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NEW ZEALAND FRESHWATER FISHERIES MISCELLANEOUS REPORT NO. 119

PROBLEMS FACING MIGRATORY NATIVE FISH POPULATIONS IN THE UPPER RANGITAIKI RIVER SYSTEM

by

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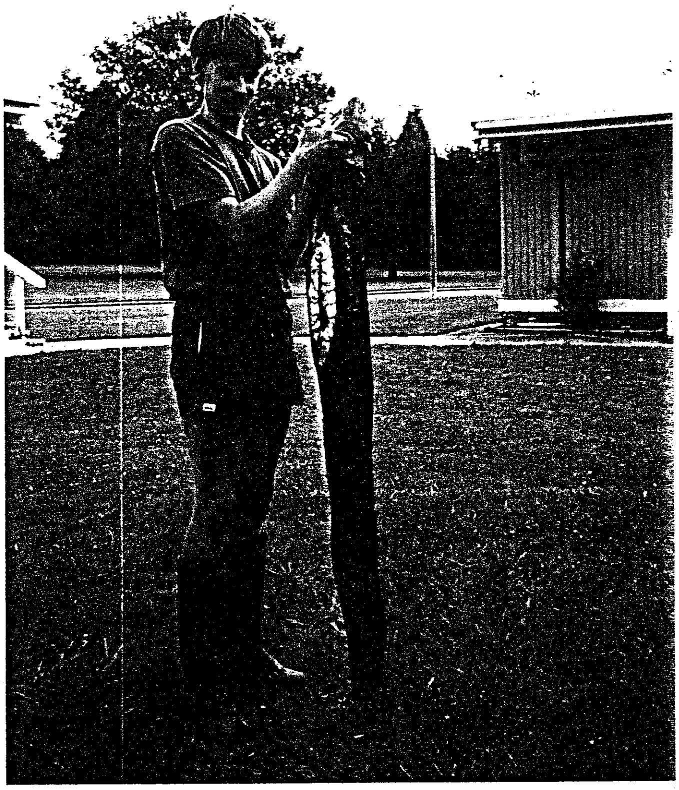
Report to: Bay of Plenty Electric Power Board



Migrant longfinned eel killed on Aniwhenua penstock screens 1992.

Photo: R J van Boven

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Servicing freshwater fisheries and aquaculture

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SUMMARY

The native fishes resident in the upper Rangitaiki River can be subdivided by two basic life-history patterns, sea-migrants and freshwater residents. Those fish that do not have to go to sea to complete their life-cycle are unaffected (or have benefitted) from the construction of hydro-electric reservoirs in the catchment. Those fishes which migrate to and from the sea face major obstacles.

Eels are the most important migratory fish in the upper Rangitaiki River. To maintain eel populations, access is vital for the juveniles (elvers). Elvers migrate upstream from the sea over the summer months. Elvers were seen at the base of the Aniwhenua Powerhouse. Adult eels migrate downstream to the sea to spawn in the autumn. Migrant eels are trapped and killed on the penstock screens. The present wastage of these breeders could be avoided.

Methods to allow the continuation of eel life-cycles in a river system modified for hydro-electric development are presented: Fish-passes for elvers can be relatively cheap to construct and economical to operate. The water requirements for elver-passes are minimal. Adult eels on their downstream migration must be caught before they become impinged on the penstock screens. Allowance should be made for the return, unharmed, of at least some adult migrants to the lower river.

With these provisions, objections to hydro-electric development that are based on damage to eel stocks, can be countered.

CONCLUSIONS:

a. Elver restocking is recommended as a cost-effective option for restoring the eel populations of the upper Rangitaiki River.

b. Elver migrations at Aniwhenua should be monitored by installing a small trap to evaluate the need for an elver pass.

c. Downstream migrant eels are being destroyed on the trash screens.

d. Techniques to predict downstream migrations and to trap and transport migrant eels could be trialed at Aniwhenua. Findings have application throughout New Zealand.

e. A superficial fisheries survey revealed no outstanding features in the Kioreweku area.

INTRODUCTION

Eels are a very important freshwater fish in New Zealand. They were a major part of the diet of the pre-european inland maori and retain cultural significance to the present day. The availability of eels for hui reflects upon the *mana* of the host tribe. The Maori people of the upper-Rangitaiki River value their eel fishery.

Eels are the dominant freshwater fish in many New Zealand waterways, they flourish in the conditions typical of hydroelectric impoundments. It could be said that construction of generation facilities on the Rangitaiki River has been beneficial to eels. Certainly productive slow-flowing aquatic habitat has been created. However a management strategy is vital if eels are to persist in the system.

Successful management of eel fisheries is complicated by the life cycle of eels: After 10 to 60 years resident in fresh water, eels become sexually mature. Adults of both species then undergo a substantial metamorphosis and migrate downstream to the sea in autumn. Where they go is unknown but they never return to freshwater. The larvae of freshwater eels have been found East of the Coral sea and it is suggested that our eels spawn deep in the Tropical Pacific Ocean near Tonga. In spring miniature eels (elvers) appear in New Zealand and migrate upstream over the summer months.

Dams, weirs and floodgates block the return upstream migration of elvers. MAF Fisheries has recognised this problem and a program of elver pass construction has been initiated in association with the owners of these structures. So far the problem of downstream migrant adults has not been practically solved. It has to be considered that there are still eels upstream of hydroelectric facilities in New Zealand whose age predates the construction.

To date we have ignored the problem. As a result, hydroelectric turbines around New Zealand take a heavy toll of downstream migrant eels. At dams with eels upstream, bits and pieces of migrant eels can be found below the powerhouse during the migration season.

The process of gaining water rights for hydro-electric power generation means that special interest groups and environmental concerns have to be considered. These concerns and constraints to development can only be expected to increase as public awareness grows. It is becoming essential to prove that environmental impacts from any development project will be minimal. The aim of this document is to provide information to assist in the management of the eel stocks of the upper Rangitaiki River.

A. ELVER RESTOCKING

Elvers migrate upstream from the sea. They reach Matahina by early summer and there are movements of elvers through the fish pass there until March. Some elvers continue upstream and appear at the base of Aniwhenua Dam from mid to late summer.

There are two options for stocking Lake Aniwhenua and the upper Rangitaiki River with elvers: The first was suggested by Mitchell (1983). Elvers can be caught below Matahina and transported and stocked into Lake Aniwhenua. Elvers concentrate in the transformer cooling water discharge below Matahina Dam. They are easy to catch and can be transported in buckets up to Aniwhenua. Although the amount caught has varied greatly each year, for the past nine years this method of stocking the upper Rangitaiki River has been used. An estimate of the numbers of elvers released is possible but detailed records have not been kept. There has been no effort to monitor the density of juvenile eels in the upper Rangitaiki River. An examination of electric fishing records in this area shows that small eels are seldom encountered. Most records of eels are from the '60s. Our recent experience has been that eels are now rare in the upper river. We electric-fished three tributaries close to Aniwhenua Barrage, sites small eels can be expected to seek to continue their growth in freshwater. We caught both rainbow and brown trout, freshwater crayfish and the rare native fish *Galaxias divergens*, but no eels (fig 1).

The second option is to build an elver pass over Aniwhenua Dam. Before elvers can reach Aniwhenua they must first climb Matahina Dam. The elver pass over Matahina Dam came into operation last summer (1991-92). Records from the automatic counter at the head of the pass indicate that approximately 120,000 elvers reached the lake (J. Boubee, MAF Fisheries, pers. comm). Considering the catchment area involved, this is unlikely to saturate available eel habitat below Aniwhenua for at least a number of years. Nighttime searches at the base of Aniwhenua in January and February, at two peak periods for elver migration, showed that elvers were present in tens rather than thousands. Therefore I intend to compare costs of constructing an elver pass in comparison to continuing the option of transporting elvers from Matahina.

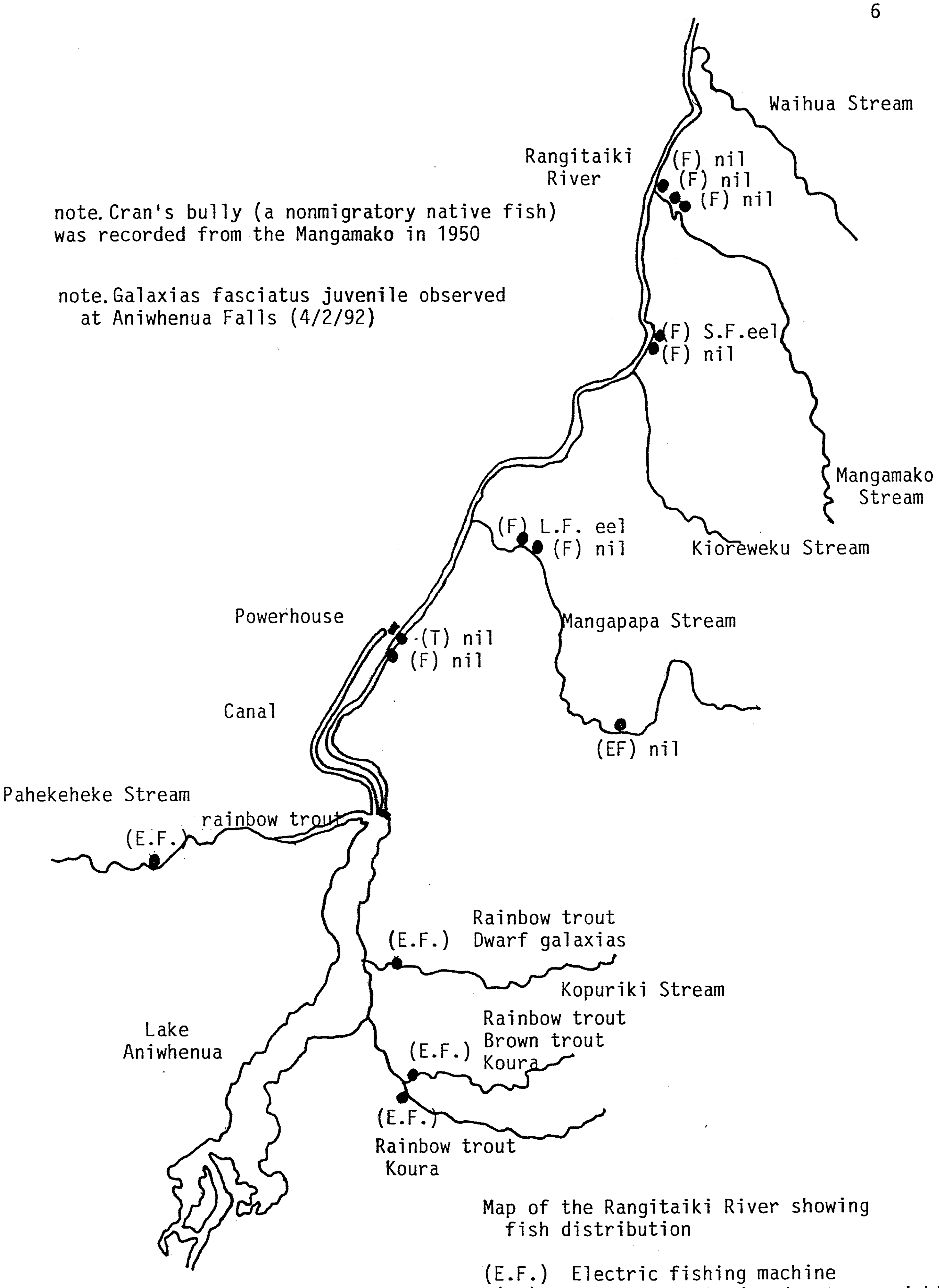
B. ELVER PASS DESIGN

1. Basic Design

When elvers climb past an obstacle they require several things. First they need a trickle of attractive water to follow. Water from a productive reservoir such as Aniwhenua can be assumed to be attractive. They need a continuous surface to climb, without gaps or overhanging points. Then they require an appropriate surface for climbing. We have developed two basic designs for elver passes:

The first uses plastic brushing within plastic pipe. Water is trickled through the pipe. Elvers climb by working their way through the brush bristles. This type of elver pass will work vertically. Only elvers can use this type of elver pass. Problems note. Cran's bully (a nonmigratory native fish) was recorded from the Mangamako in 1950

note. Galaxias fasciatus juvenile observed at Aniwhenua Falls (4/2/92)



Map of the Rangitaiki River showing fish distribution

(E.F.) Electric fishing machine
(F.) Fyke Net, baited and set overnight
(T.) Fine mesh trap

include corrosion of the wire binding the brushing together and the entrance of water rats. Rats will, over time, tunnel through the plastic brush and take up residence in the pipe. Here they live and feed on elvers.

The second design consists of gravel bonded to the inside of plastic pipe. water is trickled down the gravel and elvers climb by working against the edges of the gravel. This type of pass will also work vertically (although elvers tend to fall off the gravel with any disturbance). However it appears to be best on a slope (up to 45^{o}) where not only elvers, but a range of other native fishes and invertebrates will use it. There have been few problems with this design. However rats have again proven to be a problem at Matahina.

2. Entrance siting

Fish are stupid. There is no way that a fish can recognise a fish pass entrance on the banks of a river, no matter how good the intentions of the constructors. Fishes migrating upstream follow the main flow, only those individuals sufficient to populate the tributaries will divert from the main river flow. When an obstacle is reached where flow is too violent for the fishes to swim against (a waterfall or turbine outlets), then they change their behaviour and seek out relatively minor flows such as from a fish pass. If a fish pass is to be used by fish, then the entrance must be sited at the point where further progress is impossible. Poor entrance siting is one of the major reasons for fish pass failures.

Elvers are particularly tenacious upstream migrants. When they encounter a high velocity obstacle such as a waterfall they attempt to climb around it using the damp and mossy margins. Early this century the spectacle of vast numbers of elvers climbing Aniwhenua Falls and the resulting Maori fishery was reported on by Elson Best (1929).

At present elvers no longer appear to climb Aniwhenua Falls in significant numbers. The only fish observed climbing, on two night visits was a juvenile *Galaxias fasciatus* (one of the whitebait species). I think the falls are no longer attractive to elvers because little lake water is present in the flow. Springs and seepages through the ground from the canal comprise nearly all the flow under normal conditions (R. Ingoe pers. comm). However, when the auxiliary turbine was operated in the past elvers were attracted up the falls to the base of the barrage (D. Monti, pers. comm). As part of the water right conditions a certain volume of water must flow over the falls. I understand that decreased leakage from the canal may require the operation of the auxiliary turbine on a routine basis. If this is so then the entire question of siting an elver pass will need to be revised because the elvers will shift from where they concentrate at present.

Our observations are that at present elvers follow the river flow up to the turbine outlets. On the true left side of the powerhouse there is a substantial discharge of groundwater, no elvers were seen in this area. On the true right side of the powerhouse there are two small discharges of water, elvers are attracted to this area. The larger of these two discharges flows from a pipe set in the wall of the outlet structure. The smaller discharge flows from beneath the powerhouse, across the top of the outlet structure and trickles down the wall of the outlet structure to one side of the larger discharge. Elvers were only attracted to this smaller discharge. Elvers were seen at night, climbing the vertical wall, swimming across the top of the outlet structure and disappearing into the pipe beneath the powerhouse.

It is obvious that an elver pass with an entrance sited at this point would have a high probability of success (under present flow conditions).

3. Elver Pass Layout.

It is convenient that elvers seek to follow the drain to the back of the powerhouse. During floods the top of the turbine outlet area is a maelstrom of logs and debris, any elver pass structure would be vulnerable to damage. A vertical concrete pipe rises from the drain to road level, at the back of the powerhouse. Elvers can climb vertical wetted concrete. From the back of the powerhouse a concrete channel leading to a culvert under the roadway offers a clear route to the headpond face. An elverpass could run up this face, pass beneath the dirt roadway and then discharge into the canal some distance upstream from the penstock screens. There is electricity available at the screens to power the small pump needed to supply water to the elver pass.

4. Problems.

Where do the elvers go at present ? We failed to find any trace of the elvers that were seen disappearing beneath the powerhouse. By shining a powerful torch down the vertical pipe it could be seen that it entered the top-side of the horizontal pipe. Elvers may have to climb around an overhang to begin climbing the vertical pipe. When the torch was shone along the horizontal pipe it could be seen that the drain went past the vertical pipe for some distance. Road metal washed in from the parking area had infilled this area to some extent. Water was flowing down a slope of road metal about 50 cm behind the vertical pipe inlet. Experiments with dye showed that water from the drains on the headpond face flowed to a pipe entering the top of the vertical pipe. This drainage system extended right up to the stoplog gallery drains behind the penstock screens. No elvers were found in any of these drains.

Plans of the dam drainage system were sketchy. Much of the drainage seems to have been laid down at the time of construction and detailed records were not kept. Perhaps it is possible that the elvers have detected a minor leak from the canal by which they can gain access. It is more probable that they perish somewhere underground.

5. Solutions

Elvers can be blocked from gaining access by a smooth overhang such as a stainless steel lip. They can then be diverted into the entrance of an elver pass. It would be straightforward to thus block the drain where it flows out from the powerhouse wall.

The ensuing route of an elverpass then needs to be considered. Perhaps the best option would be to attach a pipe up the powerhouse wall and then travel around the front of the powerhouse (attaching the pipe to the inspection catwalk) to the culvert underneath the road. Another, perhaps more difficult option, would be to try to block the movement of elvers past the vertical pipe beneath the powerhouse. Possibly the drain behind the vertical pipe could be blocked and piped out. One obvious problem would be a strut of reinforcing steel which seems to have been used to support the vertical pipe while it was being set in position. Despite the advantages of having a damage proof elver pass entrance, the problems of working in a confined space at such a distance may rule this option out.

Figs 2 & 3 show details of the layout of elver pass envisaged.

6. Costs

A very crude estimate (based on costs for Matahina) is that it would cost around $50000 to build an elver pass at Aniwhenua. At present there appear to be too few elvers to justify an elver pass. One night 2 were counted on the concrete wall of the tailrace structure, the other night 14 were seen.

In contrast, when elvers are migrating at Matahina several thousand elvers can be caught in the transformer cooling water outlet within several minutes. The peak times of elver migration

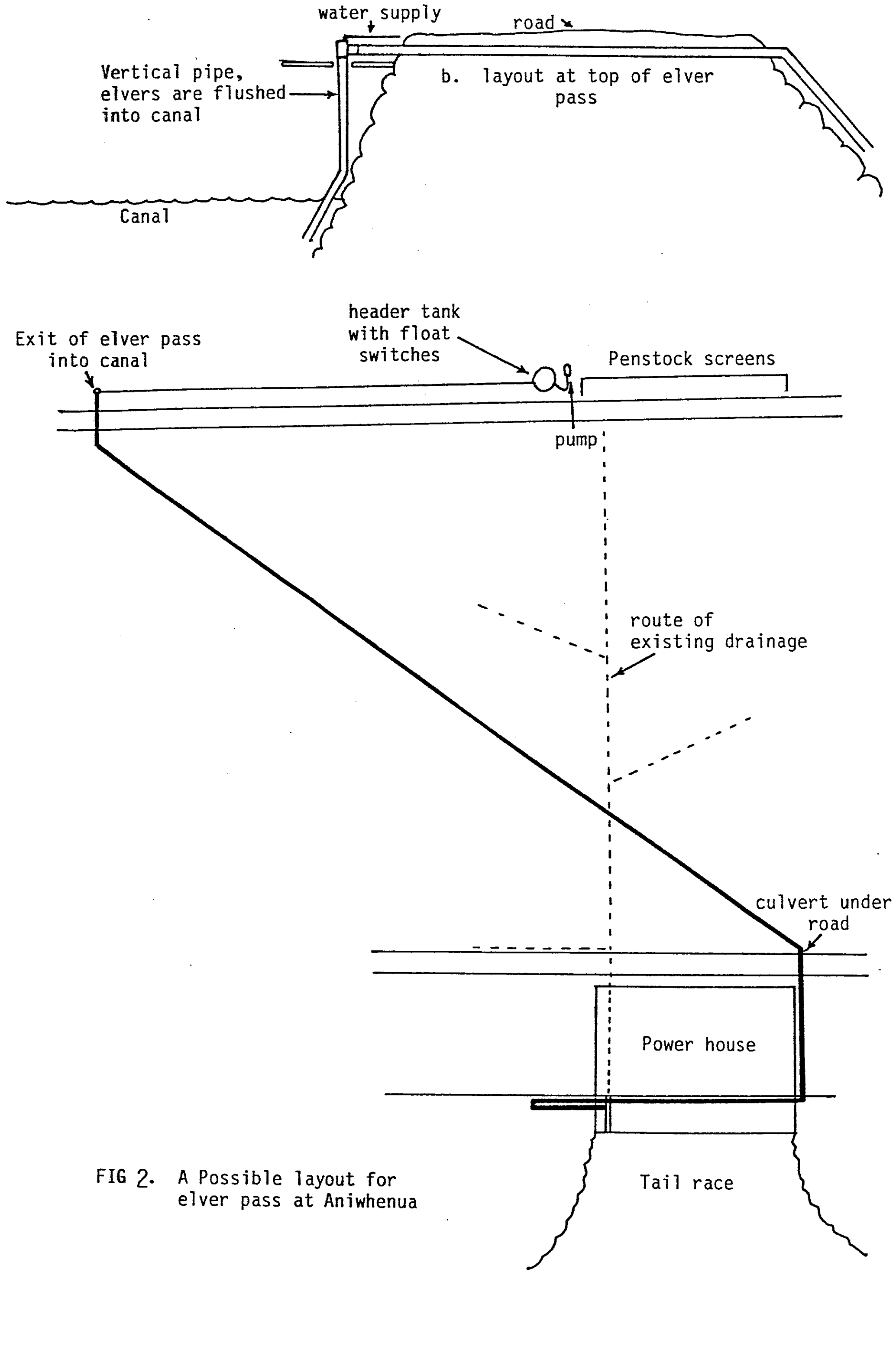
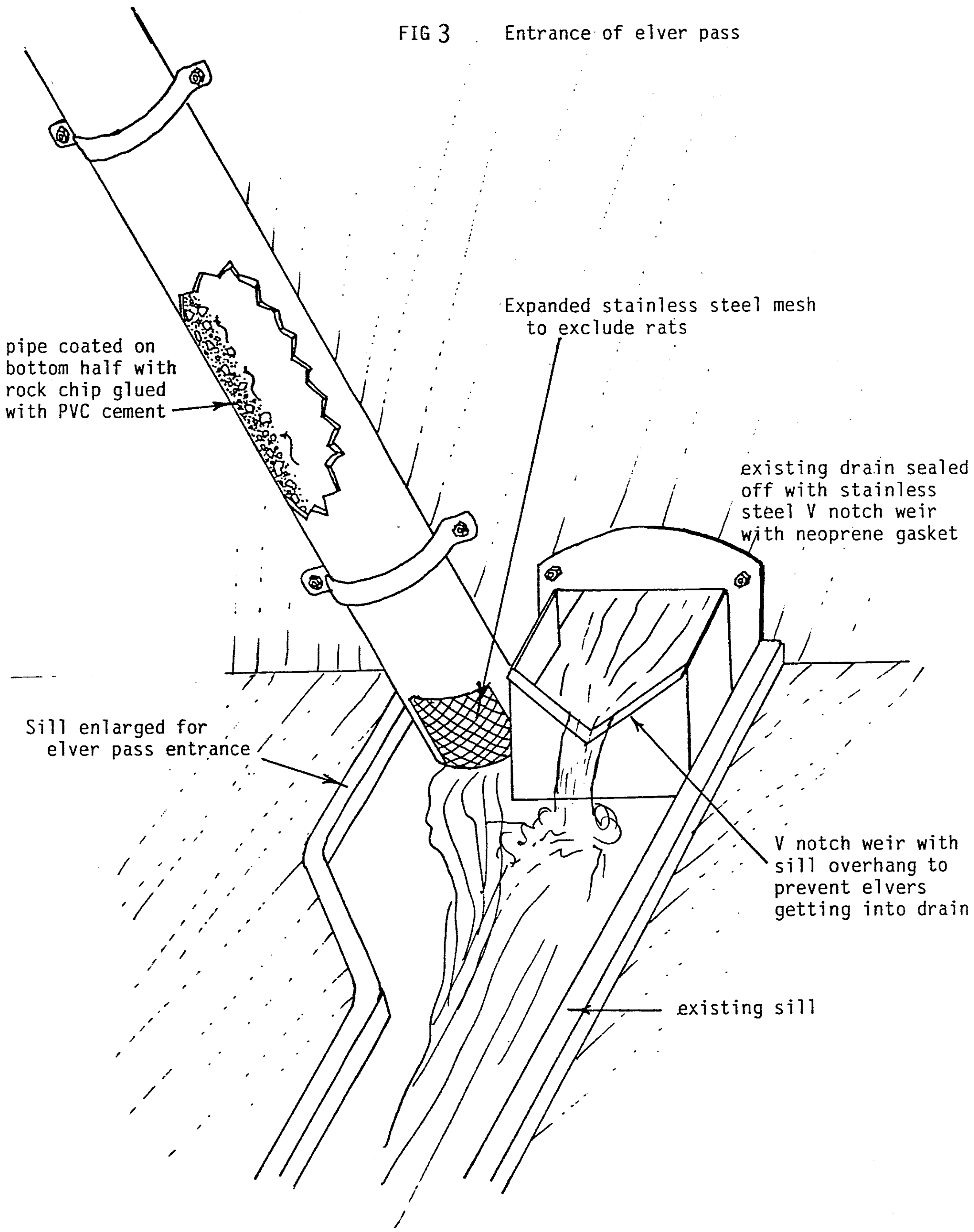


FIG 2. A Possible layout for elver pass at Aniwhenua

FIG 3 Entrance of elver pass



can be predicted. Peak movements occur at the times of spring tides (Mitchell & Saxton; 1983). If elvers were collected at peak periods and transported to Aniwhenua, perhaps 4 half-days per year would be necessary to stock a target of say 100000 elvers per year. Even if it cost $250 per day (including salaries and mileage) it would be 50 years before the cost of manual stocking exceeded the costs of constructing an elver pass. This does not even consider maintenance, energy costs and the relatively limited lifespan of plastic structures. Capital costs for restocking would be minimal, perhaps four plastic buckets with lids plus a small handnet.

In tandem with manual stocking, a trap should be built for the site at Aniwhenua where elvers are presently attracted (Fig 4). Elver numbers could then be estimated at intervals. This information would allow a decision to be made on whether sufficient elvers were arriving at Aniwhenua to justify construction of an elver pass. Trapped elvers could be released into the canal after their numbers were estimated. In this way a fish pass would essentially be operating at Aniwhenua while data necessary to support further investment was being gathered.

C. DOWNSTREAM MIGRANT EELS

The eels which appear on the penstock screens at Aniwhenua are committed migrants. The velocity of water flowing through the screens impinges them against the bars and they are unable to breathe normally. They are quickly suffocated.

Samples of migrant eels collected from Aniwhenua over the past autumn have been remarkable for the large size of the eels (fig 5). Examination of headwidths (fig 6), indicates that these eels do not represent the largest eels only, smaller eels having gone down through the turbines. If that was the case then a truncated frequency distribution with an abrupt cut-off at 30 mm would be expected.

FIGURE 4 Elver Trap

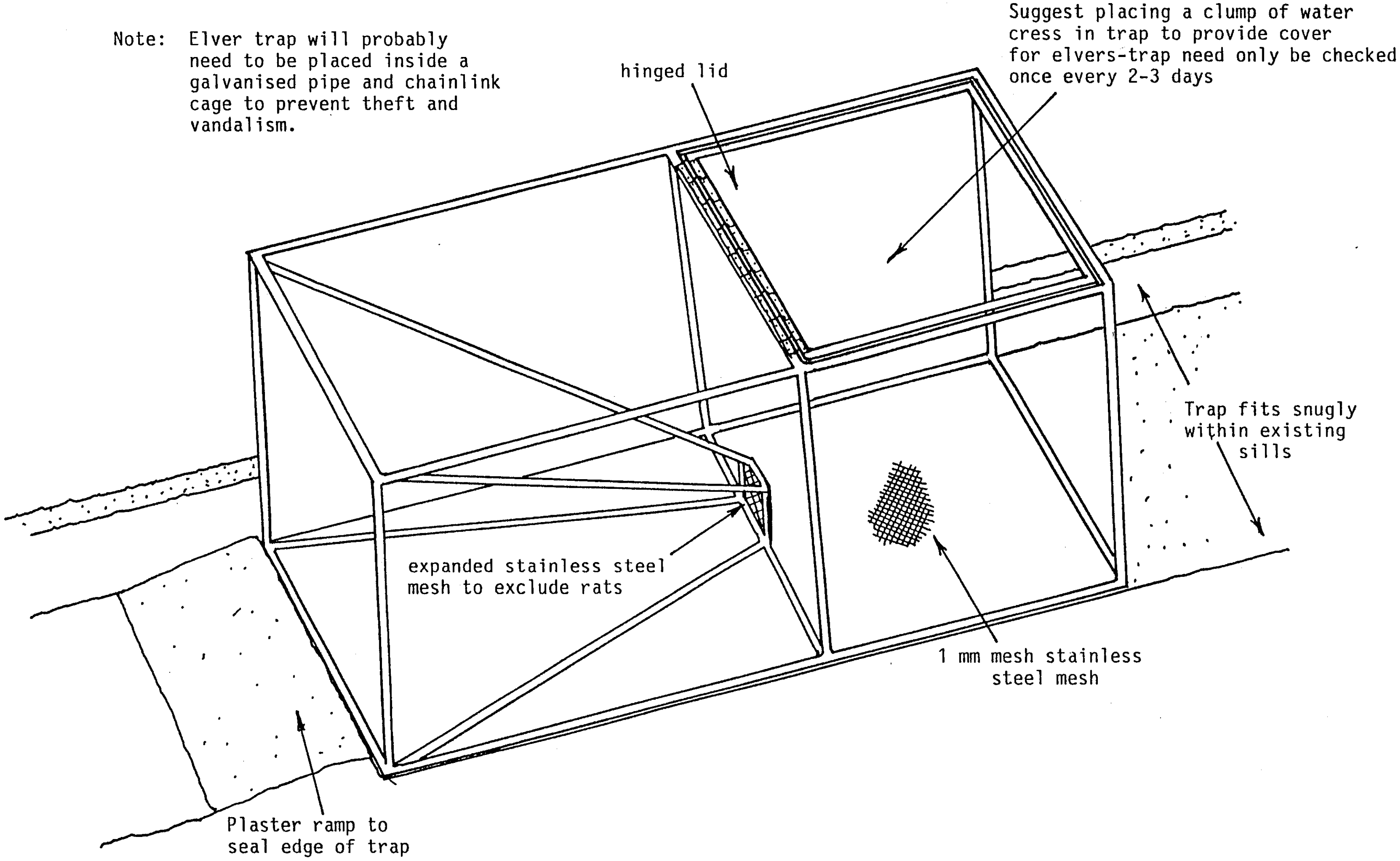
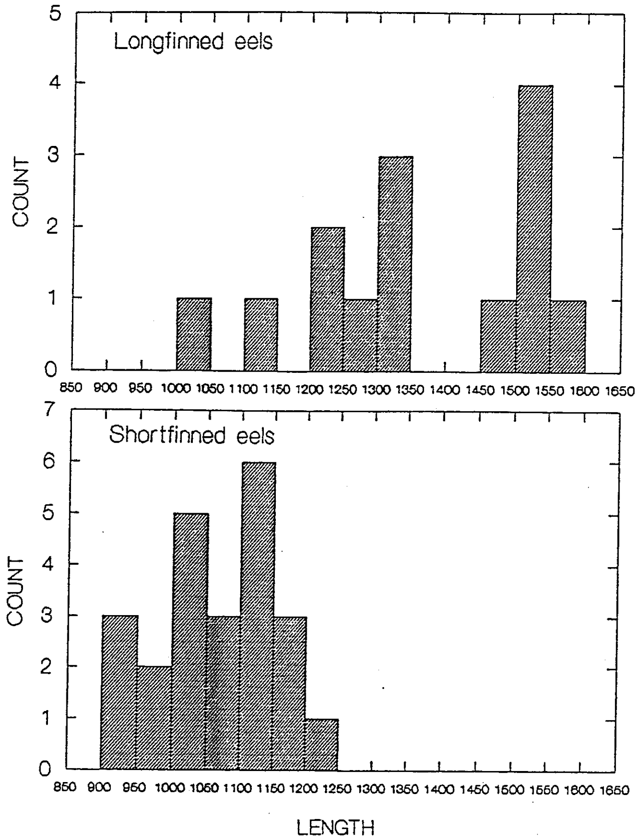
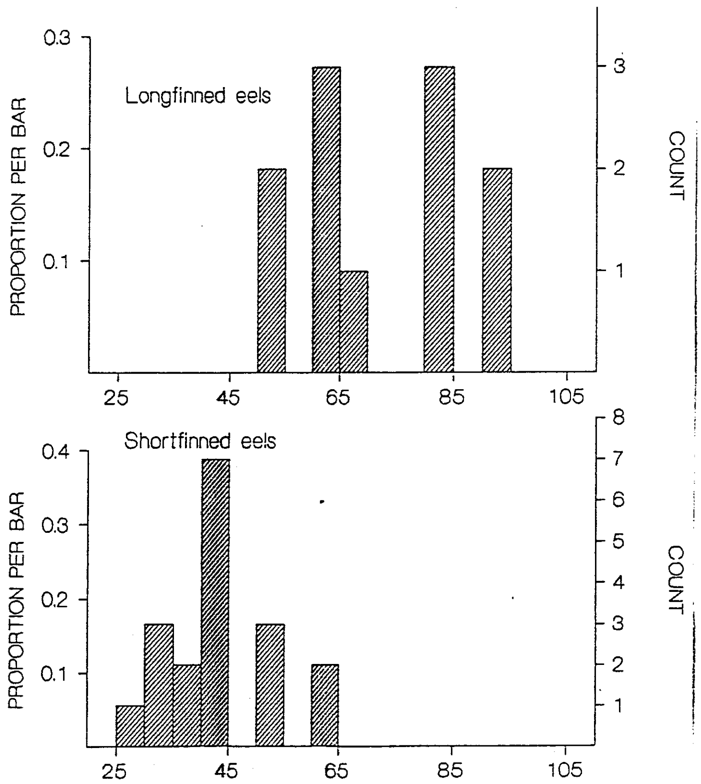


FIGURE 5



Lengths of migrant eels trapped on the penstock screens at Aniwhenua Power Station 1992

FIGURE 6



Headwidths (mm) of migrant eels trapped on the penstock screens at Aniwhenua Power Station 1992 (bar spacing of screens = 30 mm)

Aniwhenua provides excellent conditions for the growth of eels. Eels were aged using the burnt otolith technique. The results of aging estimates are shown in fig 7. A number of features of the age structure of Aniwhenua eels merit comment. First it is apparent that longfinned eels are much older at migration than the shortfinned eels. Migrant longfins were from 30 to over 60 years old and so predate the completion of Matahina Dam in 1963. Restocking of Aniwhenua with elvers did not commence until 1983 (Mitchell 1983). With the exception of 4 fish, aged 13,17,26 and 29 years respectively the shortfinned eels form a cluster aged from 8 to 11 years (fig 7). We conclude that these eels represent survivors from the first stockings of Aniwhenua. The growth rates of these eels and the sizes they have attained exceed anything previously measured in New Zealand (Chisnall & Hayes 1991). Because the stocked longfinned eels will mature at a much greater age, they do not yet feature in the catch.

The loss of these eels has a considerably greater impact upon the effective breeding population than might be expected. Fecundity (or egg output) of eels increases with size, large eels produce many more eggs. For example a 1500 mm long female longfinned eel will produce approximately 40 million eggs. An eel half as long, 750 mm, will produce only 3 million eggs. A traditional Maori fisheries management technique, which seems to have been widely practised, was the deliberate release of large migrant eels. This technique would seem to have a sound basis. How can the losses at Aniwhenua be avoided? One option would be to improve screen design so that the migrants are not impinged and killed. One way would be to increase screen area and hence reduce velocities. But this is no real solution, migrants trapped in a water body appear to die. If the screens were widened from their present 30 mm bar spacing many migrants would pass down through the turbines. This is what happens at Electricorp facilities. However our present understanding is that most of these eels are doomed. An eel going through a turbine tends to get cut into pieces. Even superficially intact eels seem to die from massive internal

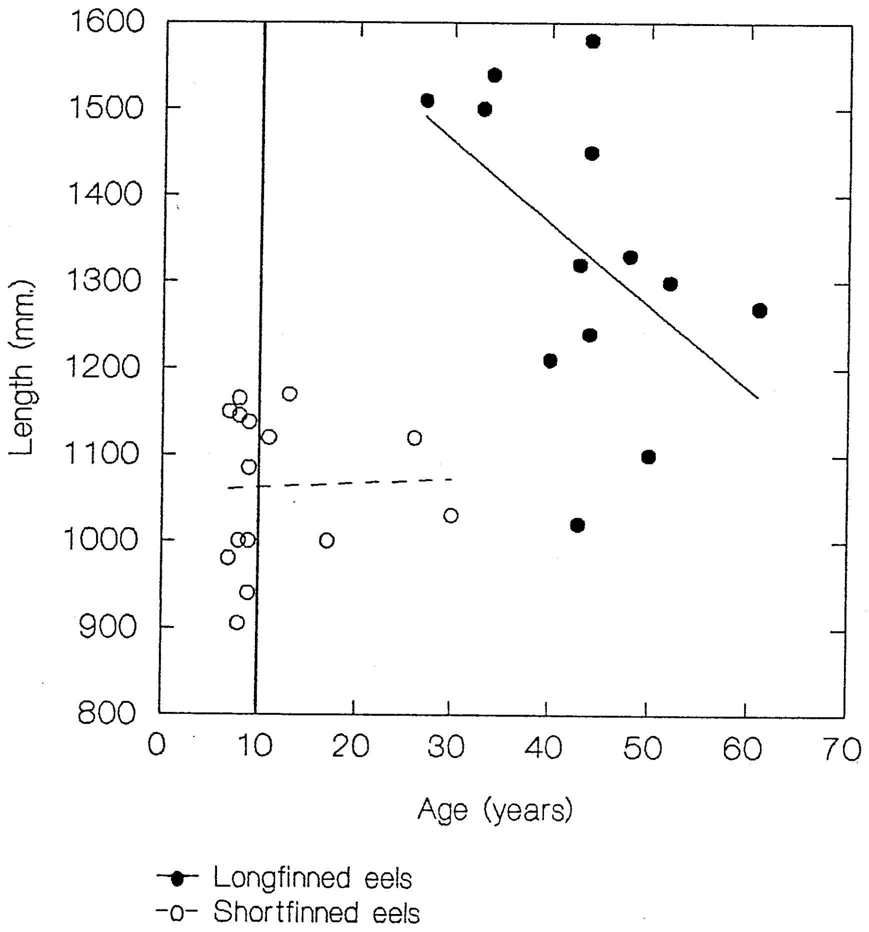


FIGURE 7 Age and size of migrant eels trapped on the penstock screens at Aniwhenua Power Station 1992.

Note. 8-11yr cluster for shortfinned eels.

damage. The relatively small size and high rotation speeds of the turbines at Aniwhenua would lead to a high mortality.

Unfortunately it appears as if the best way to deal with the problem of migrant eels is to trap them before they reach the screens. They would then have to be trucked below Matahina and released unharmed to continue their migration. Results from monitoring the migration at Aniwhenua over the past autumn show that migration is very strongly linked with rainfall events and the flow (fig 8). Therefore the times to fish are very predictable.

If it was intended to capture migrant eels then rainfall over 20mm/day in February, March and April would initiate the setting of nets. Increases in the daily average flow greater than 40% could also be used as triggers for fishing activity. Considering that migrations actually occurred for less than 0.5% of the time period in 1992 emphasises the importance of predicting fishing periods in order to minimise effort.

We are seeking support from Electricorp for research into low cost, portable nets for trapping migrant eels. I think that the Aniwhenua power canal would be an excellent system within which to trial these nets.

My recommendation is that; if the Eastern Bay of Plenty Regional Power board is committed to supporting a sustainable eel population in the upper Rangitaiki River then they must consider the requirements of downstream migrating eels. Because the methods to catch migrants efficiently have not yet been developed then experiments should be made. This work could be undertaken at Aniwhenua. Trapping must not compromise the structure or operation of the generating facility. Therefore advice and co-ordination with engineering and operations staff would be essential for this project.

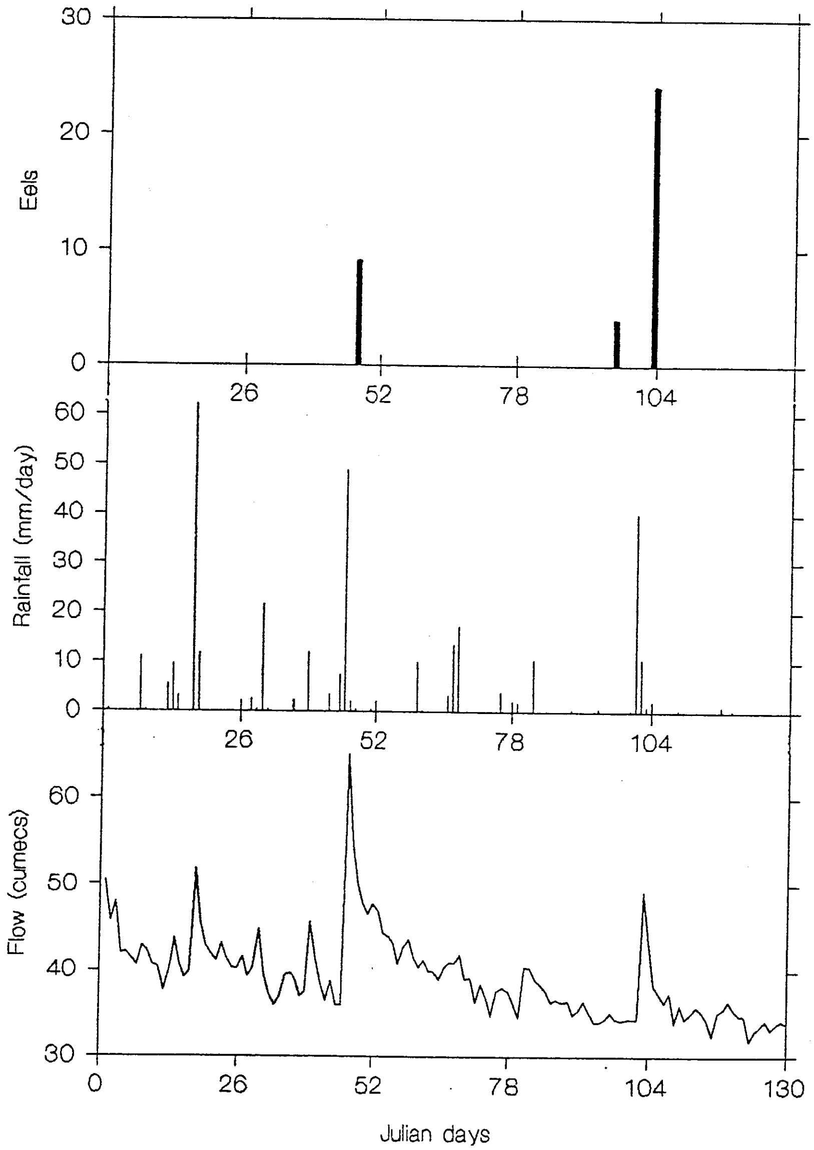


FIGURE 8 Environmental factors influencing eel migrations at Aniwhenua 1992.

D. FISHERIES IN THE KIOREWEKU AREA

Over the late summer 1992 preliminary investigations were made into the fish populations in the Kioreweku area of the Rangitaiki River. Both baited and unbaited fyke nets were set and some electric fishing was carried out. Owing to the high current velocities and general inaccessibility, the mainstem down from Aniwhenua to Kioreweku was not sampled. We understand that it supports populations of trout. Fyke nets set in side channels of the main river caught shortfinned eels. These eels were of a good size but catch rates were very low. A total of 8 fyke net sets caught 3 eels. In comparison, a single identical net set along the lower Waikato River margin during autumn, could be expected to catch 45-100 eels from an overnight set.

The Kioreweku Stream required a major investment of time to reach, although we did not expect anything unusual to be present. This stream could be fished as part of a more intensive survey. Tributary streams were fished where access was convenient. Baited fyke nets set in the Mangapapa Stream caught one longfinned eel. No other fishes were caught in the fyke nets or by electric fishing. Fig 1 shows the areas fished. In contrast, trout, native fishes and invertebrates were frequent in the streams draining into Aniwhenua. It is difficult to explain why fish numbers should be so low in the Kioreweku area. There has been little work done on the fish population in this area. There was one record (1950) on the Freshwater Fisheries Data base of Cran's Bully, in the Mangamako Stream. This fish however is nonmigratory and would not be affected by hydro-electric development.

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