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The Waiau River (Southland) whitebait fishery:a consideration of the impacts of the Mararoa Dam and flow diversion from the river

by

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prepared for:Waiau River Working Party

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Introduction

The Waiau River is truncated below its confluence with the Mararoa River by the Mararoa Dam. As a result, most of the water from the Mararoa River flows into Lake Manapouri. This lake, instead of draining down the lower Waiau to the sea below Tuatapere, dam now passes via West Arm, through the Manapouri Power Station, and to sea through a tail race leading into Deep Cove, Doubtful Sound. The flow of the Waiau immediately below the dam is at most times reduced to virtually nil (a nominal flow of 0.3 cumecs is assigned to flow through a fish pass in the dam, which may no longer be effective). Before construction of the dam, there was a median flow of ca. 400 cumecs at the dam site. Now, the river's flow below the dam redevelops through the inflows of a series of tributaries the largest of which are the Borland (72 km up stream from the sea and flow of 9.9 cumecs), Monowai (70 km and 14 cumecs), Wairaki (33 km and 7 cumecs), Lillburn (32 km and 11.3 cumecs), and the Orauea (15 km and 9.7 cumecs - note that these tributary flows are estimates, in the absence of gauging records, Riddell *et al.* 1993). By the time the river reaches the sea, from the addition of tributary flows and any gains from ground water, median flow is ca. 68 cumecs.

Water is not impounded at the Mararoa Dam at all times. In particular, when the water of the Mararoa River is turbid, and occasionally when lake level in Lake Manapouri is in danger of exceeding its permitted maximum level, water is allowed to spill at the dam and flow down the river. At such times, the flow in the Waiau can be quite similar to its pre-hydro state.

The Waiau River Working Party was convened by the Southland Regional Council to consider the environmental impacts of the Mararoa Dam, and to commission studies to clarify these impacts prior to application by Electricity Corporation of New Zealand (ECNZ) for renewal of its Resource Consents to exploit water from the river system for electricity production by the Manapouri power station at West Arm/Deep Cove. The Working Party has included amongst matters that it considers require clarification and discussion, the question of the impacts of the dam and consequent reduction of river flows, on the whitebait fishery of the Waiau River.

As in most New Zealand rivers, there is a fishery for whitebait at the mouth of the Waiau. The river has always had a locally valued whitebait fishery, though it has perhaps not attracted the intense attention characteristic of the fisheries in rivers along the coast of South Westland, nor for that matter the fishery of the Mataura River, further east in Southland (Kelly 1988); numbers of whitebaiters in these rivers, and their catches, are higher than in the Waiau.

This report attempts to address issues related to the construction of the dam at Mararoa, the reduction in flows down the Waiau River and at its mouth, and its impacts on the Waiau whitebait fishery; it is stressed at this early point that there are no data available on the level of exploitation of the Waiau River whitebait fishery, or of its productivity, before the dam was constructed, and there is only minimal information on the fishery since construction. The only historical catch information on whitebait fisheries in any part of New Zealand, other than for the West Coast of the South Island, is that provided in the N.Z. Marine Department Annual Reports on Fisheries, from the early 1930s until the mid-1950s, but even this information combines catches for all the rivers of Southland from the Waikawa to the

Waiau. So, no explicit data are known for whitebait catches from the Waiau, or any other Southland rivers.

Composition of the whitebait fishery

Five species are known to make up whitebait fisheries in all parts of New Zealand, but the proportional contributions to the fishery of the various species differ with river, season, and the characteristics of the water (McDowall 1984; McDowall and Eldon 1980). The species composition of the Waiau fishery is undocumented. The only broad, regional analysis of the composition of the New Zealand fishery (McDowall 1965) makes no mention of the Waiau, or even of Southland fisheries as a whole.

This report, therefore, attempts to place the Waiau River fishery in perspective, based on the author's long involvement in research on and management of New Zealand's whitebait species and the fisheries based upon them (McDowall 1964, 1965, 1968, 1984; McDowall and Eldon 1980), but is based on minimal objective and explicit data on the Waiau River whitebait fishery.

Factors affecting whitebait migrations

Whitebait run into all New Zealand rivers and streams, from the very smallest creeks that trickle across the sands, or wind amongst beach gravels to get to the sea, to the largest rivers like the Clutha and Waikato which discharge huge volumes of water to sea through broad, invariably open, and sometimes navigable, mouths. There are few reliable, comparable quantitative data that document the whitebait productivity of rivers around New Zealand.

Historically, total national whitebait catch has always varied greatly. Catch in the West Coast South Island) fishery, which in recent decades has been the most productive in New Zealand, and is the only area with any long-term and reasonably up-to-date documentation, varied from less than 10 tonnes to over 320 tonnes in the years between 1931 and 1973 (Fig. 1). It is recognised as a hugely variable fishery, with the reasons for this variation not understood (though there are plenty of theories that lack corroboration).

Catch also varies greatly between rivers, and to some extent this variation defies explanation. Glacier-fed rivers, such as the Cook, Karangarua, Haast and Arawata are sometimes unproductive; but in some years, or for part of some seasons, one or other, or several, of these rivers may have highly productive runs, possibly at times when the snow-fed content of their flows is less than at other times (and so the water less sediment-laden and turbid). Nevertheless, in the fisheries along the West Coast of the South Island, catches tend to fluctuate between years in a closely synchronous manner from year to year (McDowall and Eldon 1980).

Species composition varies greatly between rivers, during the season in any river, with changing river conditions in a river from day to day, and even with location in a river. These variations are complex, and to some extent understood (McDowall and Eldon 1980), but they

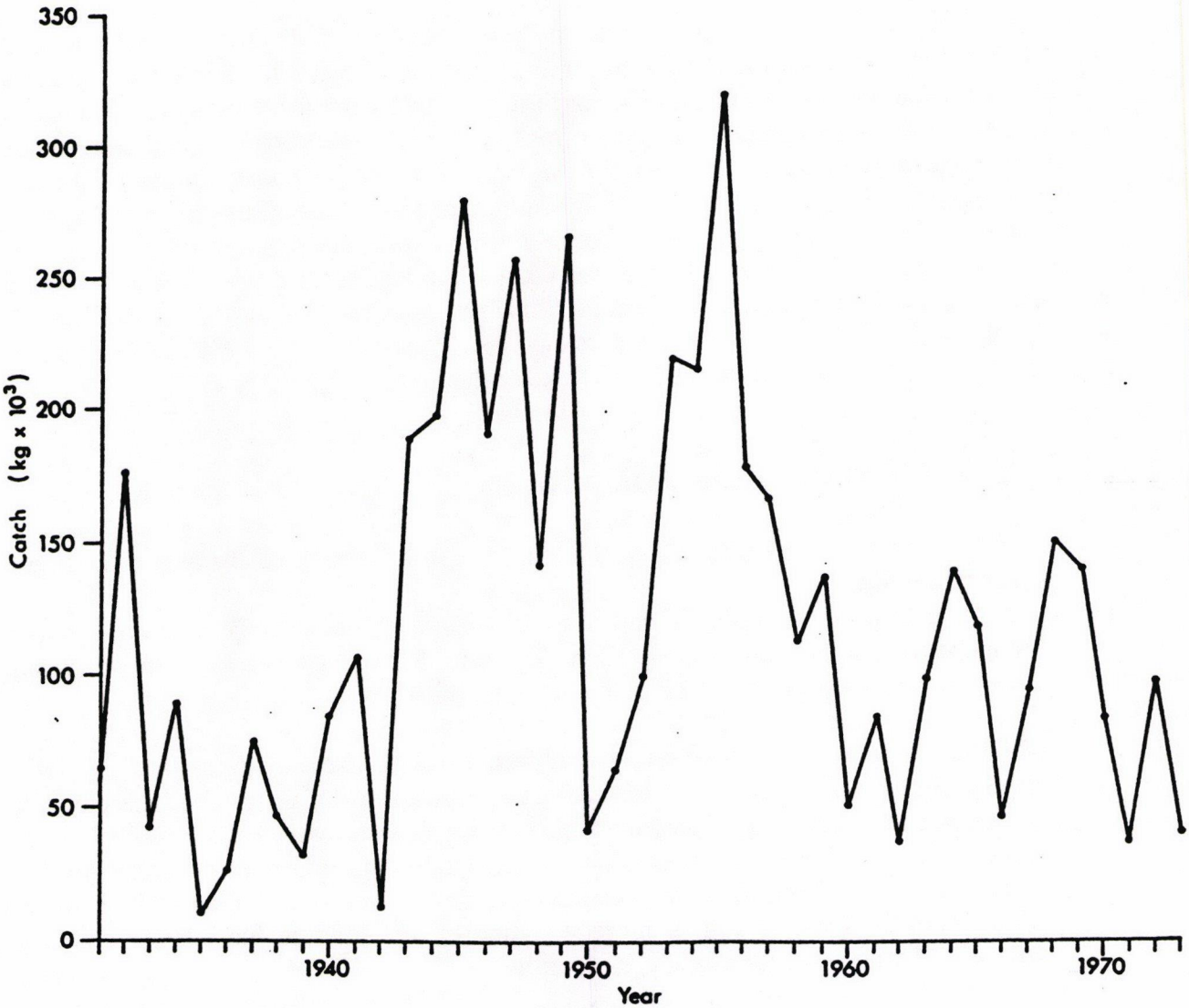


FIGURE 1. Variation in whitebait catch, West Coast, South Island, 1931-1973 (from McDowall and Eldon 1980).

nevertheless make for a highly complex fishery. The whitebait fishery in the Waiau is likely to conform to this complexity, to exhibit wide variations in productivity and species composition between and within seasons, and to show variation from time to time, and from place to place within the Waiau, in the composition of the catch.

As there are no data on these variations, on either total catch or its species composition, all that can be done is to present opinion on its likely characteristics, based on knowledge of other river systems and their fisheries.

The Waiau River whitebait fishery

Knowledge of the fish fauna of the Waiau makes it possible to predict what species will occur in the fishery, though not their proportions. Of the five species known to include a whitebait juvenile stage in New Zealand, four are recorded from the Waiau, viz. inanga — *Galaxias maculatus*, the commonest species in nearly all whitebait fisheries and likely to be the commonest in the Waiau; koaro — *G. brevipinnis*, important in some whitebait fisheries; banded kokopu — *G. fasciatus*, also locally important in the catch; and giant kokopu — *G. argenteus*, rarely encountered by whitebaiters; the fifth species, shortjawed kokopu — *G. postvectis*, has not been recorded from the Waiau, but does occur in the rivers of southern Fiordland to the west of the Waiau, and quite probably enters the Waiau, too (see McDowall 1984, McDowall and Eldon 1980; Rowe *et al.* 1992, Stancliff *et al.* 1988, for general or regional discussions of the composition of New Zealand whitebait fisheries).

Changes in the flows in the Waiau River

Since impoundment by the Mararoa Dam, there have been two principal changes to the flows in the river below the dam:

1. "Normal" flows have been reduced by diversion of water to West Arm in Lake Manapouri and thence into Deep Cove, Doubtful Sound; median flows in the Waiau at Tuatapere are now about 67 cumecs;

2. "Flood" flows also have been reduced in frequency and size; however, at times, flood flows of turbid Mararoa water are redirected down the Waiau to avoid the entry of turbid waters into Lake Manapouri; these flood flows are typically retained in the lakes system, as the flood recedes, once water quality has improved sufficiently to be acceptable to the Guardians of Lake Manapouri. This return and then rediversion of Mararoa waters may result in more variation in the flows in the Waiau, both the amount of change occurring and its rapidity.

The Mararoa dam has potential to prevent upstream migration of native fish, including species involved in the whitebait fishery, as well as eels, lampreys, and other migratory species; movements by introduced trout are also likely to be affected. These issues will be discussed in a separate report, though the potential for the dam itself to affect the behaviour of fish species involved in the whitebait fishery is noted here.

What causes whitebait to run?

Whitebait are known to fluctuate greatly in the numbers running into a river from the sea from one day to the next. Huge catches may suddenly begin, and equally suddenly end. Research on West Coast South Island rivers suggests that the initiation of large whitebait runs is usually stimulated by significant flood events in the rivers. The first major runs of a season usually follow the first series of substantial spring floods, and later runs begin typically as a large flood recedes and the turbidity levels of the water decline (Benzie 1968; McDowall and Eldon 1980). It is hypothesised that the reason for the stimulation of runs by floods is that large volumes of fresh water are being flushed to sea, and whitebait, seeking to return to fresh water, encounter the reduced salinities and salinity gradients at sea, and follow them into the river mouths. This hypothesis remains untested. In addition, floods scour out the mouths of rivers, which sometimes become narrowed, or even blocked, when the rivers' flushing flows cannot resist the closing effects of oceanic surf and coastal drift of sand and gravel. A larger, more open river mouth may facilitate whitebait migration from the sea.

Impacts of Waiau flow management on the whitebait fishery

Impacts of flow management practices on the Waiau whitebait fishery are likely to fall into two categories, viz. (a) the impacts of mouth blockage, and (b) changed flow patterns.

(a) Mouth blockage

The potential for reduced flows to lead to mouth blockage of the Waiau River is a matter for serious concern for the fishery. Fairly obviously, if the mouth closes, entry of fish into the river is prevented; while not so obvious, if the mouth is only partially blocked entry is still possible, but hindered. This prevention or hindrance affects the fishery at two levels. Firstly, the fish are not available to fishers. Secondly, and of more long term concern, breeding stock, upon which sustainability of the whitebait fisheries of Southland depends, cannot enter the river and occupy rearing and feeding habitats, mature and breed.

There is no reason to consider that whitebait return to the river of their birth (as is known to occur in salmon, a phenomenon known as homing). If whitebait are hindered or prevented from entering the Waiau, they are unlikely to "wait at sea" until the Waiau River mouth opens. Some whitebait may sense the fresh water seeping through the beach gravels at the river mouth and move inshore, becoming washed onto the beach by coastal surf. The greatest likelihood is that they will move into other rivers along the Southland coast, such as the Oreti or Aparima, or some of the smaller streams entering Te Wae Wae Bay, and thus be lost to the Waiau fishery and fish populations.

If substantial floods are allowed to flow down the river by rediversion of Mararoa flood waters and surplus waters from Lake Manapouri, then a flushing and opening of the mouth is likely to take place to the benefit of the fishery. The main period of migration from the sea by whitebait is spring (August to November), and an open river mouth at this time is crucial for the well-being of the fishery. However, in addition, emigration to sea of the

larvae of whitebait species is equally important to the viability of the whitebait fisheries of Southland. This larval emigration takes place during autumn through winter (February-June).

(b) Changed flow patterns

The impacts of reduced flows in the Waiau and reduced discharges to sea at its mouth are difficult to evaluate, in the absence of any pre- or post-impoundment figures for the productivity of the fishery. But, reduction in the general "normal" flow of the Waiau, does not necessarily result in a reduction in its fishery. To the extent that substantial floods still flow from the Waiau (when tributaries flood and/or the Mararoa is diverted downstream), natural flood events not greatly different from those of pre-dam times should still attract whitebait to the Waiau River mouth.

In the discussion that follows I endeavour to examine issues relating to the size of whitebait runs in various rivers of two areas - South Westland and Southland - in relation to what knowledge exists of their whitebait fisheries.

A rather subjective analysis of whitebait runs and river flows in a series of these South Westland rivers perhaps throws some light on the impacts of flow reductions in the Waiau. Data are available for annual catch from seven rivers - Waita, Haast, Okuru, Turnbull, Waiatoto, Arawata and Cascade - for five years - 1969-1973 (Table 1 from McDowall and Eldon 1980).

With regard to the catch figures it needs to be understood that:

(i) in any river catches fluctuate greatly between years;
(ii) fluctuations in the various rivers do not necessarily synchronise well with each other.

Flow data from the Haast and Arawata are available from gauging stations; flows in the remainder have been estimated from catchment area, topography, and the known flows of the Haast and Arawata (Table 1; M.J. Duncan, pers. comm.).

TABLE 1. Whitebait catch (kg) South Westland rivers 1969-1973 and estimated median river flows (cumecs).

River	1969	1970	1971	1972	1973	Flow
Waita	1868	3584	2269	2375	1202	19
Haast	1361	2245	412	3997	1322	124
Okuru	2914	3235	1310	5170	814	44
Turnbull	1413	1752	491	1484	313	27
Waiatoto	5430	9654	5085	7744	3955	67
Arawata	1676	2663	2164	3391	1753	125
Cascade	10752	8377	6559	12420	19620	70

In very general terms, there is little that explicitly suggests that big rivers typically have larger whitebait runs than smaller ones, though some big rivers do have large runs, examples being the Buller and Wanganui (South Westland). But some of the most productive rivers on the West Coast can only be described as "small: e.g. the Waita, just north of Haast (median flow estimated at 19 cumecs) and the Awarua, at Big Bay (12 cumecs). Both these rivers at times have very large whitebait runs, far exceeding those of nearby larger rivers like the Okuru (44 cumecs), Turnbull (27 cumecs), Arawata (125 cumecs) and Haast (124 cumecs). Rank order for catch varies substantially between rivers and years (Table 2). Thus the Haast, the second largest river, had rank order catch varying from four (1972, 1973) to seven (1969, 1971); the Waita, smallest of the rivers, had rank order catch of three (1970, 1971) to six (1972). About the only consistent feature of an analysis of rank order of catch is that the Cascade (size rank 2) and the Waiatoto (size rank 3) were consistently the two most productive rivers, usually the Cascade, followed by the Waiatoto. Whitebait runs in the Waita exceeded those of the Okuru, Haast, and Arawata in three of five years (1969-1973) and that of the Turnbull in all of these years (Tables 1 and 2). This may seem at variance with the hypothesis (see above) that big whitebait runs are attracted into rivers following floods, and there is no explicit or entirely convincing explanation for this apparent contradiction; possibly big floods are more important in attracting runs into small rivers than into large ones.

TABLE 2. Rank order for South Westland rivers: river size and catch 1969-1973 (catch data from McDowall and Eldon 1980).

		Year				
	Size	1969	1970	1971	1972	1973
1	Arawata	Cascade	Waiatoto	Cascade	Cascade	Cascade
2	Haast	Waiatoto	Cascade	Waiatoto	Waiatoto	Waiatoto
3	Cascade	Okuru	Waita	Waita	Okuru	Arawata
4	Waiatoto	Waita	Okuru	Arawata	Haast	Haast
5	Okuru	Arawata	Arawata	Okuru	Arawata	Waita
6	Turnbull	Turnbull	Haast	Turnbull	Waita	Okuru
7	Waita	Haast	Turnbull	Haast	Turnbull	Turnbull

Mean whitebait catch for these five South Westland rivers for five years is plotted against median flows in Figure 2. When the catch data for the Haast and Arawata are included there is no obvious relationship between flow volumes and catch. These two rivers are extensively glacier-fed, and it could be argued that their lower catches reflect this fact; however, the Waiatoto is also snow fed (though perhaps less than the Haast and Arawata), but has much higher catch. Elimination of all three "snow" rivers leaves only four data points, three of them clustered closely together, and there remain inadequate data for reliable analysis.

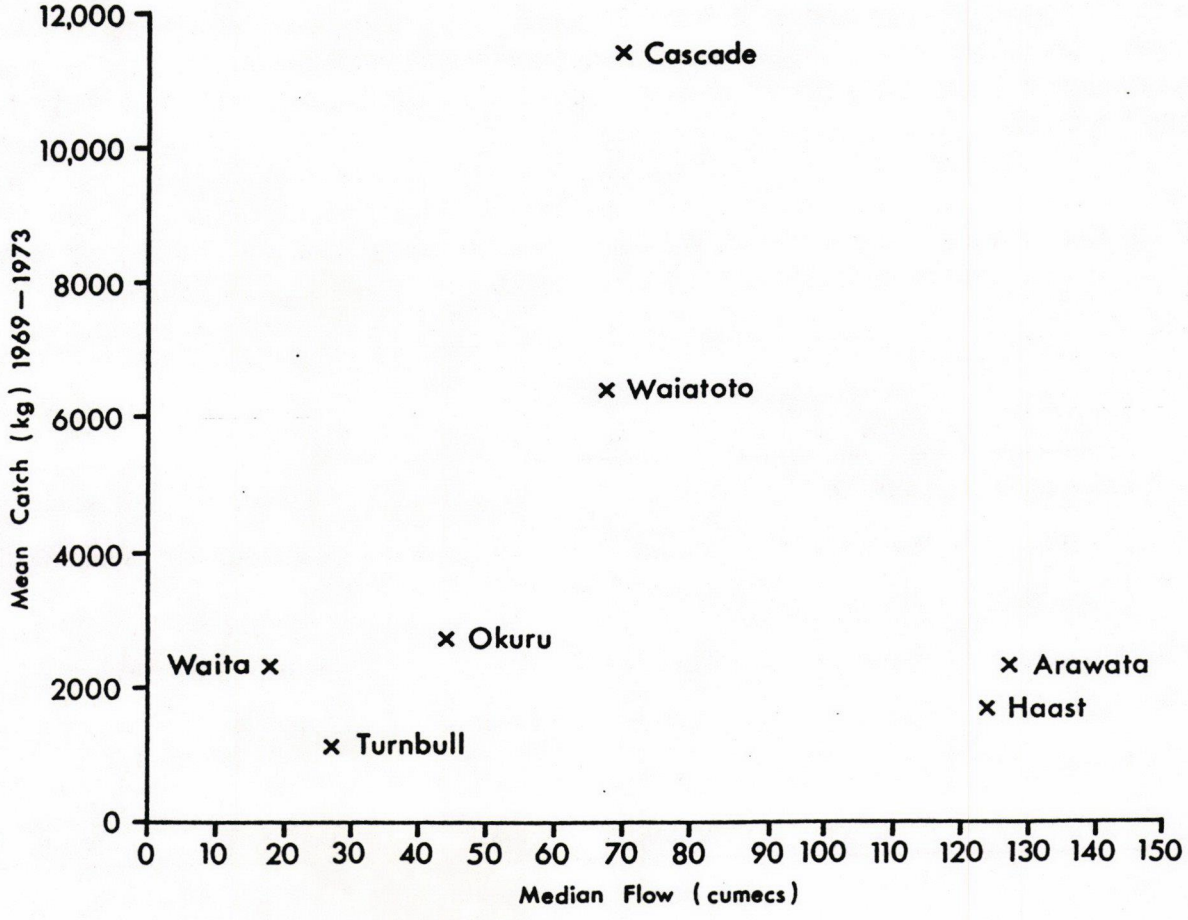


FIGURE 2. Relationship between whitebait catch and median flows in South Westland Rivers, 1969-1973.

An interesting point about the Waita, Cascade and Awarua, all highly productive whitebaiting rivers, is that each drains extensive areas of low elevation swampy lakes, but then so too does the Turnbull, which has much lower reported catches. However in the case of the Turnbull, fish migrating from the sea up the Turnbull and into the Hapuka Swamp are protected from exploitation by a closed fishing area, so that catch data for the river do not reflect the Hapuka Swamp component of the run.

This point aside, there is little to suggest from catch data for these South Westland rivers that the size of whitebait runs is related to the size of rivers.

A similarly subjective analysis of the size of whitebait fisheries along the Southland coast is also possible. There are even fewer data for these rivers than for South Westland. Kelly (1988) conducted a review of South Island whitebait fisheries which provides some information on the usage made of Southland's whitebait rivers.

According to Kelly (1988), the Waiau (post impoundment - 67 cumecs median flow) attracts an average of 50-60 whitebaiters a day, compared with 200 on the Mataura (51 cumecs), 250 on the Aparima (11 cumecs), and 60 on the Oreti (29 cumecs). But 120 are reported to fish on the Waikawa and 30-40 on the Wakapuata. He concluded that some small Southland rivers like the Waikawa and Waimatuku have fisheries that are productive out of all proportion to their size. These figures have little precision and firm conclusions cannot be drawn from them. Direct comparisons of the uses made of such rivers must take into account both the quality of their fisheries, their proximity to centres of population and various "sociological" factors like the attractiveness of the locality, or traditional fishing patterns and commitments to a river. But the Mataura River has always, even before construction of the dam on the Waiau, been the most popular and productive whitebaiting river along the Southland coast; yet it has a flow less than 15% of that of the Waiau before impoundment.[1]

Kelly's (1988) survey of New Zealand whitebaiting rivers provides little rigorous or analysable data that would, for example, allow comparisons of fishing intensity or popularity with catch and river whitebait catches. However, a conclusion similar to that drawn from the above examination of South Westland rivers seems to apply here, i.e. there is no obvious and strong connection between river size and the popularity of Southland whitebaiting rivers.

Flow volumes and whitebait fisheries - is there any causal relationship?

The data on which this discussion is based are sparse and informal, but they are about all that are available. The two scenarios discussed above provide some very general indications that productivity of the whitebait fisheries in the various rivers relates to factors that are far more complex than just river flows (though these factors may include river flows).

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[1] Dr Glenn Lauder, Department of Conservation, Invercargill has advised that the numbers of whitebaiters reported by Kelly (1988) and cited here have not applied in recent years, being much lower; however, it is not known whether this difference is a response to some recent years of poor runs, to changes in whitebaiter activity, or other sociological changes.

One point that can be derived, of relevance to both South Westland and Southland, is that rivers with flows of about 70 cumecs, such as the Cascade and Waiatoto, and even much lower flows as in the Okuru and Waita, as well as the Mataura, attract large runs of whitebait, and these are about the same size as, or smaller than, the Waiau (post-impoundment at ca. 67 cumecs). Given this point, there is no reason, based on river flows alone, why the Waiau should not also support a highly productive fishery. How the post-impoundment fishery compares with the pre-impoundment fishery is another matter.

Whitebait fishery issues related to the management of Waiau flows

Mention is made, above, of issues relating to river mouth blockage and hindrances to whitebait migration. These hindrances can be ameliorated if river flows maintain an open river mouth, or open the mouth when it is closed. For this reason, some flood flows, especially during spring, are important for maintaining access to the river for whitebait.

In addition, increased flows into the sea from the river will attract whitebait to the river on the basis of increased areas of reduced salinities at sea around the river mouth. Again, flood flows from the Mararoa River, and the lakes, are likely to stimulate runs of whitebait into the river, to some extent redressing any potential losses to the fishery mentioned above.

The critical question for this report has been to attempt to determine whether there has been any decline in the size of the Waiau River whitebait fishery, following impoundment. Examination of the whitebait fisheries of South Westland and Southland suggests that flow volumes, in themselves, are unlikely to explain differences in the size of whitebait fisheries in different rivers in close geographical proximity. About the most certain thing that can be said is that no substantial case can be made that demonstrates that small rivers have lesser whitebait runs than large ones.

This is not, however, quite the same thing as saying that a reduction in the size of the Waiau has not contributed to a decline in the size of its whitebait fishery. This question could only be answered from "before/after" data, and necessarily on the basis of a long time series of annual catch data from the river, and preferably with parallel catch data from other rivers of Southland, nearby. Otherwise, natural annual variations within and between rivers, in catch quantities and species composition, are likely to confound any effort to estimate effects. There is no opportunity to conduct such a before/after study, hence the need to rely on the sort of comparative and highly informal comparisons conducted above. The conclusions are far from having any certainty but are the best available.

Conclusion

On the basis of what little is known about whitebait catches and fisheries in the rivers of South Westland and Southland, there is no reason why the Waiau River, in its abstracted form and given that substantial floods still take place from the Waiau tributaries and by the diversion of the Mararoa, should not sustain a whitebait fishery of at least regional significance, particularly if flood flows during the spring continue to be discharged into the

river from the Mararoa River and Lake Manapouri, to ensure that the Waiau River mouth does not become seriously blocked by coastal drift of beach gravels, and to stimulate runs up the river.

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