NEW ZEALAND
MINISTRY OF AGRICULTURE AND FISHERIES

FISHERIES TECHNICAL REPORT NO. 144

FISHERIES SURVEY OF LAKE CHRISTABEL, WEST COAST ACCLIMATISATION DISTRICT, SOUTH ISLAND

W. S. JOHNSON, J. T. MACE AND A. S. TURNER

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FISHERIES MANAGEMENT DIVISION
MINISTRY OF AGRICULTURE & FISHERIES
CHRISTCHURCH

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ABSTRACT

Findings of a brief survey of Lake Christabel, West Coast, South Island, New Zealand, are described. Lake Christabel is a glacial lake (area 270 hectares, 647 metres above sea level) situated amidst dense native rain forest in mountainous country. Results of limnological and biological sampling are presented. These disclosed only native flora and fauna, i.e. exotic species such as salmonids were lacking. Although the lake has some potential for the development of a salmonid fishery, it was concluded that its greatest value is in its natural state and therefore no introductions of plants or animals should be made into it.

INTRODUCTION

In 1970 Lake Christabel was one of a number of lakes considered by the New Zealand Limnological Society for submission to the International Biological Programme Project Aqua, which concerns inland waters proposed for conservation (Luther and Rzoska 1971). The freshwater habitats were classified under Project Aqua criteria as:-

A. "Habitat in natural state or only slightly modified."

II "Sites which are important as used:

(a) for past or current research, or

(b) where extensive research is planned, or

(c) those regarded as of high potential research value."

Information listed for Lake Christabel included the comment that it was "one of the few lakes probably still in the natural state".

In 1971 the list of lakes, including Lake Christabel, was endorsed by the New Zealand Officials Committee on Eutrophication. Discussions regarding their status with the Department of Lands and Survey are continuing.

In 1974 the West Coast Acclimatisation Society requested the Fisheries Management Division to conduct a survey of Lake Christabel to determine its suitability for stocking with trout. This request followed an approach to the Society by the New Zealand Forest Service as the Waiheke State Forest, in which the lake is situated, may be developed as a Forest Park.

No record of trout liberations in the lake was found in the West Coast Society's records (West Coast Acclimatisation Society, pers. comm.) nor was there any evidence of trout having found their way into the lake from the Grey River system, which is noted for its angling from naturally reproducing stocks (Graynoth and Skrzynski 1974a). No previous fisheries survey of the lake is known to have been made.

LAKE CHRISTABEL - GENERAL DESCRIPTION

Lake Christabel is an oligotrophic lake of glacial origin, approximately 270 hectares in area and situated 647 metres above sea level (Luther and Rzoska 1971). It is located in the Waiheke State Forest, west of the Main Divide (Southern Alps) of the South Island at latitude 42^{o} 24' S, longitude 172^{o} 15' E (N.Z.M.S. 1 S46 topographical map) (Figure 1) in the headwaters of the Grey River system.

It is shaped roughly like a boomerang, one kilometre wide at its widest point and about 6 kilometres in length. The head of the lake is to the south-east and its outlet lies to the west. It is the source of the Blue Grey River, a tributary in the Grey River system (Figure 2).

The lake surrounds and catchment are steeply mountainous, with several peaks rising above 1,500 metres; the highest is an unnamed peak of 1,730 metres. Dense, virgin rain forest, typical of the West Coast bush, clothes the slopes up to the snowline at an altitude of approximately 1,200 metres and extends almost completely around the lake shoreline, virtually at water level (Plate 1). The catchment has an estimated area of 33 km^2 and an average annual precipitation of 2,500 - 3,000 mm.

ACCESS

There is no vehicle access to the lake. Access is by a marked walking track beginning at the Palmer Road Bridge over the Blue Grey River (map reference S46 : 556928). Palmer Road is an unsealed "no exit" road branching off State Highway 7 about 4 kilometres west of Springs Junction. The walking track follows up the north bank of the Blue Grey River, through heavy native bush, climbing over 300 metres to reach the lake. The track continues around the north and eastern side of the lake (Plate 1) through bush high on the mountain sides, until some 20 minutes walk beyond the head of the lake, it arrives at a New Zealand Forest Service six-man hut.

The travelling time for a competent tramper carrying a pack is estimated to be five hours from Palmer Road to the Forest Service Hut.

THE SURVEY

OBJECT

The object of the survey was to determine the suitability of the lake for the establishment of a recreational trout fishery.

ORGANISATION

A four man team comprised of three officers of the Fisheries Management Division, Ministry of Agriculture and Fisheries, and an officer of the Wildlife Service, Department of Internal Affairs, attached as field officer to the West Coast Acclimatisation Society, surveyed the lake between June 10 and 14 1974.

Figure 1. LOCATION MAP

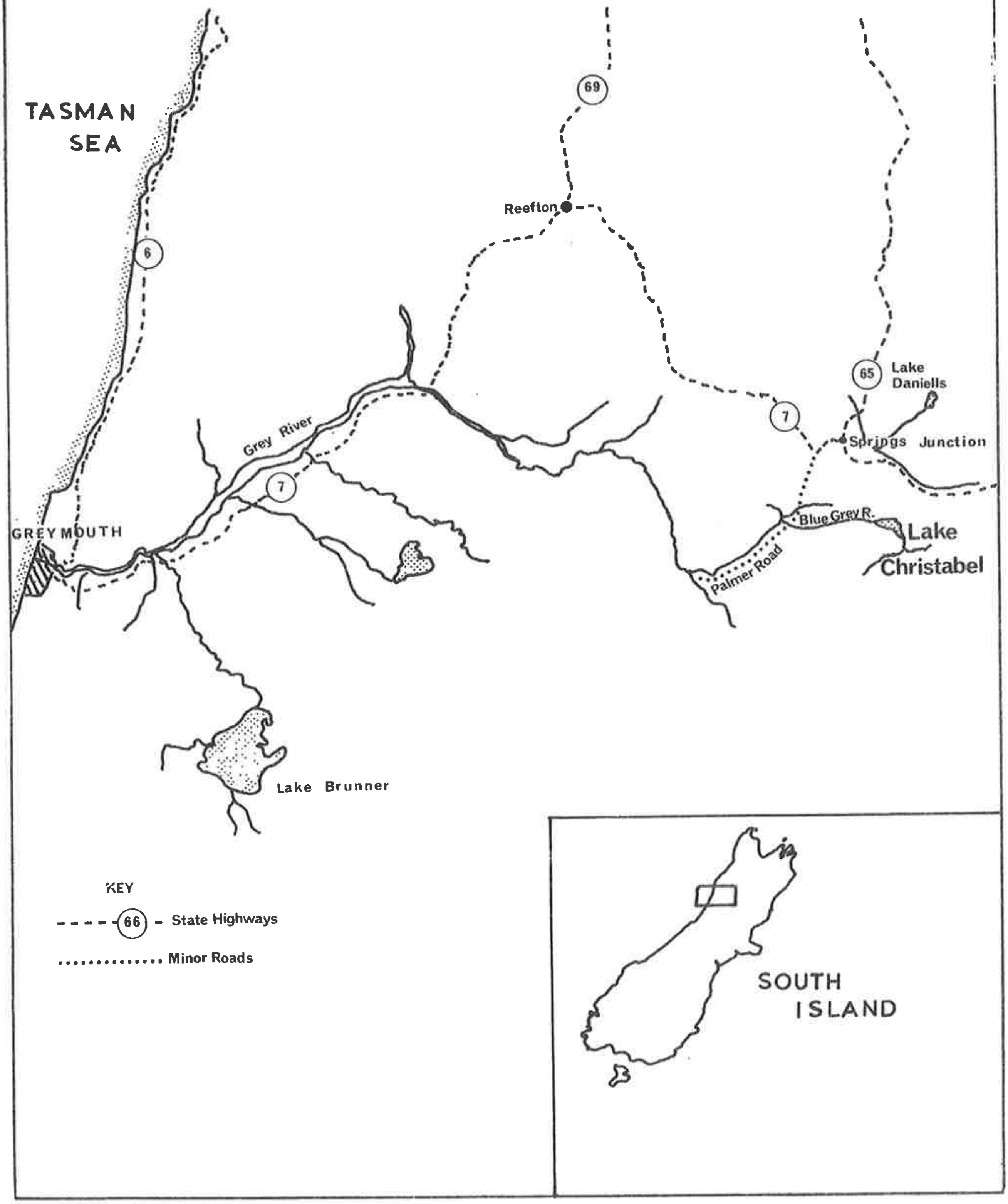
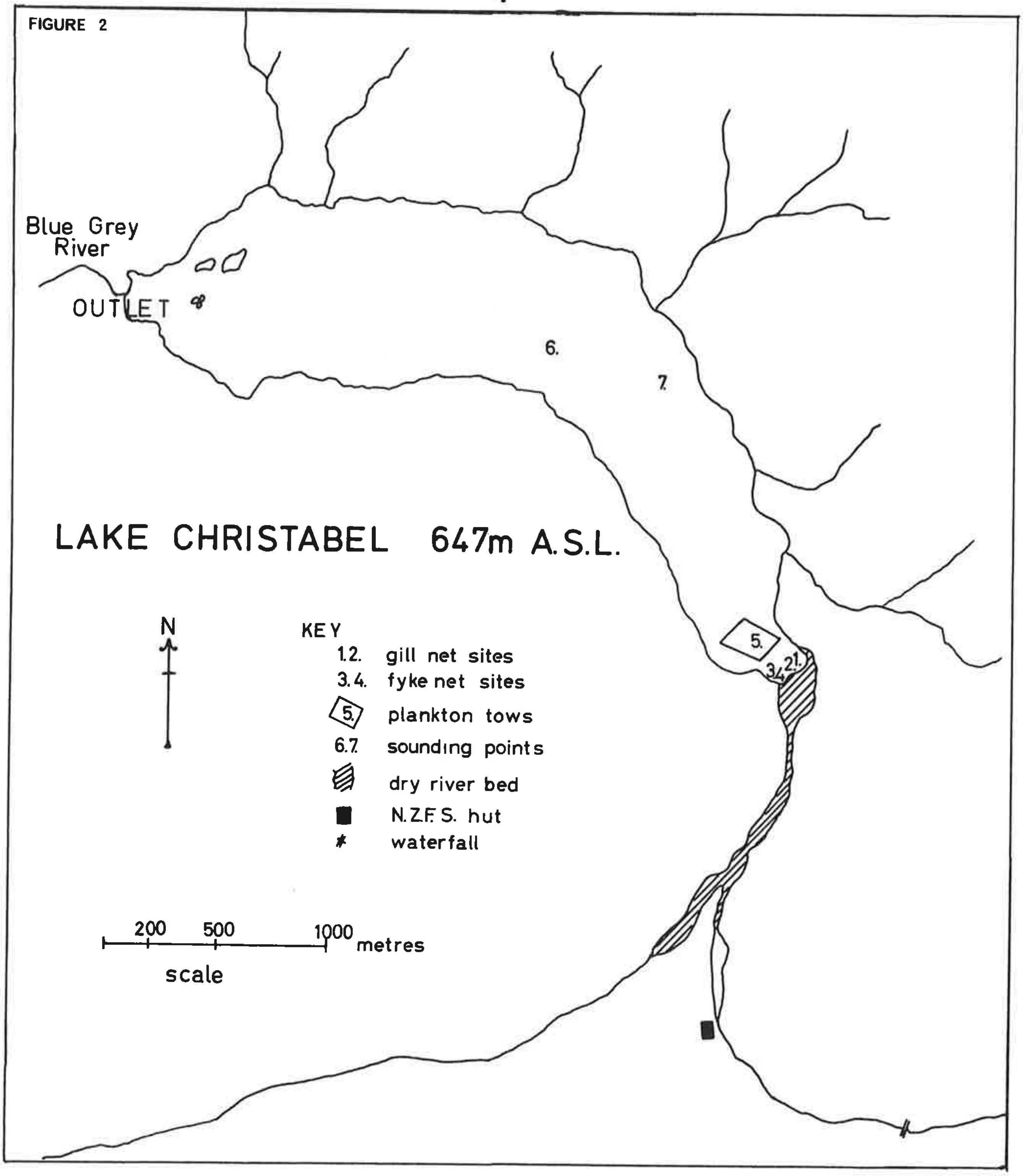


FIGURE 2


Blue Grey
River
OUTLET
6.
7.
5.
3.4.
2.1.
LAKE CHRISTABEL 647m A.S.L.
N
KEY
1.2. gill net sites
3.4. fyke net sites
5. plankton tows
6.7. sounding points
dry river bed
N.Z.F.S. hut
waterfall
200
500
1000
metres
scale

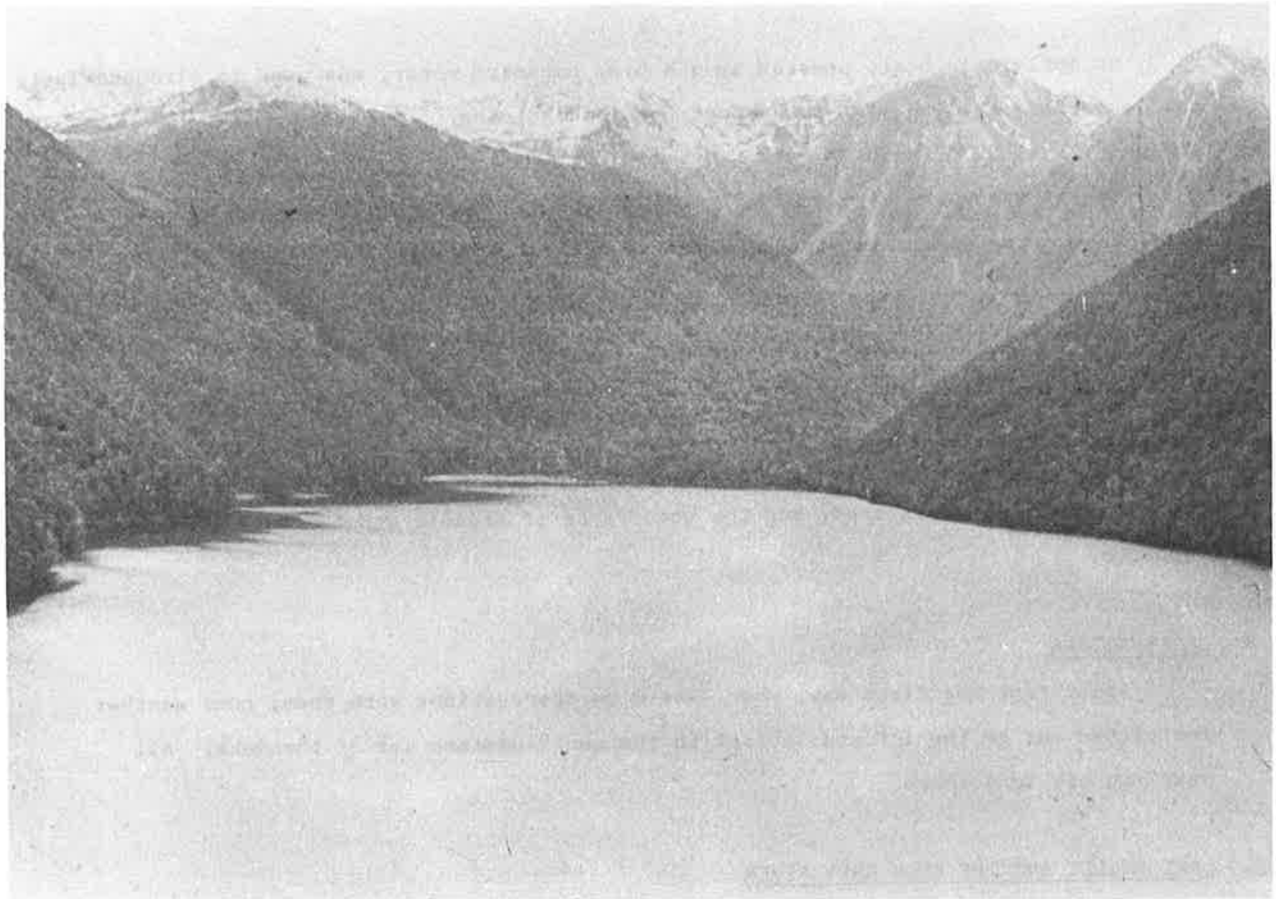


Plate 1: View of South eastern end (head) of lake showing small beach where tributary stream enters (centre left) and steep catchment. Bush clothes the slopes almost to the water's edge. The access track is through the bush on the left centre of the picture. The N.Z.F.S. hut is about 1.5 km up the valley on centre right.

The survey party and field equipment were flown into and out of Lake Christabel from the Palmer Road Bridge by helicopter. A base camp was set up in the New Zealand Forest Service hut at the head of the lake.

General observations were made from the air using the helicopter on the inward and outward journeys.

An inflatable boat, powered by a 4 h.p. outboard motor, was used to circumnavigate the lake, for sampling, and as support for scuba diving.

Two of the party were trained scuba divers and used this technique to observe fish, to examine underwater features and to collect biological samples.

Water samples and aquatic flora and fauna were collected, by methods described later, for laboratory analysis and identification.

Areas suitable for trout spawning and angling were noted, access for fish into, and out of the lake examined, and the occurrence of aquatic and terrestrial birds recorded.

OBSERVATIONS

Apart from the first day, when lake-wide observations were made, poor weather restricted use of the inflatable boat to the south-eastern end of the lake. All sampling was done there.

LAKE OUTLET AND THE BLUE GREY RIVER

The outflow from the lake was estimated to be of the order of 1.2 to 1.5 cumecs. This flowed in a defined channel for about 50 metres, after which the water disappeared underground into a bush-covered area of loosely formed, rocky, glacial moraine and/or landslide debris, forming a barrier across the valley floor (Plate 2).

Floatable debris lodged in the vegetation around the lake outlet indicated that the lake level had reached a level from 0.5 to 1.0 metre higher than that observed at the time of the survey. It would require a considerably higher lake level than this to cause a surface outflow from the lake.

The Blue Grey River emerges about 200 metres lower down the valley, at the base of the barrier, seeping and spurting from the crevices of the rocks and boulders, after its underground passage from the lake. As the river emerges from its underground outlets, it develops into a torrent, cascading and tumbling steeply down the narrow, rocky bush-covered valley.

Plate 2: Western end of lake showing outlet stream entering bush covered rubble blockage (centre). The stream reappears approximately 200 metres further down the valley, to top right of picture.

LAKE TRIBUTARIES

Numerous small streams drain through the bush into the lake from the steep mountain gullies. These are in rough, unstable channels and have highly variable flows. They are of no consequence as possible trout habitats.

There is only one tributary of significance, the unnamed tributary entering the lake at its head, or south-eastern end (Figure 2). It comprises two streams (Plates 3 and 4), draining mountain valleys to the east and west, which combine about one kilometre before reaching the lake.

However, at the time of the survey, about 500 metres before the streams joined, their flows, estimated at from 0.3 to 0.4 cumecs for one, and from 0.4 to 0.6 cumecs for the other, seeped away into the alluvial substrate of their beds. From these points the unnamed tributary displayed a dry, gravel floodbed all the way to the lake (Plates 5, 6 and 7).

Observations by the divers established the tributary discharged into the lake, after travelling underground through the alluvium, as springs upwelling from the silt-covered gravel shelf, 10 to 15 metres out into the lake (Plate 1).

From the width of the tributary's floodbed (about 200 metres at the lake edge) (Plate 7), the lack of rooted vegetation on the gravels and other evidence, it was clear that it is also subject to violent, damaging high flood discharges, as well as periods of disappearing surface flow.

LAKE WATER QUALITY

Two water samples were collected, one from the lake surface, the other from 20 metres depth. These were kept chilled until delivered for analysis to the Government Analyst in Christchurch.

The results of the analyses are given below:-

Depth	Surface	20 m
Date	13.6.74	
pH	7.2	7.1
	Grams per cubic metre	
Nitrate nitrogen	$<$ 0.05	0.05
Nitrite nitrogen	$<$ 0.001	$<$ 0.001
Ammoniacal nitrogen	$<$ 0.005	$<$ 0.005
Albuminoid nitrogen	$<$ 0.005	$<$ 0.005
Total organic nitrogen	0.05	0.18
Total organic nitrogen (filtered)	-	-
Oxygen absorbed 30 min. at 100°C	1.1	0.7
Sodium (Na)	1.6	2.0

	Grams per cubic metre	
Bicarbonate alkalinity (as NCO_3)	24	26
Hardness total (EDTA) (as $CaCO_3$)	24	21
Hardness due to calcium (as Ca)	8	8
Hardness due to magnesium (as Mg)	<1	0.5
Free carbon dioxide (Calc.)	3	3
Total solids	45	40
Total suspended solids	-	-
Chloride (as Cl)	1	<1
Sulphate (as SO_4)	3	-
Iron, total (as Fe)	0.04	0.08
Reactive silica (as SiO_2)	4	4
Manganese (as Mn)	<0.1	<0.1
Total phosphorus (as P)	0.004	0.002
Reactive phosphorus (as P)	0.002	<0.002
Potassium (K)	0.18	0.18

(For methods of analysis refer to the Government Analyst)

These results are characteristic of an oligotrophic (slightly mesotrophic), glacial, mountain lake. Total nitrogen values are as expected for a lake surrounded by bush.

<u>WATER CLARITY</u>

The lake water was slightly brown in colour, probably from humic discolouration. This is characteristic of many West Coast lakes; Lakes Brunner and Kaniere are well-known examples.

A Secchi disc had an extinction depth of 10 metres. This is about the middle value for a range of 22 New Zealand lakes examined by Irwin (1974), but would rank seventh equally of 10 lakes associated with glaciation listed in his paper. Irwin concluded that "glacial lakes with lower water clarity values are affected by glacial silt or humic colouration". He lists the causes of turbidity as:

1. Particulate matter
   (a) living organisms, particularly phytoplankton
   (b) dead organic material
   (c) particulate inorganic matter, e.g. sulphur, glacial rock flour.

2. Dissolved matter, e.g. humic material leached from surrounding bush areas.

The survey divers estimated underwater visibility as between 10 and 15 metres.

Plate 3: Tributary Stream near N.Z. Forest Service hut. View downstream towards lake (1.5 km).

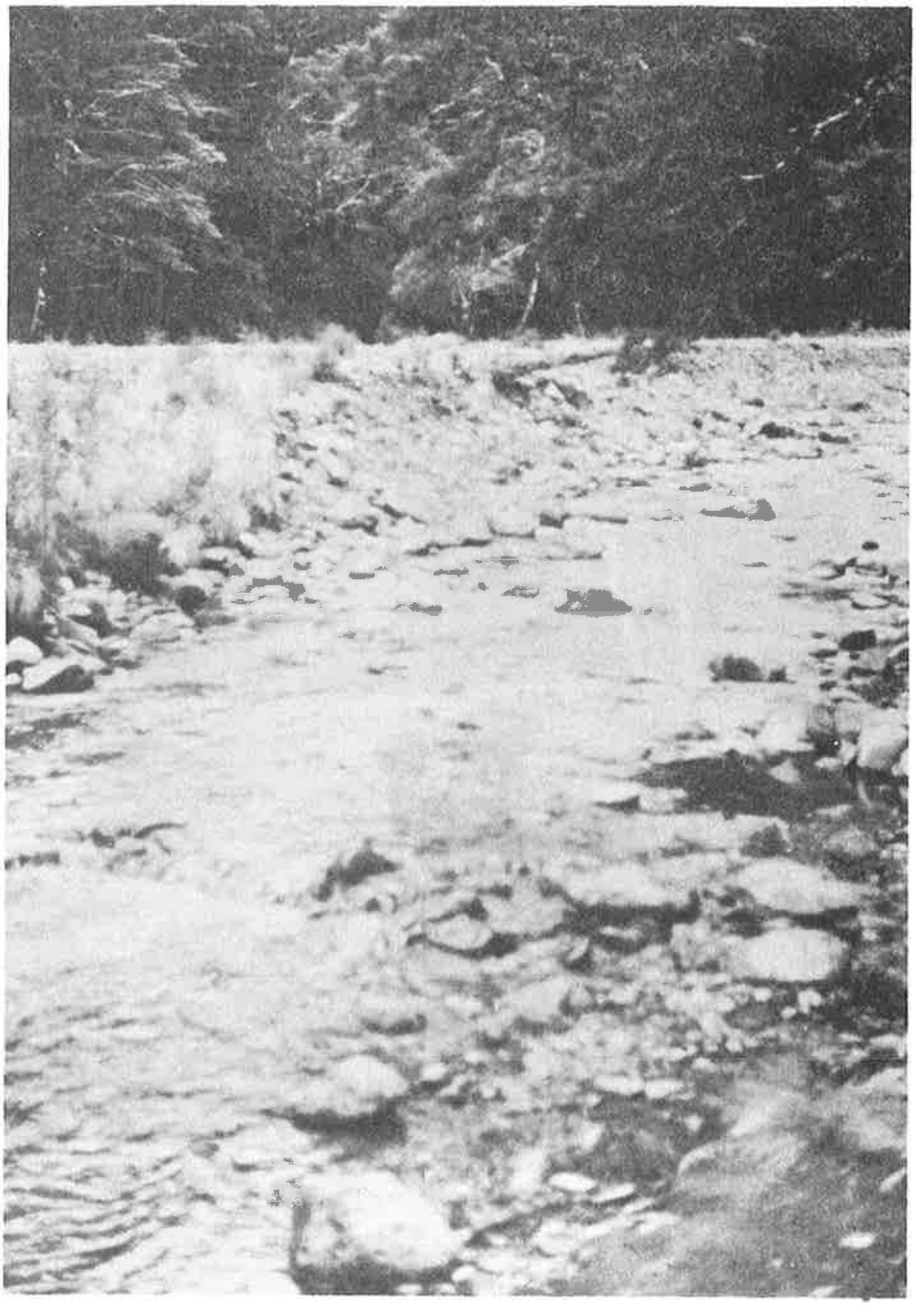


Plate 4: Another view showing area where galaxiids were caught at night.

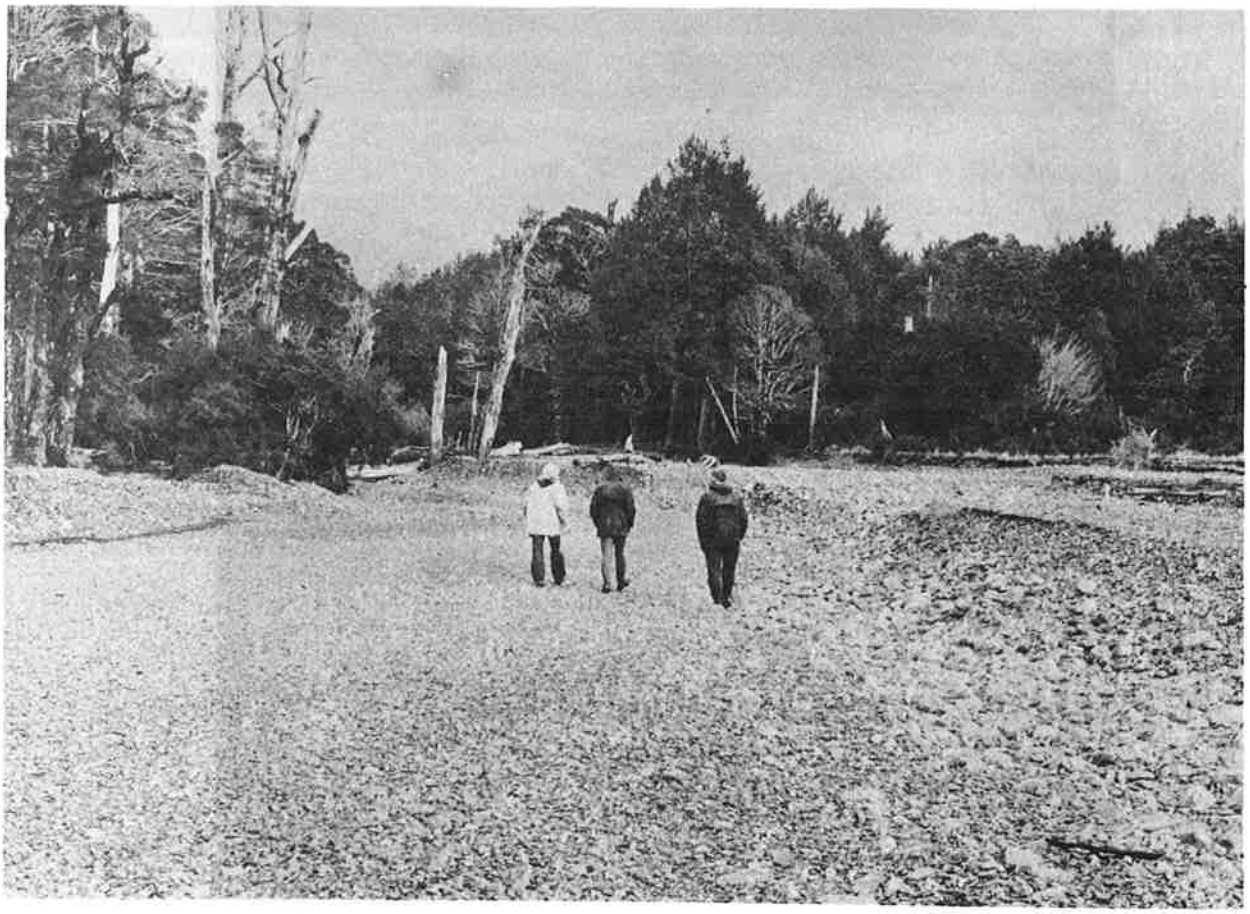


Plate 5: Upstream view below confluence of tributary streams showing dry stream bed and flood channel.

Plate 6: View down flood channel showing coarse gravel structure.

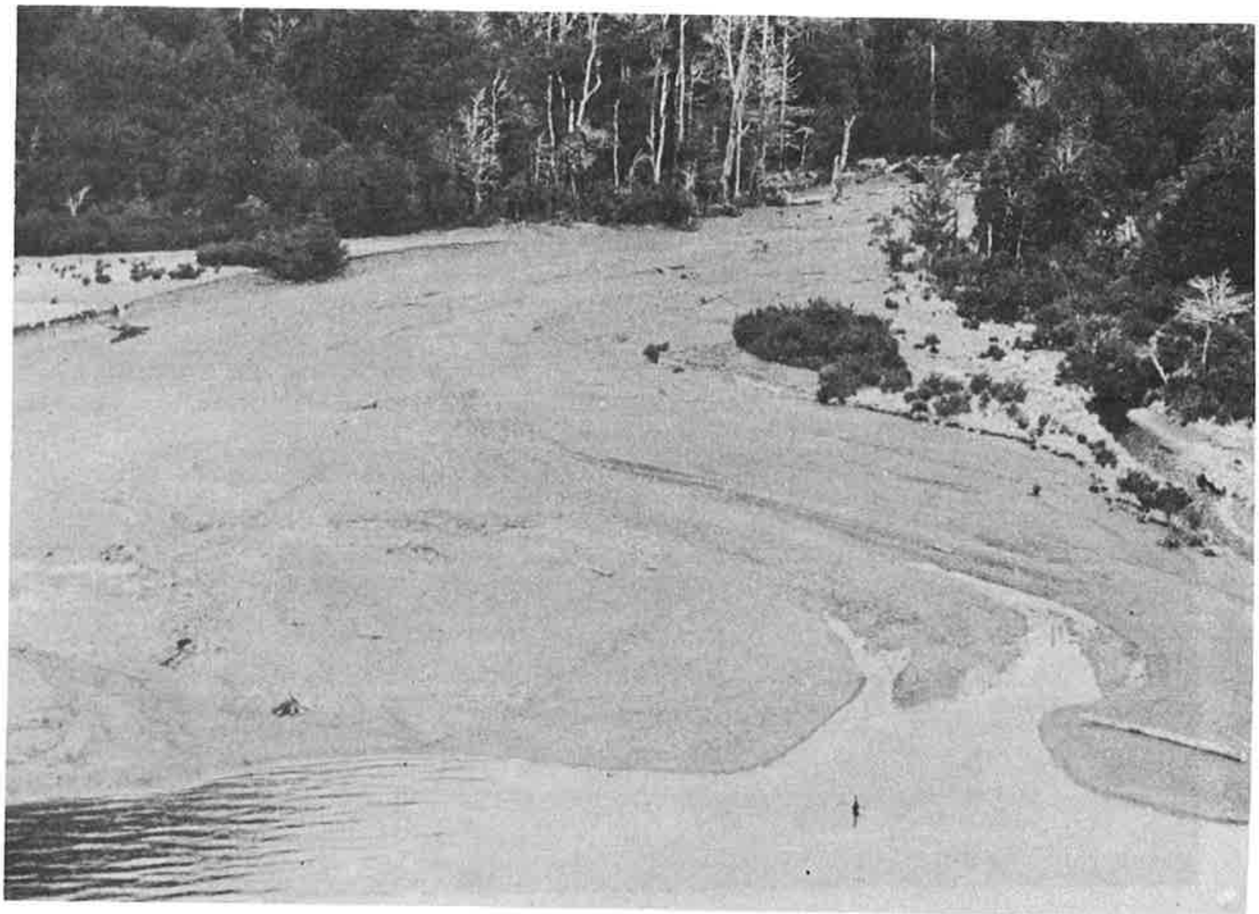


Plate 7: Aerial view of main inlet stream showing dry bed and flood plain. Shingle beach, one of the few areas suitable for angling, dropping off quickly to deep water with subsurface springs in the bottom foreground.

WATER TEMPERATURES

Water temperature was measured at the surface, and at a depth of 10 metres by divers, using a mercury thermometer.

The results were as below:

Date - 13 June 1974.

Location	Air Temperature	Water Temperature
Lake surface	3.4°C	6.0°C
10 metres depth		6.0°C
stream at N.Z.F.S hut	3.5°C	3.0°C

BATHYMETRY

Weather conditions restricted the use of the boat and limitations on the equipment available precluded any other than an estimation of the shape of the lake bed. From the steep nature of the mountainsides plunging directly into the water, with little or no apparent beach, it was considered that the basin was also steep-sided and probably of considerable depth. Hand-line soundings (positions marked on Figure 2) gave a water depth of 90 metres. This position is unlikely to be the deepest part of the lake bed. Diver observations also confirmed the abrupt underwater contour of the lake shore.

At the head of the lake there was no gradual shelving of the gravel beach formed by the tributary; this also plunged steeply down into the lake. Shallower areas occurred near the lake outlet rising to a small, rocky, bush-covered island some 100 metres off-shore.

BIOLOGICAL SAMPLING

Plankton

Horizontal plankton tows were made using a 12.5 cm diameter, No. 20 mesh, plankton net. Two tows were made on 12 and 13 June; these were at 5 - 10 metres depth at a towing speed of approximately one knot, in the area marked in Figure 2.

Zooplankton present were (in decreasing order of abundance):

Bosmina meridionalis (Cladocera)
Asplanchna priodonta (Rotifera)
and immature cyclopoid copepods.

The main, larger phytoplankton appeared to belong to the genera *Melosira*, *Asterionella* and *Sphaerocystis*.

The sample on 12 June contained more detritus, but fewer rotifers.

Rooted Aquatic Vegetation

Weed beds at the south-eastern end of the lake were observed by the divers and samples were collected for identification. Plant species present were:

Potamogeton cheesmanii
Myriophyllum sp.
Nitella sp. (Charophyte)

Myriophyllum was the dominant plant, occurring in a band from three metres depth to five metres. Isolated *Potamogeton* were scattered through these beds.

Large weed beds were seen at the shallow, western end of the lake. These appeared to consist of *Potamogeton* and *Myriophyllum*.

FAUNA ASSOCIATED WITH THE WEED BEDS

Mollusca

- Gastropoda
  - *Potamopyrgus antipoderium*
  - *Physastra variabilis*
  - *Lymnaea tomentosa*
- Bivalvia
  - *Sphaerium novaezelandiae*

Insecta

- Odonata
  - *Xanthocnemis zealandica*
  - *Procordulia grayi*
- Trichoptera
  - *Triplectides cephalotes* larvae
  - Stony larval cases (all empty, probably Leptoceridae)
- Hemiptera
  - *Sigara arguta*
  - *Diaprepocoris novae-zealandiae*

Diptera

Chironomus (? *zealandicus*) larvae

Tanypodinae sp. larvae (Chironomidae)

Arachnida

Acarina

Arrenurus sp.

The water boatman, *Sigara arguta*, was especially common above the weed beds.

FISH SPECIES

In Stream Adjacent to New Zealand Forest Service Hut

Galaxias brevipinnis were caught by dip net at night, with the aid of a Tilley kerosene lantern, and electric torches (Plate 8). They ranged in length from 70 mm to 180 mm as listed below:

Length (mm)	Sex	Condition of Gonads
179	female	gravid
162	female	gravid
156	male	mature
112	female	gravid
102	male	maturing
100	female	not mature
74	male	not mature
Others 70-80	both	immature

These fish are considered to be resident and normally spawn in the autumn (McDowall 1970). Many, especially the smaller specimens, were infested with parasites (Plate 9, see also Appendix I).

No other fish species were seen or caught in this stream.

In the Lake

The following methods were used in an attempt to sample the fish populations in the lake:

Two monofilament gill nets (60 metres in length and with 5.0 cm and 6.5 cm mesh respectively) were set at the south-eastern end. These were set at right angles to the shore and checked daily during the period 11 to 13 June. No fish were caught in these nets (Plate 10).

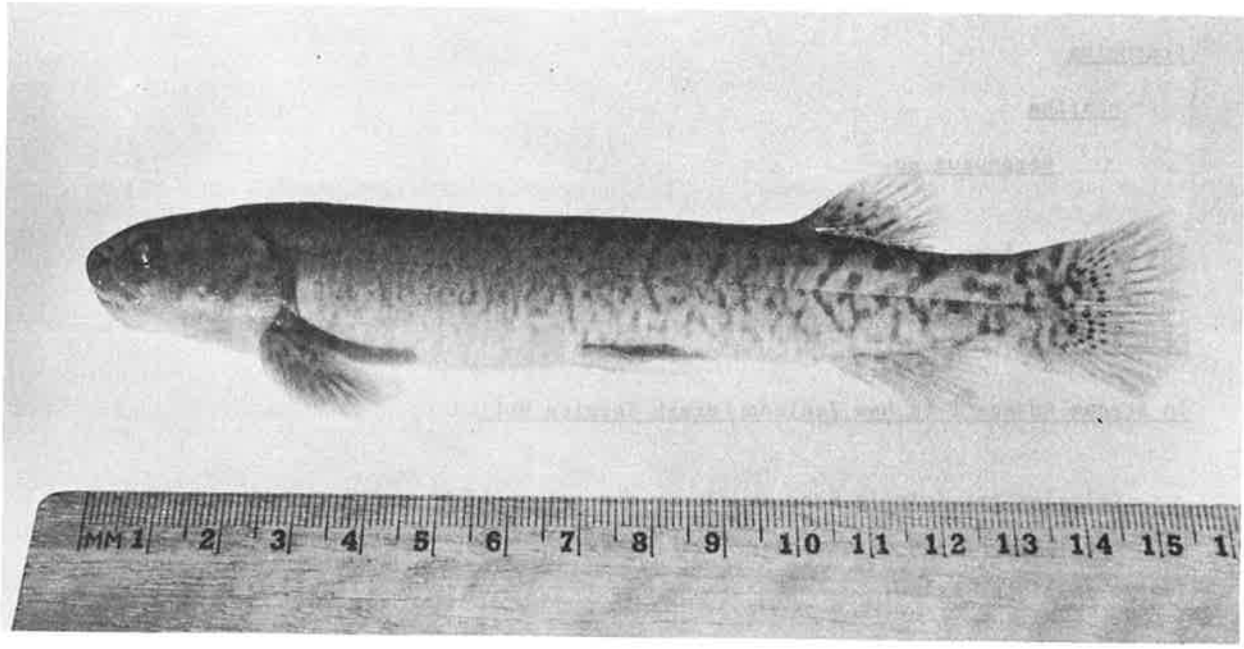


Plate 8: Galaxias brevipinnis from inlet stream near hut.

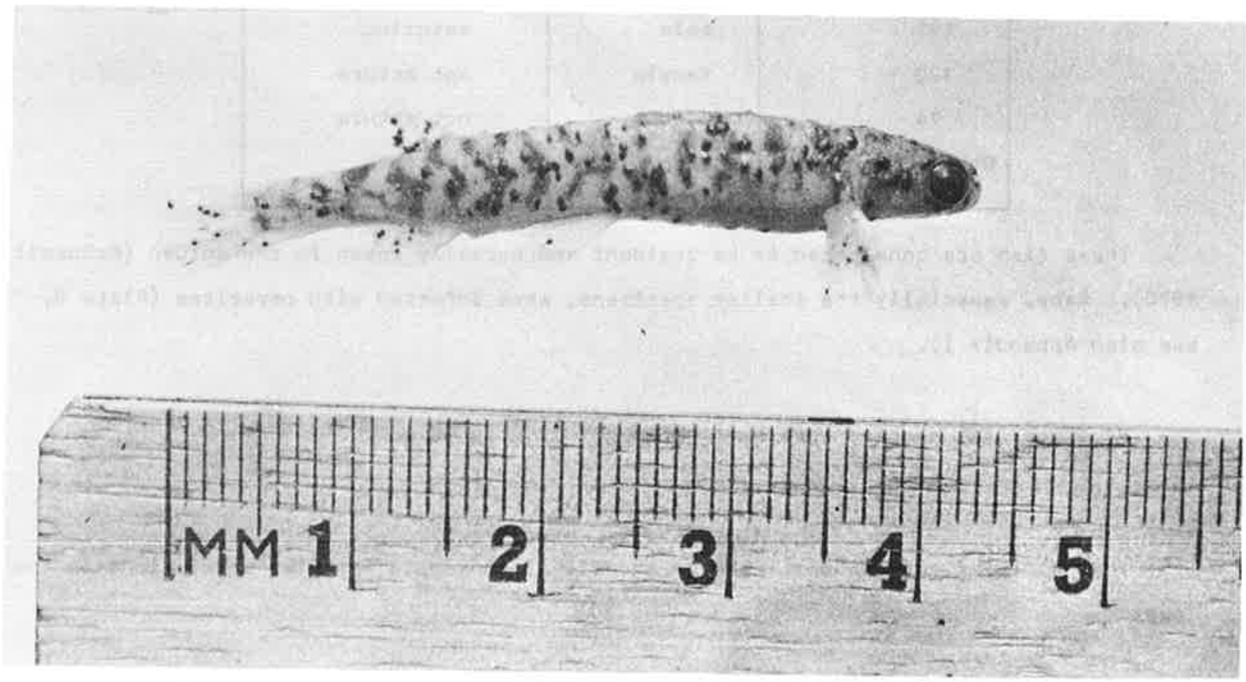


Plate 9: Galaxias brevipinnis from stream showing parasitic infestation.

Plate 10: Gill net site 1.

Two fyke nets (1.5 cm mesh) were also set at the same end and for the same period as the gill nets (Plate 11). One eel was caught in each net on the first night, and one eel in one net on the second. All were long-finned eels (Anguilla dieffenbachii). Their particulars are as follows:

Sex	Length	Weight	Age*	Stomach Contents
Female	88.0 cm	2.25 kg	30+ years	7 galaxiids 1 weta
Female	64.5 cm	0.75 kg	30+ years	2 galaxiids 2 insects
Female	88.9 cm	2.60 kg	30+ years	1 galaxiid 1 insect

*Aged from otoliths.

One eel was also seen by the divers at 10 metres depth.

Dip nets caught several immature Galaxias brevipinnis, which were widespread and abundant throughout the lake (Plate 12), particularly near the surface in the shallow areas and close to the shore. Divers also noted these fish at 10 metres depth.

Small plastic minnow traps, baited with bread, caught two immature galaxiids along the lake edge.

BIRDS

Aquatic

The following aquatic bird species were recorded at the lake during the survey:

Grey duck	Anas superciliosa	2
Scaup	Aythya novaeseelandiae	11
Black shag	Phalacrocorax carbo	5
Kingfisher	Halcyon sancta	3
White-faced heron	Ardea novaehollandiae	2

Black shags appear to roost on rocky reefs at the western end of the lake. An examination of faeces showed no sign of fish remains.

A flock of six scaup were seen at the south-eastern end of the lake on the mornings of 12, 13 and 14 June.

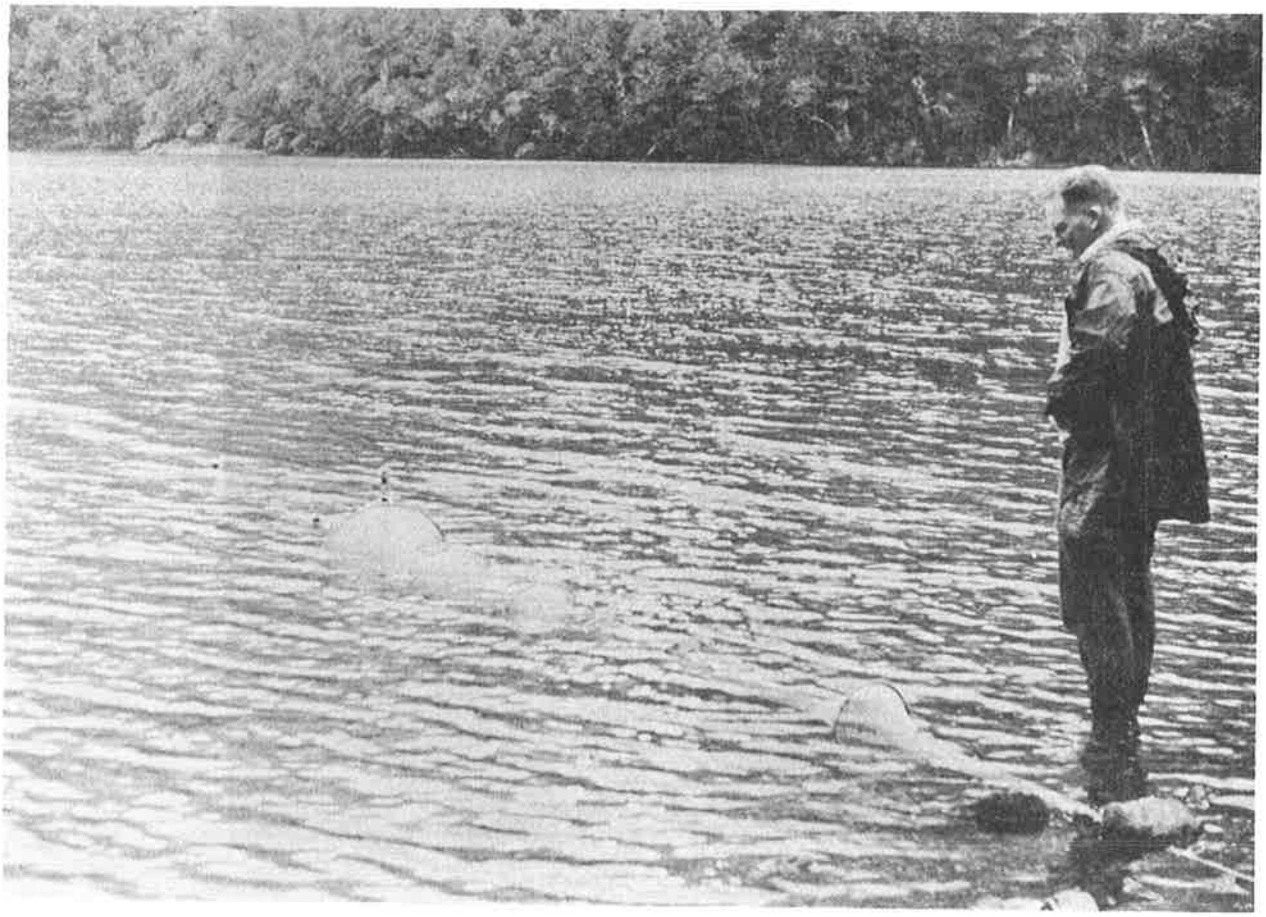


Plate 11: Fyke net site 4.

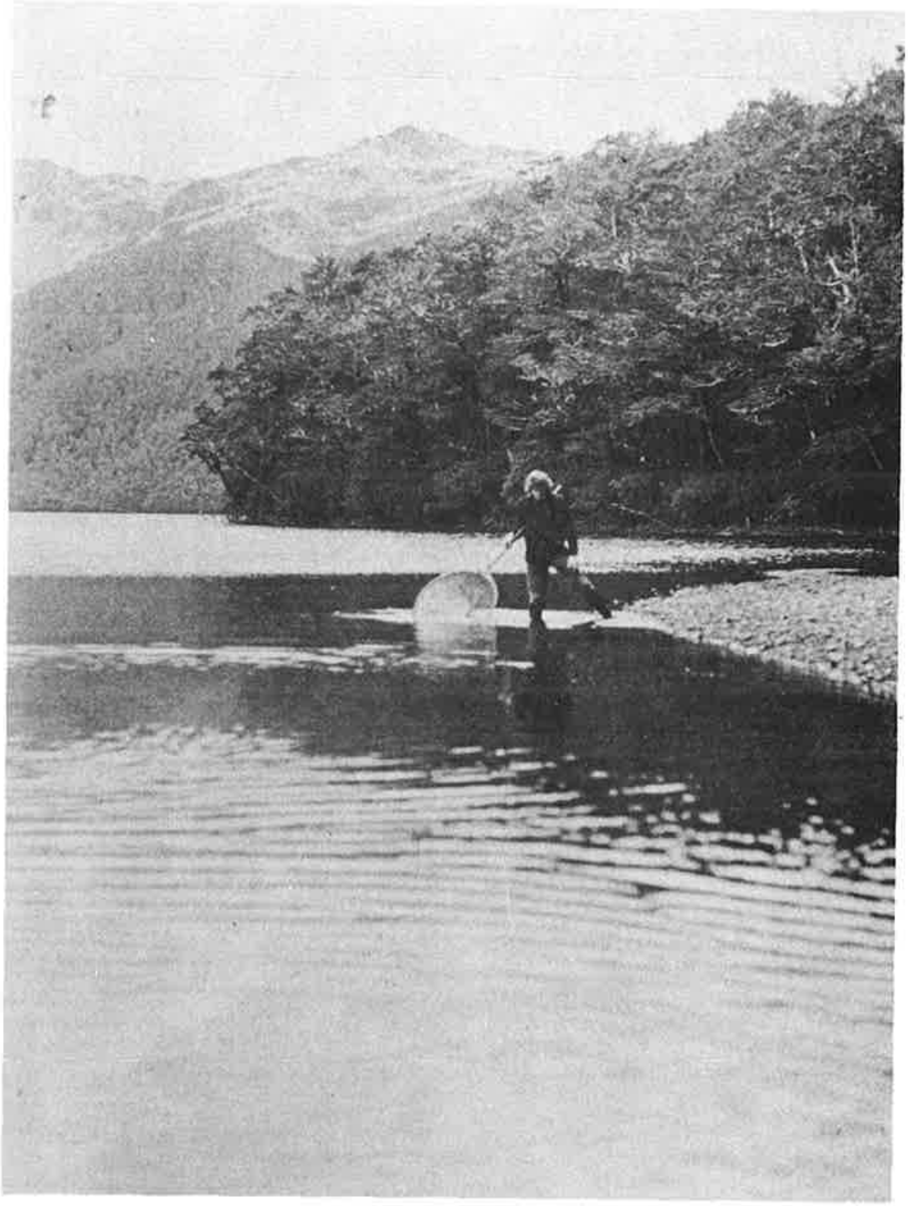


Plate 12: Netting for small fish in lake.

Terrestrial

The following species were observed:

Bellbird	Anthornis melanura
Tomtit	Petroica macrocephala
Fantail - both black and pied forms	Rhipidura fuliginosa
Robin	Petroica australis
Rifleman	Acanthisitta chloris

SURVEY CONCLUSIONS

The observations made, and the evidence reported above, although restricted by weather and by equipment limitations, support the generally-held belief of people familiar with the lake, that trout have not gained access to it, and the only fish present are native fishes. The reason for this is the strong probability that the subterranean outlet through the debris barrier has prevented trout present in the Blue Grey River from penetrating into the lake.

Galaxias brevipinnis, from the presence of both juveniles and adults, evidently is a self-perpetuating stock. G. brevipinnis is probably the most widespread galaxiid in New Zealand, occurring as both diadromous stream populations and lacustrine populations; severaly completely land-locked stocks are known and are believed to post-date the last Pleistocene glaciation (McDowall 1970). They are noted for their exceptional climbing ability.

The freshwater eels, in this case the long-finned species, are well-known to have the ability, in their juvenile migratory stage as elvers, to climb waterfalls, hydro dam spillways, and to penetrate through cracks and crevices, where the surface is damp and/or mossy and not subject to strong, direct water flows (Hardy 1950). Their presence in the lake indicates that some, at least, were able to negotiate the subterranean water paths of the outlet barrier. The age of the few specimens examined, suggeststhat the outward migration of maturing eels might not be possible.

SUITABILITY OF THE LAKE FOR A TROUT FISHERY

Lake Christabel appears, with respect to water quality and available food organisms, to be suitable for trout.

However, maintenance of a trout population would most probably depend on regular stocking, since the areas suitable for spawning seem quite limited. The outlet stream (approximately 50 metres of flowing water) does have patches of gravel where some spawning could take place. The numerous small streams in the mountain gullies are too steep and unstable, and lake-edge gravel (sometimes used by trout for spawning if there is sufficient intergravel water movement generated by wind action) is restricted to a few patches around the western (outlet) end.

Some suitable spawning gravel is present in the two streams forming the main tributary at the south-eastern end, but the intermittent nature of a continuous flow into the lake, the clear evidence of violent, damaging floods, and general instability of the bed, suggest serious problems of access for spawners and juveniles. The survival of eggs deposited in redds and of fry and fingerlings developing in the streams would be poor.

Rainbow trout (*Salmo gairdneri*) and brown trout (*Salmo trutta*) are readily available in New Zealand and mostly used for stocking waters and it is likely that a population of either could be maintained in the lake. However, the brook trout (*Salvelinus fontinalis*) which uses upwelling seepage or spring water areas for spawning, or the mackinaw, or lake trout (*Salvelinus namaycush*) which spawns in deep water on rockly ledges or reefs, could also be considered for this lake. Unfortunately, either species, though present in New Zealand, is not readily available for propagation and subsequent stocking.

Assuming a salmonid species were to be introduced into the lake, the question which must be answered is, would it be worth it, either from the point of view of the recreational angling it would provide, or through a possible change in the values inherent in the lake as it presently exists?

In our view the benefits to be derived from a trout fishery in Lake Christabel are negligible. The lake is accessible only to the individuals prepared to undertake the strenuous five hour walk into it, and such persons are more likely to have their primary interest in tramping, mountaineering, or game animal hunting. More affluent people might gain access by helicopter, floatplane or amphibian aircraft. The prospective fishery would need some particular attraction in its fish or in its very remoteness. It is hard to conceive that this kind of utilisation would become significant in the foreseeable future. It is possible that a vehicle track might reach to, or near the lake, and this would make it more accessible to the public at large, but to our knowledge this is not contemplated.

An angler, fishing from the shore, would find only a small number of places where he could even reach the water's edge; the lake edges are so steep, rocky, log-strewn and bush-clad (Plate 13) that, except for the small shingle beaches at the head of the lake, and where some side streams enter the lake, access is extremely difficult, if not impossible. Considering the likely usage of a trout fishery in Lake Christabel, regular maintenance stocking would not be warranted on the grounds of cost in terms of angling return.

Despite the physical handicaps of the area, if no other recreational fishing was available in the region, an effort to establish trout in Lake Christabel could be

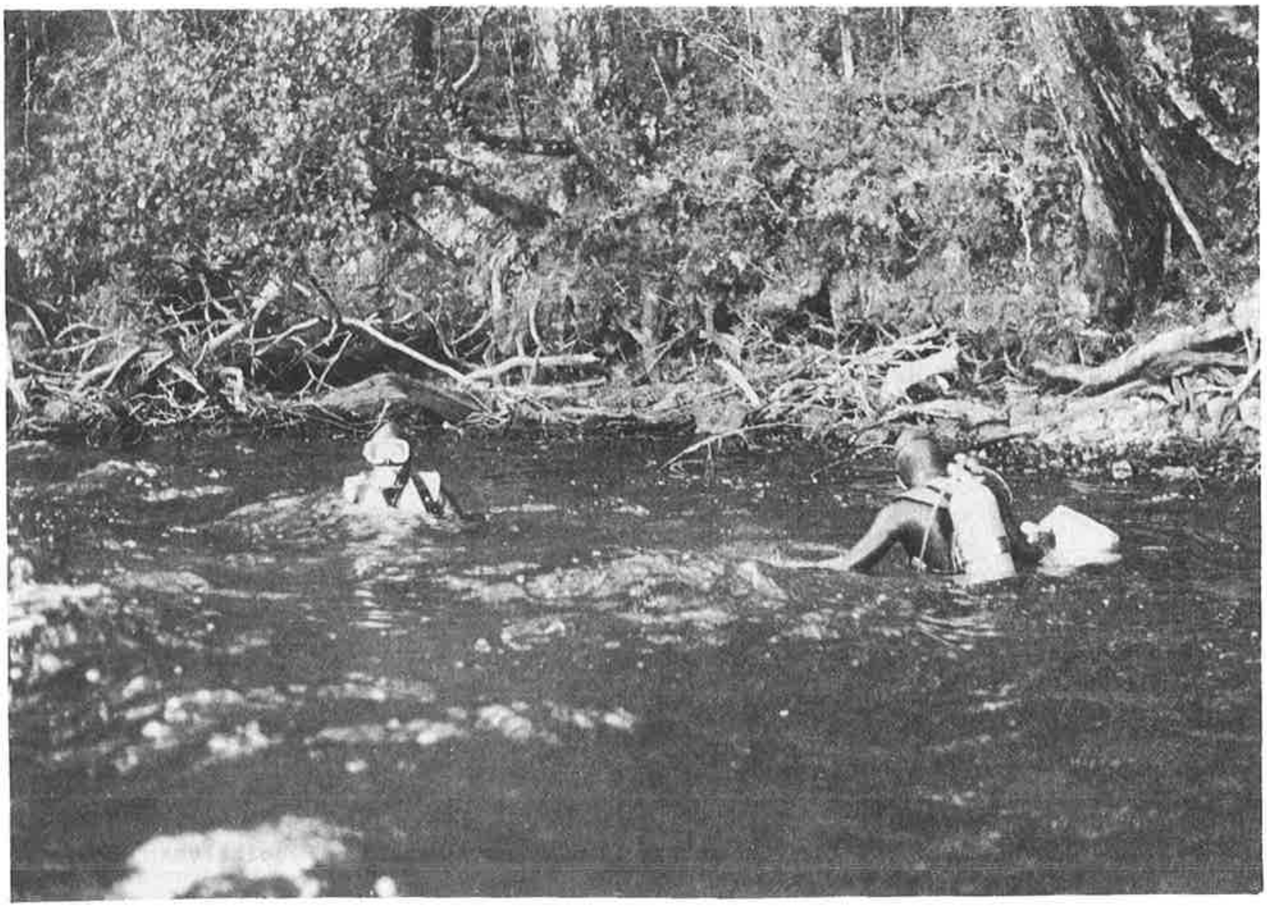


Plate 13: View of log strewn lake edge showing its unsuitability for angling.

considered. However, the upper Grey River system, of which it is a part, is accessible and noted as a good fishery. An alternative lake fishery of excellent quality is available in Lake Daniells, some 11 to 12 kilometres to the north, and this is accessible, at least part way, by four-wheel drive vehicles, and an easier walking track (Graynoth and Skrzynski 1974a,b).

Lake Christabel is one of the very few lakes in New Zealand in a natural, unmodified state, which does not already contain one, or other, species of the introduced salmonid fishes and other introduced animals or plants. We feel that this is a fortunate occurrence which should be preserved in the public interest. Therefore, we believe that, should our conclusion that the lake contains only native fish species be correct, Lake Christabel should not be stocked with trout, or any other species, but should be preserved and protected by legislation for its scientific value:

(a) an an inland water in a natural, unmodified state; and

(b) as a reference, study water for future comparison against other waters of its type affected by human activities and exotic introductions.

CONCLUSIONS

1. Lake Christabel should not be stocked with trout or any other species of fish, or any other organisms, whether native or exotic.

2. Action should be initiated to have Lake Christabel declared a Faunistic Reserve, as provided for in Regulation 98 of the Freshwater Fisheries Regulations 1951.

APPENDIX I

EXAMINATION OF *GALAXIAS BREVIPINNIS* FROM LAKE CHRISTABEL FOR DISEASE

Dr P.M. Hine examined the specimens of *Galaxias brevipinnis* and found the following:

1. The black spots on the body are due to melanisation around degenerating trematode metacercariae encysted just below the skin. Because of the degeneration it is impossible to accurately identify the trematode but it is probably a species that occurs as the adult fluke in birds. These metacercariae are locally common in *G. brevipinnis* in various parts of the country; especially in Lake Rotopounamu, a bush lake in the central North Island.

2. Other parasites present are:

   (a) Gyrodactylid monogenean flukes ectoparasitic on the scales and fin bases.

   (b) Myxosporidian protozoans of the genus *Myxobolus* or *Myxosoma* (not *M. cerebralis*) in cysts in the musculature. The distinction between the genera is based on the affinity for iodine of a minute (0.5 um) vacuole within the spores. No matter which genus it is, this is almost certainly a new species.

   (c) Metacercariae of *Stegodexamene anguillae* encysted in the liver. This species is common throughout New Zealand, the adult flukes occur in eels (except in Lake Taupo where they can complete their life-cycle without going through eels).

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