ISSN 1170-2001

NEW ZEALAND FRESHWATER FISHERIES MISCELLANEOUS REPORT NO. 35

IMPLICATIONS OF FURTHER HYDRO DEVELOPMENT ON THE FISH STOCKS AND FISHERIES OF LAKE WAHAPO, WESTLAND

by

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Servicing freshwater fisheries and aquaculture

JUNE
1990

NEW ZEALAND FRESHWATER FISHERIES MISCELLANEOUS REPORTS

This report is one of a series initiated in January 1989, and issued by the Freshwater Fisheries Centre, MAF Fisheries. The series was established to ensure that reports prepared for clients, tribunal hearings, internal use, etc., are collected together and available to future users. They are for limited circulation, and some may be confidential.

ISBN 0-477-08192-4

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1 SUMMARY

A total of four native and two introduced fish species have been recorded from Lake Wahapo. None of these are rare or endangered. Diversion of the Waitangi-taona River into the lake has substantially degraded its fishery value as the lake is turbid and macrophyte growth is probably light-limited. Nevertheless, the lake contains a typical assemblage of invertebrates, and a surprisingly good population of brown trout.

The proposed hydro developments could potentially impede fish access and will result in substantial drawdowns of lake level. To maintain fish passage a regime of controlled releases in years of low flow, is suggested. Drawdown over the 2 m operating range will reduce macrophyte biomass by approximately 80%; under this regime, these impacts will be almost immediate and irreversible.

2 INTRODUCTION

As part of an environmental impact assessment on the proposed increase in hydro generation from Lake Wahapo, the Westland Acclimatisation Society carried out a brief study on the Lake Wahapo fishery (Tonkin 1989a). This study did not deal in any detail with the implications of the proposed development, but did recommend that if the scheme went ahead then consultation with MAF Fisheries should be initiated. Accordingly on 6 June 1990, the consulting engineers, Royds Garden Ltd, contacted MAF Fisheries, requesting the present report on the impacts of the proposed development. This report is based on existing information, and a site familiarisation trip (11 and 12 June).

3 PHYSICAL DESCRIPTION

Lake Wahapo is a small glacial lake (2.25 km^2) whose outflow combines with that of Lake Mapourika to form the Okarito River. Across its narrow axis, the lake is steep-sided, reaching a maximum depth of 61 m (Irwin 1979). It shallows somewhat towards the north-eastern margin where the Waitangi-taona River enters across an actively growing fan. The Waitangi-taona naturally diverted into the lake in 1967 and subsequent stop banking ensures full flood flows now enter the lake. (Although outside the scope of this present review, it is worth noting that this diversion meant that the lake was no longer a suitable nesting area for crested grebes, of which a dozen or more pairs were known to nest on the lake (Falla 1975).)

The mean flow of this river is not known to the authors, but presumed to be 15 m^3/s, with flood flows of 400-800 m^3/s (Tonkin 1989a). During such floods there is a heavy sediment load which results in deposition of approximately 155 000 m^3/year of gravel and means that the lake is "markedly turbid ... for much of the year" (Tonkin 1989a). This is evident from secchi disc depths recorded, ie. minimum 1.0 m, maximum 2.0 m (Livingston, Biggs and Gifford 1986), with 0.95 m recorded during the present survey (11 June). Although no pre-diversion water quality data are available, it is likely that the visibility of the water was much like that of neighbouring Lake Mapourika, i.e., maximum of 7 m (Livingston, Biggs, and Gifford 1986).

4 HYDRO DEVELOPMENT

The Wahapo Power Station (formerly Okarito Forks Power Station) was commissioned in 1960, prior to the Waitangi-taona River diversion. A low weir across the lake outlet diverts approximately 1 m^3/s of water into a race and ponding area, and then to a power station built on the bank of the Okarito River. The station utilises the 33 m head to produce 280 kW (Mort, n.d.). Storage for the present scheme involves lake level drawdowns of up to 0.7 m, although this would normally occur only 2-3 times per year for approximately a week at a time (D Preston, Royds Garden Ltd, pers. comm.).

The proposed scheme will abstract 12 m^3/s (although the water right allows 15 m^3/s) with some constraints at low lake levels. The water rights require a residual flow of 0.1 m^3/s with provision made for fish passage unless "the exercise of this right will not compromise any existing fishery in the lake or lake outlet." The present weir will be strengthened but not heightened; likewise the first section of the water race will be strengthened to pass high flows back into the river downstream of the weir.

5 REVIEW OF AVAILABLE DATA

5.1 Bathymetry

See Irwin 1979.

5.2 Water Quality

Data are very limited, with no recorded temperatures, pHs or major ions being found in the literature. Stout (1975) includes Lake Wahapo among a group of Westland glacial lakes which typically have acid pH (3.3-6.8), low conductivity and low total ion concentrations. On the basis of a rather sparse phytoplankton flora, (Flint (1975) classified the lake as oligotrophic (= low production), noting that this may be largely due to the flushing effect which is proportionately greater in small lakes than in large lakes.

The present survey recorded a pH of 6.75, conductivity of 42.1 μs/cm, and surprisingly a relatively high surface temperature of 18.8°C. The secchi disc reading was 0.95 m.

5.3 Macrophytes

Prior to the present study, no data were available. The present survey has recorded a fringing margin of macrophytes around the lake to a depth of 2.5 m below lake-fill level (level on survey day was 5 cm below weir crest). In sheltered areas, macrophytes grew to the lake surface but generally commenced at 0.5 m - there was no obvious sign of the current operating regime affecting macrophyte growth. Species present were *Myriophyllum*, *Elodea* and *Isoetes*; none of these species will survive significant exposure. Because of the turbidity in the lake and knowledge that macrophyte growth in unmodified West Coast lakes normally reaches 4 m+ depth (Flain 1982), it is reasonable to assume however, that the macrophyte community is light-limited due to the turbidity of the lake.

5.4 Invertebrates

Invertebrate data have recently been reviewed by Royds Garden Ltd (1990). This report, which used extensive macroinvertebrate surveys of the waterways (but only one shoreline sample from the lake) showed that the fauna in the Waitangi-taona River below the lake was much less abundant than above the lake; it concluded that the lake acted as a barrier to downstream dispersal, and the proposed drawdown regime may not seriously retard invertebrate colonisation of affected areas.

During the present survey, quantitative weed samples (with associated invertebrates) were collected at three sites - at the top, centre, and bottom of the lake. A rapid qualitative sorting of samples was carried out. The dominant animal was the snail *Potamopyrgus* (up to 200 per square foot sample) - this species would have comprised about 90% of all animals seen. Also present was the snail *Gyraulus*, small copepods, and small numbers of aquatic oligochaete worms, chironomid (midge) larvae, larvae of the cased caddis (*Paroxyetheria*) and larvae of the moth *Hygraula nitens*. One sample contained three freshwater mussels (*Hyridella*), and these were noted as being particularly abundant below the macrophyte zone.

5.5 Fish Stocks

A survey of fish stocks in Lake Wahapo, Friends Creek, and Zalas Creek, was carried out by the Westland Acclimatisation Society (Tonkin 1989a). Briefly, the survey recorded longfinned eels, common bullies and brown trout were ubiquitous throughout the area, redfinned bullies and freshwater shrimps were found in Friends Creek, and a few quinnat salmon were observed spawning above SH6 bridge in Friends Creek. Although two galaxiids (koaro and banded kokopu) were present in Zalas Creek, neither species was found in Friends Creek; the reason for this is unknown but may be due to poorer water quality and/or temperature differences of the Lake Wahapo outflow.

The report concluded that the present outlet weir did not impede fish passage when flows were spilling over the weir.

Reference to MAF Fisheries Freshwater Fish Database indicates that shortfinned eels have been recorded from Friends Creek (although noted as 'rare' whereas longfinned eels were much more common). Also, the comparatively rare giant kokopu and shortjawed kokopu have been recorded from Zalas Creek (Main 1989).

The main periods of immigration into the lake are shown in Table 1. Although larvae of common bullies usually go to sea and return to freshwater in spring-summer, the Lake Wahapo population is probably entirely lake dwelling and no access to the sea is necessary. Should the population be migratory, they could revert to a lake dwelling form should access to the sea be denied. Unlike this, the redfinned bully is dependent upon access to and from the sea.

Table 1 Fish species present in lake Wahapo and their migration periods.

Species	Access essential	Main period immigration
Longfinned eels	Yes	)mid January -
Shortfinned eels	Yes	)mid February
Common bullies	No	
Redfinned bullies	Yes	December-March
Brown trout	Yes *	May-June
Quinnat salmon	Yes	mid April-mid May

* = assumes downstream resident trout move into the lake to spawn in tributaries.

Brown trout are resident in the lake, and it is also likely that some fish from Okarito Lagoon migrate up and through Lake Wahapo to spawn in Friends Creek and possibly also the upper reaches of the Waitangi-taona River. Small numbers of sea-run quinnat salmon also use Friends Creek and associated drains for spawning (Tonkin 1989a and pers. comm.).

As the lake is subject to level fluctuations due to the hydro development, and increased turbidity due to the diversion of the Waitangi-taona River, the fishery values have already been significantly degraded. Accordingly, it is suggested then that retention of passage for the existing fish species is a reasonable management objective; fish passage is also required under condition (c) of the water rights.

5.6 Fisheries

As the lake is within the boundary of the Westland National Park, commercial eel fishing is prohibited. Although whitebaiting in the tributaries of Okarito Lagoon is important to local people, the area is not one of national importance and does not appear in a South Island inventory (Kelly 1988). However, the lagoon as a whole is listed as a wetland of national importance to fisheries (Davis 1987) as it contains a diverse fauna, including all five whitebait species.

The Waitangi-taona River has been classified as a locally important recreational trout fishery (Richardson, Teirney and Unwin 1985) with important characteristics being the large trout, easy access and large area of fishable water, scenic beauty and solitude; overall importance ratings were exceptionally high and the river received an estimated 410 angling visits per year. As the survey was carried out over the 1979/80 angling season, these results relate to the post-diversion situation, meaning that the river described by anglers is that which now exists to then north and west of Lake Wahapo. With the diversion of the upper reaches into Lake Wahapo, the flow in the remaining sections of the Waitangi-taona River is sustained by tributaries and springs; indeed it is probable that the diversion has improved the river fishery as a whole by reducing the impact of flood flows and sediment deposition.

6 HYDRO DEVELOPMENT: IMPLICATIONS AND POSSIBLE MITIGATION

6.1 Fish Access

Under the present operating regime, fish access does not appear to be a problem. There may be some delays when flows are insufficient to overtop the weir, but flow data would indicate that this is seldom a problem.

Referring to Table 1, it is seen that five of the six fish species need access to the lake. No particular structure needs to be built to accommodate juvenile eels as these are adept at climbing, even leaving water to climb along the wetted margins of waterways. Virtually nothing is known about the swimming ability of juvenile redfinned bullies - this species is a "darter" rather than a sustained swimmer and will, no doubt, take advantage of reduced velocities among the substrate to swim upstream. Given the extended period available for immigration, this species should continue to enter the lake during weir spillages and no specific requirements are recommended as necessary.

Some specific requirements are needed for trout and salmon however, as the time "window" for their migration is shorter. There are two broad options for passage of these species:

- a fish pass
- no fish pass but ensuring adequate flow over the weir by controlled releases of stored water.

A third option could be the periodic netting of fish below the weir, and their transfer into the lake. To be effective, this would require that fish accumulate in an area that could be readily netted. It would also require a commitment by the fisheries managers to carry out/oversee the netting, and as such, may be unacceptable to the managers.

6.1.1 Fish Pass

The proposal at present is to pass the residual flow of 0.1 m^3/s down a fish ladder which would be incorporated into the new intake structure; float controlled gates would enable the pass to operate over a full range of lake levels. A flow 100 l/s would be sufficient to operate a small pass (it would provide a flow over a sill of 1.0 m x 0.15 m, I Jowett, MAF Fisheries pers. comm.), and conceivably could provide some surface flow along the rough substrate in the Wahapo River to the confluence of the Mapourika River (distance of 1 km), it would certainly be insufficient to provide for passage needs of large trout and salmon (a minimum depth of 0.3 m is regarded for adult sea-run salmon). However, it would provide habitat for native fish and small trout as well as maintaining most of the invertebrate community in this reach of river. Modification of the river bed to achieve this minimum depth requirement is probably impractical considering the large substrate and gradient (1:10).

Thus, at low flows, trout and salmon could not reach the fish pass (assuming there is no substantial leakage from the weir or overflow from the race) meaning that it would become superfluous. As the residual flow has benefits for other species though it is desirable that it still be discharged although via a pipe and not a ladder. Should a fish pass be the preferred option then a substantially larger residual flow would be required to provide access to it.

6.1.2 Flow Regime (Passage of Intermitment Controlled Releases)

Reference to the actual lake level data (1986-1988) indicate that flows overtop the weir for substantial parts of the period from April to June. Hence the present situation provides virtually no problems to salmonid (trout and salmon) passage, except for some short term delays. Consideration of the data on mean daily lake levels (1968-79, 1985-88) shows that, under the simulated operating regime, spills would still occur over the weir at least once per month on 14 of the 16 years of record for the month of April, 11 of 16 years for May, and 10 of 16 years for June. For each year, some spill would have occurred at least once over this three month period. During sustained spillages, salmonids would enter the lake, although there could be substantial delays due to the reduced frequency of spillages.

With modification to the existing weir, it should be possible to provide controlled spills to "attract" fish upstream and provide sufficient water for their passage. The quantity and periodicity of such spills should be subject to agreement between the developers and the fishery managers (the Transitional Westland Regional fish and Game Council). For instance, such flows could be in the order of 4 m^3/s for a 36-hour period (two nights, one day) to be released every three weeks from mid April to mid June should no natural spills have occurred over this time. In practice it would be possible to reduce daytime flows substantially (e.g. to 1 m^3/s) as little migration will occur during daylight.

Such controlled flows should be staged rather than being released all at once; ramping rates would need to be agreed upon e.g. increase (or decrease) of 1 m^s/s every 0.5 h is suggested for consideration.

From the mean daily lake level data, it is possible to get an idea of the probability of such controlled releases being needed.

For the three 3-weekly periods from mid April - mid June (15 April - 3 May, 4 May - 24 May, 25 May - 14 June), the occurrence of a 2 m level occurring for two consecutive days, was calculated (this being an approximation of the proposed controlled release regime). For the 16 years of data available, these conditions were satisfied for nine of those years for the first 3-week period, for eight years for the second period, and for nine years for the third period. Overall then, this indicates that normal events will provide spills of sufficient size and frequency for over 50% of the time. Thus over a 2-year period, three natural spills would occur but need to be supplemented by three controlled spills.

Although the design aspects are obviously beyond the present report, it is suggested that the existing level-board structure (adjacent to the true left bank of the Wahapo River), could be modified. This would involve excavating this area to provide controlled spills down to the 2 m drawdown permitted and some lifting mechanism to allow spillage to occur beneath the gate (provided velocity of water did not exceed 3 m/s). Alternatively, boards could be lifted from the top to allow spilling - if so, some rough ponding area would be needed immediately downstream to provide a depth of water that fish could use to jump over the boards. Should it be decided to incorporate this gate system adjacent to the raceway intake, then some attention may need to be given to the downstream side of the weir, as the slope here is somewhat greater than in the area in front of the level board structure.

6.2 Fluctuating Lake Levels

Increasing the range of drawdown from the present 0.8 m to 2.0 m will have a number of undesirable impacts.

The exposed shoreline and adjacent macrophytes already have a coating of fine grey silt. Greater drawdown will increase this rather unsightly effect. More significantly from a fisheries viewpoint, it will have a major impact on the productive (littoral) zone of the lake. The present macrophyte zone extends from near the surface (say, 0.5 m below lake-fill level), to 2.5 m. From the bathymetric map (Irwin 1979), the 2.5 m contour represents 3.7% of the total surface area of the lake (in reality it will be somewhat less than this as the Waitangi-taona River has produced a substantial outwash fan at the head of the lake which has 'obliterated' much of the shallow littoral zone in this area).

Drawdown of lakes is one of a range of management practices used to control growth of "nuisance" weeds in hydro lakes. Thus an overnight exposure of weed in lake Aratiatia produced a 25% kill of lake weed (Viner *et al.* 1989). Drawdown of a few days in Lake Wahapo would probably be sufficient to kill all exposed macrophytes. Therefore, given the frequency of drawdown, it can be expected that all macrophytes within the 2 m drawdown will die, i.e. loss of approximately 80% of the existing macrophytes. During maximum drawdown, the remaining macrophytes (2.0-2.5 m depth) would then be more susceptible to damage from the wave-slap and cropping by black swans.

Although the lake has a high density of freshwater mussels below the macrophyte zone, these are not utilised by fish as food. The animal fauna associated with the macrophytes will be the most important food source for lake fish. Hence, virtual loss of this resource will produce a corresponding decline in the fish stocks.

A further consequence of drawdown would be the periodic dewatering of the swamp area at the head of the lake (adjacent to the mouth of Friends Creek). This swamp will inevitably be an important foraging area for eels, and may also be important for some waterfowl.

Loss of macrophyte beds will be a rather immediate effect of drawdowns - after weed death, subsequent drawdowns will probably have little impact on fishery values. However, the barren lake margin will be unsightly and the lowered water level may affect water tables and hence the wellbeing of kahikateas and other trees. Consequently drawdown to the extreme range should be avoided whenever possible.

During the construction phase, it would be important not to draw the lake down below the proposed operating range. Lowering to 2.5 m would expose and kill all macrophytes. However, as some lowering is inevitable, it would be beneficial to keep the lake at a reasonably constant level - this would enable some weed colonisation to a greater depth. There is a possibility that generally lowered levels that will occur during hydro operations might enable this new growth to 'consolidate' and be retained. This would depend on the operating regime adopted, as a period of one month's "shading" (for instance, when levels return to lake-fill, any growth below 2.5 m would effectively be shaded) would cause considerable die-back of weed and two months shading would kill virtually all weed (roots would remain viable for longer periods) (R Wells, MAFTech, Ruakura, pers. comm.).

Contrary to expectations, Tonkin (1989a) found a good population of all age classes of brown trout in Lake Wahapo. This prompted him to comment that "a significant fishery exists ... and is largely unexploited by all but a few locals" (Tonkin 1989b). The nearby Lake Mapourika has an important fishery based on landlocked quinnat salmon. The outflow from both lakes, the Okarito River did not feature significantly in the most recent angler survey (Richardson, Teirney, and Unwin 1985) nor in a previous one (Graynoth and Skrzynski 1974). Given that the proposed hydro scheme has limited storage and hence limited capability to alter flows downstream of the powerhouse, it is unlikely that scheme operations will affect the fisheries values of either location.

7 RECOMMENDATIONS

1. That no fish pass be built (unless higher residual flows are negotiated).

2. That the present "rough" surface of the weir be retained (this facilitates fish passage).

3. That the presently required residual flow (0.1 m^3/s) be discharged from a pipe (or equivalent structure) rather than via a fish pass/ladder.

4. That the developers and fishery managers met to negotiate these recommended flows, using those figures given in Section 6.1.2 as a

starting point for discussion. It is suggested that the agreed flow regime be reviewed after 3-4 years to establish its effectiveness.

5. That maximum drawdown take place as infrequently as possible.

6. That, during the construction phase, the lake not be drawn down below the 2 m operating range, but be held at a reasonably constant level.

8 ACKNOWLEDGEMENTS

We wish to acknowledge the helpful discussions held with Chris Tonkin (Transitional West Coast Regional Fish and Game Council, formerly Westland Acclimatisation Society). Thanks are also due to Dr Mike Patrick, Royds, Garden Ltd, Dunedin, for a copy of the report on macroinvertebrates.

9 REFERENCES

Davis, S.F. 1987. Wetlands of national importance to fisheries. *N.Z. Freshwater Fisheries Report No. 90.* 48 p.

Falla, R.A. 1975. "The bird fauna". Pp. 319-337 *In*: Jolly, V.H. and Brown, J.M.A. (eds.) "New Zealand Lakes". Auckland University Press.

Flain, M. 1982. Quinnat salmon: a study (Lake Mapourika). *Freshwater Catch* 16: 6-7.

Flint, E.A. 1975. "Phytoplankton in some New Zealand lakes." Pp. 163-192. *In*: Jolly, V.H. and Brown, J.M.A. (eds.) "New Zealand Lakes". Auckland University Press.

Graynoth, E., and Skryznski, W. 1974. The West Coast and Westland trout fishery. *N.Z. Ministry of Agriculture and Fisheries, Fisheries Technical Report No. 120.* 30 p.

Irwin, J. 1979. Lake Mapourika 1:10,000. Lake Wahapo 1:8,000. Bathymetry. NZ Oceanographic Institute Chart, Lake Series.

Kelly, G.R. 1988. An inventory of whitebaiting rivers in the South Island. *N.Z. Freshwater Fisheries Report No. 101.* 65 p.

Livingston, M.E., Biggs, B.J., and Gifford, J.S. 1986. Inventory of New Zealand lakes. Part II. South Island. *N.Z. Water and Soil Miscellaneous Publication No. 81.* 193 p.

Main, M.R. 1989. Distribution and post-glacial dispersal of freshwater fishes in South Westland, New Zealand. *Journal of the Royal Society of New Zealand 19(2)*: 161-169.

Mort, M. (n.d.). "Ninety Years of Electric Power Supply on the West Coast." West Coast Electric Power Board. 60 p.

Richardson, J., Teirney, L.D., and Unwin, M.J. 1985. The relative value of West Coast and Westland rivers to New Zealand anglers. *N.Z. Ministry of Agriculture and Fisheries, Fisheries Environmental Report No. 75.* 101 p.

Royds, Garden Ltd. 1990. Assessment of the macroinvertebrate population of Lake Wahapo. Internal report. 5 p.

Stout, V.M. 1975. "Canterbury, Nelson, and Westland Lakes." pp. 110-122. *In*: Jolly, V.H. and Brown, J.M.A. (eds.) "New Zealand Lakes". Auckland University Press.

Tonkin, C. 1989a. Lake Wahapo fishery. Report to the West Coast Electric Power Board. Westland Acclimatisation Society. 7 p.

Tonkin, C. 1989b. Lake Wahapo Report. Westland Acclimatisation Society Annual Report 1989: 11.

Viner, A.B., Howard-Williams, C., Forsyth, D., James, M., Reid, V., and Woods, P. 1989. Weed freezing operations on Lake Aratiatia. Report prepared for North Island Hydro Group, Electricity Corporation of New Zealand. 14 p.