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NEW ZEALAND FRESHWATER FISHERIES MISCELLANEOUS REPORT NO. 40

WHITEBAIT SPAWNING GROUNDS IN THE BAY OF PLENTY

by

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(Part 1 of 3 reports)

Freshwater Fisheries Centre

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1. INTRODUCTION

Saxton *et al.* (1987) presented information on the species composition and relative importance of whitebait fisheries in 13 Bay of Plenty rivers. They found that *Galaxias maculatus* comprised most of the run in the western Bay of Plenty. Anecdotes suggest that the whitebait catch in former years was far greater than it is today; the average catch of whitebait reported by Saxton *et al.* (1987) was less than a cupful per fisher per day. Despite low catches, whitebaiting is a popular activity, with about 36 000 fishing days effort per season being spent on the fishery in these 13 rivers.

The life cycle of *Galaxias maculatus*, the common whitebait, is well known (McDowall 1968). The juvenile stage is the target for the whitebait fishery, when shoals of fish enter rivers around New Zealand in spring. Over summer, the survivors grow in fresh water and mature into the adult inanga. By autumn, inanga are sexually mature. Before each series of spring tides (March, April, and May), shoals of ripe fish migrate downstream to the estuaries to spawn.

Inanga move into flooded bankside vegetation and spawn on the full tide, where the water is tidal but fresh. The falling tides expose the eggs until the next series of spring tides. Fully developed eggs hatch when submerged, and the larvae are swept out to sea to grow into whitebait. Five months later they return to the river and the waiting fishers.

Terrestrial deposition of eggs by whitebait became generally known in the 1930s, as a result of investigations by the N.Z. Marine Department. It was soon recognised that grazing and trampling by stock posed a particular threat to developing whitebait eggs. Despite this knowledge, there has been little effort expended on managing whitebait spawning grounds in the intervening 60 years. The whitebait fishery is unprotected. There are few controls on fishing methods, and there are no reserves for rearing or breeding habitat.

Throughout the agriculturally developed areas of New Zealand there has been a steady decline in the whitebait catch. There are probably several reasons for this decline. Wetlands have been reclaimed, spawning grounds damaged, and the population may be overfished. Action to protect spawning grounds could be simple and cost effective.

The aim of this study is to provide information to DOC managers to assist with the protection and, perhaps, partial restoration of the Bay of Plenty whitebait fishery by protecting the spawning grounds from unnecessary damage.

2. OBJECTIVES

- To locate whitebait spawning grounds in the Bay of Plenty.

- To record vegetation cover and land use at spawning sites in relationship to how they might affect whitebait spawning success.

- To record land ownership so that formal moves for protection can be initiated.

3. METHODS

Two methods were used to locate whitebait spawning grounds. Firstly, the river bank was searched on foot or by boat, looking and listening for fish activity. Fish could often be seen shoaling in the shallows. Within flooded vegetation, patches of milky, sperm-discoloured water indicated spawning sites. Spawning fish make a characteristic "spattering" sound. This, and the lower pitched "sucking" sound of eels preying on the spawning fish, often helped to locate sites from some distance. Pegs were placed to mark spawning sites and, after the tide had fallen, the area was checked to confirm the presence of eggs.

Secondly, we used clues from the environment to locate spawning grounds. We found that whitebait tend to spawn upstream of the interface between salt water and fresh water in the tidal zone. Areas of suitable slope and vegetation near the upstream limit of saltwater penetration were likely sites for spawning activity. A salinometer was used at high tide to locate the upstream limit of saltwater penetration.

At low tide, burrows made by the estuarine crab *Helice crassa* were used as an indicator of the limit of salt water; there must be some salt intrusion for this crab to occur. As the salt influence reduces, the burrows become restricted to the lower banks and then peter out, which gives a good indication of the saltwater limit.

Bankside vegetation also was used to indicate possible spawning sites. Table 1 lists (i) plants characteristic of good spawning sites, (ii) areas that are too saline, and (iii) those that are too wet for whitebait spawning.

4. RESULTS

4.1 Wairoa River

Date of observations: 21/04/88, 17/05/88.

Spawning observed: +.

Eggs found: +.

Locality: Eggs were found on the banks of five small drains, 3 km upstream from the main road bridge (Fig. 1). Spawning occurred from the mouths of the drains to 45 m upstream.

TABLE 1. Indicator plants for whitebait spawning sites.

PLANTS COMMONLY USED FOR SPAWNING		
Tall fescue	*Festuca arundinacea*	Dark green "tussocky" grass with dead yellow seed stalks in autumn.
Paspalum	*Paspalum paspaloides*	Creeping blueish-green grass growing out onto the water.
Lotus	*Lotus major*	Creeping stems with light green, clover-like leaves and a yellow "pea-like" flower.
Sedge	*Carex geminata*	Broad-leaved sedge with brown "tassels" of seed heads.
Rush	*Juncus gregiflorus*	Round, dark green, shiny stems; forms mounds of roots and old stems.
PLANTS GROWING IN PLACES THAT ARE TOO SALINE		
Rush	*Juncus maritimus*	Round, brown, dull stems. Grows onto mudflats.
Bachelor's buttons	*Cotula coronipifolia*	Fleshy-leaved, small herb with masses of smooth, round, bright yellow flowers.
PLANTS GROWING IN PLACES THAT ARE TOO WET		
Watercress	*Nasturtium officianale*	Dark green, indented leaves; rounded white flower spike.
Toad rush	*Juncus bufonus*	Low-growing rush with soft, light green stems.

Vegetation: Spawning was amongst clumps of *Festuca* and within plants of *Blechnum capense*, *Lotus major*, and *Trifolium repens*.

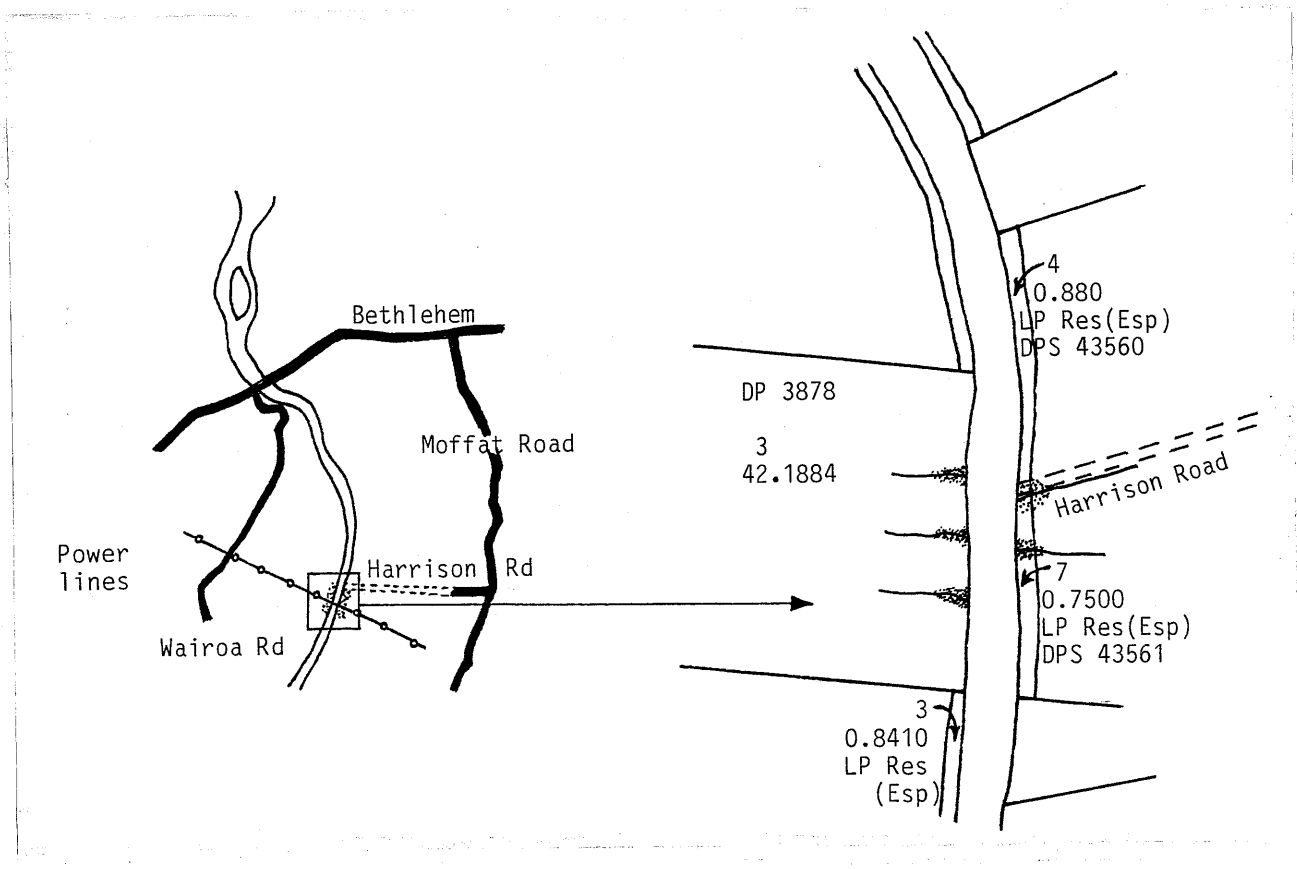

FIGURE 1. Whitebait spawning sites on the Wairoa River (Tauranga).

Land use: Dairy farming.

Threats to survival of eggs: The steep sides of these drains prevent stock from grazing the spawning vegetation at present. Weed control, drain cleaning, or bank slumping could eliminate these spawning sites.

Land tenure: The drains on the true left bank lie on block 3, DP3878 5.0 1390 C. The drains on the true right bank pass through an esplanade reserve, DPS 43561.

4.2 Kaituna River

Date of observations: 23/02/88, 20/03/88, 18/04/88. Spawning was observed at the same sites in autumn 1989 and 1990.

Spawning observed: +.

Eggs found: +.

Locality: Spawning occurred on both banks of the mainstem, 2 km upstream from the cut (Fig. 2). The true left bank was the favoured site and spawning occurred along an 120 m stretch extending back 8-10 m from the river's edge. Some spawning also occurred on the true right bank opposite the main site. The banks appear to have been artificially raised during stopbanking, and channels connected to old borrow pits have cut through the banks to the river. Spawning was observed, and eggs were found, on the margins of the borrow pits close to the channels.

Vegetation: *Paspalum, Festuca,* and *Juncus gregiflorus* on patches of slightly higher ground were used amid a swampy area covered with *Glyceria maxima, Juncus bufonus, Typha orientalis,* and *Paspalum.*

Land use: Grazing dry stock on the true left bank (cattle, goats, sheep). Grazing dairy cattle on the true right bank.

Threats to survival of eggs: Part of the left bank was fenced in autumn 1989, but grazing is a threat in dry autumns. The right bank is grazed regularly. Possible salt intrusion since opening of the Kaituna Cut has killed bankside willows and they are now collapsing onto the site. Remnant native vegetation (*Phormium, Coprosma,*

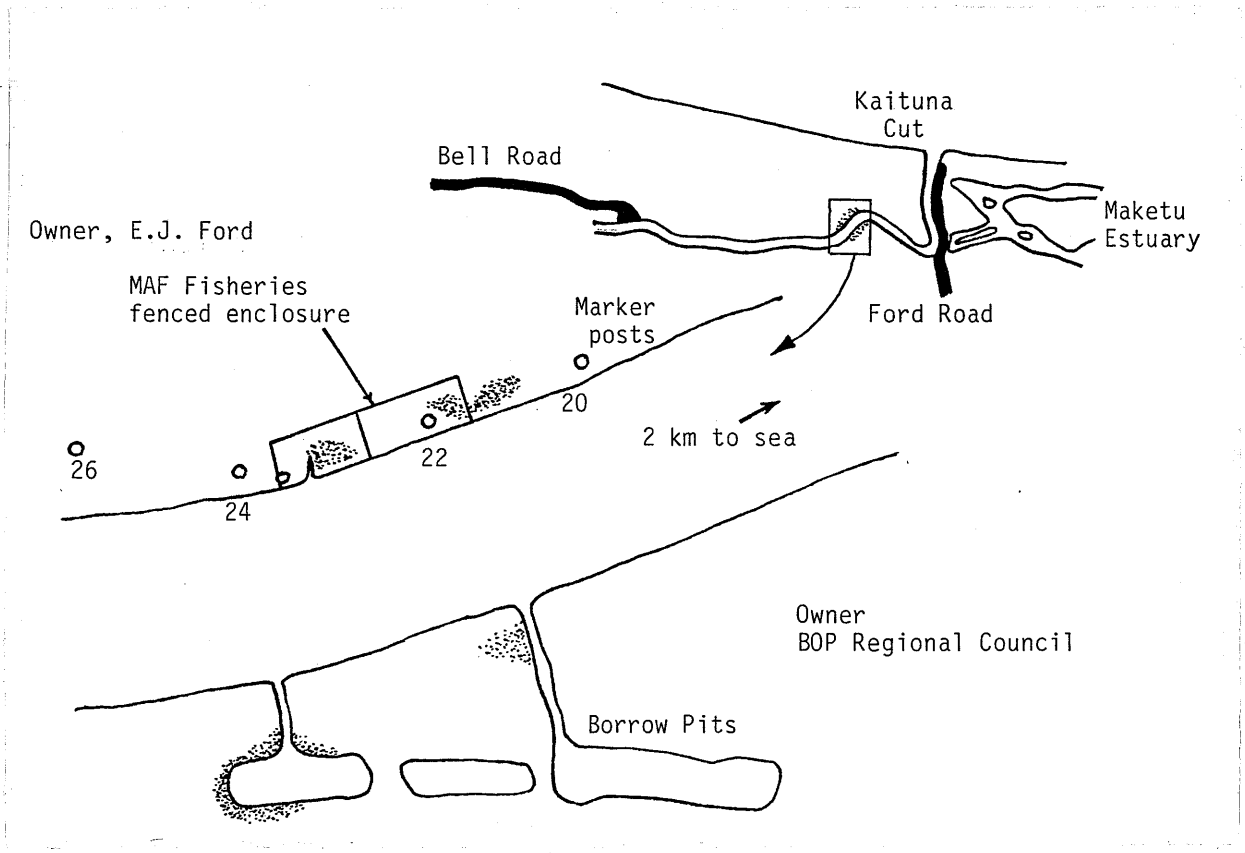

FIGURE 2. Whitebait spawning sites on the Kaituna River.

Cordyline) attracts stock. A surveyed public access road goes through the middle of the spawning site on the right bank.

Land tenure: The true left bank is the property of E.J. Ford, Moehau Street, Te Puke. The right bank is part of the lower Kaituna Flood Protection Scheme and is administered by the Bay of Plenty Regional Council.

4.3 Pongakawa System

Date of observations: 23/03/88 (most eggs were two days old, therefore spawning occurred 21/03/88).

Spawning observed: +(in Pongakawa Canal only).

Eggs found: +.

Locality: Three separate spawning grounds were found; Kaikokopu Canal, Pongakawa Canal, and Pukehina Canal (Fig. 3). On the Kaikokopu Canal, small patches of eggs were found on both banks immediately upstream of the junction of the Wharere Canal. No spawning was found along several kilometres of the Wharere Canal, and the upstream limit of saltwater penetration was not reached. On the true right bank of the Pongakawa Canal, beginning at the junction with the Pukehina Canal and continuing upstream, eggs were found along 100 m of bank. Spawning was in progress at this site. A small patch of eggs also was found on the true left bank of the Pukehina Canal some 50 m upstream from the junction with the Pongakawa Canal.

Vegetation: Eggs were laid among *Festuca, Paspalum*, and *Lotus*. The canals were bordered with dense beds of *Glyceria maxima* that were below the spawning level. Lanes to whitebait stands had been cleared through the *Glyceria* margin. These lanes appeared to assist the fish to reach the spawning grounds, as eggs commonly were abundant in vegetation nearby.

Land use: Dairy cattle were being grazed throughout this area.

Threats to survival of eggs: Cattle browsing the vegetation and trampling the eggs.

Land tenure: The Kaikokopu Canal is bordered by Maori land and a Wildlife Refuge (Fig. 3). The Pongakawa and Pukehina Canals are on riparian reserve land.

4.4 Rangitaiki River

Date of observations: 30/04/87, and six visits by DOC and/or MAF staff in autumn 1988.

Spawning observed: Only on 30/04/87.

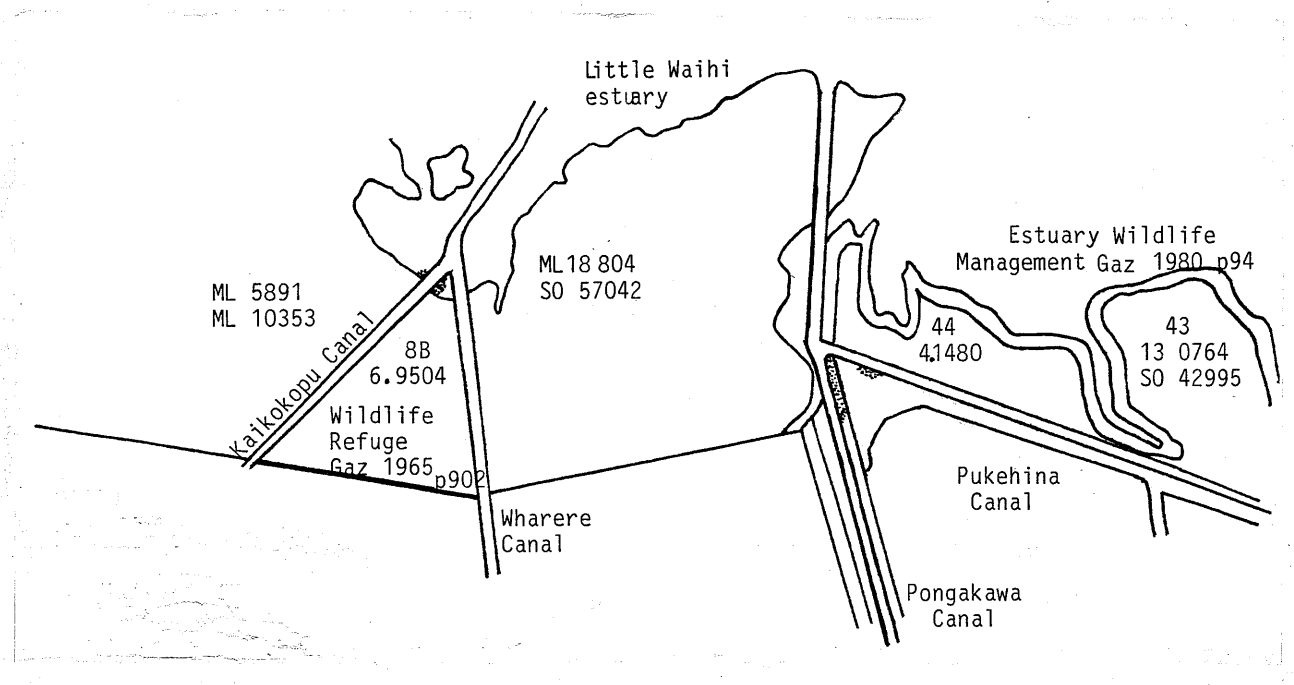

FIGURE 3. Whitebait spawning sites on the Kaikokopu, Pongakawa, and Pukehina canals.

Eggs found: Only on 30/04/87.

Locality: Spawning was observed 200 m downstream of the bridge on the true right bank. Eggs were found on the left bank in patches from 30 m to 200 m below the bridge (Fig. 4). Favoured sites for spawning appeared to be the grassed slopes of indentations in the river bank.

Land use: Dairy cattle are grazed along both banks.

Threats to survival of eggs: When this spawning ground was revisited in 1988, it was found that a combination of heavy grazing plus river erosion had caused slumping and undercutting, leaving vertical mud banks along this section of river. The river also was carrying a heavy load of silt from dam reconstruction at Matahina. The Thornton Canal enters the Rangitaiki below this site and the banks are heavily grazed. No eggs were found at the Thornton Canal site in 1987 or 1988. Although Saxton *et al.* (1987) found the Rangitaiki to be the best whitebait river in the Bay of Plenty, spring 1988 was a particularly poor year (A. Stancliff, pers. comm.).

Land tenure: This land is owned by the Bay of Plenty Regional Council.

4.5 Whakatane River

Date of observations: 20/03/88, 20-21/04/88.

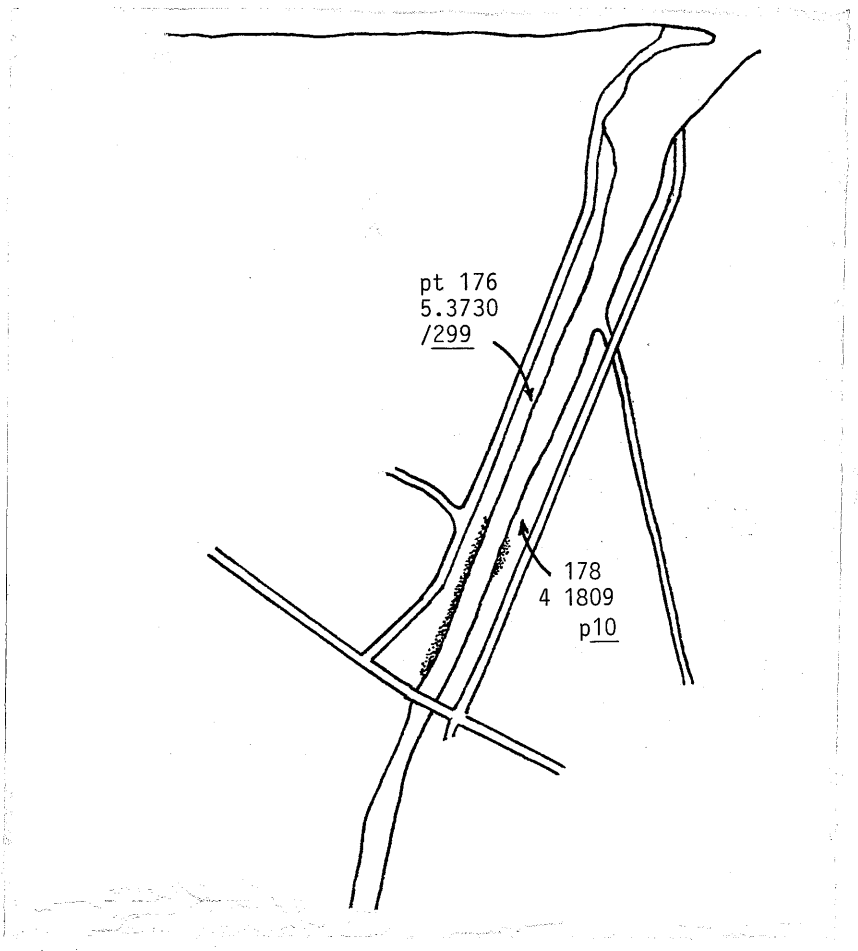

FIGURE 4. Whitebait spawning sites on the Rangitaiki River.

Spawning observed: +.

Eggs found: +.

Locality: Searches along 8 km of river bank, beginning 500 m below the Whakatane Board Mill, revealed a limited amount of spawning. Spawning was seen at the upstream limit of saltwater penetration opposite the mill, on the true right bank only (Fig. 5). The site was on the floodplain, in a limited area where small ditches and hollows made stock access difficult.

Vegetation: Spawning was observed amongst *Festuca* tussocks. Elsewhere in the area, a stock track had been beaten along the river's edge and dense vegetation was absent.

Land use: Grazing for dairy cattle.

Threats to survival of eggs: Grazing and trampling by cattle.

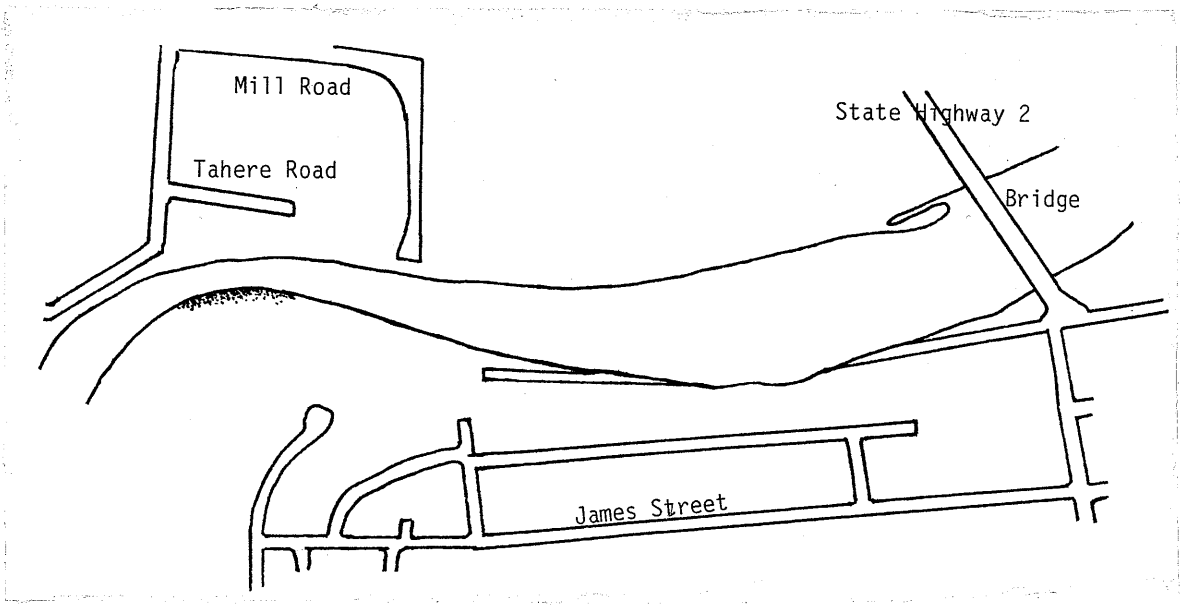

FIGURE 5. Whitebait spawning site on the Whakatane River.

Land tenure: This land is owned by the Bay of Plenty Regional Council.

4.6 Tunanui and Waiotane Streams (small streams draining into Ohiwa Harbour)

Date of observations: These two streams were studied closely during 1986/87 to investigate the ecology of spawning sites.

Spawning observed: +.

Eggs found: +. *Galaxias fasciatus* eggs also were found laid with *G. maculatus* eggs in the Waiotane in June 1986.

Locality: Spawning occurred above the upstream limit of saltwater penetration, where salt-tolerant rushes gave way to *Festuca, Paspalum, Lotus,* and *Trifolium* (Fig. 6). The length of stream bank used for spawning varied with the amount of spawning. Few eggs were laid in March (0.2%), the majority (92.6%) were laid in April, and the remainder (7.2%) in May. In April, 90 m of the Tunanui bank was used for spawning. Egg-laying sites were scattered widely, with few eggs away from the main 8-m-long site. The main site was almost the only area used over the other months.

Land use: Occasional grazing.

Threats to survival of eggs: Periodic drain cleaning. Loss of spawning sites and reductions in the abundance of inanga adults and whitebait were observed after draglining.

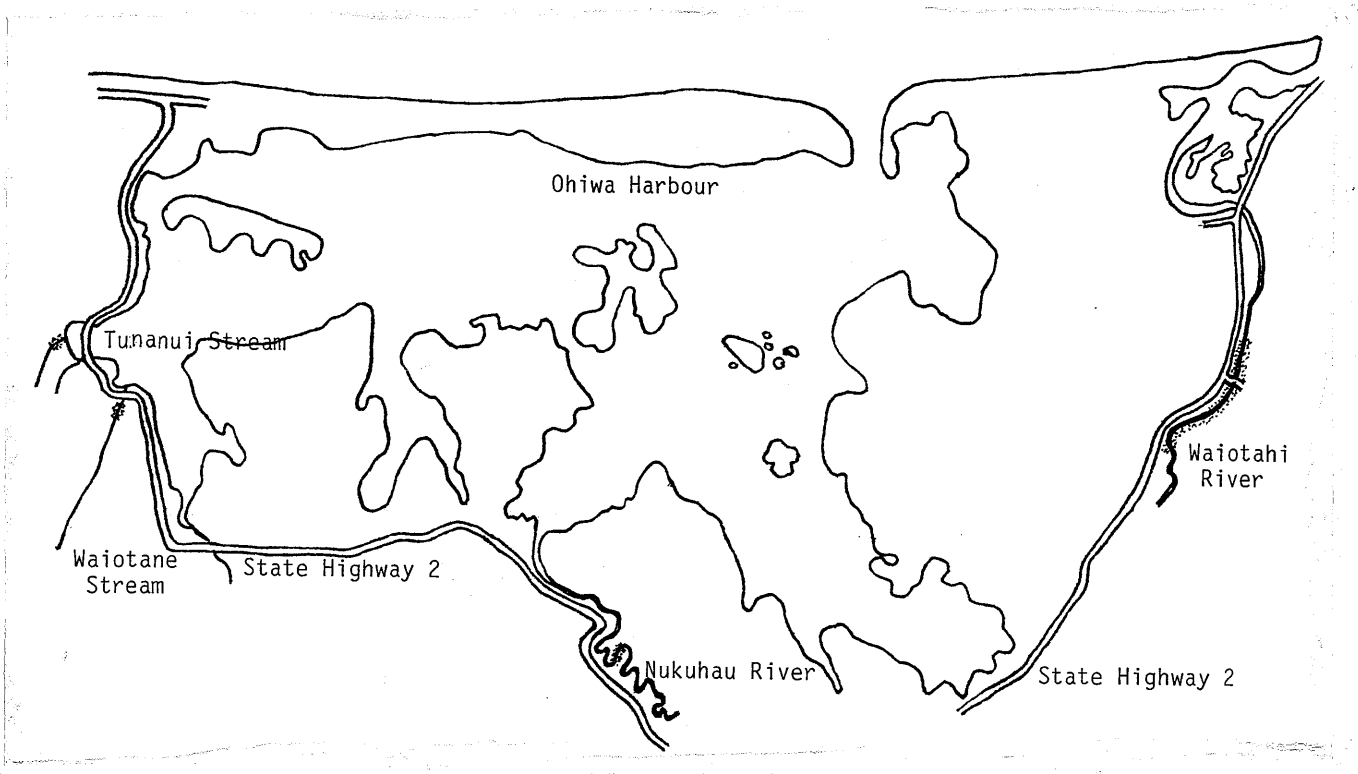

FIGURE 6. Whitebait spawning sites on the Tunanui and Waiotane Streams and the Nukuhau and Waiotahi Rivers.

Land tenure: Crown land.

4.7 Nukuhou River

Date of observations: 31/03/87, 01/04/87.

Spawning observed: -.

Eggs found: +.

Locality: Eggs were found at the mouth of the small stream on the true right bank, opposite the old dairy factory. Considering that this river is a popular whitebait fishery, very little spawning was found. Saltwater penetration ceased at the meander surrounding the old marae, and that area is considered to be a likely spawning ground (Figs. 6 and 7).

Vegetation: *Festuca, Paspalum, Juncus.*

Land use: Grazing by dairy cattle and sheep.

Threats to survival of eggs: Grazing and trampling of eggs.

Land tenure: Maori Land.

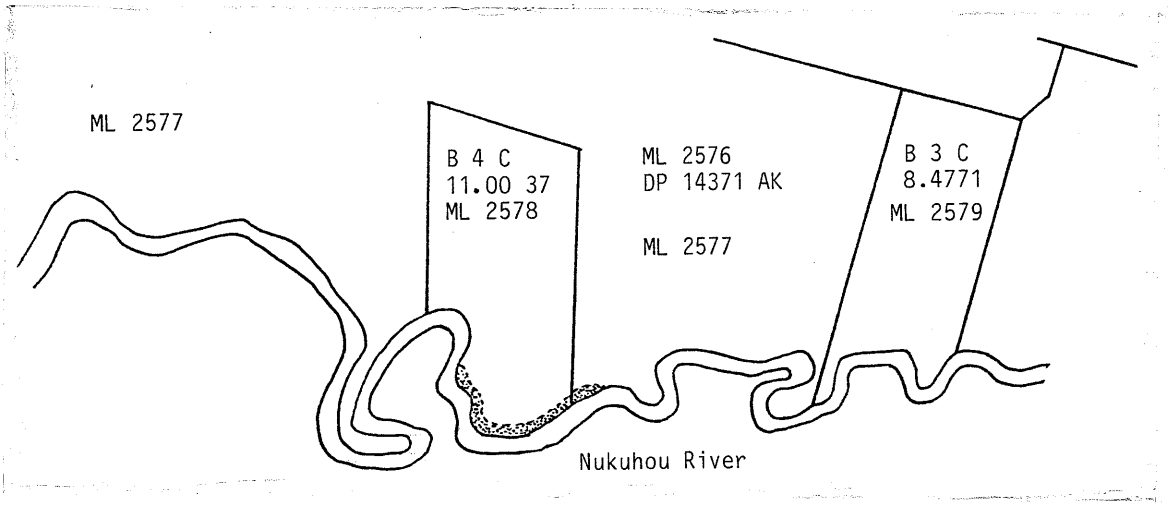

FIGURE 7. Probable whitebait spawning site on the Nukuhou River.

4.8 Waiotahi River

Date of observations: 02/04/87, 18/04/87, 29/04/87, 21/03/88.

Spawning observed: +.

Eggs found: +.

Locality: The intensity of spawning and the length of river used altered as the season progressed (similar to the small streams flowing into Ohiwa Harbour). On 02/04/87, spawning was found in patches along 1.5 km of river bank, with the greatest intensity of spawning occurring below the road bridge (Figs. 6 and 8). No spawning occurred on 18/04/87, but on 29/04/87 spawning was found below the road bridge only. On this smaller spring tide, later in the season, only 50 m of river bank, on the true left bank, was used for spawning. The same area of bank was used again in 1988. This river has a low gradient, and, depending on the tide, salt water can travel a considerable distance along the bottom of the river, well past the major spawning ground. Spawning was not found past the upstream limit of saltwater penetration.

Vegetation: *Festuca, Paspalum,* and *Lotus.*

Land use: The major spawning ground on the true left bank is fenced off from stock. The spawning ground continues beside the main road where access by grazing animals is not possible. The scattered spawning sites upstream, on the true right bank, are grazed by dairy cattle.

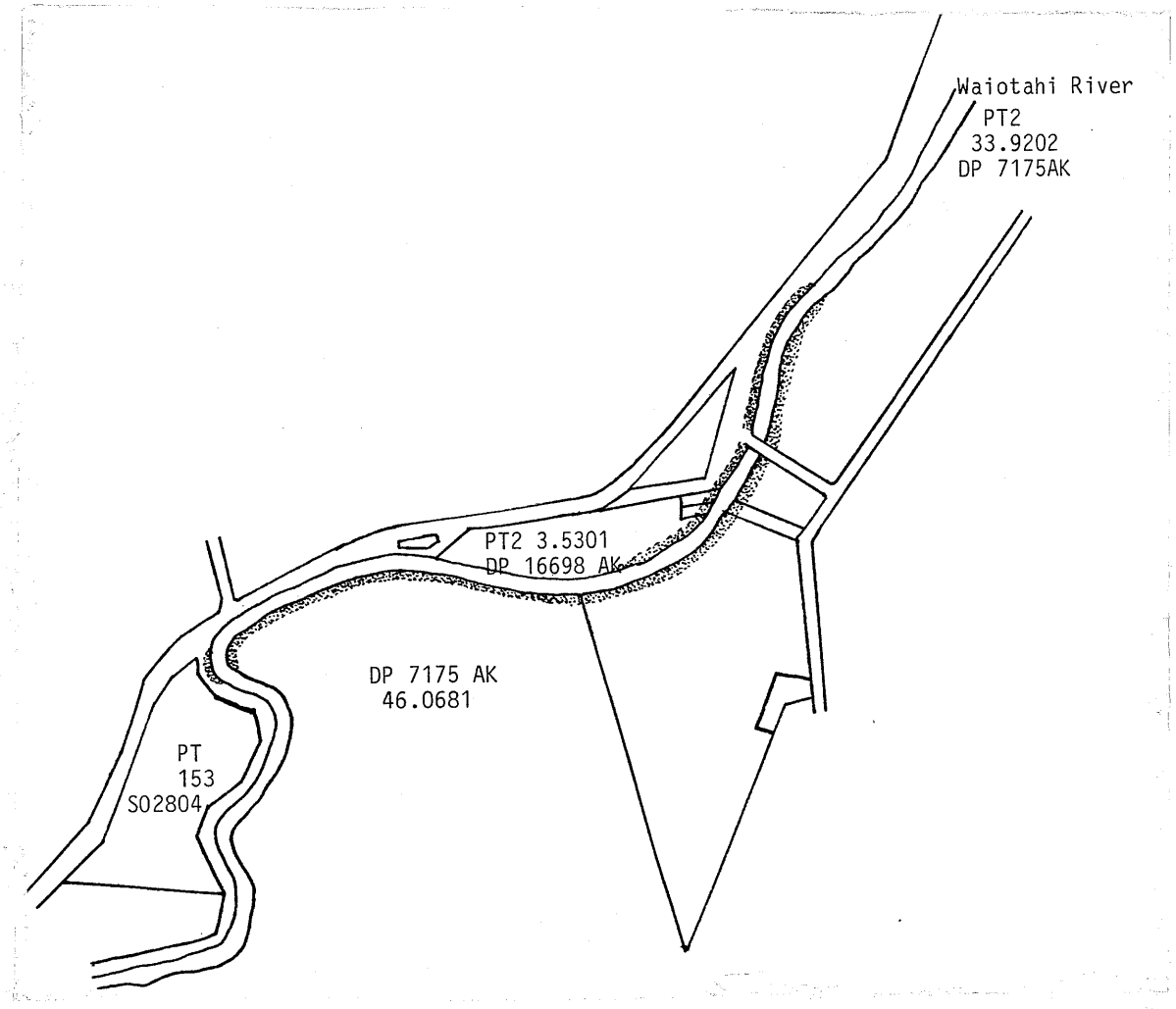

FIGURE 8. Whitebait spawning sites on the Waiotahi River.

Threats to survival of eggs: The right bank is break-grazed, i.e., cattle are moved to new pasture after the vegetation has been closely cropped and thoroughly trampled. As whitebait spawn in long vegetation, grazing by cattle prior to hatching will reduce egg survival.

No spawning was found along a section of the left bank which was planted with willows with an understorey of blackberry, although inanga used the pasture immediately upstream of this plantation for spawning.

Land tenure: The major spawning ground on the true left bank is part of the road reserve. The other bank is a mix of freehold titles with no riparian reserve.

4.9 Waioeka and Otara Rivers

Date of observations: 22-23/02/88, 20-23/03/88, 19-20/04/88, 17-18/05/88.

Spawning observed: +.

Eggs found: +.

Locality: Isolated pockets of eggs were found on the Waioeka River and a major spawning ground was observed on the Otara River, 1.25 km upstream from the confluence with the Waioeka (Fig. 9). This spawning ground is on the true left bank of the Otara River, on the floodplain behind Opotiki township. This was the largest spawning ground found in the Bay of Plenty. It consisted of a shallow basin, 100 m x 75 m, dissected by a narrow, but deep, channel.

Vegetation: The floor of the basin was too wet for spawning. This area was dominated by *Juncus bufonus, Callitriche stagnalis, Ludwigia palustri,* and *Nasturtium officinale.* Slightly higher ground was found within the basin and around the margins, dominated by *Festuca* and *Paspalum.* It was in these better-drained areas that whitebait spawning was concentrated.

Land use: Cattle grazing.

Threats to survival of eggs: Grazing and trampling. The lessee has attempted to fence off the area with electric fencing after DOC staff told him of the importance of the spawning ground. In the long term, a lush cover of grasses could probably best be maintained by permitting grazing outside the spawning season, and then excluding stock from January until May.

Land tenure: Owing to changes in the course of the Otara River since the original subdivisions were made, the ownership of this land is unclear. At present, the Opotiki District Council assumes responsibility for the land.

4.10 Waiaua River

Date of observations: Autumn 1988.

Spawning observed: +.

Eggs found: +.

Locality: This is an extensive site straddling the Waiau road bridge (S.H. 35), extending 20 m downstream and 30 m upstream on both banks of the river. It includes a small "island" off the true right bank below the bridge (Fig. 10).

Vegetation: *Festuca, Paspalum.*

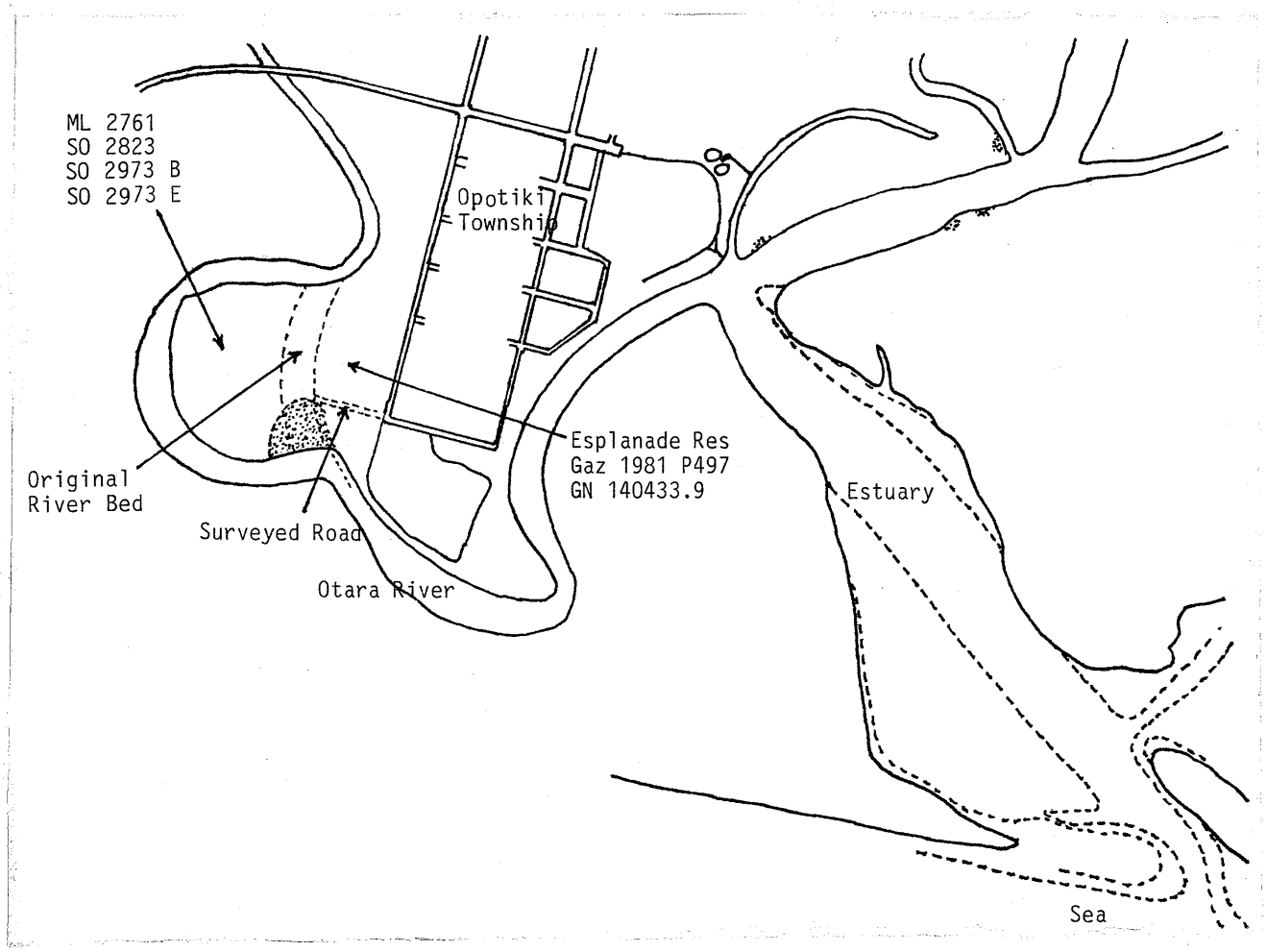

FIGURE 9. Whitebait spawning sites on the Waioeka and Otara Rivers.

Land use: Grazing by cattle, including mobs of cattle being driven up and down the East Coast.

Threats to survival of eggs: Trampling by mobs of cattle, plus normal grazing.

Land tenure: The true right bank is part of the road reserve and the left bank was gazetted as a riparian reserve in 1966.

4.11 Wairoa River (Hawkes Bay)

Date of observations: 19-20/04/88.

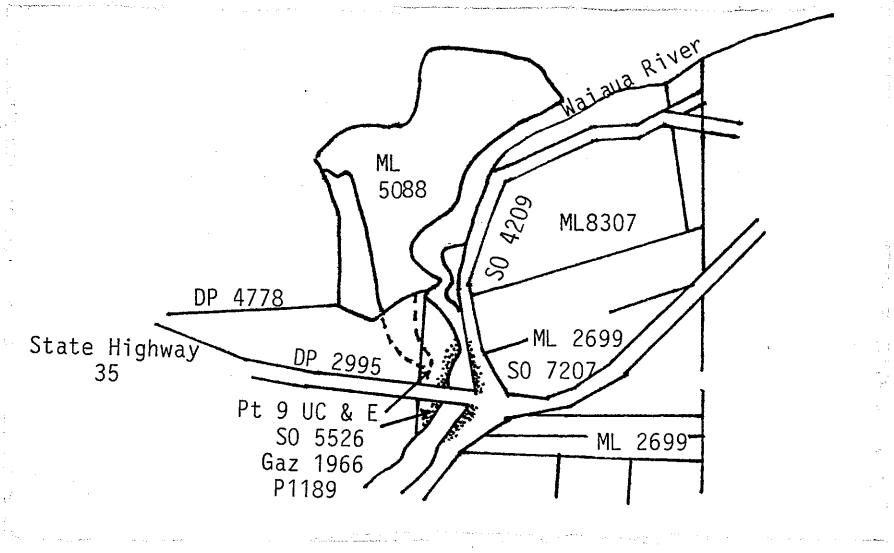

FIGURE 10. Whitebait spawning sites on the Waiaua River.

Spawning observed: -.

Eggs found: +.

Locality: Spawning was observed on the true right bank of the Wairoa River, from opposite the mouth of the Awatere Stream upstream to the boat launching ramp (Fig. 11).

Vegetation: *Pennisetum clandestinium, Agrostis stolinifera, Festuca, Paspalum.*

Land use: The spawning ground is protected from stock grazing by the township. The bankside vegetation below the bend in the river (Fig. 11) is affected by saltwater influx at high tide. Above the township, the river banks were heavily grazed.

Threats to survival of eggs: This site was visited one month after Cyclone Bola. No bank slumping was observed in the vegetated areas through the township. No attempts to exclude stock from the river margins were observed on a boat journey up the river to the railway bridge. The grazed river margins had slumped.

5. DISCUSSION

The spawning grounds of whitebait occur in the intertidal zone of estuaries. Although this spawning behaviour protects the eggs from aquatic predators, it exposes them to losses owing to modern agricultural practice. As the parent fish breed only once, whitebait are particularly sensitive to spawning losses.

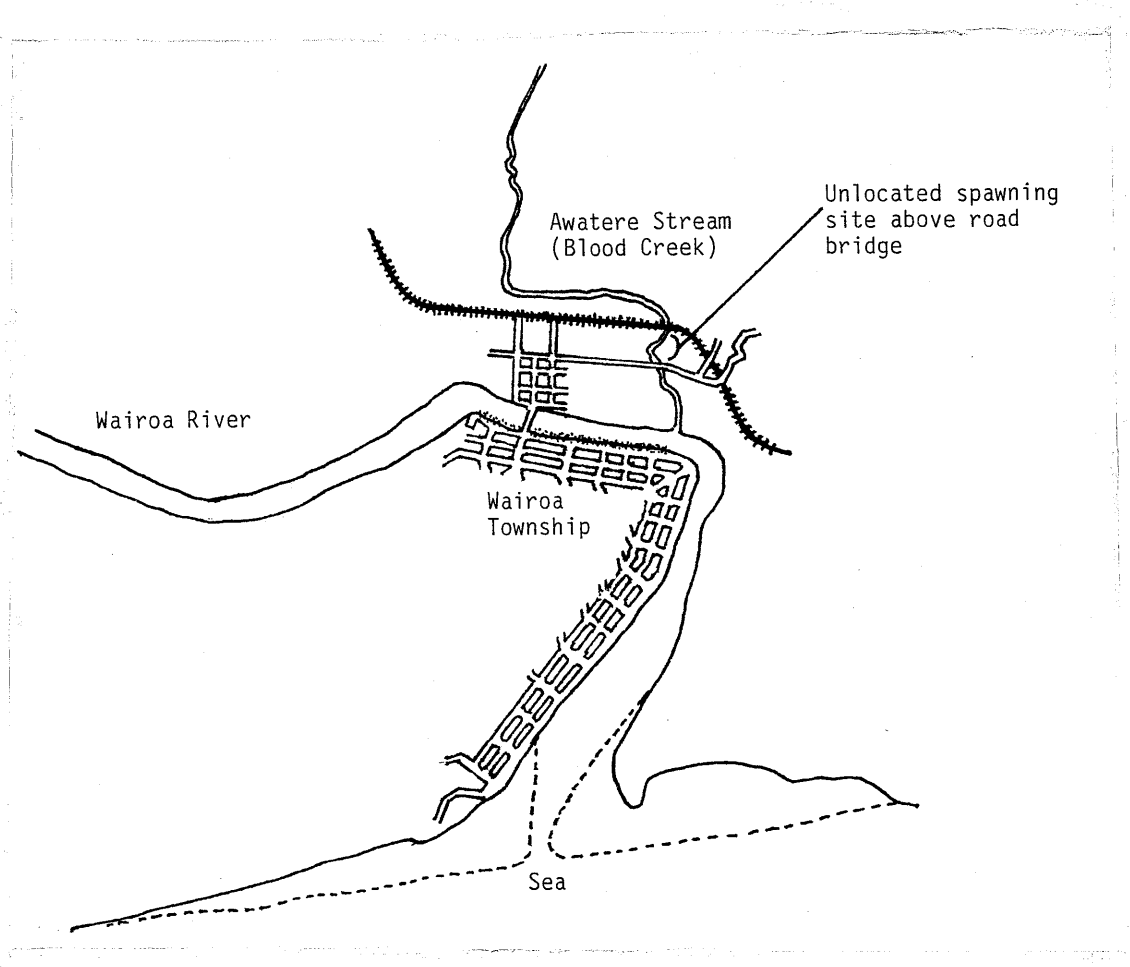

FIGURE 11. Whitebait spawning sites on the Wairoa River (Hawkes Bay).

If the survival of whitebait eggs can be increased, then whitebait stocks and the fishery will benefit. This investigation suggests that spawning grounds in the Bay of Plenty are very limited both in location and in area. Spawning habitat is a "bottleneck" through which the population must pass.

Small areas of land are involved, and most of them are owned by the regional authority. Therefore, it should be feasible to organise a management programme.

What management practices would enhance whitebait egg survival? While whitebait eggs are developing on the river bank, they are exposed to terrestrial conditions. Eggs left in dry air quickly desiccate. Spawning inanga select areas of the river bank where eggs will be protected from desiccation and other environmental extremes. The same limited sites appear to be used repeatedly every spring tide cycle and from year to year. A common feature of the spawning grounds examined was a thick mat of fibrous-rooted vegetation at ground level. They also commonly had a stream or a

channel leading into them. This may ease access for the spawning shoals, and help the larvae to be flushed out into the river as they hatch. Spawning grounds varied in slope, plant species composition, and soils. We even found eggs laid on mud under undercut banks. But the common theme to all spawning sites was moisture retention by the vegetative cover, plus a peat or clay-rich soil.

Whitebait were not found spawning in estuaries, on anaerobic soils, or on water-logged soils. Spawning whitebait were found to prefer relatively well drained sites, where no free water remained after the tide fell. However, sufficient moisture was retained in the soil and vegetation so that humidity around the eggs was high.

None of the spawning grounds found during this investigation was in anything like its natural condition. European settlement has altered river channels and bankside vegetation. For example, the Kaituna Cut greatly altered the penetration of salt water into the Kaituna River. Estuaries are unstable environments and the behaviour of whitebait is sufficiently flexible for them to survive under these conditions.

Despite this flexibility, however, whitebait eggs are not adapted to survive desiccation or trampling. In natural conditions, eggs are protected from dehydration by long vegetation. Grazing removes the vegetation, and eggs are killed by trampling, exposure, and dehydration.

Whitebait spawning grounds were located on 14 rivers and streams in the Bay of Plenty and on the Wairoa River, Hawkes Bay. Many spawning grounds were very limited in extent and probably do not represent the full area used for spawning.

Almost every whitebait spawning ground found in the Bay of Plenty is grazed during the spawning season. Based on the observed state of the spawning grounds, it is remarkable that even the present fishery still exists.

Some form of protection for whitebait spawning grounds in the Bay of Plenty is necessary. Grazing by cattle is the major land use that threatens the survival of developing whitebait eggs. The obvious method of protecting spawning grounds is to exclude cattle by fencing or ditches.

The most commonly used spawning substrate was dense mats of exotic grasses. If all grazing is removed, these grasses will be succeeded with different vegetation, for example gorse and blackberry, which would provide less suitable spawning habitat. Grazing is the most cost-effective method to maintain grasses. It may be feasible for local farmers to manage spawning grounds by controlled grazing outside the spawning period, but this may be difficult as it requires the active co-operation of farmers over a long period.

Alternatively, it may be simpler to fence-off the spawning grounds permanently. Grasses and scrub communities should be succeeded by native plants, which are likely to be acceptable for whitebait spawning.

As all but two of the whitebait spawning grounds identified were located on land in public ownership, it should be feasible for DOC to manage these areas for whitebait production.

6. RECOMMENDATIONS

- Known whitebait spawning grounds should be fenced off from grazing stock, or retired from grazing during the main whitebait spawning period.

- Research should be undertaken into methods for optimising whitebait egg survival by management and manipulation of riparian vegetation.

  To pursue these concepts, the spawning ground on the left bank of the Kaituna River has been selected as an experimental area. It was fenced off in autumn 1989, and the density and survival of eggs inside and outside the enclosure is being monitored.

  Long-term monitoring will be required to follow changes in spawning site selection as the vegetation alters, now that it is no longer grazed. At present, the fish have shown a strong preference for spawning within the fenced-off area.

7. ACKNOWLEDGEMENTS

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8. LITERATURE CITED

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