To the Ministry of Works and Development

SUBMISSION ON THE PROPOSED LUGGATE/QUEENSBERRY HYDRO-ELECTRIC DEVELOPMENT

BY

G.J. GLOVA

S.F. DAVIS

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FISHERIES ENVIRONMENTAL REPORTS

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LUGGATE/QUEENSBERRY HYDRO-ELECTRIC DEVELOPMENT:

FISHERIES SUBMISSION

1. INTRODUCTION

Fisheries Research Division (F.R.D.) has been asked by the Department of Internal Affairs (D.I.A.) to submit a brief submission assessing the potential effects of proposed hydro-electric developments on fisheries in the Upper Clutha Valley (that portion of the catchment lying upstream of Lake Roxburgh). This is in addition to the comprehensive Environmental Impact Report submitted by D.I.A.

Four distinct development options have been proposed for the Luggate/Queensberry hydro-electric scheme. These were described in a recent report prepared by Brown (1980) of the Investigations Section, Power Division, Ministry of Works and Development. We have since been advised, though unofficially, that Option 4 has been chosen for preparation of the Planning Application. This Option, as we understand it, involves:

(i) the Luggate Dam with integrated power house facilities,

(ii) the Queensberry Dam at Maori Point (see map) flooding back to Luggate tailwater and discharging via a canal to a power house at Gravelly Gully.

In the latter scheme, approximately 9.5 km of the Clutha River (from Maori Point to the power house site) would become a residual river subject to an allocated minimum flow, spillway discharges, and flow contributions from its tributary streams.

The proposed hydro-electric development schemes will exert varying adverse effects on both recreational and native fisheries. Of particular

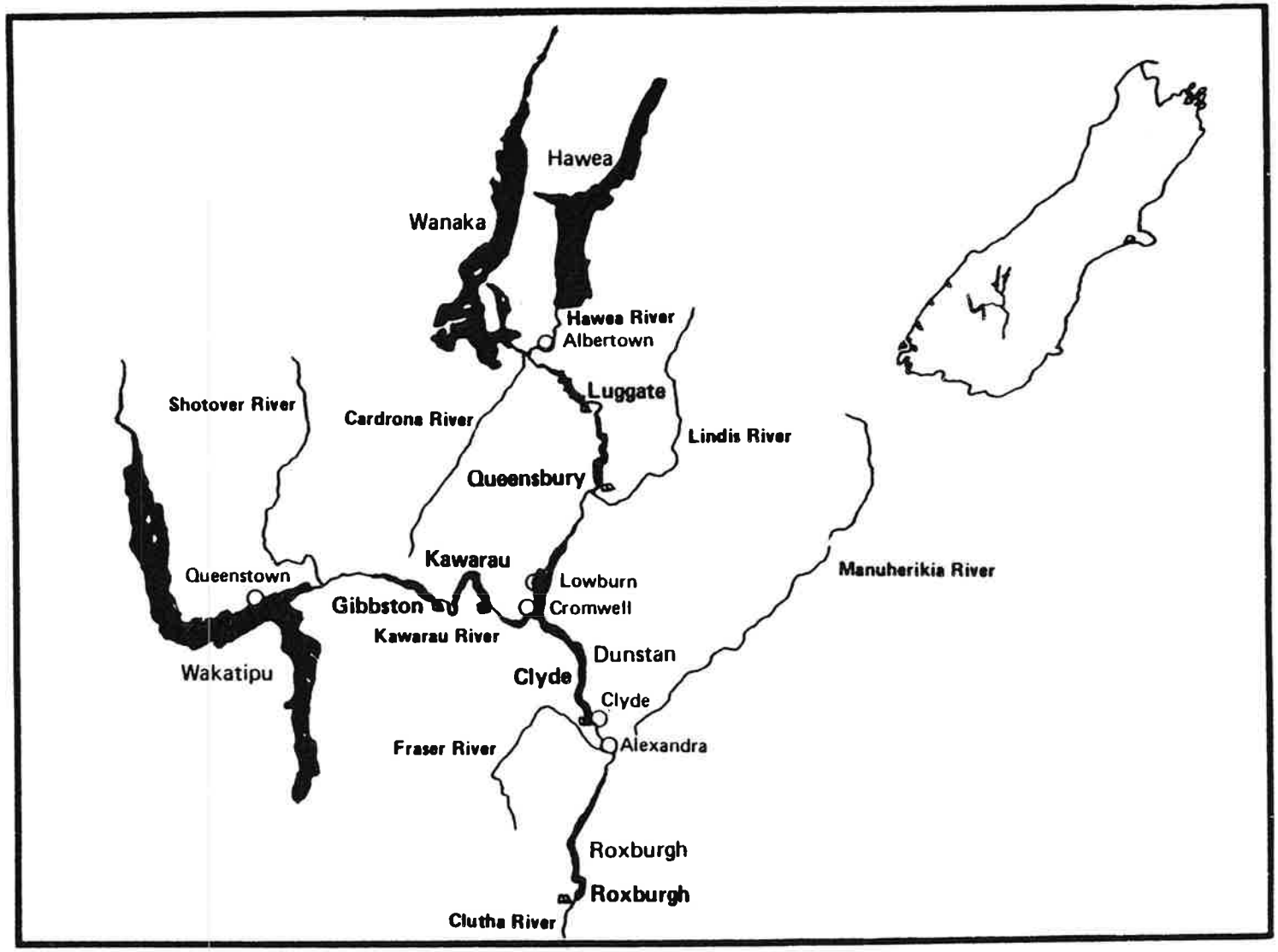

FIGURE 1. Upper Clutha Valley and proposed dam sites.

concern is the trade-off of a high quality "big river" fishery upstream of the proposed dam sites, for a lake fishery. With the continuing loss of our natural river fisheries, emphasis should be placed on providing the best fishery possible in residual rivers.

Accordingly, F.R.D. is greatly concerned about

(i) the flows (both minimum and spillway discharges) in the residual river

and

(ii) the problems of fish passage at dam sites, and possibly in the residual river itself.

These concerns, and possible compensation to fisheries are discussed in this submission.

2. THE FISH

(a) General

Fisheries in the Clutha River system are bisected by the Roxburgh Dam: downstream areas contain both sea-run and voluntary freshwater-resident stocks whereas upstream areas contain virtually "landlocked" stocks.

As no fish pass facilities were provided over or around the Roxburgh dam, anadromous (upstream sea-run) stocks of both native and introduced species were rapidly eliminated after commissioning of the dam in 1956. As a result of this, the fish fauna in the Upper Clutha has been transformed from what was a complex mix of both sea-run and voluntary freshwater-resident stocks in the pre-Roxburgh era, to a simplistic "landlocked" group at present.

(b) Introduced Species

Upstream of Roxburgh, there are populations of three introduced species of salmonids: quinnat salmon, brown trout and rainbow trout. Landlocked salmon populations are generally thought of as the lake-resident type, whereas trout are of both the lake- and stream-dwelling types.

Quinnat salmon are widely distributed in the Upper Clutha system. They occur in the source lakes and in Lake Roxburgh, and it appears that there may be a considerable downstream displacement of these fish via the Roxburgh Dam spillway to the lower river (Flain 1980). Little is known of the magnitude of their populations and of their basic life history, i.e. movements/migration, spawning areas, fry nursery areas, feeding grounds in lakes, etc. Like all Pacific salmon species, they die after spawning, but are of a considerably smaller size at maturity than their sea-run conspecifics.

Trout of both species are abundant and widely distributed in the Upper Clutha system, though populations of rainbows are more commonly

associated with lakes, and those of browns with streams. In an electric fishing survey on a total of 23 tributary streams of the Upper Clutha system, conducted by D.I.A. in February 1980, rainbows were found in only six of the streams (Cardrona River and its tributaries), whereas browns were present in virtually all. Both species are present in the Upper Clutha River though it appears from a creel census conducted by D.I.A. in 1979-80, that they are more abundant in reaches nearer to the source lakes. Jowett (1980) observed large numbers of trout of varying sizes in the section between the Wanaka outlet and Albert Town, while conducting hydrological studies in the area in November 1980. This reach contains an abundance of cover in the form of large boulders and an adequate food supply from the lake. Below Albert Town, he observed very few fish and described the habitat as poor (high water velocities, little cover and resting areas).

As yet, little is known of the basic life history patterns of the trout stocks in the Upper Clutha. No doubt there is considerable movement of trout populations between the Clutha River and some of its tributaries, in order for fish to meet the requirements of their different life stages (e.g. adult spawning, fry and juvenile rearing). Though there are a number of tributary streams, many are considered of marginal use for trout spawning and rearing. In some, the flows are intermittent (e.g. Albert Burn, Schoolhouse Creek, Kidd Creek) while in others sediment loads may be high (e.g. tributaries of Kawarau River, particularly the Shotover River) or silt deposits excessive (e.g. lower Kawarau River). Of the tributaries to the Clutha from Roxburgh up to the source lakes, those considered to be important for trout are the Kawarau, Lindis, Cardrona and Hawea. However, the recruitment potential of the Lindis and Cardrona is reported to be severely limited, as large sections go completely dry, particularly when demands for irrigation are high (Hutchinson, 1980).

The spawning areas of salmonids in the Upper Clutha system are poorly known. From a survey done in 1973, Hutchinson reported (1980) that well

graded spawning gravels were reasonably abundant, but scattered, at several points in the Clutha and Kawarau, and throughout the Lindis and Cardrona. He was of the opinion that a significant portion of the present rainbow trout recruitment arose from the Upper Clutha. Jowett (1980) commented that spawning habitat in the Clutha River in the vicinity of the proposed Queensberry Development, appears to be limiting, but that below the Lindis confluence some of the minor braids contain substrates suitable for spawning. However, these would most likely dry up under the minimum flow conditions of the future residual river.

(c) Native Species

Up until recently, little was known about the native fish species in the Upper Clutha. From the rather limited survey conducted by D.I.A. in February 1980, it appears that there may be no more than four species: two bullies (Gobiomorphus breviceps and G. cotidianus) and two galaxiids (Galaxias vulgaris and G. brevipinnis). These species appear to be widely distributed in the Upper Clutha system, with vulgaris and breviceps being mainly in the Clutha River and its tributaries, while brevipinnis and cotidianus are in the tributaries of the source lakes.

Eels continue to persist in relatively low numbers in the Clutha River system above the Roxburgh Dam. As far as we know, these populations consist only of the longfinned eel, Anguilla dieffenbachii. They are mainly relict populations, consisting of immature individuals that were in the area prior to the commissioning of the Roxburgh Dam in 1956. There is however, indirect evidence of some recruitment to the fishery. Present catches in Lake Wakatipu consist of two distinct size classes: a significant number of very small eels considered to represent relatively recent recruitment, and diminishing numbers of very large eels representing pre-Roxburgh recruitment. As no elvers (young eels from sea) have been reported getting past the Roxburgh Dam, it is believed that recruitment might occur via the headwaters of the Mataura River during extreme floods (P.R. Todd, pers. comm.).

In the lower river, a range of native species is present, such as common smelt (Retropinna retropinna), the giant kokopu (Galaxias argenteus), a sea-going population of koaro (Galaxias brevipinnis) and numerous other estuarine and marine migrants. Juveniles of both G. argenteus and G. brevipinnis are part of the whitebait group.

3. FISHERIES

(a) Recreational

The recreational fisheries of the Upper Clutha system presently consist of "landlocked" stocks of quinnat salmon, rainbow trout and brown trout. Quinnat salmon provide a lake fishery although there is some evidence of migration between the various lakes via the Clutha and Kawarau Rivers (R.T. Hutchinson, pers. comm.). Trout provide both lake and river fisheries and migrate freely throughout the Upper Clutha system.

Salmon make a significant contribution to recreational fishing in the source lakes and Lake Roxburgh, although these lakes, and the Upper Clutha, are better known for their excellent trout fishing. Presently, both the salmon and trout fisheries are wholly sustained by natural spawning, although in the past the rainbow trout fishery was to some extent augmented by hatchery stocking programmes managed by D.I.A.

River fisheries are typically best in those sections immediately downstream of natural lakes, where conditions are stable and the food supply abundant. This is certainly true of the Upper Clutha. Upstream of Roxburgh, the main fishery is reported to be in the Lowburn-Wanaka section, with the stretch from the Cardrona confluence to the Wanaka outlet offering one of the best fly-fishing areas in the South Island (Anonymous 1972). This has been further confirmed by Hutchinson (1980) in a survey done in 1973, who reported that the most productive section of the Clutha, in terms of catchable-size trout, was that part of the

river extending upstream from the township of Cromwell to the Wanaka outlet. Similarly, in the Kawarau River, the most productive area is reported to be that stretch from the Lake Wakatipu outlet to the Shotover River confluence.

Downstream from Cromwell to Lake Roxburgh, the Clutha is not rated as a popular fishing area, as its waters are subject to frequent discolouration, access is difficult, fishing is unproductive, and the number of fish utilising these waters is probably low (Anonymous 1972).

Below Lake Roxburgh, sea-run quinnat salmon and brown trout, and river-dwelling brown trout fisheries occur. Sea-run trout are larger on average than river resident fish (Graynoth 1974). A recent examination of scale samples from angler-caught quinnat salmon (Flain 1980) has indicated that fish which have spent an extended time in freshwater make a significant contribution to the salmon fishery in the lower river. This suggests that downstream displacement of lake-resident salmon is occurring past Roxburgh, and adding to the sea-run stocks of the lower river.

An evaluation of angler usage of the Clutha River is provided by the National Angler Survey presently being conducted by F.R.D. and the Acclimatisation Societies. The survey's main objectives are to assess, for each society, which rivers are the most popular with anglers, and to determine why anglers choose to fish a particular river. An outline of the survey is given by Teirney (1980) in a recent article in Freshwater Catch.

Data from these studies are still being collected, with preliminary reports expected to appear after mid-1981. The data available so far have been kindly made available to us by Ms L. Teirney, for the purpose of writing this submission. The estimates quoted below are therefore based on extrapolations from incomplete data, although we are confident that the final results will confirm the general trends we have indicated.

Because the survey considered each acclimatisation society individually, separate results are avilable for the Clutha below Cromwell (where it falls within the Otago Society district) and above Cromwell, where it lies in the Southern Lakes district. Data for other societies in the South Island provide estimates of the number of anglers travelling outside their home district to fish the Clutha. Table 1 summarises the results for both sections of the river.

TABLE 1. Summary of available data on angler usage of the Clutha River. (L.D. Teirney pers. comm.)

Society District	Results for anglers within the Society district		Results for anglers from outside the Society district	
	Est. Total No. of anglers	Est. Total visits/year	Est. Total No. of anglers	Est. Total visits/year
Otago (below Cromwell)	1 800	19 000	300	900
Southern Lakes (above Cromwell)	700	8 400	600	4 600

These figures indicate that the Lower Clutha is heavily fished by local anglers but receives little pressure from outside the Otago Society, while the Upper Clutha is popular with anglers from all over the South Island, with "outside" anglers accounting for nearly half the anglers fishing the river.

For the lower Clutha trout fishery, proximity to home, ease of access and the large area of water available to anglers were considered important, while scenic qualities rated average or slightly above average. By contrast the Upper Clutha, while also rated highly for ease of access and area of water fishable, was rated well above average for its scenic qualities and atmosphere of peace and solitude. The quinnat salmon fishery of the Lower Clutha accounts for about 17% of the total fishing effort in that reach.

Although the Upper Clutha receives less overall fishing pressure than the lower Clutha, the survey results clearly demonstrate the high recreational value of the upper river. The proportion of usage coming from anglers outside the immediate area is one of the highest so far determined by the survey, being exceeded only by the Waitaki River. The Clutha overall is considered of greater relative importance to the angler than the Taieri River, and approaches that of the Mataura - a nationally important trout fishery.

(b) Commercial

Eels provide the only commercial fishery in the lakes above the Roxburgh Dam. This fishery is presently worth from $90,000-$100,000 annually, though it is doubtful that this harvest can be maintained without adequate recruitment. Present recruitment into Wakatipu, probably via the headwaters of the Mataura River is unsatisfactory to ensure a long term viable fishery. F.R.D. is concerned for the maintenance of eel stocks in all waters where they have historically had access - this includes the source lakes of the Upper Clutha. As the new lakes above the Luggate/Queensberry dams are unlike to become very significant eel fisheries (e.g. difficulty in fishing hydro lakes - excessive silts, steep banks, etc.), consideration should be given to providing sufficient recruitment to the source lakes. The trout fisheries of these lakes are not as dependent upon stocking with hatchery-reared fish as will be the hydro lakes and in systems offering natural reproduction for trout, eel predation is likely to be minimal.

In the lower river, Watties/ICI have operated an experimental quinnat salmon ranching project at Kaitangata since 1976. The objective is to produce a commercial return of sea-run salmon to their facility. The raceway has the capacity to rear up to 200,000 fingerlings annually, to a size of about 10 g. Over the four years since commencing operation, approximately 485,000 fingerlings have been released. This represents

an average annual production equivalent to about 35 km of natural spawning stream, based on F.R.D.'s estimates of production of salmon fingerlings from Glenariffe Stream on the Rakaia River (M.J. Unwin pers. comm.). Such an enhancement to the number of salmon juvenile out-migrants should ultimately provide anglers with an increased adult salmon run, as well as providing a commercial return to the salmon ranch operators. Fish which stray from the recapture facility and continue their upstream migration will also contribute to the spawning population.

4. RESIDUAL RIVER

(a) General

With the continuing loss or deterioration of our "big river" fisheries to developments, we must endeavour to get the best possible fishery in residual rivers. To achieve this a residual river must have an adequate minimum flow, and fluctuations in flow must neither be too rapid, nor too great in magnitude. As spillway discharges at the Queensberry Dam will be flushed into the residual river, the difficulties in meeting the latter requirements are recognised. However, with the appropriate built-in safeguard devices (e.g. by-pass valves in power house) and flood operation procedures, much can be done to reduce the magnitude of deleterious effects on fisheries from spillway discharges.

(b) Minimum Flow

We have already illustrated at some length that the stretch of the Upper Clutha River that will be directly affected by the Luggate/Queensberry development is a highly valued "big river" fishery. The resulting lake fisheries are unlikely to be of very high quality as there will only be a small littoral area, a draw-down effect, and a relatively rapid turnover of water. The type of fishing available to the angler will be limited compared to the variety available at present, and access for shore fishermen will also be a problem. To compensate at least in part, for

the near total replacement of this "big river" fishery with a lake one, requires a residual river that will provide both juvenile and adult trout with an environment of high quality water, an abundance of food, and adequate cover (for territorial maintenance, avoidance of predators and rest). A pre-requisite to achieve such an environment is a sufficient flow of water.

The question, what is a suitable minimum flow, is not easily answered. There are the needs of fish and wildlife, and a host of recreational users (anglers, jet boaters, canoeists, bathers, rafters, etc.) to consider. Jowett (1980) has made an attempt to assess the flow requirements of the various instream users, with particular emphasis on fish. Essentially, his evaluation is based on a series of transect measurements of various hydraulic parameters in two reaches of the Upper Clutha (above and below the Lindis confluence). Using a computer model, he has attempted to predict the amount of habitat available for trout for a range of reduced flows. Based on his computer predictions and on-site evaluation, he considered that flows of 10 m^3/s would be grossly inadequate to maintain a reasonable fishery, whereas flows from 20-30 m^3/s, possibly varied seasonally, would be acceptable. At the latter flows, his model predicts that the amount of suitable habitat for spawning, resting and rearing of fish would increase significantly over present conditions, whereas the level of food production would remain about the same.

To maintain the integrity of the river and its fish stocks, we suggest that a minimum surface flow of 30 m^3/s be maintained in the Queensberry residual river, year round, not including the inflows from tributary streams. This would be approximately a tenfold reduction in the river's present mean annual discharge at this point. The summer flows of the tributary streams, including the Lindis River, would contribute little to the residual river, and any additions from them should be regarded as a bonus. We are of the opinion that a minimum

flow of 30 m^3/s would maintain an acceptable trout fishery, and would also provide adequate water for other recreational uses. At such a level of flow, problems of fish passage in critical areas are not likely to occur.

This decision is of course, highly speculative, and requires considerable further study before it should be made final. Accompanying reduced flows are the problems of channel simplification, increased sedimentation, encroachment of streambank vegetation, increased algal growth, changes in stream temperature regime, etc., all of which we have only had time, as yet, to take "professional guesses" at.

(c) Spillway Discharges

Jowett (1980) has estimated that the mean annual Queensberry spillway discharge will be about 15 m^3/s, with the greatest flows occurring from October-May. He further has estimated that annual maximum daily mean spillway discharges could vary from 210-1183 m^3/s for return periods of 2 and 1000 years, respectively. Though fish stocks in the residual river would be seriously affected by such discharges, little can be done about it.

However, we are most concerned that the rate of change of spillway discharges be as gradual as possible. Flood operating procedures as described by Jowett (1980) would do much to reduce adverse effects on fish. Maintaining a gradual rate of change on both rising and falling discharges, would respectively, allow fish to seek more secure shelter, and prevent them from getting stranded in areas that are de-watered.

We strongly recommend that full discharge bypass valves be integrated into the design of the power house. Jowett (1980) has indicated that spillway discharges could increase by a maximum 360 m^3/s in 3 hours in the event of an emergency shut-down at full flow with the lake at maximum control level. Such rates of increase would be devastating

on both the fish populations and the fishery, and should be avoided at all costs.

5. FISHERIES COMPENSATION

(a) Cessation of Existing Water Abstractions from Lindis River.

The Lindis River catchment, though relatively large (508 km^2) contributes little (mean annual flow of about 5 m^3/s) to the Clutha River flows, except during floods. However, it is important to consider that it is the only tributary stream of significant use to fish within the proposed residual river section of the Upper Clutha River. As such, it will become of increasing importance in future years, and efforts should therefore be made to enhance its fish-producing potential.

Presently, the fish carrying capacity of the Lindis River is seriously limited by water abstraction for irrigation. During January-March, the period when natural river flows are lowest and irrigation demands high, much of the river downstream of the irrigation intakes, goes dry. Irrigation demands during this period are generally between 2-3 m^3/s, approximately double that of the flow remaining in the river at the Lindis Crossing Bridge (see Jowett 1980).

We recommend that as compensation to fisheries, the proposed Luggate/Queensberry development include provisions to supply Clutha River water from the new lakes to the existing irrigation works presently abstracting water from the Lindis River. Brown (1980) in his preliminary investigation report on the Luggate/Queensberry Development stated that "the possibilities for irrigation are all compatible with the hydro-electric development options ....". As there is the potential for irrigation water to be made available from the hydro-scheme, this request should be seriously considered. Cessation of water abstraction from the Lindis is seen to be the most effective and cheapest form of fisheries enhancement. This

would restore the natural flows to the river and would greatly improve the summer low flow conditions for both the rearing of fish (e.g. reduce stream temperatures and algal growth, increase habitat diversity, improve food supply) and recreational use.

(b) Fish Passage

The proposed Luggate/Queensberry dams will completely obstruct upstream migrations/movements of fish. We understand that at present there are no plans for the provision of fish pass facilities around, or over these dams. As anadromous salmonids are already precluded from these waters by the Roxburgh Dam, fish pass facilities on the proposed Luggate/Queensberry dams are considered to be of doubtful value by D.I.A. Rather, they propose to maintain each new impoundment as a separate lake fishery, by continued stocking with hatchery-reared salmonids.

The potential for both anadromous and catadromous (species which migrate downstream to spawn) fish in the Upper Clutha is virtually unlimited. They were present in abundance prior to the commissioning of the Roxburgh Dam. The re-establishment of such fish stocks in these waters should be seriously considered from a cost/benefit viewpoint. Presently, only one dam exists on the Clutha River with no fish pass facilities. As more of the same are built, it will become increasingly more difficult and more costly to provide such facilities for sea-run fish, if we so wish.

In view of the increasing number of large rivers which are being modified by both hydroelectric developments and/or water abstractions (e.g. Waitaki, Rangitata, Rakaia), the option of providing access for anadromous fish stocks to the whole of the Clutha system should not be eliminated prematurely.

We suggest that it would be appropriate at this stage of planning to investigate the costs and relative merits of providing access for anadromous

fish above Lake Roxburgh, and past the proposed new dams.

Should no fish pass facilities suitable for anadromous salmonids be provided at the damsites (both existing and new), consideration should at least be given to maintaining the wild eel fishery in the lakes of the Upper Clutha. This can be done in one of two ways:

(1) Trap elvers below Roxburgh and transfer them by vehicle or aircraft to Lakes Wakatipu, Wanaka and Hawea.

(2) Install elver passes on all dams (both existing and new) to allow the young eels to pass over them. These would require very little water, merely a wetted surface, roughly textured, such as broom heads which the fish can climb through.

6. SUMMARY

(i) Although the fish stocks of the Clutha River have been bisected by the Roxburgh Dam since 1956, it is important to view the whole river as one system.

Above Roxburgh, lake-resident quinnat salmon, extensive stocks of brown and rainbow trout, two species of bully, two species of galaxiid and the longfinned eel are found.

Downstream of Roxburgh, sea-run stocks of both quinnat salmon and brown trout, as well as river-dwelling brown trout occur. A range of native species are also present.

(ii) The recreational fishery of the Clutha comprises both lake and river stocks of quinnat salmon, brown and rainbow trout. In the Upper Clutha, the best river fisheries for trout are found immediately downstream of Lakes Wanaka and Wakatipu. Below Lake Roxburgh, sea-run brown trout are highly rated by anglers.

Fishing pressure is greater on the Clutha below Cromwell than on the upstream reach, most being local anglers. However, the Upper Clutha River is highly rated by visiting anglers, who account for almost 50% of the fishing pressure in this area. The popularity of the Clutha River amongst anglers approaches that of the Waitaki and Mataura fisheries - both considered to be of national importance.

(iii) In the Upper Clutha lakes, eels presently provide a commercial fishery worth about $100,000 annually. However, without adequate recruitment of juveniles upstream of Roxburgh Dam, it is unlikely that this harvest can be maintained.

(iv) An experimental quinnat salmon ranch has been operating at Kaitangata since 1976. There is great potential for future substantial enhancement of the salmon run to the Clutha.

(v) A minimum surface flow of 30 m^3/s in the Queensberry residual river is recommended, not including any inflows from tributary streams.

(vi) Incorporation of full discharge bypass valves into the power house design is recommended. Careful management of the rate of change of spillway discharges would help to reduce the adverse effects of floods on fish.

(vii) Cessation of all water abstractions from the Lindis River, and replacement of existing irrigation and stock water supplies with water from the new lakes is recommended.

(viii) It is suggested that the costs and design feasability of providing access for anadromous fish and/or juvenile eels throughout the Clutha River system be investigated.

7. LITERATURE CITED

Anonymous. 1972. The Effects of Hydro-electric Power Development on the Resources of the Clutha Valley. Report to the Commissioner of Works by an Interdepartmental Committee. 167 pp.

Brown, A.S. 1980. Upper Clutha Valley Investigations: Luggate/ Queensberry Hydro-electric Development. Preliminary Investigation Report, November 1980. 43 pp.

Flain, M. 1980. Those Dammed Clutha Salmon. Freshwater Catch 7: 7.

Graynoth, E. 1974. The Otago trout fishery. N.Z. Ministry of Agriculture and Fisheries, Fisheries Technical Report No. 127. 31 pp.

Hutchinson, D. 1980. Development on the Clutha River. Freshwater Catch 8: 19-20.

Jowett, I.G. 1980 (provisional report). Luggate and Queensberry Development - Residual River. Investigations Section, Power Division, Ministry of Works and Development, Wellington. 33 pp.

Teirney, L.D. 1980. The National Angler Survey. Freshwater Catch 8: 17-18.