Salmo trutta* and Rainbow Trout *Oncorhynchus mykiss* exist in the upper reaches of the river. Below the confluence of the Shotover River, the turbulence of the river appears to make it uncongenial to fish.

Noteworthy flora: No information.

Scientific research and facilities: See general account of Kawarau Catchment Wetland Complex.

Conservation education: No information.

Recreation and tourism: See general account of Kawarau Catchment Wetland Complex. The Kawarau River is considered by canoeists to be the premier, remaining big white-water river in New Zealand. There is still one rapid on the river of such ferocity that it has never been canoed during normal flows.

Management authority: See general account of Kawarau Catchment Wetland Complex.

Jurisdiction: See general account of Kawarau Catchment Wetland Complex.

References: Anon (1985, 1991, 1992); Otago Fish and Game Council (1991).

Reasons for inclusion:

- 1a The Kawarau River is a particularly good example of a river in a deeply entrenched, narrow channel. This is a wetland type characteristic of New Zealand. It is also a wetland type that is becoming increasingly rare as water resource related activities such as hydro-electric generation and abstraction have modified many rivers of this type elsewhere in New Zealand.

Source: J.M. Neilson and Pam Cromarty.

Greenstone River and Caples River (69b)

Location: 44°56'S, 168°18'E (at the confluence of the Greenstone and Caples Rivers). 35 km southwest of Glenorchy, Otago Region, South Island.

Area: Unknown.

Altitude: Approximately 330 m to 610 m.

Overview: The Greenstone River and Caples River are part of the Kawarau Catchment Wetland Complex. The rivers are in an area of great scenic beauty, and have a unique, distinctive greenish tinge. A variety of wetland types is present. The area is one of considerable recreational and economic importance, and also has great Maori historical importance.

Physical features: The rivers flow through a region of sedimentary rocks comprised of mudstone and sandstone. Greywacke, a hard muddy-grey sandstone, gives the rivers their distinctive greenish tinge. Schist is also present. The Greenstone River receives its inflow from Lake McKellar, and eventually flows into the Caples River. The latter also receives inflow from the Ailso Mountains, and eventually flows into Lake Wakatipu. Greenstone ("pounamu") occurs in Greenstone Gorge and Caples Valley. The Greenstone River cuts the talc-serpentine rocks 6 km upstream from the Caples River; greenstone is found in the river, but good stones are rare and small. The average annual rainfall in the area is 1,000 mm.

The Caples Valley is the simplest and lowest of the two valley systems. Over the 14 km length of valley studied, it falls 170 m (altitudinal range 300-500 m), and has a relatively narrow valley floor with alluvial flats interspersed with stream fans and a few rock slides. The grassy flats are a mixture of grazed pasture grasses and native herbs, without tussocks. On the northeast side of the valley, a forest of Silver Beech, Mountain Beech or Red Beech extends from the edge of the valley floor to the treeline, up to subalpine scrub in gully heads, but otherwise giving way abruptly to narrow-leaved snow tussock grassland. On the southwest side of the lower valley, the forest is more patchy, being replaced by induce shrublands of Manuka or *Coprosma* sp., by bracken fernland, and in the lowermost valley, by scrub weeds and forest regeneration of Kohuhu and Broadleaf (Department of Conservation, 1993c).

The Greenstone Valley has a broader floor, often 500 m wide, and a very gentle gradient, with a fall of just 120 m over the 18 km length of its main flats (altitudinal range 490-610 m). The meandering river is flanked by alluvial floodplain, older terraces, stream fans of various ages and rock falls. There is one small gorge cut through a "roche moutonnee" and associated with lateral moraine. Red Tussock or Hard Tussock grasslands occupy most of the valley, along with stream meanders, bogs and ponds of valley wetlands. The valley sides are mainly forested with Silver Beech, Mountain Beech and Red Beech, but with several exceptions. Deforested slopes on parts of the southwest side support *Coprosma* shrubland; Bog Pine shrubland grows on old fans in the lower valley, and the valley floor edges in general have a fringe of mixed conifer and *Dracophyllum* woodland and shrublands, and seepage communities (Department of Conservation, 1993c).

Ecological features: Wetlands occupy many different landforms, and are diverse and complex, reflecting a wide range of conditions of water fluctuations, fertility and aeration. Some of the vegetation types occupy more than one landform, and many of them grade into each other or form mosaics with the grasslands and scrub types (Department of Conservation, 1993c). Nine principal wetland types are found in the valleys of the Greenstone and Caples Rivers. These are as follows:

Floodplains

These are sites close to major river and stream courses which are wet only at times of flood, although the plants of low-lying surfaces must benefit always from a constant shallow water table. The common initial colonists of flood-deposited alluvium are *Raoulia tenuicaulis*, *R. haastii*, *Muehlenbeckia axillaris* and *Epilobium melanocaulon*. Slightly older surfaces are then colonised by Hard Tussock, Sweet Vernal, *Coprosma perpusilla*, *Leucopogon fraseri*, *Geranium sessiliflorum* and a great diversity of grasses, herbs and shrub seedlings.

Turf of flood channels and lake edges

Minor channels beside streams and rivers which carry water only at flood times carry a turf of pioneering species, the commonest being *Gunnera dentata*, *Leptinella squalida*, *Hydrocotyle hydrophila*, *Plantago triandra*, *Eleocharis acuta* and *Pratia angulata*. At least another 40 herbaceous species of wetland and grassland play a part in this vegetation. Turfy sward also covers low steep river banks, growing among tussocks, and can extend across the level surfaces of river flats where the tussocks and other grasses are depleted, as in the Caples. Here again the flora is large, but the common dominants are *Nertera setulosa*, *Hydrocotyle "montana"*, *Pratia angulata*, *Leucopogon fraseri*, *Acaena inermis*, *Leptinella squalida*, Browntop, Sweet Vernal and White Clover. There is even one dwarf shrub of virtual turf habitat, a native broom *Carmichaelia uniflora*, which locally forms extensive patches on these turfy flats.

Swards of damp valley floors

The most frequent wetland habitat of the valley floors is found as narrow strips in abandoned river channels where one river terrace meets the scarp of the next and older terrace. Parts of these channels may hold ponded or running water, but their adjacent moist silty soils inevitably have low sedge and grass swards in which the following are common: *Carex gaudichaudiana*, *Eleocharis acuta*, *E. gracilis*, *Carex coriacea*, *Hydrocotyle sulcata* and *Potentilla anserinoides*. The naturalised Jointed Rush *Juncus articulatus* is often a component of the dampest swards. Naturalised species become more important in this vegetation in the lower Greenstone and in the Caples, e.g. *Poa pratensis*, *Holcus lanatus*, *Stellaria alsine*, *Prunella vulgaris* and Browntop. Several mosses play a major role in damp ground where these swards grade to pool edges, especially cushions of *Drepanocladus*, *Bryum*, *Breutelia* and *Philonotis* species.

Aquatic vegetation

The aquatic flora is relatively limited. A few native species occur in most of the habitats (e.g. *Potamogeton* sp., *Myriophyllum pedunculatum*, *M. propinquum* and *Eleocharis acuta*), but others are more restricted. Naturalised species occur mainly in the meandering streams and ponds in the valley floors.

Flushes of bog edges and hill toe slopes

Flushes, where water is seeping downslope in shallow channels, of peat as well as silt, one to several metres wide, are common around the margins of level bogs, or interspersed among bogs and grasslands on slight slopes of valley-side benches. The most constant species are *Carex echinata*, *Ranunculus cheesemanii* and *R.*

glabrifolius, then as fertility increases, *Hydrocotyle sulcata*, *Juncus articulatus*, *Epilobium brunnescens* and *Schizaeilema nitens*. Much broader areas of flushed ground are a frequent feature of many hill bases, the water emerging near the foot of the colluvial slopes where they meet the fans and terraces of the valley floors. They are often characterised by the presence of the tussocky sedge *Schoenus pauciflorus*, but in association with a diversity of other plants. These include Red Tussock, sphagnum moss and shrubs such as *Coprosma propinqua*, *Hebe odora*, Manuka or Bog Pine, and the wetland herbs *Carpha alpina*, *Oreobolus strictus*, *Gonocarpus micranthus*, *Gnaphalium traversii*, *Plantago triandra* and *Carex echinata*. These species are indicative of relatively fertile wetlands, perhaps attracting cattle use for this reason. These hill toe seepages with their soft ground are the sites where livestock trampling impacts are most severe.

Sphagnum bogs

Bogs where sphagnum mosses are dominant are found on several different landforms, but typically on level ground or very gentle slopes having a constant water table. Some valley flats in the upper Greenstone have extensive sheets of *Sphagnum cristatum* (c.90% cover), with scattered Blue Tussock and Sweet Vernal, grading into and among *Schoenus pauciflorus* and Red Tussock. *S. cristatum* is especially common in bogs within forest openings northeast of Pass Burn, mostly in very uniform communities. Typical cover is *S. cristatum* (50%), *Dracophyllum prostratum* (25%), *Carex gaudichaudiana* (20%), *Carpha alpina* (3%) and *Drosera arcturi* (2%). In places, the sphagnum is associated with Bog Pine and *Carex coriacea*. In the wettest hollows, *Sphagnum falcatulum* replaces *S. cristatum*. As sphagnum bog becomes more shaded, within mountain beech forest, *Sphagnum australe* becomes the dominant species, and its carpets hold large pure patches of *Isolepis habrus*, *Juncus novae-zealandiae*, *Oreobolus strictus* and, with increasing shade, *Carex dissita* and *Uncinia filiformis*. *Sphagnum cristatum* bog merges and intermingles with cushion bog.

Cushion bogs

Here the dominant plant is the comb sedge *Oreobolus pectinatus* growing as firm rounded cushions, covering areas often 10 to 50 m across, in peaty hollows and on gently sloping upper alluvial fans and glaciated benches. The sites where *Oreobolus pectinatus* is most abundant are those having a water fluctuation slightly greater than where sphagnum is dominant.

Red Tussock grasslands

Red Tussock *Chionochloa rubra* grassland grows extensively on stable floodplains which are not necessarily wet. It grades into most other wetland types, at least three of which have distinctive associations of plants as follows: in swampy patches on wet alluvial flats, Red Tussock grows with *Schoenus pauciflorus* and *Carex sinclairii*; on silt of flood-prone river margins, Red Tussock is joined by swards of *Carex coriacea*, *C. kaloides* and *C. buchanaii*; around the margins of peatland, Red Tussock associates with *Juncus conglomeratus* as it grades into sphagnum bog or *Carex gaudichaudiana* sward.

Bog Pine wetland and heathland

Bog Pine *Halocarpus bidwillii* grows on infertile soils on moraines and fans. Bog Pine can also be prominent among sphagnum and cushion bogs, and in heathland (Department of Conservation, 1993c).

For much of their lengths, the rivers are enclosed by beech forest with Red Beech, Silver Beech, Black Beech and Mountain Beech. Broadleaf, Lancewood, Mountain Ribbonwood, Bog Pine and Celery Pine are also present. This is mostly the original vegetation. In some areas, the rivers are bounded by pasture.

Land tenure: The rivers and associated wetlands are a mixture of Crown land held as Conservation Area, managed and administered by the Department of Conservation, and Crown land with a lease over it, administered by the Commissioner of Crown Lands. Land in the surrounding areas is a mixture of Crown land held as Conservation Area, Crown land with a lease over it, and freehold land on the river flats and terraces. Land near the confluence between the Caples and Greenstone Rivers is predominantly Crown land with the status of Scenic and Recreation Reserve, managed and administered by the Department of Conservation.

Conservation measures taken: Parts of the rivers and adjacent areas are Crown land with the status of Conservation Area and National Park, managed and administered by the Department of Conservation. In October 1990, the Minister of Conservation applied for a National Water Conservation Order over the Kawarau River and all contributing waters, in particular the Kawarau River upstream of the yet-to-be-formed Lake Dunstan, and the Shotover and Nevis tributaries. Further details are given in the general account of the Kawarau Catchment Wetland Complex.

Hunting and fishing regulations are very strict; fly-fishing is restricted to the main rivers, and the bag limit is three. Electric fences are used to control cattle and keep them out of the forest. Other controls relate to burn-offs on leased land and the use of helicopters.

Conservation measures proposed: Several different land transactions have been negotiated between the Crown and the former owners of the Routeburn and Greenstone Stations which have yet to be concluded. One such transaction, between Routeburn Station and the Crown (Lake Sylvan area), aims to address the problem of stock trespass through exchange of land, fencing and controlled grazing, while another, between Routeburn Station and the Crown (Mount Aspiring National Park Boundary), aims at rationalising and clarifying the national park boundary. In addition, the Crown has attempted unsuccessfully in the past to negotiate three additional agreements:

- Lake Rere Reserve Additional: This relates to an extension of the reserve boundaries to include part of the catchment on the north side of Tooth Peak. Purchase of Elfin Bay Station by the Crown will allow this to proceed with improvements.
- Greenstone Station Surrender Areas: Two areas of retired land on Greenstone Station (part of the catchment of Greenstone and Caples Rivers) totalling approximately 3,900 ha were to have been surrendered out of the pastoral lease as a condition of a run plan. This requirement was not carried forward to the stage of the land improvement agreement being registered on the title, and attempts by agencies to complete the surrender action have not been legally enforceable on subsequent owners with the result that the land has remained in the title.
- Mavora Walkway: Proposed deviations to enhance walking opportunities for the public, and to save on maintenance costs in relation to the walkway.

Land use: Fishing, tramping, tourism, recreation, aeroplane tours and grazing. Farm development has tended to occur only at low altitudes and on the freehold river flats and terraces. Although the pastoral leases contained extensive areas of land at high altitude, much of this was of little use for grazing. Hunting and tramping are the main recreational activities here.

Possible changes in land use: During 1992, Elfin Bay, Greenstone and Routeburn Stations (Crown Pastoral Leases) were purchased by the Crown (*i.e.* the lessee's interest was purchased) for the purpose of use in possible future settlement of the Ngai Tahu land claim (a Treaty of Waitangi claim). The Greenstone and Caples Rivers flow through these stations. The three properties were placed in the Crown Land Bank pending possible future settlement of the land claim, subject to certain conditions being agreed to by Ngai Tahu. These conditions included a

statement that the purchase of the lessee interest does not bind or commit the Crown to transferring the lessor's interest to Ngai Tahu, or granting development rights or licences for the use of conservation or national park land in association with the leases nor to transferring the lessee's interest without making adequate provision for ongoing public recreation access. The Crown through the Commissioner of Crown Lands is administering the properties and continuing their farming operations. Settlement of the Ngai Tahu land claim is currently under negotiation between the Government and Ngai Tahu. As part of this process, the Department of Conservation prepared a draft report entitled "Assessment of the Conservation Values: Elfin Bay, Greenstone, and Routeburn Stations".

Disturbances and threats: Possible threats to the Greenstone and Caples Rivers include a proposed road through the Greenstone Valley and a road bridge over the Greenstone River. The road would improve access, and may result in an increase in the volume of trampers to a level which may be beyond the sustainability of this sensitive area. A jetty is proposed at the mouth of the Greenstone River, and there is a proposal to install monorail transport up the valley and through the gorge. Helicopter landings at one of the huts threaten the very sensitive environment, and may lead to distress amongst bird communities in the immediate vicinity. An increase in the number of people fishing in the river could lead to over-fishing.

Hydrological and biophysical values: The rivers and their associated wetlands play a general role in the maintenance of water quality and in supporting food chains.

Social and cultural values: The area is very important economically and socially because of its values for tourism and recreation (see under "Recreation and tourism" below). The Greenstone River is known as "Waipounamu" by the Maori. The valley was used as an ancient trail for transporting greenstone from Lake Wakatipu to the villages of the Fiordland coast.

Noteworthy fauna: A small colony of Black-fronted Tern *Chlidonias albostratus* and a larger colony of Black-billed Gull *Larus bulleri* nest in the lower Caples River flats during summer. Other waterfowl include the Paradise Shelduck *Tadorna variegata*. The adjacent forests support a variety of native landbirds including Kea *Nestor notabilis*, South Island Robin *Petroica australis australis*, South Island Fantail *Rhipidura fuliginosa fuliginosa*, South Island Tomtit *Petroica macrocephala macrocephala*, Grey Warbler *Gerygone igata*, South Island Rifleman *Acanthisitta chloris chloris* and Bellbird *Anthornis melanura melanura*. Bats are also present.

The Greenstone and Caples Rivers are of international importance for their Rainbow Trout fishery. The only native fish known to occur in the rivers is the Koaro *Galaxias brevipinnis*, but other species such as Long-finned Eel *Anguilla dieffenbachii*, Common Bully *Gobiomorphus cotidianus* and Upland Bully *G. breviceps* are likely to be present (Department of Conservation, 1993c).

Seventeen invertebrate groups or species have been identified in streams in the Greenstone/Caples area. These include mayflies (*Deleatidium* sp., *Nesamaletus* sp., *Oniscigaster* sp. and *Coloburiscus* sp.), stoneflies (*Stenoperla* sp., Gripopterygiidae and Notonemouridae), caddisflies (Rhycacophilidae and Hydropsychidae) and dobsonflies (Corydalidae). These insects are generally indicative of environments with high water quality.

Noteworthy flora: See under "Ecological features" above. Approximately half of the vascular plants found in the Greenstone/Caples catchment area occur in wet places; this is true of both native and naturalised species. Thus, of a total vascular flora of 362 species (305 native and 57 naturalised) at the Elfin Bay, Greenstone and Routeburn Stations, 171 species (146 native and 25 naturalised) are wetland plants.

Scientific research and facilities: There are no specific research facilities in the area. Various research, survey and monitoring programmes has been carried out in relation to the sport fishery (on sport fish species and aquatic invertebrates), general wildlife and botanical values.

Conservation education: Two school lodges are located in the area, one near Glenorchy and one at Kinloch. The latter, in particular, provides accommodation for many school groups in the Otago/Southland education area. Kinloch Lodge has virtually continuous use from October to March inclusive. The Glenorchy Lodge is used mostly by the East Otago High School. The Otago School of Physical Education (part of the University of Otago) has an annual summer field camp, and the University of South Australia has a biennial camp at Paradise. All groups, primary, secondary and tertiary, use the Greenstone and Caples Valleys to varying extent for outdoor education studies, recreation and teaching of bushcraft skills.

Recreation and tourism: Located on the northwestern shore of Lake Wakatipu, these rivers and their catchments fall within the recreation opportunity and tourism infrastructure that Queenstown/Glenorchy and Te Anau/Milford provide for both overseas and New Zealand visitors. For more than 120 years, tourists have ventured to this part of New Zealand to experience the scenic and recreational attractions for which the area has become known. Many visitors who use the recreational opportunities offered in the Greenstone/Caples area take advantage of the range of accommodation and transport services that are readily available in the region. In 1990, the Queenstown Lakes District Council estimated that 100,000 people travelled the Glenorchy Road each year, with only 9% being local rate-payers. The Greenstone/Caples and other southern region walking tracks feature in at least seven well-known guide books used by overseas visitors. The Greenstone Track is advertised overseas by Routeburn/Greenstone Valley Walks Ltd.

The outdoor recreation and tourism include a diversity of activities which capitalise on the natural attributes of a high quality landscape and the challenge of adventure free from the trappings of civilisation. Activities in the general area include tramping, hunting, fishing, pony trekking, tour groups/day visitors, scenic aerial flights, educational groups, and commercial tourist operators (guided walks).

Many of the rivers which drain into Lake Wakatipu, notably the Greenstone, Caples, Von and Lochy, offer some of the best Rainbow Trout fishing in New Zealand. The Greenstone River offers domestic and international visitors a back-country or wilderness angling experience where high catch rates of large sport fish can still be obtained in scenic surroundings. The Caples River is also visited by domestic and overseas anglers, and provides a wilderness fishing experience, offering trophy size Rainbow Trout and Brown Trout.

Management authority: See general account of Kawarau Catchment Wetland Complex.

Jurisdiction: See general account of Kawarau Catchment Wetland Complex.

References: Brailsford & Mitchell (1986); Department of Conservation (1993c).

Reasons for inclusion:

- 1a The Greenstone River and Caples River are part of the Kawarau Catchment Wetland Complex, a complex of high quality wetlands of a type characteristic of New Zealand.
- 1c The rivers play a major hydrological, biological and ecological role in the natural functioning of a major river basin, and are particularly important in the maintenance of water quality.
- 2a The rivers support a population of a globally threatened species of bird, *Chlidonias albostrigatus*.

Source: J.M. Neilson and Pam Cromarty.

Dart River and Rees River (69c)

Location: Dart River, 44°33'S, 168°22'E; Rees River, 44°43'S, 168°28'E. At the head of Lake Wakatipu, 17 km northwest and 13 km northeast of Glenorchy Village, respectively, Otago Region, South Island.

Area: Unknown.

Altitude: 305-518 m.

Overview: The Dart River and Rees River are part of the Kawarau Catchment Wetland Complex. The Dart and the Rees are braided river systems of high quality, containing large areas of "clean" gravel and outstanding habitat for wildlife. The rivers support a diverse range of riverbed birds (17 species, including a number of endemic species), and are particularly noteworthy for their breeding populations of Wrybill *Anarhynchus frontalis* and Banded Dotterel *Charadrius bicinctus*. The rivers are still in a relatively unmodified state, and there are few problem weeds currently associated with the braided river habitats. A few willows *Salix* sp. are found at the lower ends of the rivers, but there are no lupins or other brush weeds in the wetlands. River controls works are few in number and mostly confined to the lower end of the rivers.

Physical features: The Dart and Rees Rivers are relatively unmodified braided rivers occupying former glacier-filled valleys. Braided rivers in New Zealand are specialised rivers derived from outwash gravels spreading out to create expansive river beds in which river flows can meander and break up into many small channels or "braids". They are found only in Canterbury, the Mackenzie Country and Otago. Elsewhere in the world, braided rivers of this type are found only in Alaska and parts of Canada. Braided river habitat is unique in that it is created by a naturally unstable river substrate. A highly fluctuating river flow causes continuous motion of the riverbed substrate, preventing the establishment of vegetation. Braided rivers are sensitive to human alterations in flow because they are "closely in tune" with natural fluctuations.

The Dart River originates off the Barrier Range and Forbes Mountains. After flowing westwards for approximately 30 km, it turns south and flows into Lake Wakatipu. Braiding of the river begins near the Beansburn confluence at about 442 m above sea level and ends at the lake at 305 m. The braiding substrate consists of sand, shingle and cobble, dominated by schist-derived rock. The braided section takes the form of a two kilometre wide fan, from above the Glenorchy-Routeburn Bridge to the delta at the head of Lake Wakatipu. There are still glaciers at the head of the Dart Valley, and at times of the year the river can be discoloured due to glacial flow concentrations.

The Rees River originates from the Forbes and Northern Richardson Mountains, and joins the Dart River 1.5 km upstream from the head of the lake. There are no glaciers present at the head of the Rees Valley, so water quality is generally of a more stable nature. Although the Rees River has a much smaller catchment than the Dart, it develops a braid of similar substrate (*i.e.* sand, shingle and cobble) for the lower 15 km of its length. Braiding in the Rees starts at about the confluence of Hunter Stream (518 m above sea level).

Flows in both rivers are generally low in late winter and early spring, and occasionally also in autumn when dry conditions exist. High flows occur in late spring and early summer, when the region is susceptible to flooding following heavy rain from the northwest.

Ecological features: The upper reaches of the Dart and the Rees are single channel rivers with a significantly different structure to the braided river found in the middle to lower reaches of the rivers. They are mountainous rivers with a steep gradient, unsorted boulder substrate and highly oxygenated water. The middle and lower reaches are braided rivers. Braided rivers are "multi channelled" rivers having major and minor channels. The movement of the major channel causes the formation of a variety of habitats in addition to the riffles (shallower, faster

moving water) and edges of pools. These include islands, low terraces, backwaters, seeps and disconnected pools. There are few areas of vegetation on the river beds, and these consist mainly of short native tussock associations (Silver Tussock *Poa* spp.) and Hard Tussock *Chionochoila rigida*, with some areas of Matagouri *Discaria toumatou*. Areas of swampland in the lower delta and near where the Dart River enters Lake Wakatipu support native species of *Carex*.

The beds of both rivers are flanked in their lower reaches by developed pasture of exotic grasses on the flats and by overgrown and top-dressed tussock country on the hills. Presumably the river banks were originally clothed in beech forest *Nothofagus* spp., which still survives in the upper reaches of the rivers (in Dart Conservation Area and Mount Aspiring National Park).

Land tenure: The rivers and surrounding areas are Crown land in various categories.

Conservation measures taken: The river beds (except for that part of the Dart River in Mount Aspiring National Park) are un-allocated Crown land, with no overlying protected status. The upper part of the Dart River, its headwaters and surrounding land are Crown land within the Mount Aspiring National Park. Part of the Dart River flows through the Dart Conservation Area. Other stretches of river flow through leasehold Crown land and Crown land which was formerly pastoral leasehold and is now administered by the Commissioner of Crown Lands. Glenorchy Swamp is a Wildlife Management Reserve.

In October 1990, the Minister of Conservation applied for a National Water Conservation Order over the Kawarau River and all contributing waters, in particular the Kawarau River upstream of the yet-to-be-formed Lake Dunstan, and the Shotover and Nevis tributaries. Further details are given in the general account of the Kawarau Catchment Wetland Complex.

Conservation measures proposed: The Dart and the Rees Rivers are included in an application for a National Water Conservation Order over the Kawarau Catchment, made by the Minister of Conservation in October 1990.

Land use: Within the protected areas, the main uses are conservation of flora and fauna, protection of wildlife and recreational use, including sport fishing, game-bird hunting, deer hunting and tramping (a major use during the summer months). On the unprotected area, uses include extensive livestock grazing, jet-boat tours, sport fishing, game-bird hunting and other hunting. There is some mining (gold and scheelite) in the catchment.

Possible changes in land use: See under "Disturbances and threats".

Disturbances and threats: The greatest threat to the braided river systems is development of the water resources, including extraction for irrigation purposes, damming and channelisation for flood protection. Channelisation has occurred to a limited extent on the Dart, and this has resulted in the loss of some braided river habitat. Further channelisation is possible on both the Dart and the Rees, as is reclamation for agricultural development.

Bird species favouring braided rivers require large stretches of clean shingle for breeding, with a variety of minor braids for feeding. Such areas along the Dart and Rees Rivers may be removed in the interests of flood protection, or for extra pasture. The extraction of water for irrigation purposes may occur on the Dart in the future, but is not expected to be a threat on the Rees. Extraction of water is a threat to braided rivers and the birds that use them as it causes a muting of the naturally erratic flows which are characteristic of braided rivers. A consequence of this could be an increase in vegetation on the braided habitat, leading to a loss of suitable nesting sites for birds.

Damming on the Dart or Rees would, depending on the precise location of the dam, inundate riverine habitat, trap material that would otherwise continue to be moved downstream, potentially lead to downstream erosion, and/or produce a totally new flow regime with daily fluctuations which would destroy the river structure and food supply on which the riverbed birds depend.

Other threats include livestock grazing on marginal strips and dunes in the river bed, an increase in the growth of willow and scrub-weed on the river bed, drainage of swampy areas, and an increase in jet-boat traffic (causing disturbance to wildlife and increased mixing of sediments in the water).

Hydrological and biophysical values: The Dart and Rees Rivers are the major tributaries of Lake Wakatipu, and thus play a major role in the maintenance of water quality in the lake. Lake Wakatipu is one of three main feeder lakes for the Clutha River. The Clutha River carries the largest average flow of any river in New Zealand, and is important for hydro-electricity generation, urban, rural and industrial water supply, recreation and effluent dilution. Lake Wakatipu contributes slightly less than one-third of the flow of the Clutha River.

Social and cultural values: The rivers support an important recreational fishery for introduced Brown Trout, Rainbow Trout and land-locked Quinnat Salmon. The area is also important for waterfowl hunting (Canada Goose, Paradise Shelduck, Mallard and Grey Duck) and jet-boat tours.

Noteworthy fauna: The Dart and Rees Rivers are particularly important for bird species characteristic of braided river habitats. These include South Island Pied Oystercatcher *Haematopus finschi*, Pied Stilt *Himantopus leucocephalus*, Banded Dotterel *Charadrius bicinctus*, Wrybill *Anarhynchus frontalis*, Spur-winged Plover *Vanellus miles*, Southern Black-backed Gull *Larus dominicanus*, Black-billed Gull *L. bulleri* and Black-fronted Tern *Chlidonias albobristatus*. The Dart and Rees Rivers consistently hold the largest breeding colonies of Black-billed Gulls in Otago. Bird surveys have been carried out on a periodic basis since 1967, and have indicated that there has been an increase in most riverine shorebirds and gulls since 1984, including South Island Pied Oystercatcher, Banded Dotterel, Wrybill, Southern Black-backed Gull, Black-billed Gull and Black-fronted Tern. The upper reaches of the Dart and Rees Rivers also support a population of Blue Duck *Hymenolaimus malacorhynchus*. Other Anatidae occurring in the area include native species such as Paradise Shelduck *Tadorna variegata*, Grey Teal *Anas gracilis* and Grey Duck *A. superciliosa*, and introduced species such as Canada Goose *Branta canadensis* and Mallard *Anas platyrhynchos*. McKinlay *et al.* (1990) provide further details of the avifauna of the Dart and Rees Rivers.

The Dart and Rees Rivers support valuable fisheries for Rainbow Trout, Brown Trout and Quinnat Salmon. Both rivers are major migration routes for these sport fish which spend most of the year in Lake Wakatipu and then move upstream to spawn in the rivers and their tributaries. The Dart and the Rees are therefore essential for the maintenance of the Lake Wakatipu fishery.

The invertebrate fauna of the Rees River has been relatively well documented. The river channels are dominated by aquatic insect species of which the caddisfly *Aoteapsyche colonica* is typical. The caddisfly fauna of the main river is less diverse than that of the forested streams that flow into it. The moths *Eudonia cataxesta* and *Orocrambus xanthogrammus* are typical of unstable river beds with a sparse vegetation of *Raoulia* cushions and some *Epilobium* species. Stable terraces have a comparatively rich invertebrate fauna including the local moths *Orocrambus haplotomus* and *Scoparia asaleuta*. The seldom collected *Kaiwaia caerulea* has been found at these sites. Diurnal moths are a feature of this habitat, as are diurnal spiders, cicadas, beetles and bugs. Wet hollows containing *Gunnera* support a small but highly interesting moth fauna containing the normally coastal moth *Merophyas paraloxa*. This is an important habitat type that is very vulnerable to modification associated with development, and has now completely disappeared from most braided rivers in Otago (Patrick, 1990).

Noteworthy flora: No plant species of note are associated with the braided rivers.

Scientific research and facilities: Wildlife surveys have been carried out on the Dart and Rees Rivers since at least 1967, and bird count data are available for the years 1967, 1982, 1984, 1990 and 1991. There are no specific scientific research facilities available in the area.

Conservation education: None at present.

Recreation and tourism: The most significant area for recreational sport fishing in the Rees River is in the middle reaches of the river. Small populations of large, often trophy-size Brown Trout and Rainbow Trout reside here. Unlike most fishing areas surrounding the head of Lake Wakatipu, this area is sheltered from northwesterly winds. It is therefore a popular fishing venue for local people and visiting anglers, with the majority of the latter being escorted by professional fishing guides. Over half the angling effort is guide-related. Spawning Quinnat Salmon congregate at the mouth of the Rees River in April every year, creating a sport fishing opportunity that has become a regional event.

Management authority: See general account of Kawarau Catchment Wetland Complex.

Jurisdiction: See general account of Kawarau Catchment Wetland Complex.

References: Anon (1991); Department of Conservation (1991); McKinlay *et al.* (1990); Otago Fish and Game Council (1991); Patrick (1990).

Reasons for inclusion:

- 1d The braided river habitats found in the Dart and Rees Rivers are a good example of a wetland type that is uncommon on a global scale. This is a wetland type characteristic of New Zealand.
- 2a The rivers support populations of three globally threatened species of birds, *Hymenolaimus malacorhynchus*, *Anarhynchus frontalis* and *Chlidonias albostratus*.
- 2b The Dart and Rees Rivers are largely unmodified ecosystems of large size containing populations of almost all of the species which are specially adapted to braided river habitats; they are thus of special value for maintaining the genetic and ecological diversity of the region.
- 2c The rivers are of special value as breeding habitat for a variety of waterfowl including several threatened species.
- 2d The rivers are of special value for endemic bird species, notably *Hymenolaimus malacorhynchus*, *Haematopus finschi*, *Anarhynchus frontalis*, *Larus bulleri* and *Chlidonias albostratus*.

Source: J.M. Neilson and Pam Cromarty.

Lake Hayes (70)

Location: 44°59'S, 168°49'E. 10 km northeast of Queenstown and 6 km south of Arrowtown, Otago Region, South Island.

Area: c.185 ha.

Altitude: c.310 m.

Overview: Lake Hayes is one of the most scenically attractive landscapes of its type in New Zealand. Its importance for recreation and tourism is significant. The lake supports a number of threatened and endemic waterfowl.

Physical features: Lake Hayes lies in a shallow depression formed by glacial action, which has also shaped the surrounding landscape including the "roche moutonnee". The subsequent melt formed one large glacial lake over the area now occupied by Lake Wakatipu and Lake Hayes. During this melting period, a large outwash fan (piedmont) built up between the two lakes where Queenstown airport is now situated. Wave action on the original large glacial lake formed beach terraces around Lake Hayes at a higher level (c.380 m above sea level) than the present lake. Contemporary wave action has washed away most of the fine silt and clay materials from these deposits, and this has rendered these "pebble banks" very susceptible to

erosion. The lake is highly eutrophic due to a large extent to fertilizer run-off and other nutrient enrichment from surrounding agricultural land.

The average annual rainfall is approximately 681 mm, with the rainfall being fairly evenly distributed throughout the year, although there is a tendency towards a winter minimum. Hail showers or thunder occur infrequently, but are possible in any month of the year. Temperatures may reach 35°C in summer, while ground frosts occur in winter. There are approximately 1,970 hours of sunshine per year. Lake Hayes is exposed to southerly and southwesterly winds. However, strong winds are not common in the Lake Hayes area except in the spring, when southerlies and southwesterlies of greater than 21 knots are often experienced. Throughout the year, winds occur mainly in the afternoon and evening, with frequent calm periods at night and in the morning.

Ecological features: The wetland vegetation is not particularly notable for its botanical values. The high proportion (about two thirds) of adventive plants around the shores is an indication of the degree of modification of the original native plant cover. The vegetation which has the greatest value for wildlife (at least for waterfowl) is the *Typha orientalis-Carex secta-Salix* community at the south end of the lake.

Land tenure: The lake is Crown land, mainly with the status of Recreation Reserve, although there is also a small area of Government Purpose (Wildlife Management) Reserve. Surrounding areas are a mixture of Crown land (Wildlife Refuge) and freehold land, with some proposed reserves.

Conservation measures taken: The lake is partly included within a Recreation Reserve and a Government Purpose (Wildlife Management) Reserve which together total approximately 53.68 ha. All shoreline reserves and proposed reserves have been given the status of Wildlife Refuge; this covers approximately 354.68 ha, including the bed of the lake (as at 1981).

The lake has been zoned for recreation and wildlife protection. Some fencing has been carried out to protect the shoreline trees which provide a source of food and shade for fish, and stabilise the shoreline. Further trees will be planted for aesthetic reasons, and to provide a buffer strip on both banks to improve fisheries and protect wildlife.

Conservation measures proposed: Measures to maintain and improve the water quality of the lake and its value as wildlife habitat and for fisheries were proposed in the Lake Hayes Management Plan, which recognised the importance of the area to both wildlife and the wider community. The Management Plan indicated means of managing threats and disturbances at the wetland and in the surrounding catchment to achieve this purpose. Important aspects included control of grazing, fencing and reduction of eutrophication.

Land use: Tourism and recreation at the wetland; farming and grazing in surrounding areas.

Possible changes in land use: None known.

Disturbances and threats: The principal threat is increasing eutrophication as a result of fertilizer run-off and other nutrient enrichment from surrounding agricultural land.

Hydrological and biophysical values: The lake plays a role in supporting food chains.

Social and cultural values: The importance of tourism to New Zealand and the popularity of outdoor recreation have led to human invasion without major detrimental changes to the environment. The wildlife and natural environment have been identified as being highly valuable, and are therefore stringently protected.

Noteworthy fauna: Lake Hayes is important for a wide variety of waterfowl, including Great Crested Grebe *Podiceps cristatus australis*, Australasian Bittern *Botaurus poiciloptilus*, White-faced Heron *Egretta novaehollandiae*, Great Egret or White Heron *E. alba*, Black Swan *Cygnus atratus*, Paradise Shelduck *Tadorna variegata*, Grey Teal *Anas gracilis*, Mallard *A. platyrhynchos*, Grey Duck *A. superciliosa*, New Zealand Shoveler *A. rhynchotis variegata*, New Zealand Scaup *Aythya novaeseelandiae*, Marsh Crake *Porzana pusilla affinis*, Pukeko *Porphyrio porphyrio melanotus*, Common Coot *Fulica atra* and New Zealand Kingfisher

Halcyon sancta vagans. The Common Coot, a recent colonist in New Zealand, was first proved breeding at Lake Hayes and is now widespread and increasing.

The lake also supports an important recreational fishery producing numerous and large Brown Trout *Salmo trutta*. Perch *Perca fluviatilis* also live in the lake and provide a major portion of the anglers' catch. Native species of fish include Upland Bully *Gobiomorphus breviceps*, Koaro *Galaxias brevipinnis* and Long-finned Eel *Anguilla australis*.

Noteworthy flora: No plant species of particular note are known from the lake. The native vegetation has largely been replaced by a mixture of exotic species, although some native species are still present around much of the lake.

Scientific research and facilities: A management plan for Lake Hayes was prepared by the Department of Lands and Survey in 1982 (Anon, 1982).

Conservation education: No information.

Recreation and tourism: In a survey in 1980, Lake Hayes was ranked as the most popular recreational area of its type in the Lake Wakatipu environs. Recreational activities include swimming, fishing, power-boating and picnicking.

Management authority: The Department of Conservation (Otago Conservancy) is responsible for the management of Crown land and wildlife. The Otago Regional Council has statutory responsibilities for water resources under the Resource Management Act 1991. The Otago Fish and Game Council manages sport fishing (trout and salmon) and game-bird hunting.

Jurisdiction: Territorial: Otago Regional Council and Queenstown Lake District Council. Functional: Department of Conservation and Otago Fish and Game Council.

References: Anon (1982).

Reasons for inclusion:

- 2a Lake Hayes supports a breeding population of a globally threatened species, *Botaurus poiciloptilus*.
- 2c The lake is of special value as a breeding and/or moulting area for a variety of waterfowl, notably *Tadorna variegata*, *Anas superciliosa*, *A. rhynchotis*, *Porzana pusilla* and *Fulica atra*.
- 2d The lake supports a number of endemic species of birds, including *Tadorna variegata* and *Aythya novaeseelandiae*.

Source: J.M. Neilson and Pam Cromarty.
