RECOMMENDATIONS FOR A FISH PASS ON THE BRAEMAR LAGOON WATER LEVEL CONTROL WEIR

REPORT PREPARED FOR THE DEPARTMENT OF CONSERVATION BY:

CHARLES MITCHELL & ASSOCIATES
Te Manu Road
RD 2
ROTORUA

April 1994

ISSN 1171-9834

© 1994 Department of Conservation

Reference to material in this report should be cited thus:

Mitchell, C., 1994.
Recommendations for a fish pass on the Braemar lagoon water level control weir.
Conservation Advisory Science Notes No. 91, Department of Conservation, Wellington. 10p.

Commissioned by: Bay of Plenty Conservancy
Location: NZMS

EXECUTIVE SUMMARY

It is recommended that a fish pass suitable for native migratory fish be constructed over the water level control weir on the Braemar Lagoon. Braemar lagoon is a productive lowland wetland. Habitat of this type has become uncommon in the Bay of Plenty owing to the intensity of land development. The control weir is typical of the type of structure placed across waterways and which results in the loss of migratory fish populations upstream.

The fish pass design recommended is an "enhanced" boundary layer design. This type of fish pass aims to create low water velocities as a boundary layer. Boundary layer water velocities are independent, to a considerable degree, of water velocities in the water column. The boundary layer is made as deep as possible by maximizing the channel roughness of a flume. Small, relatively weak swimming native fish can move upstream within.this boundary layer of slow flowing water.

The fish pass design is intended to be robust and durable. It is constructed of treated timber and can be built by semiskilled labour. Material costs are intended to be low. The fish pass is designed to allow the weir to be manipulated when necessary. Reinstatement of the fish pass after the stoplogs have been removed and then replaced is intended to be easy.

INTRODUCTION

The water control structure on the outlet to Braemar Lagoon controls water levels of a significant area of wildlife habitat. Management of water levels has been intended to increase the amount of habitat available for waterfowl to breed and feed. The area is a mosaic of productive wetland and swampland, habitat now scarce on the intensively developed Eastern Bay of Plenty coastal plain.

In addition to waterfowl the area offers valuable habitat for native freshwater fish. Unfortunately, most native freshwater fish must migrate to and from the sea to complete their life-cycles (McDowall 1990). Most native freshwater fish migrate upstream from the sea as small, weak swimming juveniles 30 -70 mm in length. A structure such as the water control weir has the potential to completely block this upstream movement of native fishes. The result is a loss of habitat and a decline in the population size. Not only are rare species such as the giant kokopu likely to be involved at Braemar, but also fish which provide the whitebait and eel fisheries.

The water control weir is a well designed, permanent structure. Approximately 50 cm above the former stream level, a concrete sill has been constructed. Slots cast in the wingwalls of the sill and in concrete upstands set across the sill, support a stack of stoplogs which control the lagoon water level. Removal of the stoplogs allows the lagoon to be lowered down to sill level if required.

Soon after construction of the weir there were concerns over the impact of the structure on migratory fish (C. Richmond pers comm.). The Department of Conservation was placed in a difficult position, a structure intended to enhance wildlife obviously had the potential to adversely affect other wildlife. DoC also has legal responsibilities under the fish pass regulations to ensure that fish passage is provided past structures built across waterways.

As a result of ongoing discussions over the years it was decided that the most productive option would be to provide a fish pass over the weir. In this manner it was considered that not only would the enhancement of water fowl habitat be possible but native fishes could also benefit from construction of the weir.

The aim of this report is to suggest a practical low cost structure to provide passage for juvenile native freshwater fish over Braemar Lagoon water control structure.

METHODS

An estimate was made of the fish populations above and below the weir on 26-27/10/93 so inferences could be drawn on the likely impact of the weir. The outlet stream both above and below the weir was dipnetted with a 2 m^2 dip net. The weir was visited 2 hrs after nightfall and all downstream faces carefully inspected, using a 55 watt halogen spotlight, for evidence of native fishes and invertebrates attempting to climb the weir. At the same time a series of 3 mm & 6 mm mesh fyke nets were set upstream and downstream of the weir and left overnight. Fyke nets with 12 mm mesh were set in the lagoon to attempt to trap larger fish. All fish caught were counted and measured before release unharmed. Elvers were tranquilized to permit measurement.

The results of this survey were quite clear. A range of juvenile native fish were abundant below the weir. Twenty two short finned eel elvers ranging from 8.3 - 11.5 cm. total length were caught, plus one longfinned eel elver. Two hundred and fifteen freshwater shrimps were caught, 53 smelt, 4 common bullies, 1 redfinned bully, 1 inanga and 1 banded kokopu whitebait. Table 1 lists the species caught in this survey. At night the downstream faces of the weir were found to be covered in juvenile eels (elvers) and freshwater shrimps attempting to climb the weir by clinging to the wetted sides of the concrete upstands. Trapping upstream took one shortfinned eel elver (9.1 cm.) and one hundred and eight shrimps, showing that both these excellent climbers were capable of scaling the weir.

The catch in the lagoon was dominated by quite small shortfinned eels. Twenty three of this fish ranging in length from 30-70 cm. were caught. In addition six juvenile goldfish from 9-20 mm. were caught. This exotic fish is capable of breeding within the lagoon and so maintains a landlocked population. The suprise catch was one 11 cm. male giant bully, This fish is an obligatory migrant from the sea and must have come over the weir. At times in the recent past the stoplogs have been removed and the lagoon has been drained. This giant bully may have entered the lagoon at that time and has remained there since. Although the tributaries draining into the lagoon were not examined, koaro and banded kokopu could reasonably be expected to be present.

What was missing from catch in this admittedly brief survey were the shoaling, non-climbing species, inanga and common smelt. These fishes could be expected to flourish in the lagoon and eventually contribute to the local whitebait catch. If these species could be allowed into the lagoon then it could be expected that all other native fishes would also get over the weir.

Therefore inanga and smelt should be the target species for a fish pass over the control structure. The design should cater for the relatively poor swimming prowess of these two non-climbing species. Of course there is the option of draining the lagoon for a period each year to allow fish upstream past the weir. Unfortunately draining the lagoon over the spring/summer migration period of most native fish is unlikely to suit the requirements of waterfowl, which will be breeding at this time.

Table 1. Fish species expected (*) or caught above and below the Braemar Lagoon control weir.

Species	Below Weir	Above Weir
Longfinned eel *Anguilla dieffenbachii*	caught	caught
Shortfinned eel *Anguilla australis*	caught	caught
Giant kokopu *Galaxias argenteus*	*	
Inanga *Galaxias maculatus*	caught	
Common smelt *Retropinna retropinna*	caught	
Giant bully *Gobiomorphus gobioides*	*	caught(!!)
Common bully *Gobiomorphus cotidianus*	caught	
Redfinned bully *Gobiomorphus huttoni*	caught	
Freshwater shrimp *Paratya curvirostris*	caught	caught
Banded kokopu *Galaxias fasciatus*	caught	*
Koaro *Galaxias brevipinnis*	*	*

FISH PASS DESIGN REQUIREMENTS

It was found that at least some species of fish and invertebrates, capable of climbing vertical wetted concrete as juveniles, were able to migrate past the weir. What is required is a fish pass design capable of allowing small weak swimming fishes upstream. To achieve this goal it is necessary to present the fish with a layer of slow flowing water. Hydraulic flume studies (Mitchell 1989), showed that native fishes are adept at selecting slow flowing zones to make upstream movement easier.

However to generate low water velocities within a channel requires a very low gradient. A channel of sufficient length to produce a slow flow from the weir crest to the stream below, at Braemar, would have to be very long. In turn this implies a structure that would be both difficult to construct and expensive. It is obvious that the flow down any channel of reasonable length (and thus cost), would have to be slowed with baffles or similar devices.

One layer of water which is always relatively slow flowing and which displays hydraulic behavior quite different from the water column, is the boundary layer. Any object in a water flow has a "skin" of water which moves more slowly than the surrounding flow. The "skin" of water increases rapidly in thickness as the roughness of the object increases. Diving observations in rapids show that small fish can find areas of quite slow flowing water between the stones, despite the high velocity of the water above (C. Mitchell, pers obs.).

Lonnebjerg (1990), reported that a " natural-artificial" stream channel lined with rocks was successful in allowing a wide range of small fishes upstream. The fish were moving within the boundary layer and had an infinite range of water velocities to choose both for swimming and to rest in.

The fish pass design suggested here relies on a layer of rocks and cobbles to generate a boundary layer on the bottom of a flume. Elvers can move upstream beneath the rock layer, other fishes find shelter and resting places between the rocks.

Entrance design is a critical feature of fish passes. Unless fish can easily find the fish pass entrance then it will fail. Fish will usually follow the main flow upstream and most will not seek alternatives with less flow until further progress upstream is impossible. At Braemar weir, the pools in the rock rip-rap below the concrete sill represent the upstream limit for the swimming fishes. It is at this point that the fish pass entrance should be sited.

The design is planned to have a constant slope of less than 5^0 Therefore the fish pass first travels away from the weir and then makes a 180^0 turn back toward the weir. The entrance is then sited close to the concrete sill. A doglegged fish pass as proposed is also inherently stronger (although more complex to construct). Rock rip-rap below the sill is rearranged to give a low and constant gradient riffle leading up to the fish pass entrance. Elsewhere the rocks should be set to make an impassable barrier to fish.

FISH PASS CONSTRUCTION DETAILS

The fish pass design proposed consists of a flume of dressed, tantalized 8x2 planks spiked together with 4" and 6" galvanized nails. Edges of the flume components are planed straight before assembly. Rebating the edges of the bottom planks would make an even better seal. Edges are butted together and sealed with silicone rubber cement before assembly. Subsequent swelling of the timber and blockage with debris should seal any minor leaks. Knotholes should be plugged with plywood plates.

The four planks comprising the flume bottom are tied together with 4x2 r/s bearers at 1.0 m centers. The sides of the flume are spiked directly onto the edge planks of the bottom. The whole flume rests upon 6x2 r/s joists bolted onto 1/4 round no 1 fence posts driven into the bankside.

One difficulty in construction will be driving the supporting fence posts in straight lines into a bank which has been reinforced with boulders. The upper limb of the fish pass flume rests upon the central row of fence posts. The posts are to be set in threes so that the central posts both support the upper limb and also carry the joists for the lower limb. These posts will have to trimmed off to a line after driving, to give the correct slope for the flume to rest upon.

Owing to the price of butyl rubber sheet, there is only a short section of butyl rubber sheet used at the head of the pass. Sealing of the fish pass otherwise relies upon the quality of carpentry when the flume timbers are assembled. Alternatively the entire fish pass could be lined with a custom made liner of butyl rubber. It is anticipated that costs will probably double or more with this step, unless the fish pass is used as advertising or similar.

It is recommended that 150-200 mm diameter stones be used to completely cover the bottom of the flume. Quarry stones have sharper edges and can be expected to slow down water flow more effectively than rounded river stones.

Removal of the stoplogs from the bay where the fish pass has been installed will require that two short wooden cleats, which divert water into the fish pass, be unbolted and lifted aside. The flume is then left unattached to the stoplogs.

One feature not shown in the drawing, owing to the perspective used, is a packing piece dyno-bolted to the wingwall of the flume. The true left side of the fish pass rests upon this packing piece. As can be seen from Fig 1, the true right side of the fish pass is freestanding.

Figs 1,2 3 & 4 show details of the fishpass.

Predation by birds may become a feature of the fish pass. If this is considered to be a problem then a cover for the fish pass may have to be built. A cover could also reduce vandalism, for example the stones could easily be thrown away. These problems can be tackled as they become apparent.

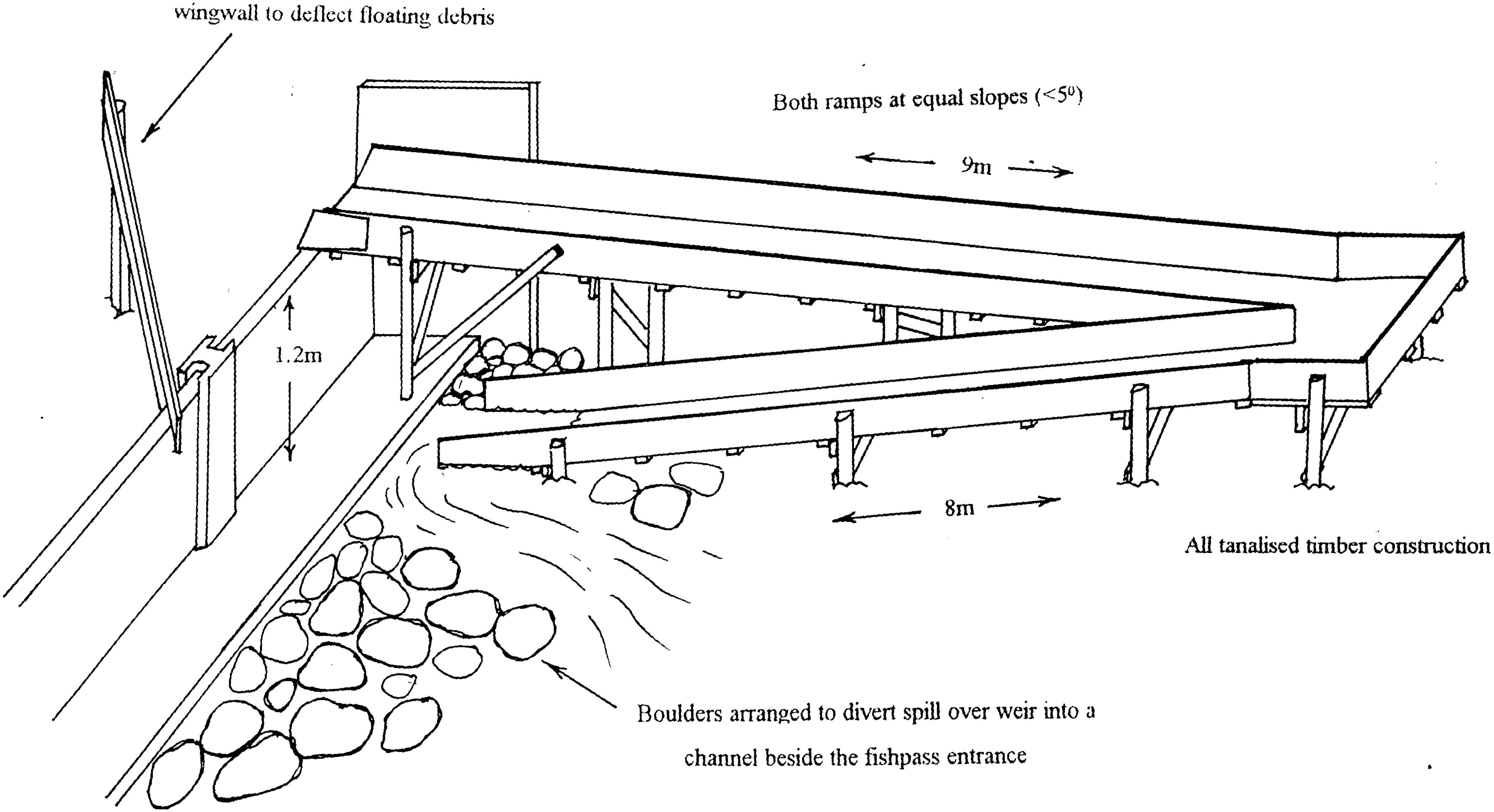
A debris deflector of two lengths of 8x2 bolted together is suggested across the bay where the fish pass is sited. However it will still be probably necessary for the fish pass to be inspected at reasonably frequent intervals over the main summer migration period, for removal of debris which could choke up the exit to the fish pass. It is also suggested that some monitoring or observations of the fish pass be carried out after it is installed. Unforeseen problems could then be rectified and some idea of the performance gained.

REFERENCES

Lonnebjerg, N. 1990: Fishways in Denmark. *Proceedings of the International Symposium on Fishtivays '90 in Gifu, Japan:* 253-259.

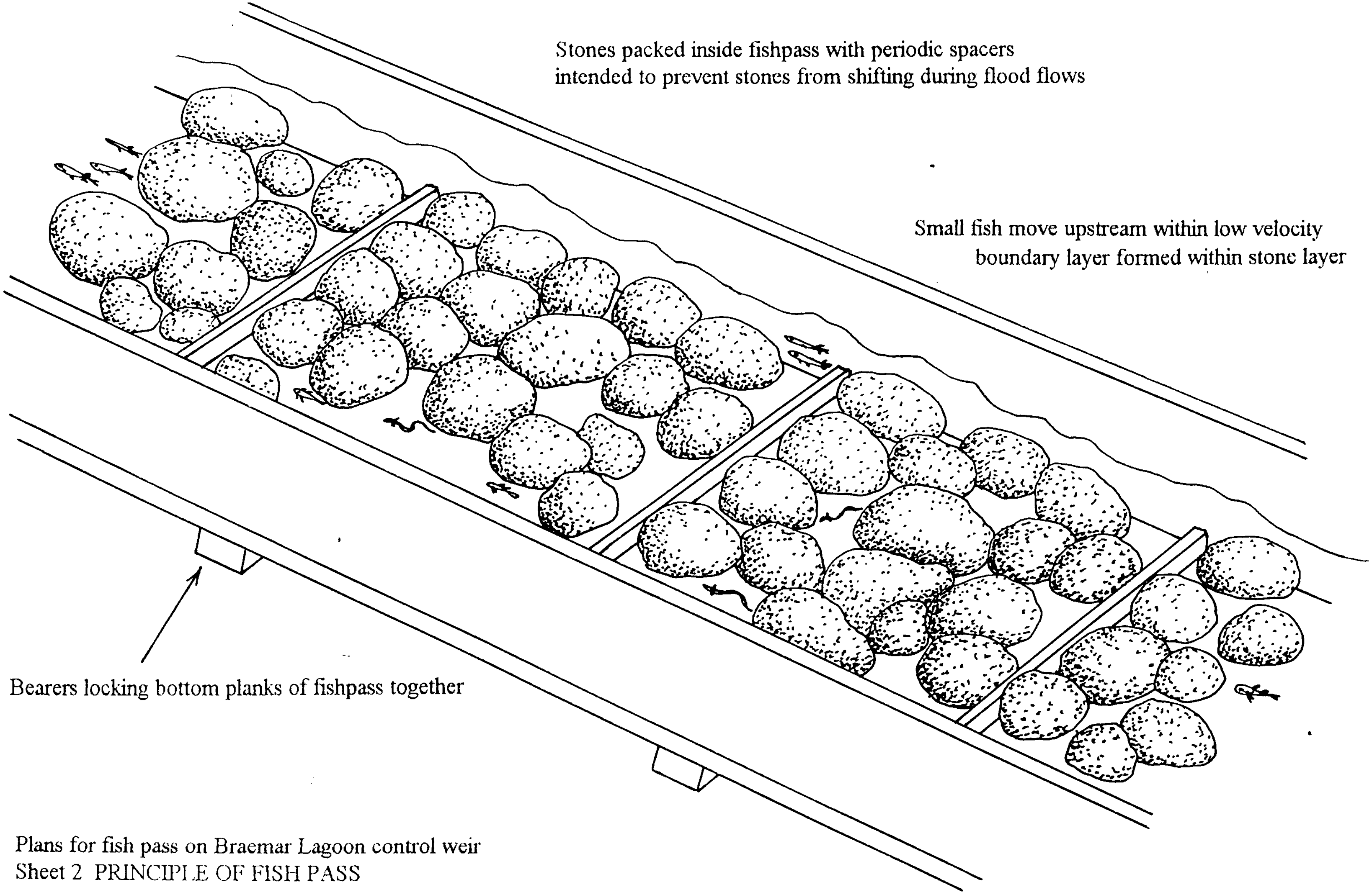
McDowall, R.M. 1990: New Zealand Freshwater Fishes: a natural history and guide. Heinemann Reed-MAF publishing group. Auckland-Wellington 553 pp.

Mitchell C.P. 1989: Swimming performances of native freshwater fishes. *New Zealand Journal of Marine and Freshw ater Research 23:* 181-187.



Plans for fish pass on Braemar Lagoon control weir
Sheet 1 DRAWING SHOWING GENERAL LAYOU'

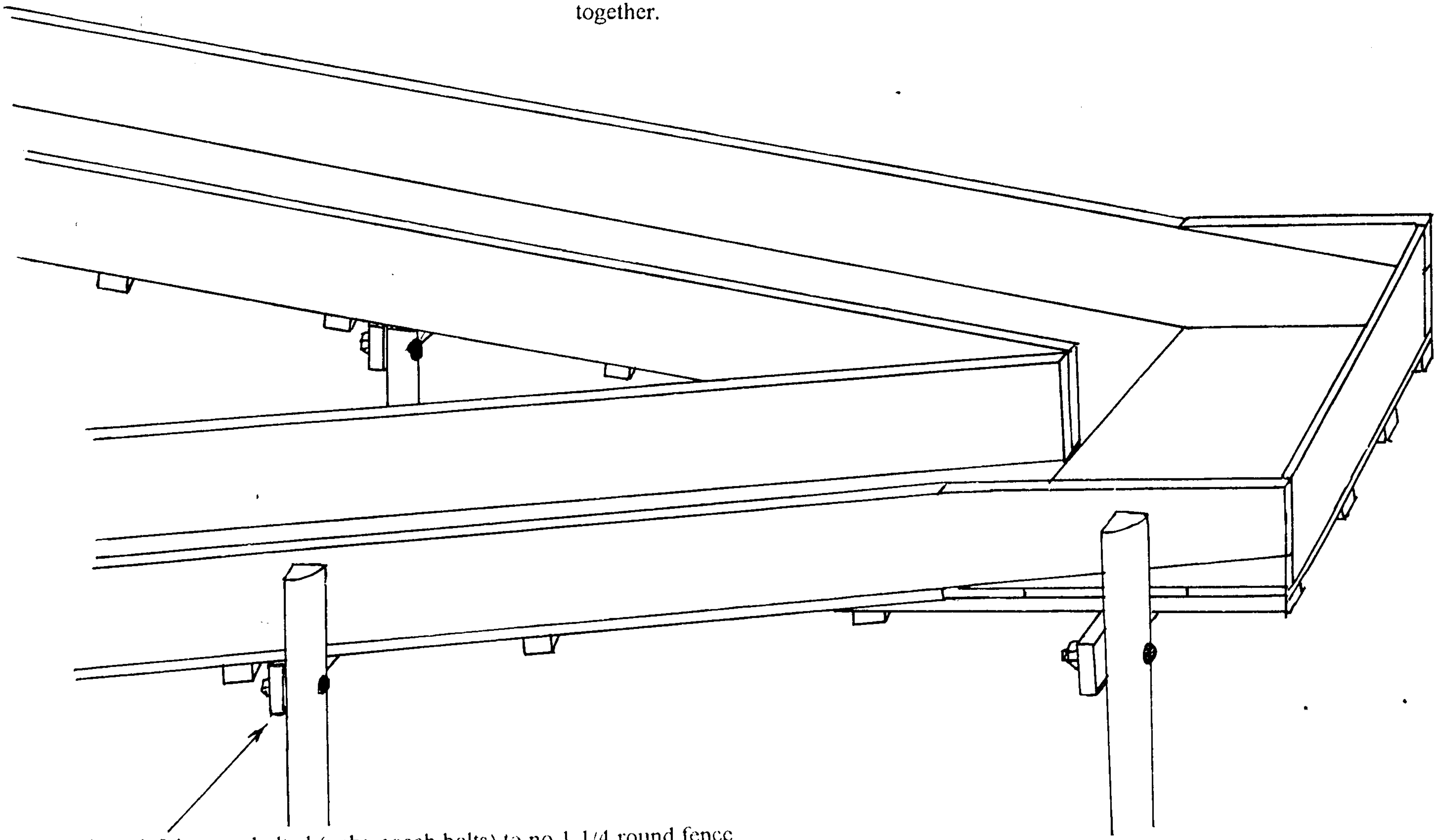
Charles Mitchell & Associates
Te Manu Road RD 2 ROTORUA



Plans for fish pass on Braemar Lagoon control weir
Sheet 2 PRINCIPLE OF FISH PASS

Charles Mitchell & Associates
Te Manu Road RD 2 ROTORUA

All flume timbers dressed tantalized 8x2.
All joints planed to fit and sealed with silicone rubber sealant before spiking flume together.



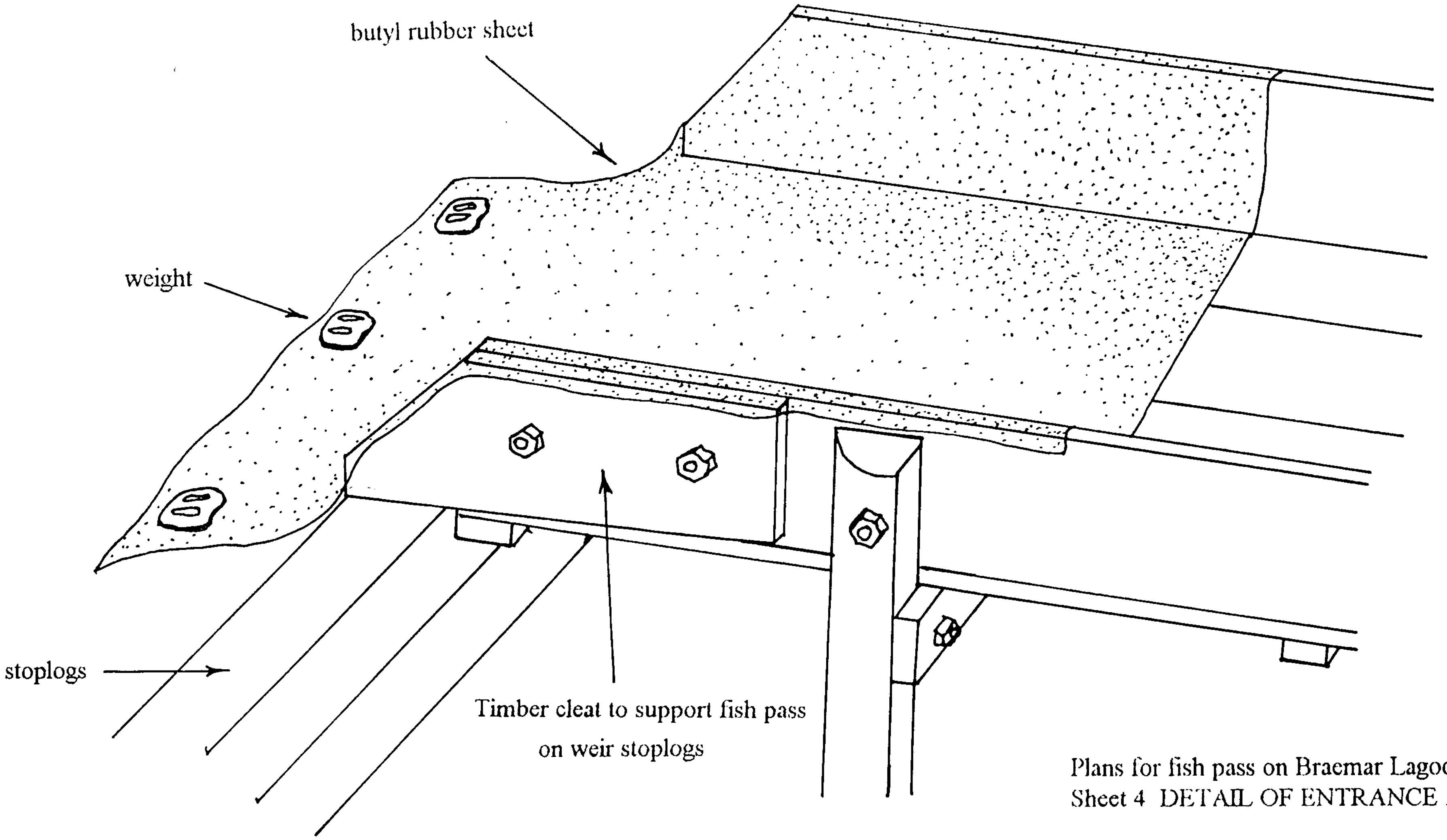
Fish pass supported on 6x2 bearers bolted (galv. coach bolts) to no 1 1/4 round fence posts driven into bank. Fence posts must be braced

Plans for fish pass on Braemar Lagoon control weir
Sheet 3 DETAIL OF TURNING POINT OF FISH PASS

Charles Mitchell & Associates
Te Manu Road RD 2 ROTORUA

Butyl rubber flap nailed to flume with galv. flathead clouts
Flap is weighted and dropped into water above flume to seal fish pass entrance

Cleats on each side can be unbolted to allow stoplogs to be lifted out



Plans for fish pass on Braemar Lagoon control weir
Sheet 4 DETAIL OF ENTRANCE AREA