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Fisheries Environmental Report No. 38

Residual flows in the upper Ohau River

Fisheries Research Division
Ministry of Agriculture and Fisheries
Twizel

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Residual flows in the upper Ohau River

by

G. J. T. Trought

Report to: New Zealand Electricity Division

Ministry of Energy

Fisheries Research Division

N.Z. Ministry of Agriculture and Fisheries

Twizel

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FISHERIES ENVIRONMENTAL REPORTS

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CONTENTS

		Page
1.	Introduction	5
2.	Methods and results	9
	2.1 Trout spawning surveys	9
	2.2 Fry trapping	9
	2.3 Electric fishing	11
	2.3.1 Wairepo Creek	18
	2.3.2 Wildlife area	18
	2.3.3 Ohau River	18
	2.4 Drift diving	21
3.	Discussion	22
	3.1 Fish recruitment	22
	3.2 Effectiveness of the fish pass	22
4.	Conclusions	25
5.	Future studies	26
6.	Acknowledgments	27
7.	Literature cited	27

TABLES

1.	Results of electric fishing on 1 September 1983	18
2.	Results of electric fishing on 9 November 1983	19

FIGURES

1.	Upper Waitaki catchment, showing the location of control structures and dams.	6

Page

2. Ohau River and canal system, showing the location of electric fishing sites. 7

3. Fry trap used on the Ohau River, 8 October-21 November 1983. 10

4. Fry trap in operation during a flood. 10

5. Record of spills over the Ohau weir during 1983. 12

6. Estimate of total fry migration, 8 October-21 November 1983. 12

7. Lake Ruataniwha, 24 November 1983. 14

8. Ohau River at site 3 (lower ford). 14

9. Ohau River at site 4. 16

10. Ohau River at site 5 (middle ford), during a flood. 16

11. The fish pass and Lake Ohau outlet weir. 17

12. Length-frequency distribution of trout fingerlings and fry caught by electric fishing in the Ohau River on 1 September and 9 November 1983. 20

13. Flow requirements of fisheries and NZE. 24

1. INTRODUCTION

The upper Waitaki catchment is currently under study by Fisheries Research Division (FRD), of the Ministry of Agriculture and Fisheries, to establish the effects of hydro-electric power development on its fisheries. The most recent change in the catchment was the creation in 1982 of a new lake, Lake Ruataniwha, by the construction of a dam on the Ohau River, about half way between Lakes Ohau and Benmore (Fig. 1).

Lake Ruataniwha has been developed as a recreational facility by the provision of camping areas, boating facilities, sporting areas, and picnic amenities. The lake is divided into 3 major sections, Kelland Ponds, Wairepo Arm, and the lake proper (Fig. 2), Kelland Ponds and Wairepo Arm are joined by a box culvert designed to allow canoe access between them. Wairepo Arm is fed at its southern end by Wairepo Creek, as well as by numerous ephemeral streams. On its southern shore, Lake Ruataniwha has 2 wildlife areas which were formed by enclosing shallow inlets with islands and boulder barriers. These areas are fed by ground seepage and consequently have clearer water than the lake itself.

The residual Ohau River has a normal flow rate of 0.4 m^3/s and flows into Lake Ruataniwha (Fig. 2). This flow rate is rarely changed, but can be varied from 0 to 1.5 m^3/s by adjustment of a control gate on the Lake Ohau outlet weir. The control structure was designed as a fish ladder, but is referred to as the "Lake Ohau outlet weir irrigation culvert" because it provides water for stock and irrigation.

The residual flow in the Ohau River is increased when the level of Lake Ohau rises above the weir (520 m above mean sea level). However,

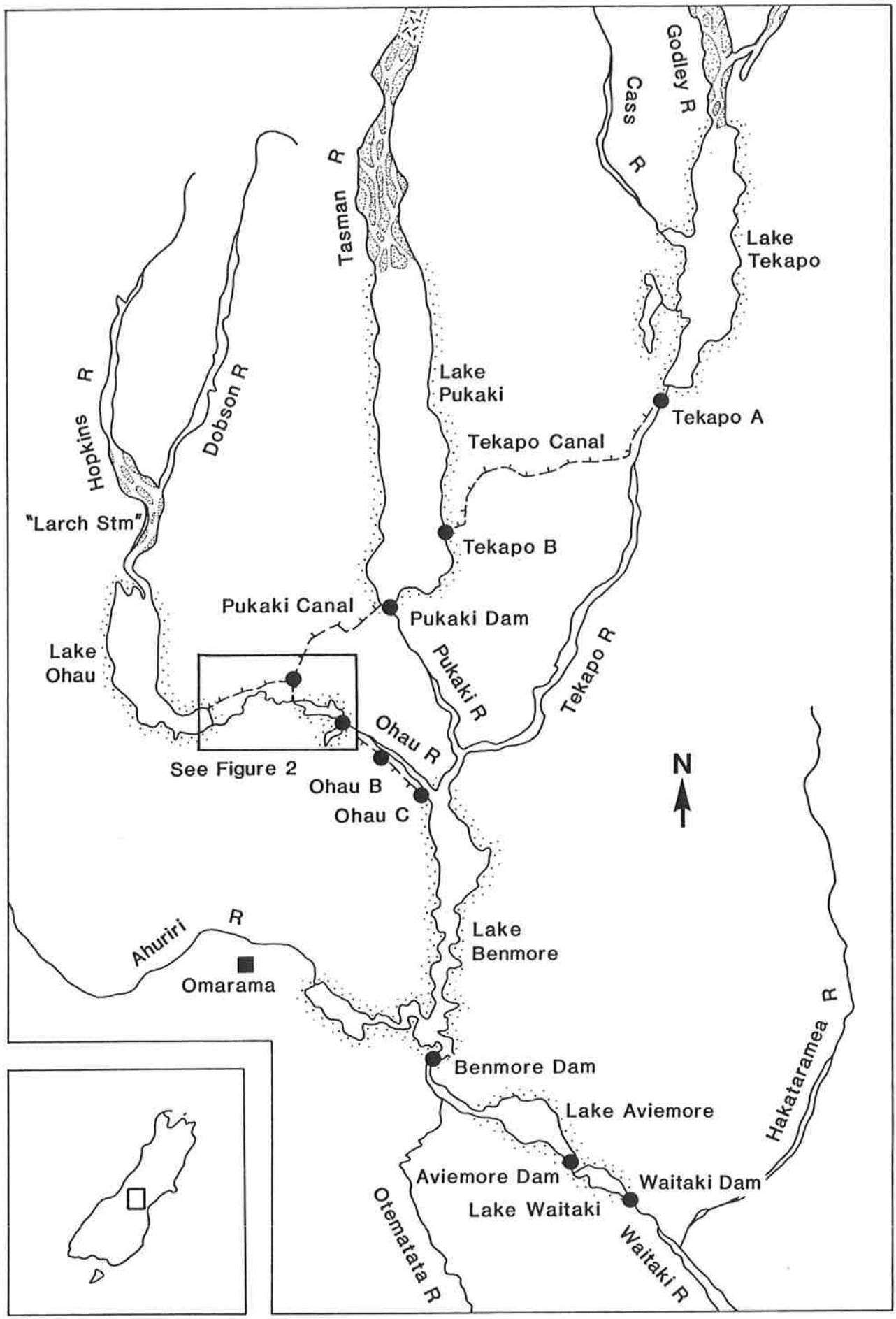

FIGURE 1. Upper Waitaki catchment, showing the location of control structures and dams.

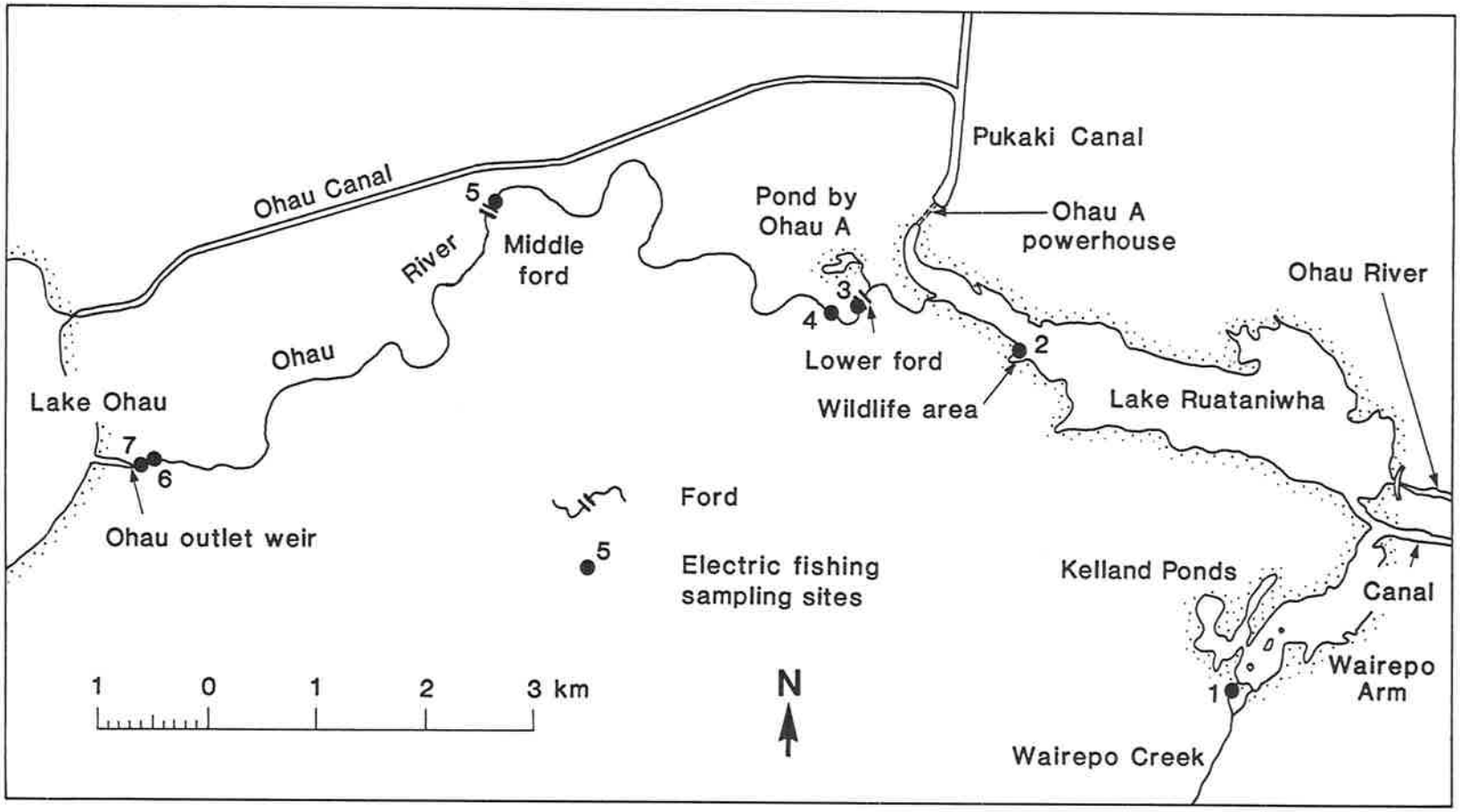

FIGURE 2. Ohau River and canal system, showing the location of electric fishing sites.

this rarely happens because the present water right requires that New Zealand Electricity Division (NZE) control Lake Ohau within narrow limits to a level below 520 m.

The largest flow into Lake Ruataniwha is from the Pukaki Canal, which has a maximum recorded daily average flow of 482 m^3/s. Water in this canal originates from Lakes Pukaki and Ohau, and the clarity varies from 0.35 to 5.0 m (Secchi disc measurements taken during 1983) depending upon the source; water from Lake Ohau is much clearer than that from Lake Pukaki.

This report has been compiled to assist NZE in deciding on satisfactory residual flows for the Ohau River between Lakes Ohau and Ruataniwha. Although residual water has been flowing since the construction of the Ohau A powerhouse, NZE is legally entitled to take all water flowing from Lake Ohau. The purpose of this study was to determine the importance of the residual flow to the fish stocks and fisheries of the upper Ohau River and Lake Ruataniwha.

Information was required urgently, therefore there was not sufficient time to undertake a prolonged or detailed study. The value of the Ohau River as a trout spawning and fry rearing area was assessed by visual surveys of the extent of suitable spawning gravels, by electric fishing, and by trapping young fry and fingerlings. The numbers of adult trout in the river were also assessed by drift diving, visual observation, and angling surveys.

2. METHODS AND RESULTS

2.1 Trout spawning surveys

A foot survey along 4.5 km of the upper Ohau River was carried out in September 1983. No trout redds were observed. Although most of the river surveyed was made up of large stones and boulders unsuitable for spawning, some isolated patches of suitable gravel were found. Many suitable spawning areas were observed subsequently, during a drift dive on 15 December 1983.

2.2 Fry trapping

During 8 October-21 November 1983 a fry trap (Fig. 3), with a mouth opening of 50 x 180 cms, was placed facing up stream in the centre of the main river flow, 400 m up stream of the lower ford. The trap was checked and cleaned every 2 days, because algae gradually clogged the mesh and reduced the water flow through the trap. Captured fish were identified, anaesthetised, and measured.

Trapping was complicated by rapid fluctuations of the river level caused by water spilling over the Ohau weir. Although the trap was moved to a shallower site to prevent damage when the flow increased (Fig. 4), it was not unusual for the flow to vary from its normal level of 0.4 m^3/s to 50 m^3/s and back to 0.4 m^3/s in a 6- to 7-day cycle (Fig. 5).

To obtain an estimate of total fry outmigration, the river was gauged during normal flow to determine the proportion of the river flow

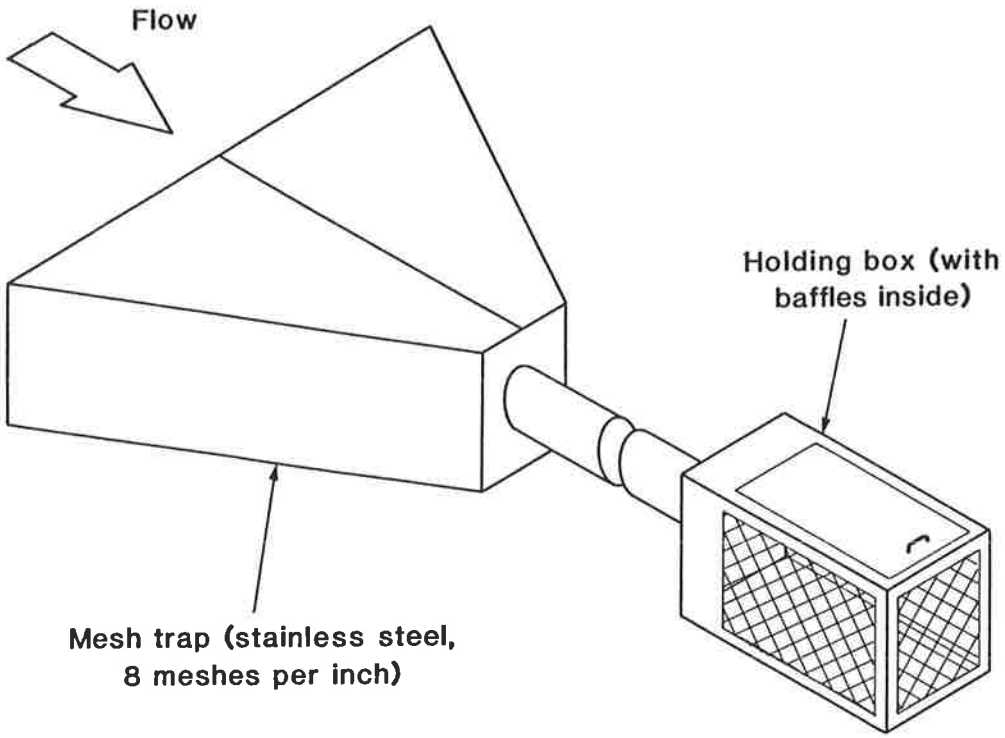

FIGURE 3. Fry trap used on the Ohau River, 8 October-21 November 1983.

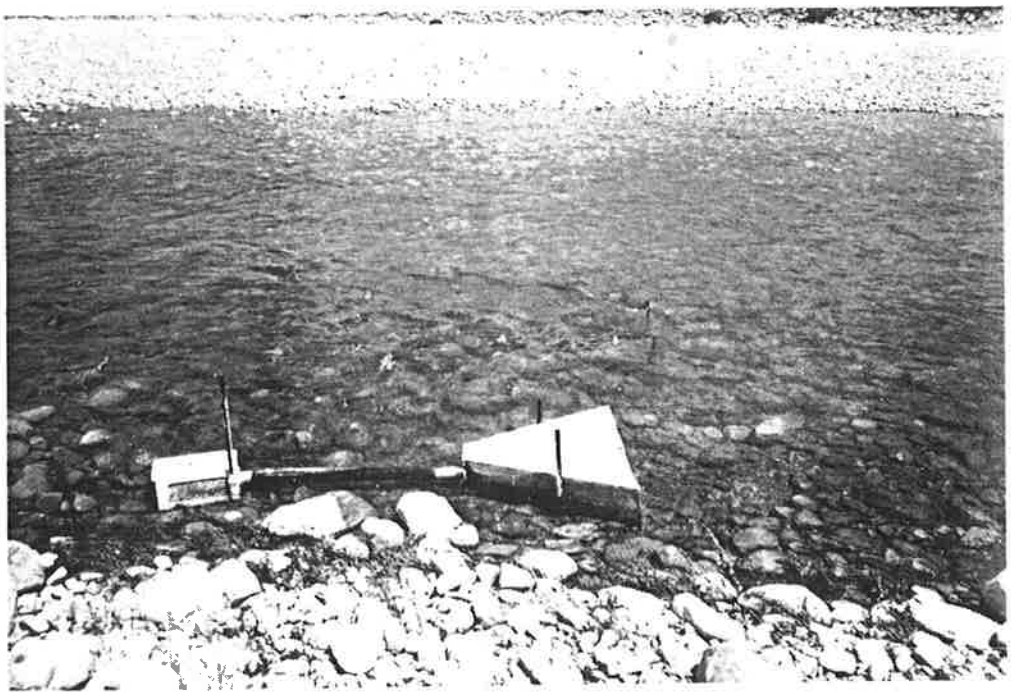

FIGURE 4. Fry trap in operation during a flood. The usual position of the trap can be seen marked by metal stakes near the middle of the river.

passing through the fry trap. The trap catches were then multiplied by this factor. The same procedure was used during the flood of 29 October 1983.

It was assumed that fry migrating down stream were randomly distributed across the width of the river channel, and that the trap caught all fry in the area fished. (These assumptions may not be valid.)

No fry were captured until after the flood which occurred during 24-28 October (Fig. 6). From 28 October onwards, the numbers of outmigrants slowly decreased. The numbers of fry migrating down stream were fairly low. This could be due to a small spawning run resulting in a small number of fry, fry remaining resident in the river, or a combination of both these factors. The results of electric fishing on 9 November 1983 suggested that some fry remain and rear to yearlings in the river (see section 2.3).

2.3 Electric fishing

Seven sites were sampled with electric fishing equipment (Burnet 1959). Sites were chosen in Wairepo Creek, Lake Ruataniwha wildlife areas, and the upper Ohau River. The river sites were chosen to represent the different substrate and flow types present in the Ohau at normal flows. The relative proportion of each habitat represented by the sampling sites was then estimated from a detailed aerial photograph. Sites ranged in size from 24 to 120 m^2. They were fished with a single electrode and up to 3 runs were made through each site, as is required by the removal method of estimating fish populations described by Carle

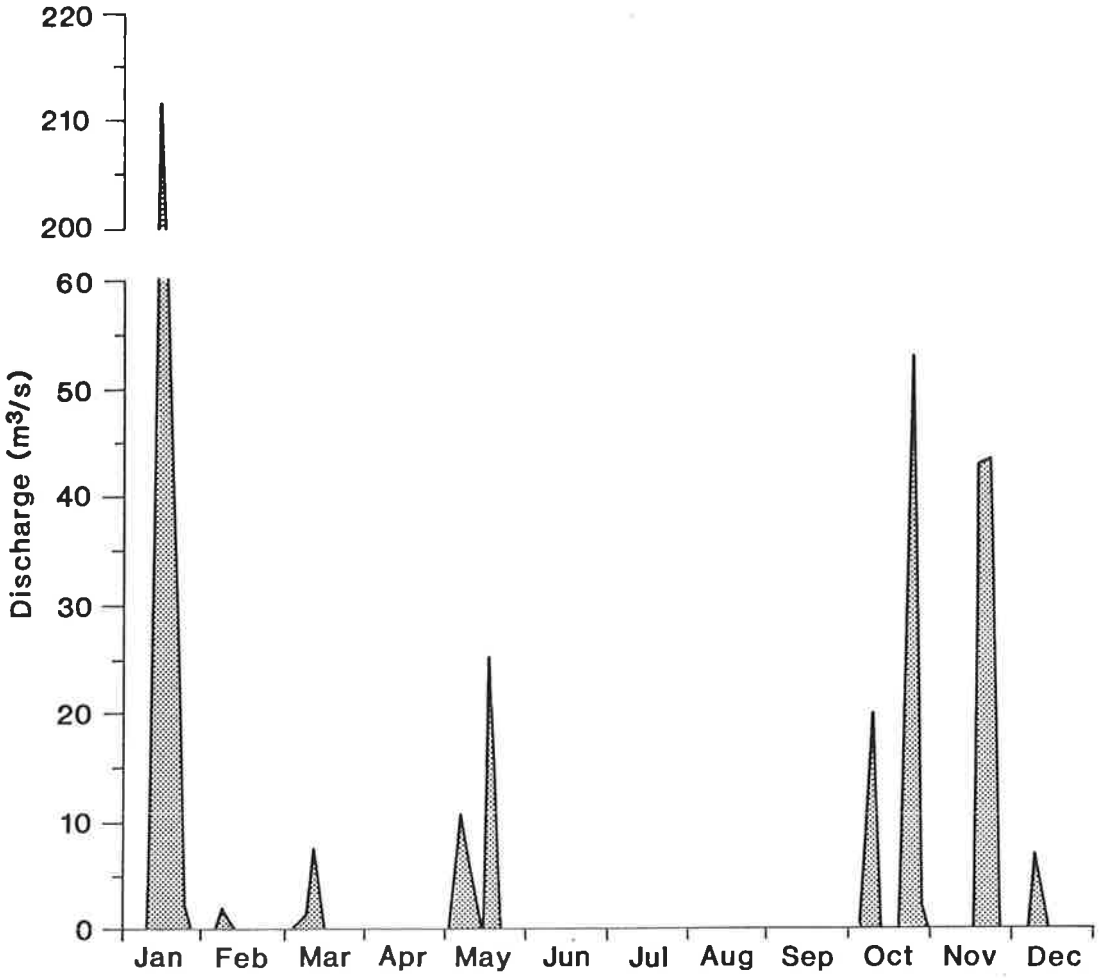

FIGURE 5. Record of spills over the Ohau weir during 1983.

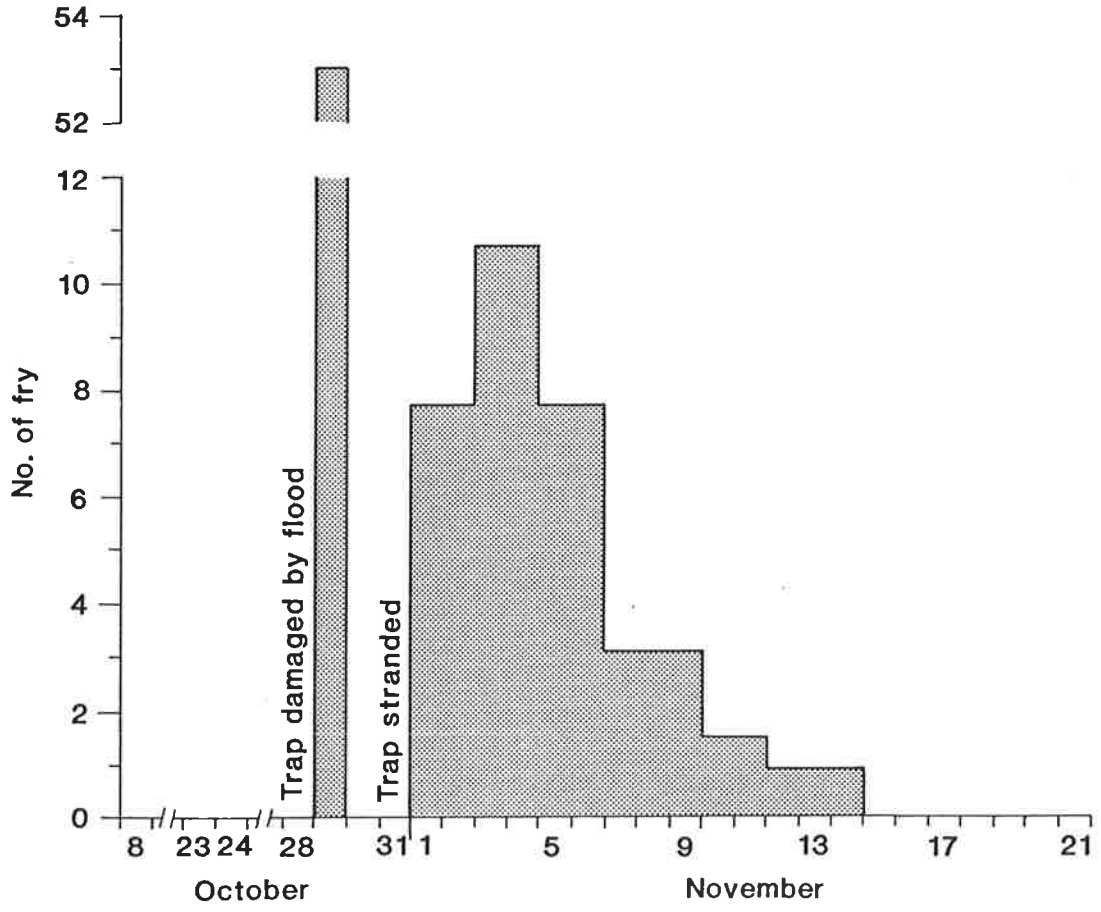

FIGURE 6. Estimate of total fry migration, 8 October-21 November 1983.

and Strub (1978). All trout caught were anaesthetised, weighed, measured, and released.

Physical descriptions of the electric fishing sites are as follows:

1. Wairepo Creek (site 1)

This is a small slow-flowing creek that branches to enter the southern end of the Wairepo Arm in 2 places. The creek is silty in its lower reaches, but becomes shingly for a few kilometres further up stream. The area sampled was from the culvert under the road to the lake shore, an area of about 60 m^2. A short stretch of faster water where the creek entered the lake was included in the sampling. Grasses and algae along the margins of the creek provided cover for fish.

2. Wildlife area (site 2)

This site consisted of a strip of boulders and shoreline in the wildlife area on Lake Ruataniwha (Fig. 7). Although there were no plants, cover for fish was provided by the boulders.

3. Ohau River (sites 3-7)

Five sites were chosen to represent the various flow and substrate types in the river. Only the river margin was fished, therefore the fact that the margins are usually more productive than the rest of the river must be taken into account when estimating the number of fish in the river.

FIGURE 7. Lake Ruataniwha, 24 November 1983.

FIGURE 8. Ohau River at site 3 (lower ford).

Site 3 (Fig. 8) was above the lower ford and consisted of a 20-m reach, with large to medium sized boulders and slow-flowing water. The strip fished was 3 m wide, and comprised about one-third the width of the river at the site. Site 3, as with all the other Ohau River sites, had no instream or riparian plant cover.

Site 4 (Fig. 9), below the fry trap, consisted of small boulders and large stones in a moderate flow (0.5 m/s). A strip 1.5 m wide along the margin was fished.

Site 5 (Fig. 10) was down stream from the middle ford. There was almost no flow in this shallow area, and the substrate comprised small stones interspersed with a few larger ones. The area was 2 m wide and was distinct from the main stream by having almost no flow. It was characteristic of many long shallow pools in the river.

Site 6 was made up of small pools (0.5-2 m diameter) off to the side of the main flow of the river, but still in the river bed. These pools were very shallow and were fed by water trickling from the main flow.

Site 7 (Fig. 11) was in the pool below the weir culvert. There was little flow at the site. The bank in this area consists of a rip-rap of large boulders, 1-1.5 m in diameter. An 18-m reach was electric fished.

Electric fishing was carried out on 1 September and 9 November 1983. Only sites 1, 3, 4, and 5 were surveyed on 1 September. Results from the electric fishing surveys are shown in Tables 1 and 2.

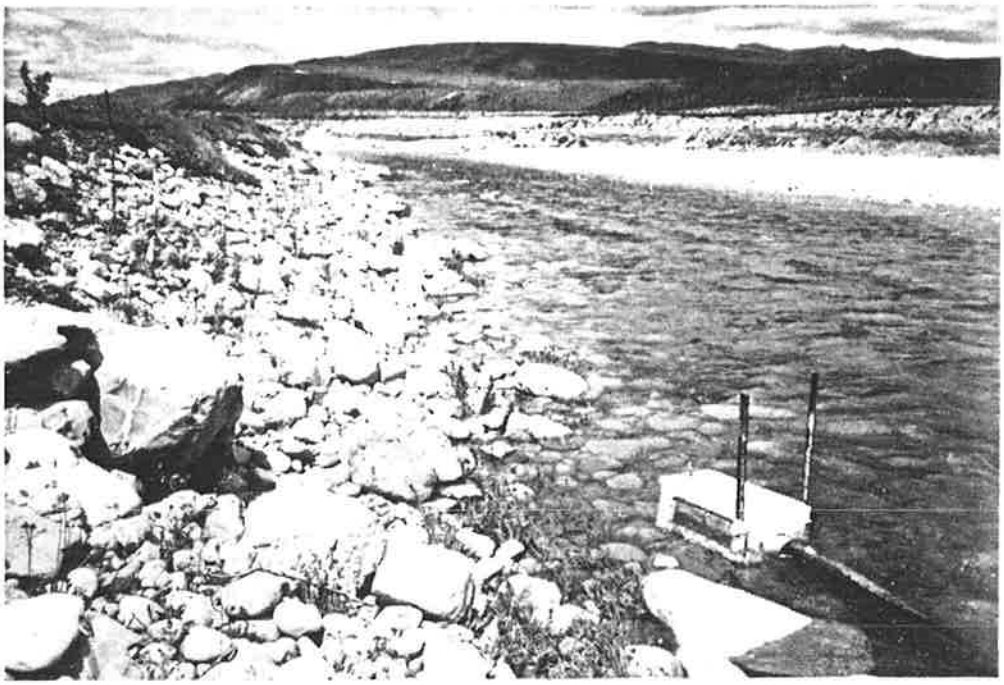

FIGURE 9. Ohau River at site 4.

FIGURE 10. Ohau River at site 5 (middle ford), during a flood.

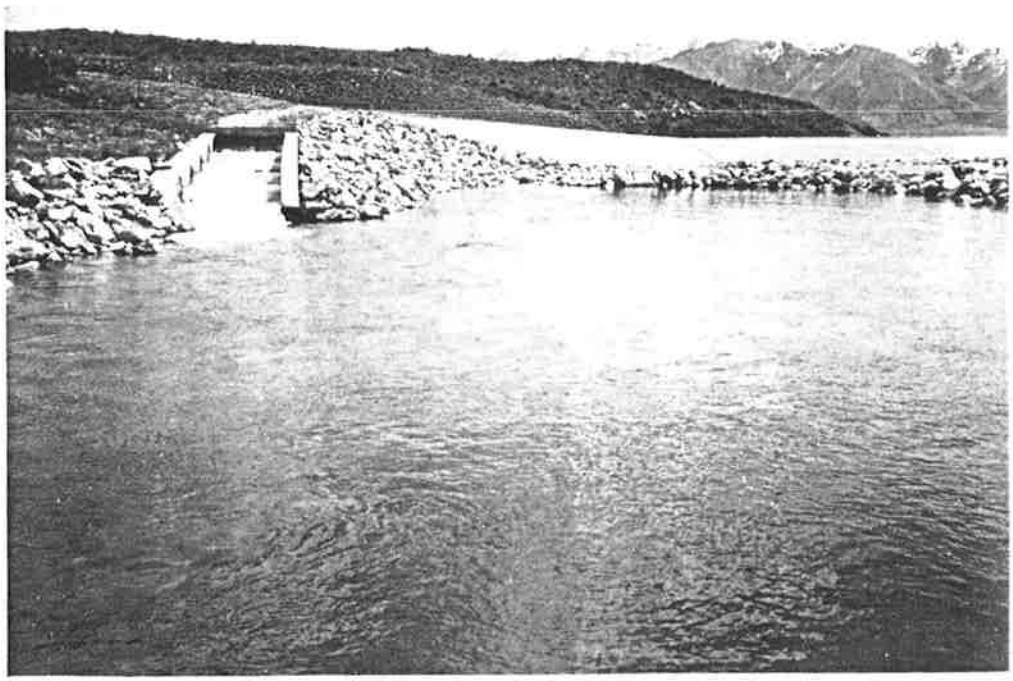

FIGURE 11. The fish pass and Lake Ohau outlet weir.

TABLE1. Results of electric fishing on 1 September 1983 (see Fig. 2 and text for locations and descriptions of electric fishing sites).

	Site 1	Site 3	Site 4	Site 5
Area (m^2)	60	114	108	120
Estimated population size	0	9	8	13
Mean length of fish (mm)	N/A	148	161	123
Density (No. of fish/m^2)	0	0.078	0.074	0.108
% of each site type in Ohau River (estimated from aerial photograph)	N/A	20	67	10

N/A = not applicable.

2.3.1 Wairepo Creek

No fish were found at site 1. Its silty bed appears to be unsuitable for spawning and this probably explains the absence of any juvenile fish.

2.3.2 Wildlife area

Site 2 appears to be a good habitat for fingerlings and adult trout. However, few fry were caught during electric fishing (Table 2).

2.3.3 Ohau River

From the results of electric fishing on 1 September 1983, a density of approximately 0.078 trout/m^2 was calculated for the whole Ohau River. These fish were 1-year-old fingerlings and had a mean length of 139 mm.

A similar survey on 9 November 1983 produced an estimate of 0.71 trout/m^2 for the whole river. The mean length of fish caught was 31 mm

TABLE 2. Results of electric fishing on 9 November 1983 (see Fig. 2 and text for locations and descriptions of electric fishing sites).

		Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7
Area (m^2)		60	27.5	60	58.1	30	24	36
Estimated population size	- fingerling	0	4	0	0	0	0	7
	- fry	0	2	1	31	89	8	0
Mean length of fish (mm)	- fingerling	N/A	150	-	-	-	-	141
	- fry	N/A	34.0	29.0	32.3	33.2	27.0	-
Mean weight of fish (g)	- fingerling	N/A	52	-	-	-	-	39.6
	- fry	N/A	0.49	0.24	0.37	0.41	0.15	-
Density (No. of fish/m^2)		N/A	0.22	0.016	0.53	2.96	0.33	0.19
% of each site type in Ohau River (estimated from aerial photograph)		N/A	N/A	20	67	10	3	0 (unique site)

N/A = Not applicable.

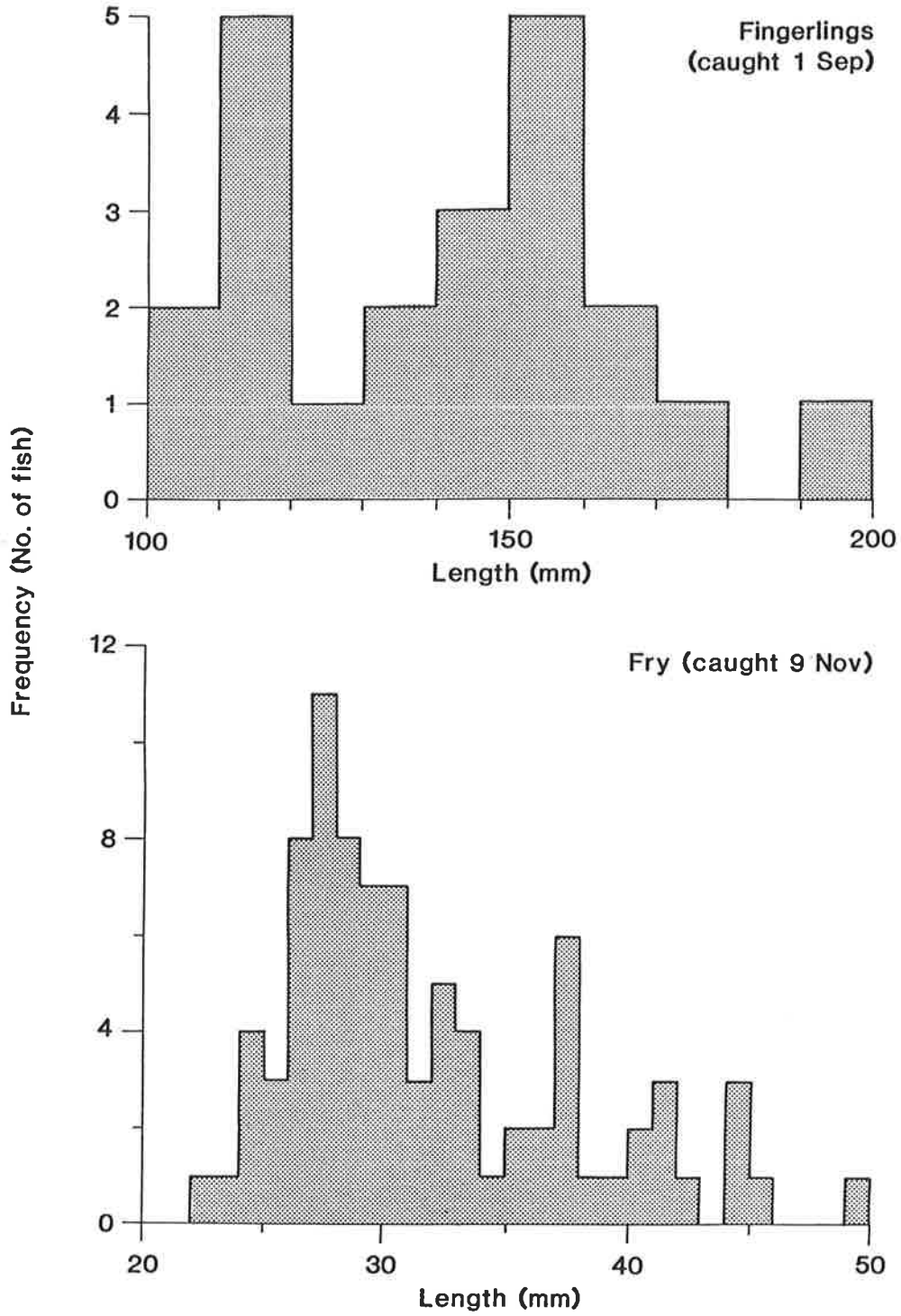

FIGURE 12. Length-frequency distributions of trout fingerlings and fry caught by electric fishing in the Ohau River on 1 September and 9 November 1983.

(Fig. 12). All the fish measured were fry which had emerged in the previous 2 months. These data suggest that fish remain in the residual Ohau River up to the age of 1 year.

Based on these values, estimates of the total fish population for the Ohau River are about 8000 fingerlings on 1 September 1983, and between 100 000 and 200 000 fry on 9 November 1983. These estimates are based on the assumption that densities of fish are similar over the full width of the river. This may not be so at all sites. If it is assumed that fish live exclusively along the margins, the fry population on 9 November 1983 was about 25 000.

The density of fingerlings estimated for the Ohau River during the survey period compares favourably with densities recorded from the Mary Burn (FRD unpublished data) and the Ahuriri River (Jellyman *et al.* 1982).

2.4 Drift diving

Two divers drifted down about 3 km of the Ohau River on 15 December 1983. Emphasis was put on diving in pools where resident adult fish were likely to be found.

Six large brown trout were observed, all within 1.5 km of Lake Ruataniwha. Numerous fingerlings were also seen holding position in the main flow of the river. No large fish were found in the upper river.

Although there appears to be an abundant invertebrate fauna, particularly caddis larvae and snails, there were few resident adult fish in the river.

3. DISCUSSION

3.1 Fish recruitment

There is insufficient information to accurately assess the numbers of fish entering Lake Ruataniwha via the hydro canals and Ohau A powerhouse, or to assess the survival rate of fish after passing through the turbines. A major tagging and recapture programme would be required to assess recruitment from the canals.

There is a small amount of angling done in the residual Ohau River. The "swimming hole" and other large pools are fished with fly and spinning techniques. However, the adjacent Ohau Canal is undoubtedly more popular with anglers, and contains a greater stock of fish than the residual river.

The Waitaki Valley Acclimatisation Society recommended to NZE that a minimum flow of 7 m^3/s would be required in the upper Ohau River to support angling. Our observations tend to confirm that flows of this size would be required to provide sufficient water in the runs and riffles to support large resident trout, which are otherwise confined to pools. As there are few pools, low flows seriously limit the amount of habitat available to trout and this leads to a concentration of angling pressure on these locations.

3.2 Effectiveness of the fish pass

There is considerable doubt about the effectiveness of the fish pass at the Ohau outlet weir (see Fig. 11). At full flow, the stilling

basins are turbulent and charged with air bubbles. This means that the water is of lower density and fish are less able to swim through it or to leap over the sills.

At reduced flows, fish can swim up stream to the downstream entrance of the culvert. However, they may not be able to swim through the culvert because of the velocity barriers inside it. On 18 February 1982, 721 mature sockeye salmon were released into the holding pool below the fish pass. Subsequently, some salmon were observed ascending the step pass. However, when "Larch Stream", their spawning stream, was trapped during March 1982, only 15 fish (2%) were recaptured. It is possible, but unlikely, that the fish surmounted the pass, but died in Lake Ohau as a consequence of being netted below Ruataniwha Dam and transported to the fish pass. It is also considered unlikely that these fish migrated to other spawning areas, because historically over 95% of the sockeye in the Waitaki catchment spawned in Larch Stream.

This is good evidence that something is wrong with the fish pass and that specific studies are needed to assess its operation. Given the existing physical structures, there are 3 flow management options which could be adopted:

1. No flow - fish pass switched off.

2. Fish pass operating - 0.4 m^3/s residual flow (existing situation).

3. Culvert operating at 1.5 m^3/s maximum flow, and fish pass inoperative.

These options could be varied through the year, depending on fisheries and power generation requirements.

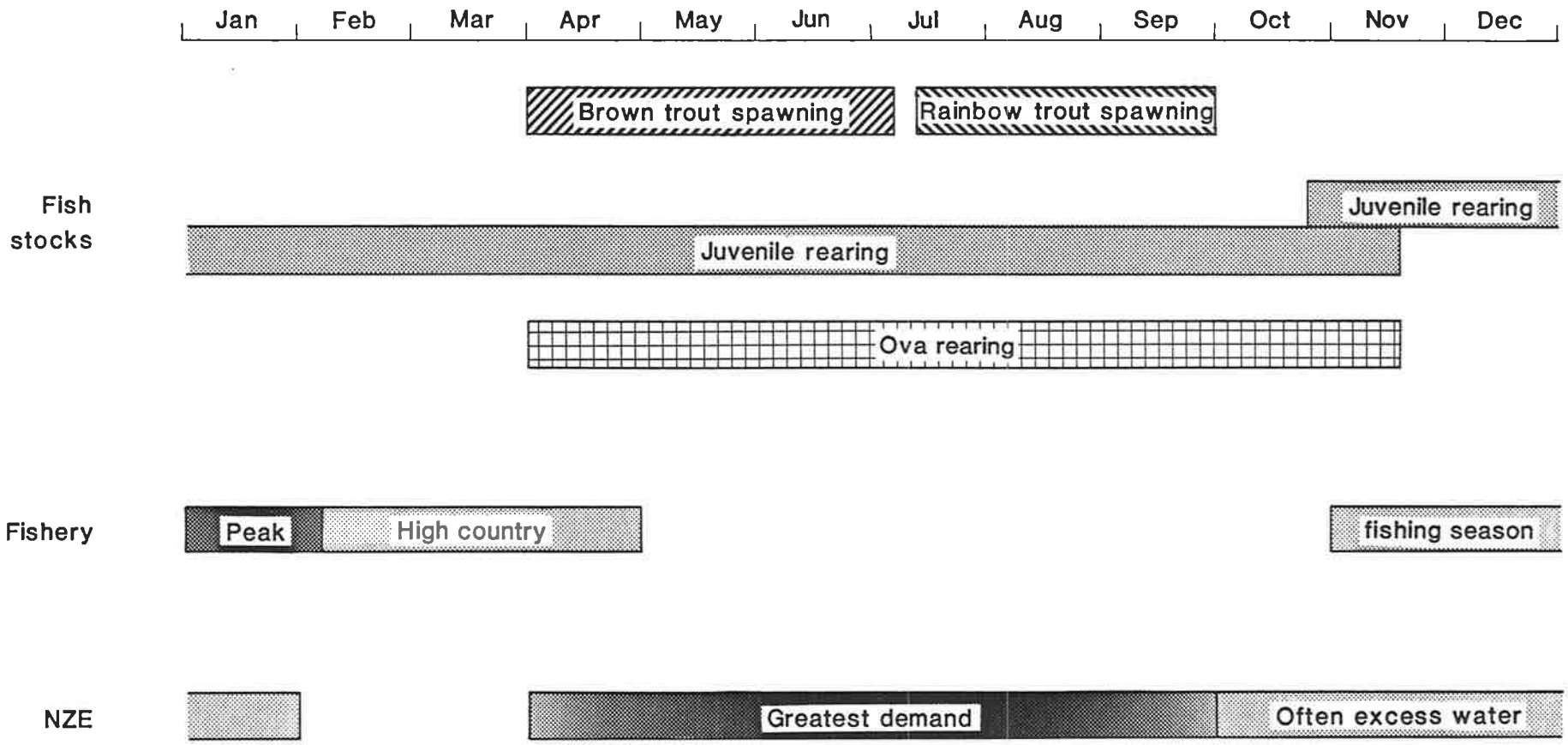

FIGURE 13. Flow requirements of fisheries and NZE.

From a fisheries viewpoint, water is required all year round (Fig. 13). Requirements are least in late summer-early autumn, because the juvenile trout could, presumably, safely emigrate to Lake Ruataniwha.

4. CONCLUSIONS

Lake Ruataniwha and the Wairepo Arm have been developed as a recreational centre for the public. Anglers enjoy the good access to wildlife areas at both Lake Ruataniwha and the Wairepo Arm. With this emphasis on recreation, it is important to ensure an adequate supply of fish, as a worthwhile fishery would encourage other recreational pursuits.

Fish in Lake Ruataniwha may have come from the hydro canals, or from Lake Ohau when it spills down the Ohau River, or may already have been in the Ohau River when it was dammed. Because trout which have reared in the residual Ohau River above Lake Ruataniwha have yet to be caught (they are only 1-2 years old), it is very difficult to estimate the relative importance of this source of fish.

Fisheries Research Division considers that the present flow of 0.4 m^3/s through the fish pass should be maintained until future work gives more definite answers about the importance of this flow, or higher flows, to the fishery. Indications at present are that this flow does provide a nursery for trout, and these fish may prove to be important as a source of supply to Lake Ruataniwha.

5. FUTURE STUDIES

1. Fisheries Research Division's netting programmes in Lake Ruataniwha and the hydro canals will be continued.

2. It is proposed to construct a temporary fish trap on the Ohau River during winter 1984 to capture adult trout on their spawning migration.

3. Spawning areas will be located by regular surveys.

4. The effectiveness of the fish pass at different flows should be assessed.

5. Transect measurements and photographs of the amount of habitat at different residual flows should be taken. (It is difficult to predict the residual flow that will occur if the fish pass is switched off.)

6. Temperature records and observations of algae build-up during summer or low flows would be useful.

7. It could also be desirable to assess the cost-effectiveness of concrete and boulder weirs along the Ohau River. In Norway, the effects of severe water abstraction from rivers have been reduced by the construction of long sloping weirs at 200- to 400-m intervals along the river banks (E. Graynoth pers. comm.). These weirs impound long, deep (2-4 m) pools which provide suitable habitat for brown trout and other fish. These areas have proved very popular for recreational activities, such as swimming,

boating, and fishing. The river is transformed into a series of long, wide pools and appears to contain a great deal of water, even though the residual flow can be very low.

Information would be required on the costs of constructing such weirs and the effects of spillway floods and bedload movement on them.

6. ACKNOWLEDGMENTS

My thanks to Eric Graynoth and Sally Davis, who helped with the manuscript, and to Simon Bloomberg and Graeme McGregor who gave valuable advice and information. Thanks also to Carol Whaitiri for typing the manuscript.

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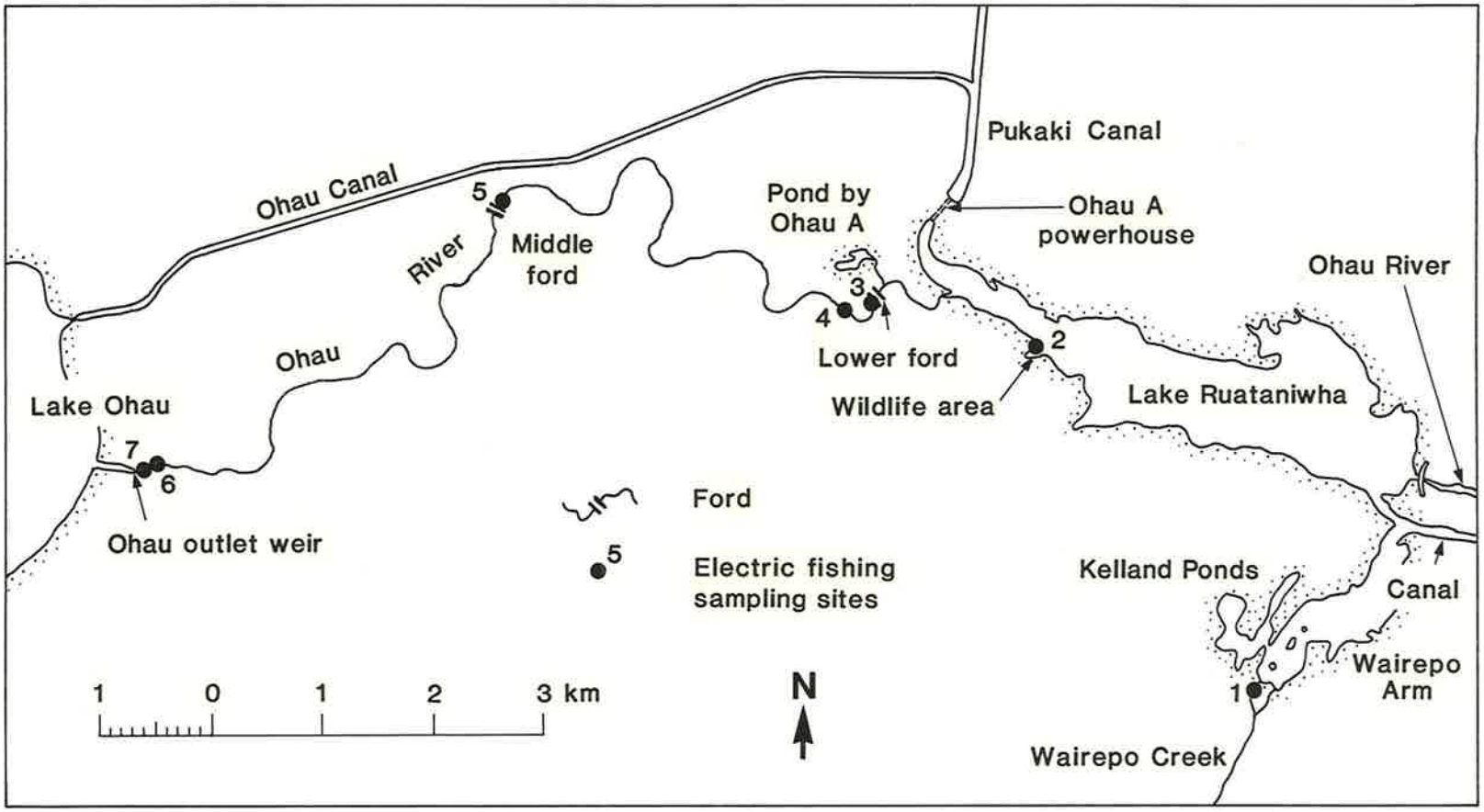


FIGURE 2. Ohau River and canal system, showing the location of electric fishing sites.

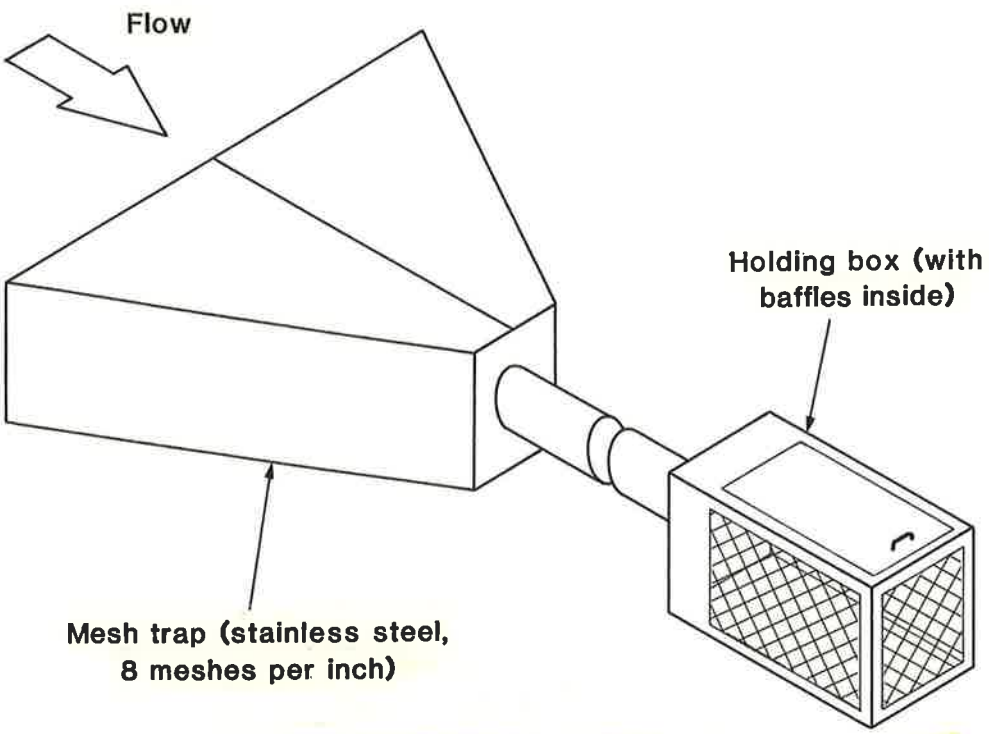
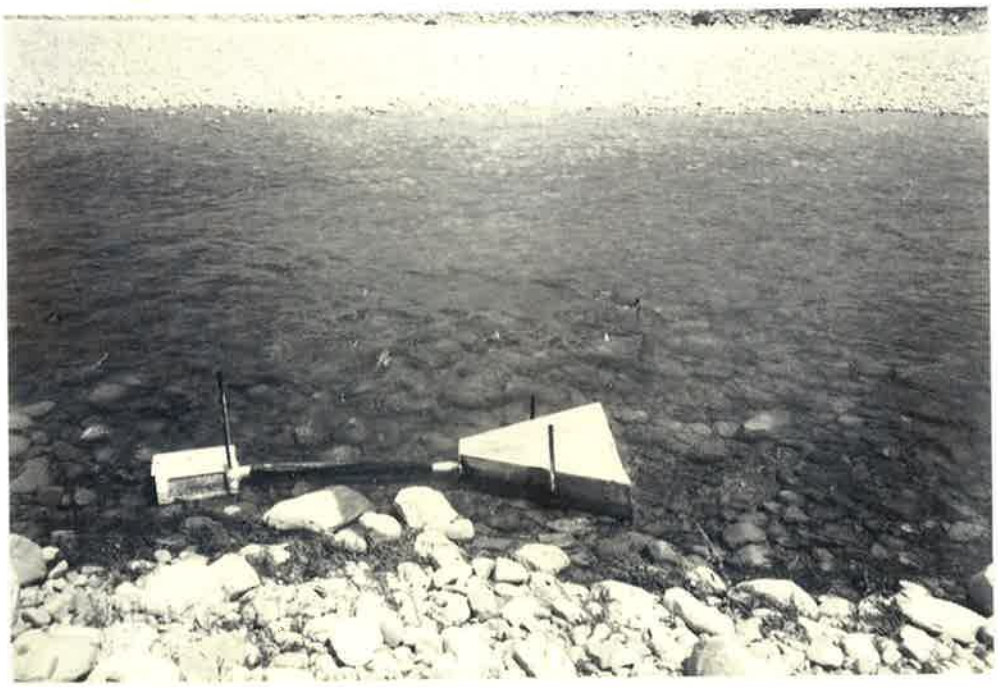


FIGURE 3. Fry trap used on the Ohau River, 8 October-21 November 1983.



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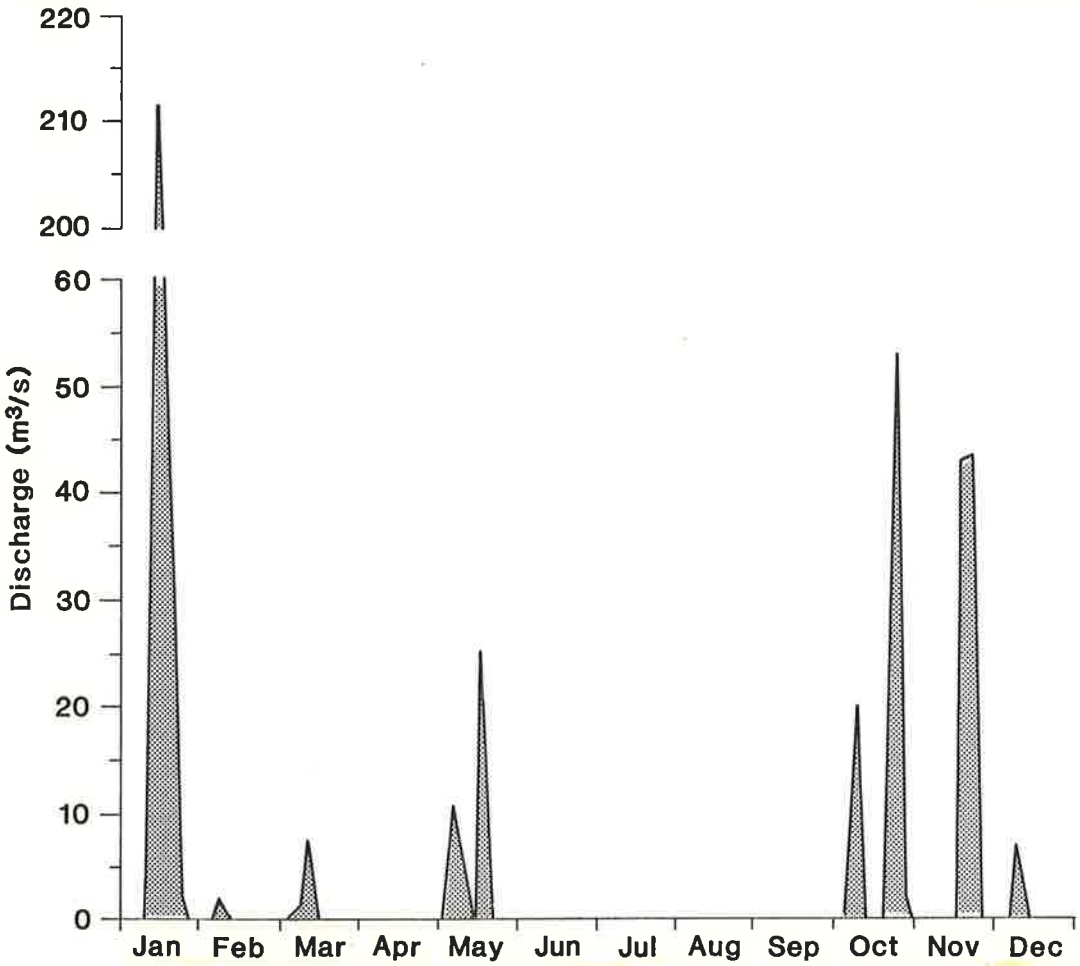


FIGURE 5. Record of spills over the Ohau weir during 1983.

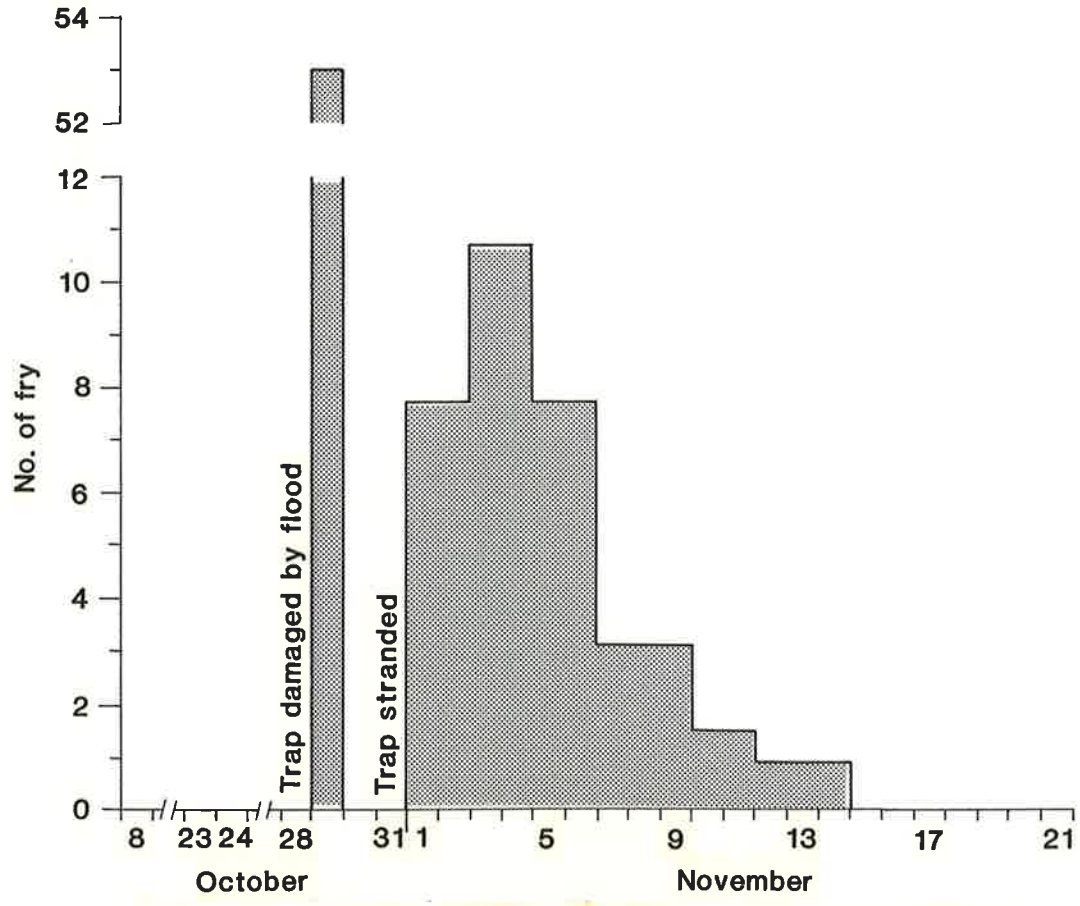
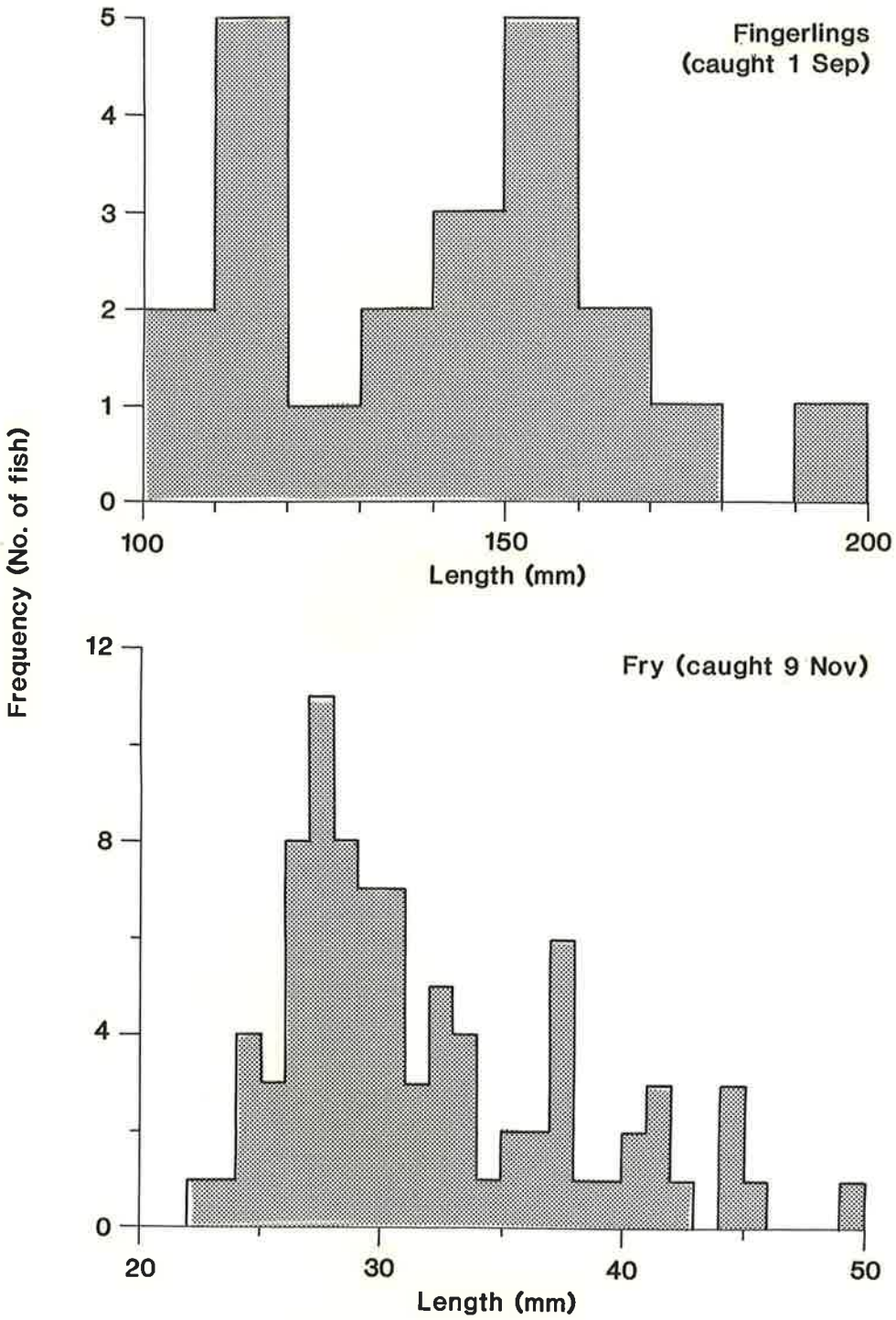


FIGURE 6. Estimate of total fry migration, 8 October-21 November 1983.

FIGURE 7. Lake Ruataniwha, 24 November 1983.

FIGURE 8. Ohau River at site 3 (lower ford).

FIGURE 11. The fish pass and Lake Ohau outlet weir.



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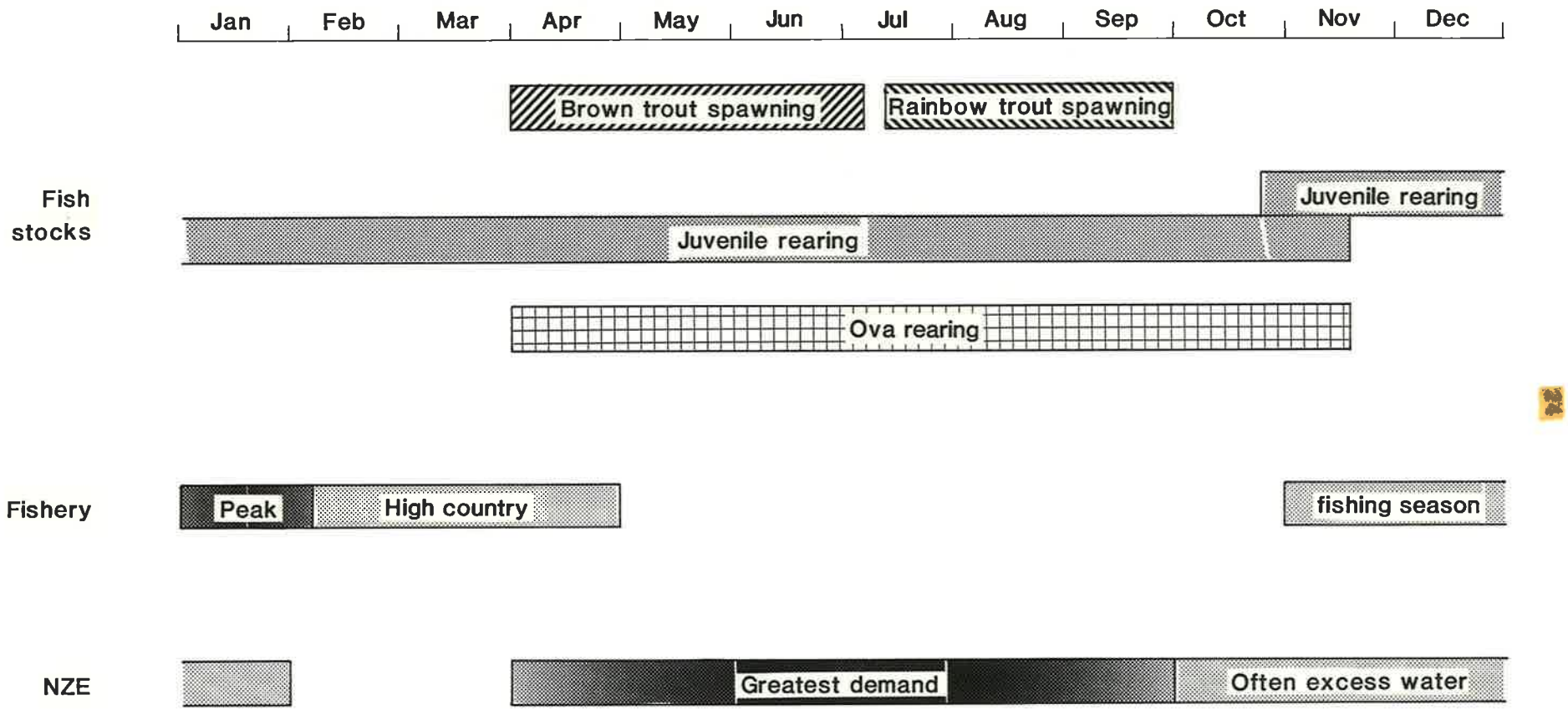

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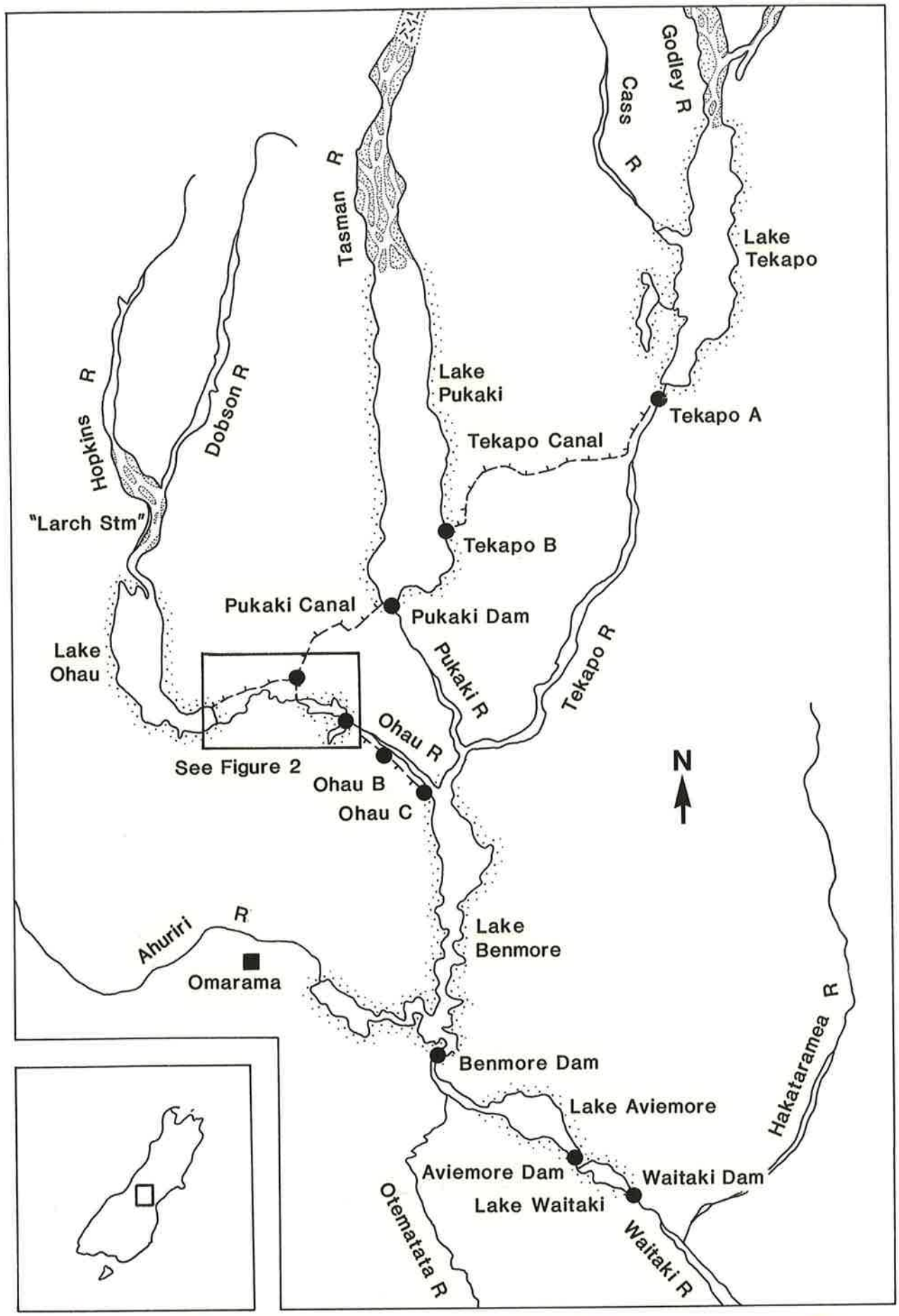

FIGURE 1. Upper Waitaki catchment, showing the location of control structures and dams.