ISSN 1170-2001

NEW ZEALAND FRESHWATER FISHERIES MISCELLANEOUS REPORT NO. 24

ENVIRONMENTAL ASSESSMENT OF THE PROPOSED LAKE ROTORUA CONTROL STRUCTURE

by

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Report to: Bay of Plenty Catchment Commission

Freshwater Fisheries Centre

MAF Fisheries

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ROTORUA

Servicing freshwater fisheries and aquaculture

1989

NEW ZEALAND FRESHWATER FISHERIES MISCELLANEOUS REPORTS

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ISBN 0-477-08365-X

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Impacts on fisheries

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INTRODUCTION

1. The Ohau Channel

Lake Rotorua and Lake Rotoiti lie together on the eastern edge of the North Island volcanic plateau. Formerly they were one extensive lake but after downcutting of the outlet, two separate lakes emerged. Both lakes are part of the same drainage system, lake Rotorua drains into lake Rotoiti via the Ohau channel. From lake Rotoiti the water then flows on down the Kaituna river to the sea. As part of a comprehensive management plan, "The Kaituna Catchment Control Scheme", it is proposed to build a permanent control structure across the Ohau channel to control the level of Lake Rotorua. The impact of this structure on fish populations and fisheries must be discussed.

2. Fish and Fisheries of the Rotorua Lakes

Severe rapids are found in the gorge of the upper Kaituna river. Water velocities are so high that the upstream movement of fishes is blocked. Therefore native fishes such as eels, torrent fish, red-finned bullies and giant kokopu (see appendix for scientific names), all of which have an obligatory marine life cycle stage, were not naturally found in the Rotorua lakes.

Originally a rather limited fauna of the common bully and koaro (both of which can form landlocked populations) were present. Early records indicate that these fishes, particularly koaro, were very abundant and together with koura and kakahi, were an important part of the diet of the local maori.

Part of the impact of european culture included introduction of northern hemisphere sporting fishes. Of course it is well known now that brown trout and particularly rainbow trout provide very valuable fisheries in the Rotorua lakes system. However these introduced predators had a drastic effect on the abundance of koaro. Captain G. Mair described fishing for koaro in the Hamurana stream in the 1860's.

"A long funnel-shaped net with a pocket was stretched across the river.....The net was lowered in position and pegged to the bottom with forked sticks at about 8 p.m.; then a 50 ft canoe was moored to a stake at the lower end. Two hours then elapsed, when the pocket was lifted, the end untied, and several hundredweight of the fat little fish were emptied into the canoe. This process was repeated during the night till quite a ton weight had been obtained.....Of course, the introduction of trout was the deathknell of the koaro". (from McDowall 1984).

Following the elimination of their food source, the condition and growth of trout deteriorated. Between 1906 and 1909, the Tourist Department employed a man at Mercer to net small fish from the Waikato River. These fish (collectively called inanga) were then sent through on the train and released into Lake Rotorua (P. Burstall, DOC smelt file). Smelt (Retropinna retropinna), established from these liberations, now form a major component of trout diet in the Rotorua-Taupo district (Myleschreest, pers comm.).

All the afore-mentioned fishes, native and introduced, are species which normally have a marine stage in their life-cycle. Landlocking has resulted in no real change to their life-cycle, merely a substitution of the lake for the sea-going stage. One common feature is that landlocked fish tend to be smaller, perhaps because food and space is less abundant in freshwater.

3. The Ohau Channel

The Ohau channel is broad and meandering. There are no rapids or waterfalls which could impede fish movement between the two lakes. The upper section is degrading and has a bottom of coarse sands and fine gravels, whereas the lower section is aggrading and finer sediments dominate (S. Pemberton pers.comm.). `Choking' and resulting high velocity water from the existing control structure has caused a large pool to develop immediately downstream.

4. Fish and Fisheries of the Ohau Channel

Considerable numbers of smelt (known locally as inanga) migrate up the Ohau channel from Lake Rotoiti. There are two major movements within the year. The first is in late September - early October and consist of adult sexually mature fish. The second migration occurs in March-April and is made up of small, juvenile fishes (S. Newton, pers.comm.). The abundance of smelt at these times makes it worthwhile to fish for them using whitebait nets (or a local, rather elongated variant). It is highly probable that a traditional maori fishery would previously have existed to take similar movements of koaro (D. Stafford pers.comm.).

Trout are likely to be attracted into the channel when smelt are abundant. Trout also move between the two lakes. Catches of `Rotoiti' type trout are common in Lake Rotorua close to the outlet (D. Flashoff & S. Newton pers.comms) but perhaps the most compelling evidence comes from tagged trout. Tagged fingerlings reared at the Ngongotaha hatchery and released at Hinehopu at the far end of Lake Rotoiti were later recaptured in the fish trap on the Ngongotaha stream. After presumably spawning in their home stream the same fish were later recaptured in Lake Rotoiti (N. Ewing pers. comm.). Although they have not been recorded it is highly likely that small trout, right down to fingerling size, will also move up (and down) the Ohau channel.

Apart from serving as a passageway between the two lakes, the

Ohau channel is also used for those aspects of the fishes' life cycle which require a stream bed. In the case of both trout and their distant relation smelt, egg laying (or spawning) normally occurs in streams. Eggs are either laid in nests (redds) excavated in coarse gravel (trout) or in the case of the very much smaller smelt, are buried by water flowing over moving sand. After hatching, the young fish are carried downstream to complete their life cycle in the sea (or the lakes in this case).

Trout spawning has always occurred in the Ohau channel (S. Newton, pers.comm.) and since the installation of the temporary control structure, scour has produced a particularly attractive bed of clean gravels along the true right bank of the pool below the weir. Spawning occurs over the winter months and hatched fry can be seen moving downstream (D. Flashoff, pers.comm.). It is possible that the Ohau channel is a significant spawning area for Rotoiti trout. Likewise, although the proportion of mature smelt which spawn in the channel over the spring migration is unknown, it could be considerable.

The Ohau channel is a popular fishing area. Trout are concentrated in the channel and become accessible to the shore based angler. Fishermen are particularly attracted to the present control structure. Trout and smelt accumulate in the pool below and the structure itself offers a snag-free casting area. Concentrations of spawning trout up to 100m out into Lake Rotorua also attract seasonal fishing interest (N. Ewing pers.

comm.).

The other fishes found in the Rotorua lakes; common bully, feral goldfish and mosquito fish, have no specific life-cycle requirements for running water. None are threatened or form a fishery in the Ohau channel.

Impacts on Fisheries from the proposed Control Structure

It is obvious that the Ohau channel is important to smelt and trout. Placing a barrier across this channel will impede the free movement of these fishes. As far back as 1974 it was recognised that smelt were both accumulating below the weir and were also being harvested as they attempted to swim around it (DOC smelt file). In 1977, when it was estimated that over half a million smelt/week were being netted at the weir, some of the gabions were moved apart to allow smelt easier passage into Lake Rotorua. In 1978, Mr N. Ewing of the then Wildlife Service used a current meter and operator borrowed from M.O.W.D. to estimate current velocities critical for smelt passage. The values obtained; "....not greater than 0.5 m/s for short distances and not greater than 0.21 m/s over distances in excess of two metres", are very similar to those measured by testing smelt swimming performance in a hydraulic flume (Mitchell in press). From that study values of up to 0.35 m/s for obstacles 6m or less in length and 0.25 m/s for obstacles 15 m or longer were obtained. Fish used were juvenile sea run smelt which are similar in length (35-45 mm) to mature lake smelt. As peak swimming speed increases with the length of fish, it can be expected that still lower water velocities would be needed to allow migrations of juvenile lake smelt (25-35 mm) over the control structure. Mature trout, being far larger fish, could be expected to have little trouble until water velocities exceeded at least 1.5 m/s.

A crude estimate of average water velocities over the weir that would occur over a range of flows has been calculated using the supporting data provided with the water right application.

Hm	Q	dc (.67 Hm)	Cross sectional area (m^2)	Mean veloci (m/s)
1.27	11.7	.85	5.10	2.29
1.47	16.6	.95	9.11	1.82
1.67	23.1	1.12	13.75	1.68
1.88	31.4	1.26	18.58	1.69
2.07	39.6	1.39	22.97	1.72
2.27	49.4	1.52	27.56	1.79

This suggests that velocities over the structure will deter adult trout and that smelt would have little chance of negotiating this structure.

Previously roughness, porosity and irregularities in the gabions allowed fish passage. Fish are very effective at selecting optimum routes, exploiting eddies and slack water zones to make their way around fast water barriers. However, the new structure will be uniform concrete and deliberate provision for fish passage will have to be made.

RECOMMENDATIONS

To allow smelt and fingerling trout passage it is recommended that the high crest of the weir be lowered to 279.55 and that boulders be set in the weir crest to a height of 279.70. This should recreate a hydraulic crest of around 279.6. Boulders of about .3m x .3m, set .3m apart in staggered rows across the entire high crest of the weir should be used. It is intended that a turbulent layer of water with average velocities around .3 m/s and ample resting areas with velocities .2m/s or lower will be formed (Fig. 1). Further, a channel .4m wide x .3m deep should be left in the high crest on either side. This will allow at least some low velocity flow during periods of low water.

At Hm below 1.4m, wind and current action will tend to pile drifting lakeweed against the outer row of boulders. Careful hydraulic engineering may avoid this problem by spacing and angling boulders to form a small standing wave and a back eddy along the upstream edge (Fig. 2). At higher flows the water and weed will simply flow over the boulders. A more expensive solution requiring ongoing maintenance would be provided by angled trash screens set toward the central low crest. Horizontal rounded bars should be largely self-cleaning (Fig. 3).

Trash screens of this type could be readily installed at any time after the weir is commissioned if they are proven to be necessary.

The proposed weir crest `fish ladder' is intended to provide a broad front over which fish can move, making netting and other predation more difficult. This aspect would be further enhanced by piling rocks against the upper face - this will also provide further irregularities in the current plus turbulent boundary layers which fish can exploit to move upstream.

Neither bullies or the remnants of the koaro population are expected to be affected by the weir. These two species are adept at exploiting boundary layers and can rest passively on the bottom in high velocity water using the `airfoil' effect of water flowing over their fins. Short bouts of high speed darting followed by resting on the bottom allows them to make headway against high current velocities.

To ease passage for larger trout it is recommended that square section .3m x .3m x 1.3m deep, concrete nibs be built down the sides of the low crest weir (Fig. 4). A series of three of these nibs on either side are suggested to provide back eddies and turbulence where fish can rest while moving upstream. In addition, if these structures are made integral with the weir, then they could also function as supports for the stoplogs.

In an identical pattern to the high crest, boulders should be set into the top of the low crest (possibly leaving a strip clear down the centre to maximise propeller clearance) (Fig. 4). These boulders will ease passage for smaller trout and may eventuate as the only feasible route for late-summer movement of smelt in a dry/low flow year.

Construction Phase Impacts

It is anticipated that the major impact during construction of the control weir will arise when flow is first put through the diversion channel. Considerable amounts of silt and fines can be expected to move into the Ohau channel at this time as the bed of the diversion channel becomes sorted. Stabilisation of both the sides (presumably with gabion mattresses) and a minimum of rock fill along the bottom, is recommended before opening the diversion channel.

There is also some concern that the proposed alignment of the diversion channel will act to divert water across the channel and erode the opposite bank. Flow from this diversion channel will almost certainly erode the tail of the spawning gravels (which lie downstream of the present weir. It is suggested that the alignment be altered so as to divert water into the channel further downstream and at a more acute angle. - possibly sited with the true left bank close to the small footbridge which presently spans the silted remains of a former channel.

The remaining spawning gravels, up to the coffer dam surrounding the construction site, will lie in static water during the construction phase. Failure of some trout spawning in the Ohau channel can be expected if construction extends into May, June, July.

If it was practicable to schedule construction over the period October - March, then impacts upon trout spawning could be minimised.

In the longer term, fish movement over the stabilizing gabion baskets placed at the mouth of the diversion channel can be expected to be similar to the present temporary control weir.

APPENDIX

Common scientific names of fish cited in this study:

Eels	_Anguilla dieffenbachii_
	Anguilla australis
Redfinned bully	_Gobiomorphus huttoni_
Common bully	_Gobiomorphus cotidianus_
Torrent fish	_Chiemarrichthys fosteri_
Koaro	_Galaxias brevipinnis_
Giant kokopu	_Galaxias argenteus_
Smelt/inanga	_Retropinna retropinna_
Brown trout	_Salmo trutta_
Rainbow trout	_Onchorhynchus mykiss_
Goldfish	_Carassius auratus_
Mosquito-fish	_Gambusia affinis_

Complete descriptions of these fishes can be found in McDowall, R.M. 1978: "New Zealand Freshwater Fishes - a Guide and Natural History". Heinemann Educational Books, Auckland 230p.

Other literature used:

DOC smelt file : File 7 Vol. II 5/1

Correspondence relating to smelt 1970-1984. Closed file of Wildlife Service, Rotorua.

McDowall, R.M. 1984: The New Zealand Whitebait Book. A.H. & A.W. Reed Ltd, Wellington. p210.

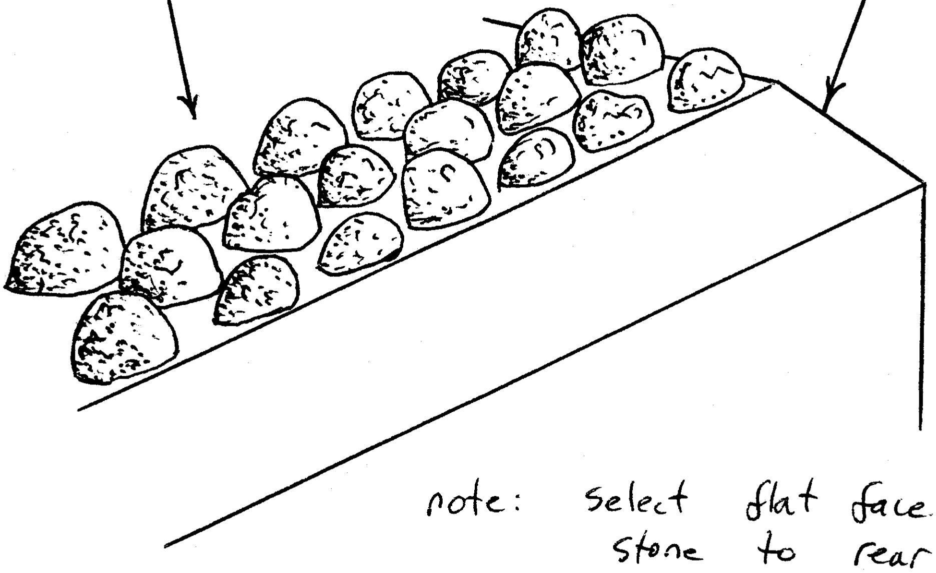
Acknowledgements

This report was greatly improved by contributions from the following: Mr S Newton, Kamatua of the Ngati Piako, Mr N. Ewing, Senior Fisheries Officer, D.O.C., Rotorua, C. Richardson, D.O.C., Rotorua, D. Flashoff and last but not least Mr G. Pemberton, B.O.P. Catchment Board.

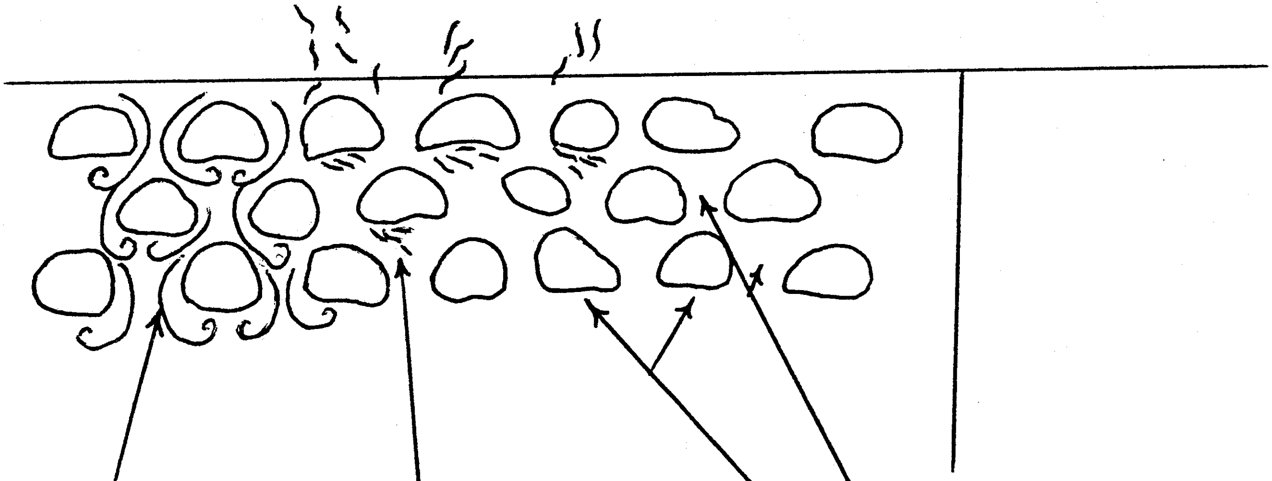
Stones: ·3 x ·3 m across top,
·2 m above crest level
set ·3 m apart in rows
·3 m between rows, stones
in each row staggered to
oppose upstream gap.

note: flat-topped stones would make for safer footage for anglers.

Note: angled edge ≈ ·5 m wide x ·3m deep provides a velocity gradient & entrance for fish coming to ladder



note: select flat face of stone to rear when possible.



simplified water flow

fish shelter at back or lee of stones, swim in bursts through channels between stones.

water velocity no greater than ·5m/s pref ·3 m/s.

velocity in lee of stones ·2m/s or less.

FIG 1. low maintainence, vandalproof fish ladder for small fish.
HIGH WEIR CREST, OHAU CHANNEL CONTROL STRUCTURE.

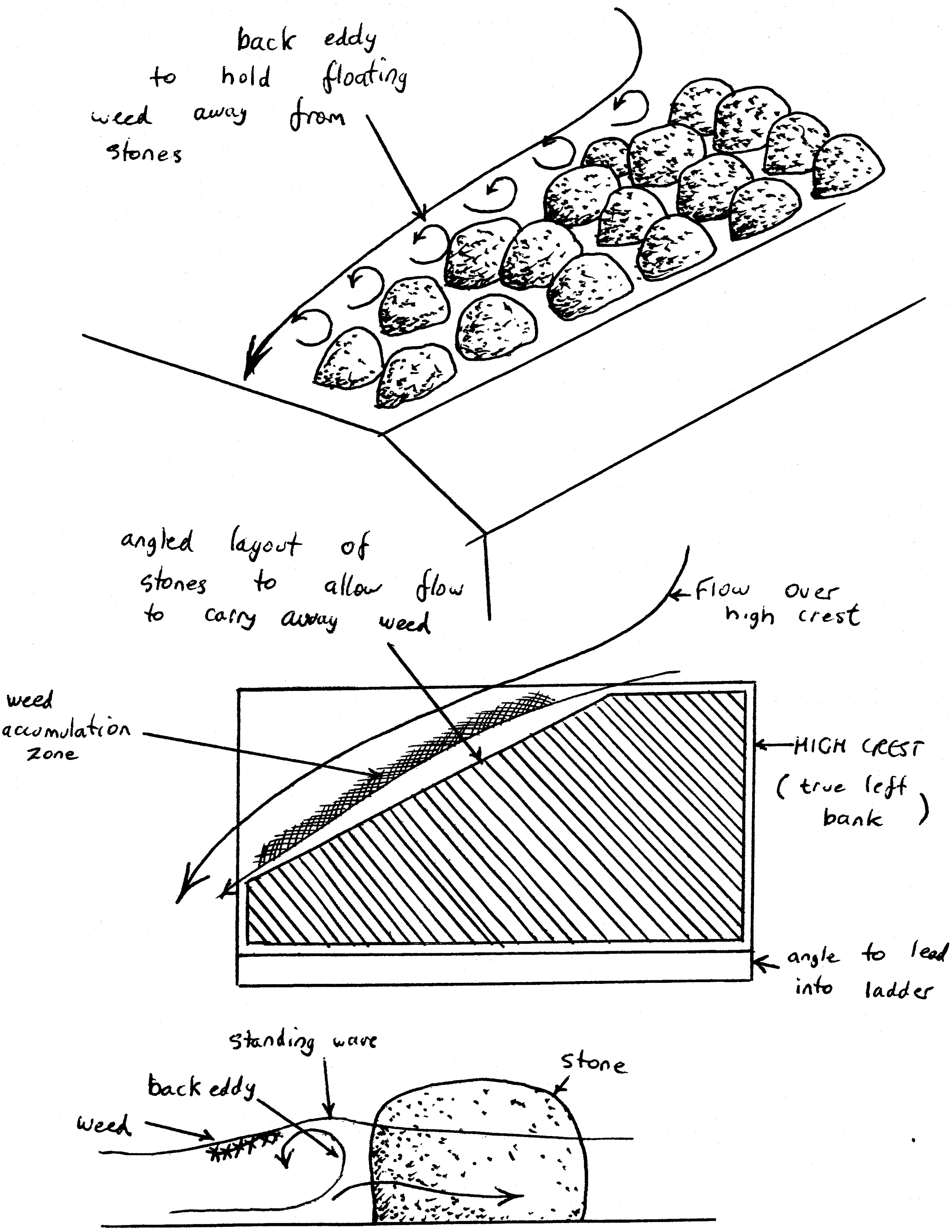
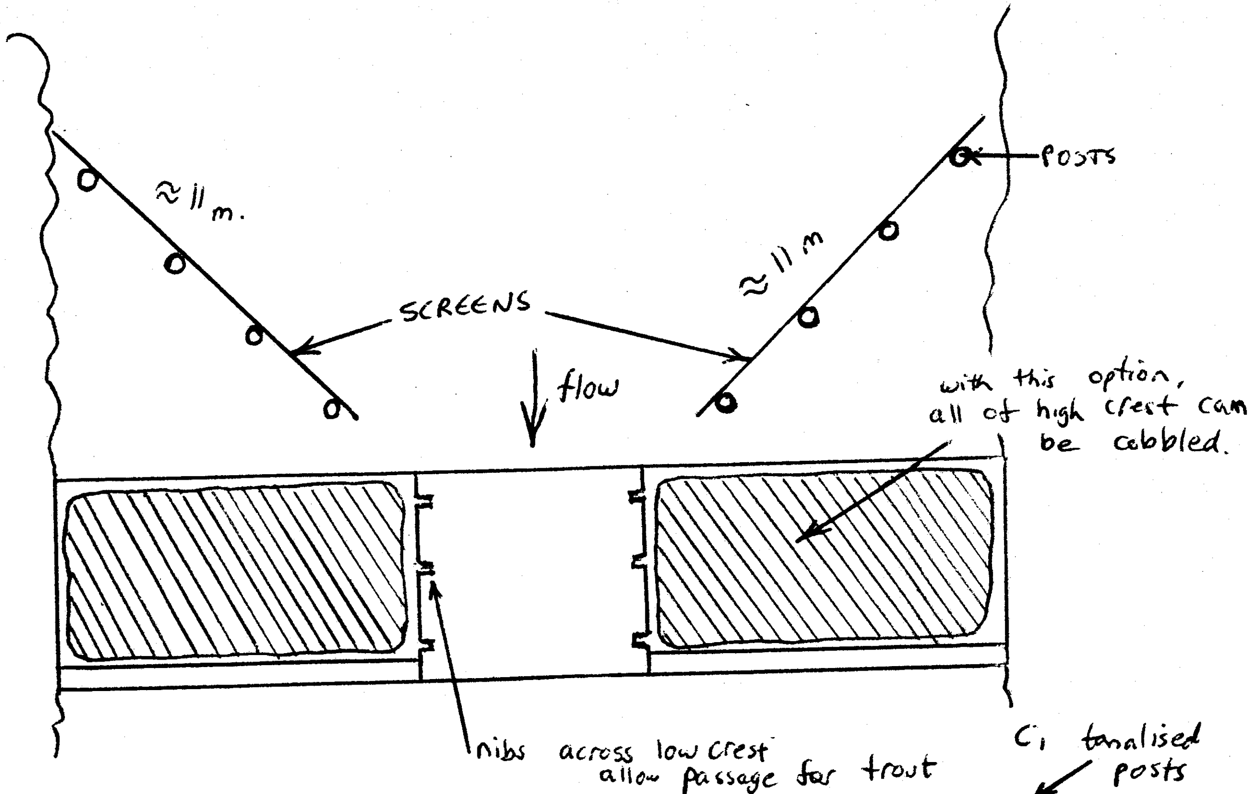


FIG 2. Suggested layout of fish ladder to reduce weed fouling.



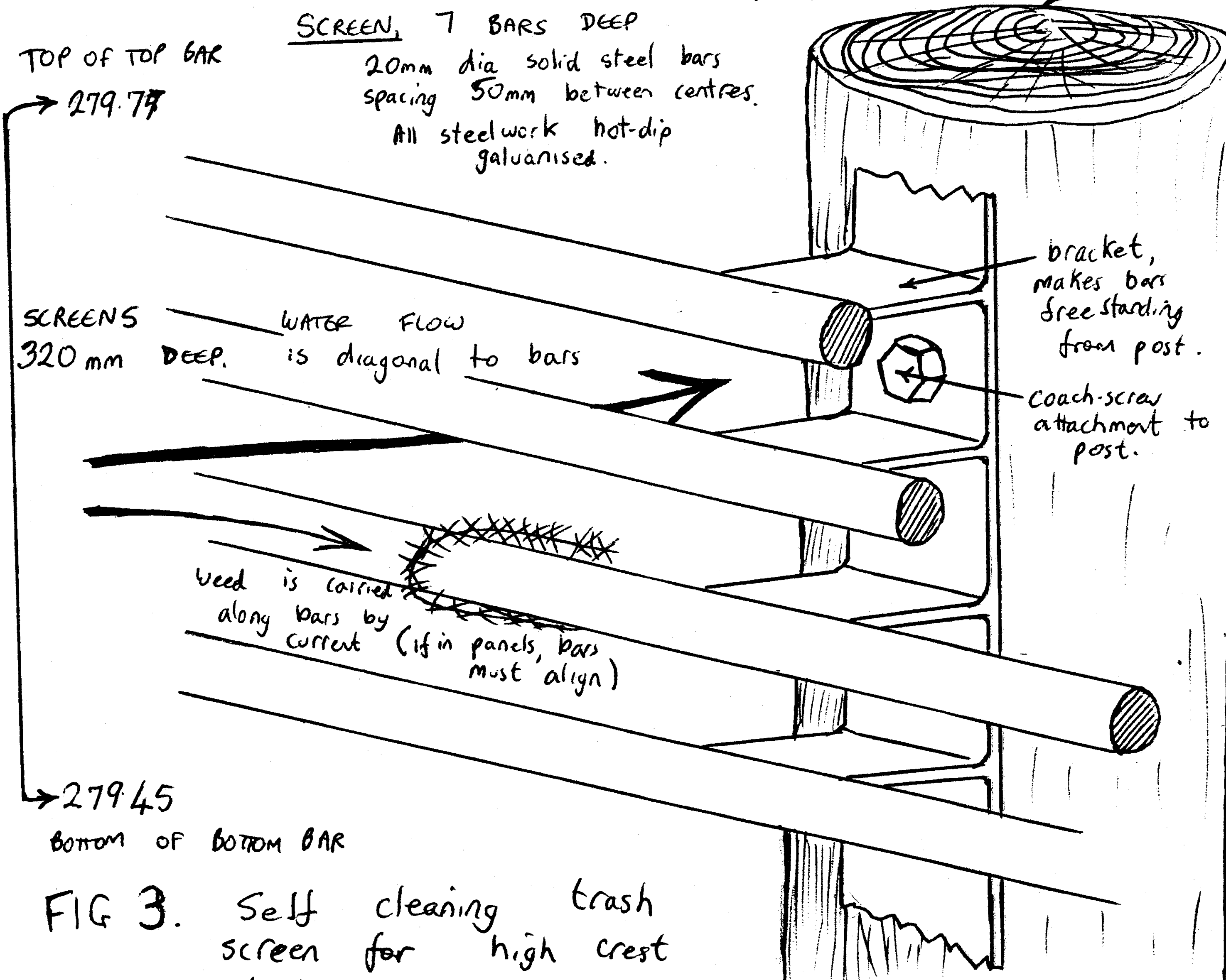
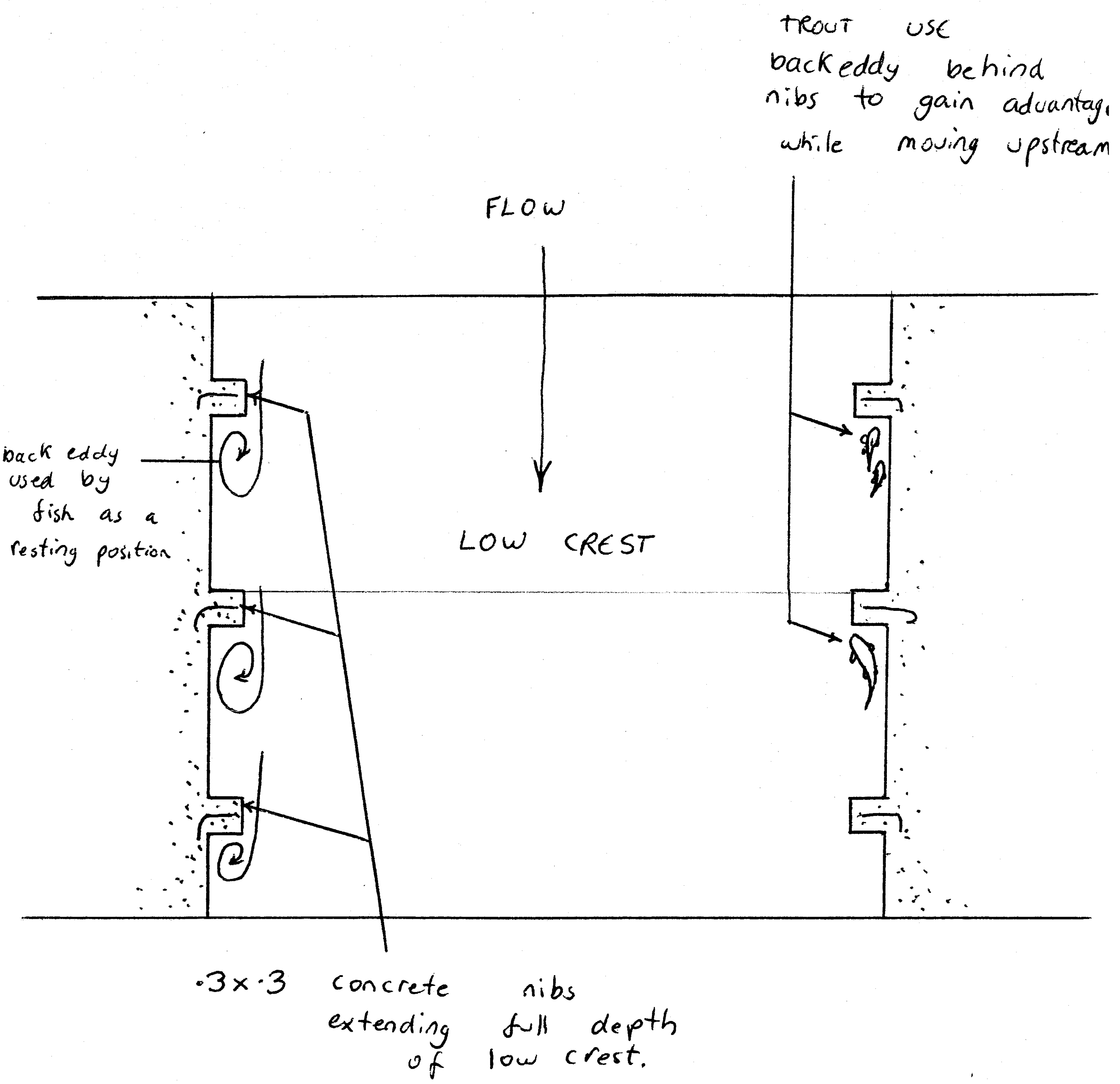


FIG 3. Self cleaning trash screen for high crest weir



note. central nibs can function as supports for stoplogs

FIG. 4 Suggested layout of vertical concrete nibs along the sides of the low crest.