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NEW ZEALAND FRESHWATER FISHERIES MISCELLANEOUS REPORT NO. 42

WHITEBAIT SPAWNING GROUNDS ON THE LOWER WAIKATO RIVER

by

C. P. Mitchell

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Freshwater Fisheries Centre

MAF Fisheries

PO Box 6016

ROTORUA

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1. INTRODUCTION

After salmon and trout fishing, the whitebait fishery is probably New Zealand's most popular freshwater fishery. Hardy (1986) found that during the season, whitebaiting is the major recreational activity in the lower reaches of many rivers. The Waikato River whitebait fishery is the largest in the North Island, and rivals the production in the important South Island West Coast rivers (Stancliff *et al.* 1988a). However, estimates of the annual whitebait catch show a three-fold decline over the past 50 years, from an average of 46 000 kg in 1931-1950, to 14 000 kg from 1968-1985 (Stancliff *et al.* 1988a).

The most common whitebait in the Waikato are the juveniles of *Galaxias maculatus* (inanga). The biology of inanga was first studied in the 1920s and 1930s by Captain Hayes of the N.Z. Marine Department; greater detail was added by Burnet (1965), Benzie (1968), and McDowall (1968).

Sexually mature inanga migrate down rivers at the time of peak spring tides in autumn. Shoals of fish spawn together beneath vegetation flooded by the spring tides, and the eggs are then left exposed until flooded by the next series of spring tides. Hatching occurs shortly after re-immersion, and the larvae are swept out to sea by the ebbing tide. After five months feeding on zooplankton in the ocean, juvenile inanga return to fresh water over the spring months.

It is on this return migration that the fish are caught as whitebait. Those that evade the whitebaiters' nets spend the following six months feeding and growing in fresh water before returning to the estuary to spawn in autumn. Few fish survive to spawn after the second year, although returning upstream migrations of spent fish have been recorded in the Waikato system (Stancliff *et al.* 1988b).

The sites chosen for spawning are in tidal fresh water, usually at the upper limit of salt influence. Many of these areas have been modified by agricultural and urban development, and exotic plant species (e.g., pasture grasses), have replaced indigenous vegetation over much of New Zealand. Flood protection schemes, farm drainage projects, and other river modifications prevent access to spawning grounds. Like many other native species, inanga populations have declined because of habitat loss.

Apart from policing fishing methods and stands, little effort has been expended to protect the whitebait fishery. Small areas of land, usually in public ownership, are involved. It may be feasible to protect and manage spawning sites to maximise spawning success. The first step is to identify those areas used by whitebait for spawning.

2. OBJECTIVES

- To identify whitebait spawning grounds on the lower Waikato River.

- To record vegetation cover and land use associated with whitebait spawning grounds.

- To make management recommendations for the protection and restoration of whitebait spawning grounds.

3. METHODS

Vehicle-based surveys were made on the true left bank of the Waikato River in 1983, 1984, 1986, and 1987, and selected areas were searched for whitebait eggs.

Extensive surveys over the lower Waikato delta were carried out by boat on 28 May 1987 and 17 May 1988. Previous experience suggested that attention should be focused on stream mouths, but, at intervals, promising areas of the main banks also were examined. Searches for eggs were made by parting the bankside vegetation and looking closely for the 1-mm-diameter eggs.

A subjective estimate of egg abundance (high or low density, or absence) was made at each site. Notes were made of the topography, vegetation, and any other features. River water conductivity was measured at each spawning site to estimate the limit of salt water penetration. Areas where spawning was found were compared to records of past surveys (Hayes 1931, MAF unpublished data).

A quantitative estimate of egg abundance was made at one high density site (NZMS 260, R13.692297, site 16, Fig. 1) on 9 June 1987. The true right bank was a stopbank, constructed to protect pasture, and grazed by cattle, horses, and sheep. The true left bank was covered in unmodified swamp vegetation. Fifty-three transects were run across the intertidal zone of this small stream, and whitebait eggs were counted within a continuous series of 10 cm^2 quadrats. Eggs adhere to vegetation and detritus, and full counts in each quadrat often required the careful parting and removal of several layers of material.

4. RESULTS

A total of 67 sites was searched for whitebait eggs (Fig. 1). Of the 11 sites where eggs were found (sites 5, 6, 11, 13, 15, 16, 17, 18, 19, 33, and 42), eight (73%) were on small tributaries. Eggs were found from the outlet to 300 m upstream.

Main river bank sites usually supported only low egg densities, whereas sites on small tributaries tended to have higher densities. About 2.7 km of the river delta was used for spawning. Only one spawning site was found on the true right bank (Fig. 1). No eggs were found at any of the sites searched on the Aka Aka system (which is reputed to be an important spawning area).

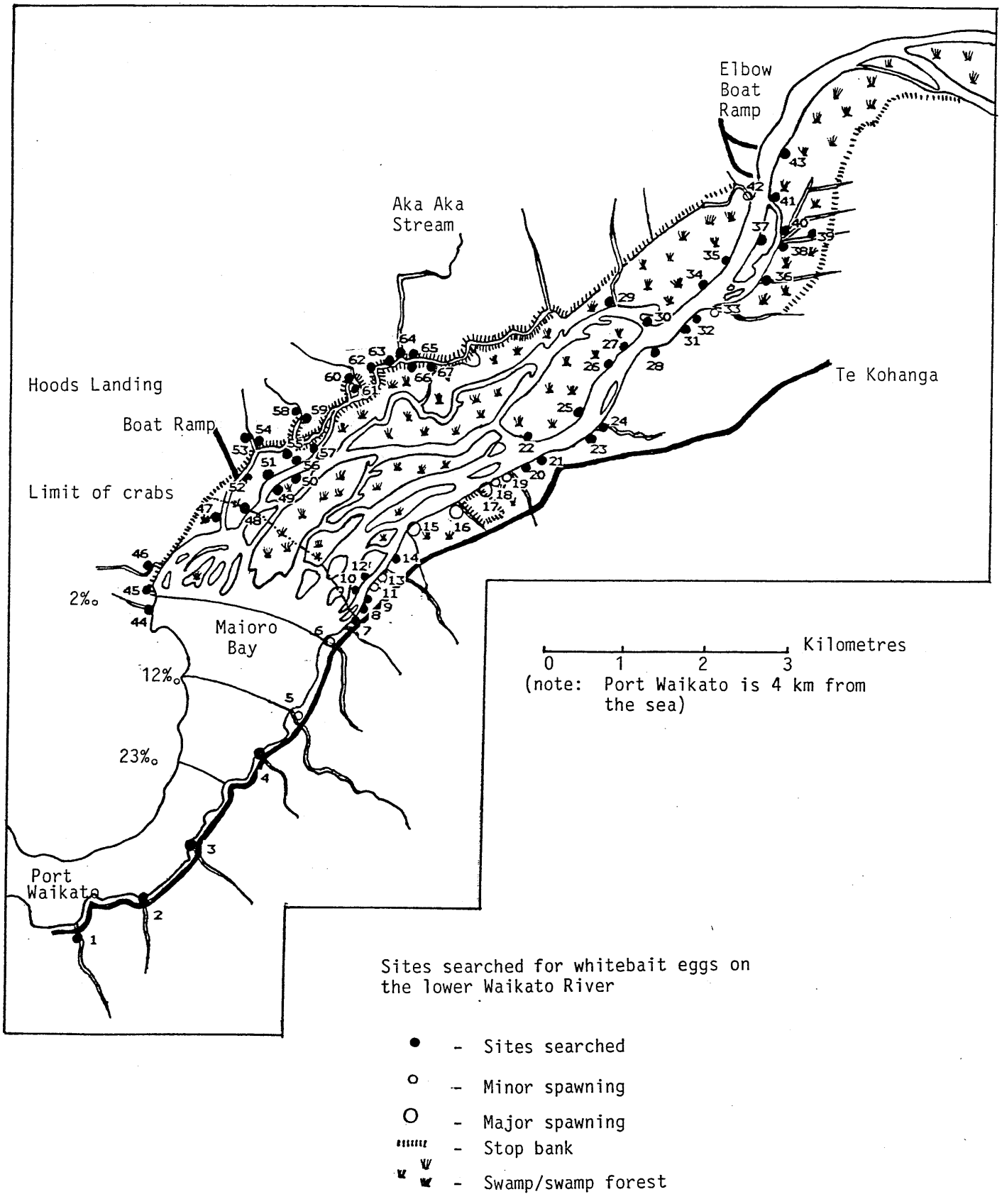

FIGURE 1. Sites on the lower Waikato River searched for whitebait eggs.

Spawning grounds used in 1987 were used again in 1988, and it is likely that suitable places are used repeatedly, year after year. However, a major site on the Okahu Stream (site 5, Fig. 1), which was found in 1983, appears to have been abandoned. The catchment above this site was developed into pasture during 1983. Grazing pressure was noted when the site was revisited in 1984, 1986, and 1987, and no further evidence of spawning was ever found. The site had become covered with silt and was repeatedly trampled by cattle over this period.

Saline water was not found at any of the whitebait spawning grounds. Saline water intrudes into Maioro Bay as a 'front', rather than as a 'wedge', as occurs in smaller river systems. At 'normal' river level, on a 3.9 m tide (peak spring tides reach 4.4 m above chart datum), 23°/oo salinity water was found at 2 m depth at NZMS 260, R13. 652 245, 12°/oo salinity water was found at map reference 660 255, and 2°/oo salinity water was recorded at map reference 665 267 (Fig. 1). The edge of the area of islands (Fig. 1) has rather shallow, fast-flowing water, and no salinity could be detected there. However, it was observed that the estuarine crab, *Helice crassa*, had made burrows that gradually petered out upstream of a line from map reference 675 272 to 658 285 (Fig. 1). As these crabs are intolerant of continuous exposure to fresh water, it must be presumed that saline intrusions reach this limit, at least occasionally. Below this limit, whitebait spawning was found only well upstream along the banks of inflowing tributaries, where the tidal rise consisted of backed-up fresh water.

Table 1 lists the major vegetation types at each of the sites checked for whitebait spawning. Seventy-three per cent of the spawning grounds found were under tree cover, mostly alder. Eggs were found at 23% of the ungrazed sites, whereas only one of the grazed sites was used for spawning (site 16, right bank), and this small area was associated with a much larger, ungrazed site.

Bank and vegetation profiles were taken along the small stream at site 16 (Fig. 2). About 8000 eggs were laid on the grazed bank, whereas an estimated one million plus eggs were laid in ungrazed vegetation on the opposite bank. Spawning fish penetrated up to 3.5 m from the stream bank during tidal inundation. Eggs were laid under flaxes and wandering jew growing on the slightly better-drained bank levee.

5. DISCUSSION

5.1 Characteristics of Spawning Sites

Spawning whitebait prefer relatively well-drained sites where no free water remains after the tide falls. These areas are slightly higher than most of the delta area. Whitebait eggs were not found on anaerobic or water-logged soils.

TABLE 1. Vegetation types and occurrence of whitebait spawning at sites on the lower Waikato River.

Ground cover	Presence of large trees: Alder	Willow	None	No. of sites
Glyceria		7,33*,41	8	4
Apium		31,32,39	5*,9,13*,51	7
Toi Toi/*Apium*		24,40,64	10,67	5
Flax/*Apium*		28,38,57,65		4
Flax/*Carex*/Parataniwha		55,56		2
Flax/Parataniwha/Wandering jew	11*,12,14,15**, 16(l.b.)**, 17**, 18*,19*,20,21,22, 25, 26,30,48,49,50		27	18
Glyceria/*Apium*/Wandering jew	61	34,35,36,42*	37,43	7
Tall Fescue/*Carex*/Dock		45	2,3,4,6*44,52, 58,62,66	10
Juncus/Grass/Clover	23,16(r.b.)*	46	1,29,47,53, 54,59,60,63	11

* = whitebait eggs observed
X = site was grazed.
** = major whitebait spawning site.
l.b. = left bank at site 16.
r.b. = right bank at site 16.

Most of the delta is very flat, and is submerged, often to a considerable depth, during spring tides. Drainage is provided by natural levees along stream banks and where the river passes close to hills, where the banks are slightly higher than normal. These are the areas where whitebait spawning was found.

In 1931, Hayes wrote " ... *The nature of the whole of the remaining banks of the mainland and also of the islands was totally different, and it appeared that ... the highest tides of the series immediately subsequent to the full of the moon ..., would not only completely submerge at least all of the land on the islands but that it would cover them too deeply thereby producing conditions which judging from previous observations during the spawning act would be entirely unsuitable.*"

Although laid in freely draining areas, whitebait eggs are susceptible to desiccation. The dense mat of herbaceous vegetation and fibrous roots close to ground level in ungrazed areas maintains moisture levels. Whitebait adults appear to choose sites were the eggs will remain damp until the next series of spring tides.

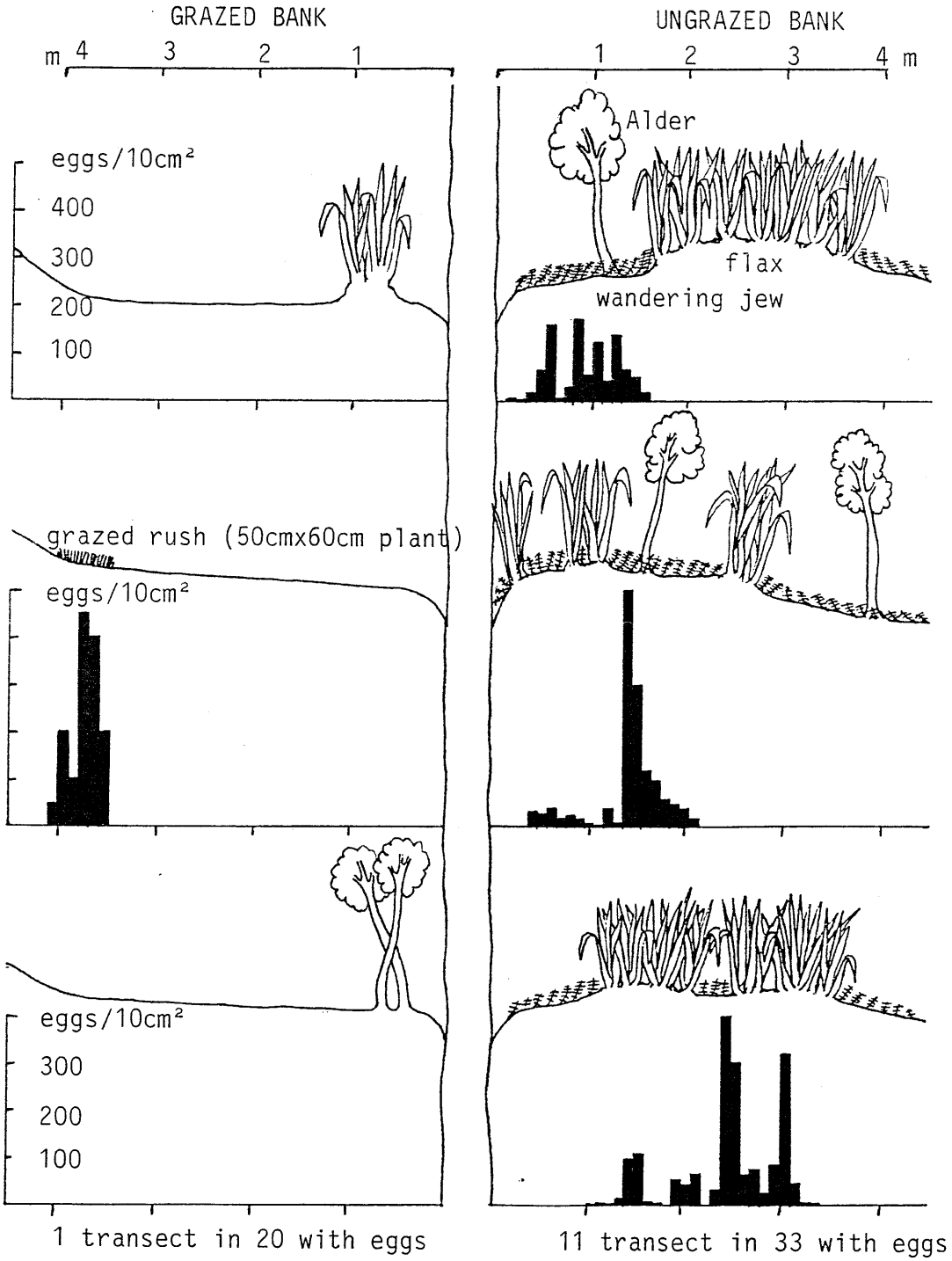

FIGURE 2. Bank and vegetation profiles along a small stream (site 16 in Fig. 1) used by whitebait for spawning.

Whitebait have been reported spawning in water that was "quite salt" (Phillipps 1925), but this was not observed on the Waikato River. Conductivity measurements showed all sites to be well above saline influence.

In marked contrast to other areas surveyed (e.g. the Bay of Plenty), 75% of the whitebait eggs found were laid under tree cover. The long-term modifications to vegetation caused by grazing are demonstrated by the high proportion of grazed sites dominated by exotic grasses, and by the fact that 85% of the river bank in grasses had lost all trees. The effect of grazing is dramatically shown by site 16, where there were more than 100 times more eggs laid on the ungrazed/unmodified bank, than on the grazed bank.

5.2 Patterns of Vegetation

The Waikato delta covers a large area and has many vegetation types. Over the areas that are suitable for whitebait spawning, there are two opposing forces controlling vegetation structure. Firstly, bare sandbanks and silted channels are colonised by *Glyceria maxima* and then by *Apium nodiflorum*. Later, this community becomes overshadowed by willow (*Salix*) and displaced by wandering jew (*Tradescantia fluminensis*). Older areas become dominated, in turn, by alder *(Alnus glutinosa)* and flax (*Phormium tenax*), plus a range of native species. At this stage, the community has begun to resemble kahikatea (*Podocarpus dacrydiodes*) swamp forest - patches of which persist on the larger islands in the delta. Away from the flax-dominated margins, an understory of *Cordyline australis, Coprosma australis,* and *Coprosma robusta* forms. Other plants include *Blechnum capense, Freycinthia bankseii,* taro, and arum lilies. On the swamp floor grow wandering jew and parataniwha (*Eleostomum rugosum).* It is these areas that are preferred spawning sites for whitebait.

Grazing pressure, mainly from cattle, changes the vegetation structure. Even lax grazing eventually eliminates all palatable species, resulting in a more open understory. Finally, even flaxes are removed by cattle 'plucking' them from the soft mud (uprooted flax bushes with chewed leaves can be common along Kariotahi beach, 10 km north of the river mouth). An understory, more or less trampled, of toi-toi and wandering jew then develops. The quick-growing annual, *Apium*, can also dominate damper sites in these areas. Heavier grazing pressure results in the elimination of small trees and the occurrence of patches of bare or poorly vegetated ground, often churned to a morass.

Grassed areas form along levees, stopbanks, and drainage channels, where drainage is better and stock have easier access. Whitebait commonly spawn within this vegetation type on other river systems, but were not found to do so on the Waikato, perhaps because a wider range of vegetation was available.

Continuous grazing resulted in close-cropped pasture dominated by browse-resistant plants (e.g. clover and ryegrass). No spawning was found at any heavily grazed sites. It is obvious that control of grazing is necessary if spawning areas for whitebait are to be protected on the lower Waikato River.

5.3 Historical Perspective

In 1931, Captain Hayes of the N.Z. Marine Department made a survey of whitebait spawning areas on the Waikato River. He located seven spawning sites, one of which was quite extensive, plus six more localised sites. Comparison of his map (Fig. 3) with our results (Fig. 1) shows that spawning activity has shifted downstream. Hayes commented on damage by stock to the major spawning area: *"The fact that damage by stock occurs still applies to the main banks of the Waikato River, cattle having access to the [spawning] grounds on the left bank particularly from Kaitangata Point to Tikirahi and at Whiskey's Drain"* (sites 33-23, Fig. 1). Today, the vegetation through these areas is heavily modified by grazing, and fish seem to have abandoned the area. Encroachment by stock is still in progress from Tauranganui downstream, which is the area where most spawning occurs. From Hayes map, it was estimated that 2.8 km of river bank were used for spawning in March 1931.

5.4 Spawning Production and the Whitebait Fishery

The present catch of whitebait from the Waikato River is about 14 000 kg, representing a minimum of between 19-30 million individual whitebait. To produce this catch alone, without escapement, would require, at a conservative estimate, the production of 2000-3000 million eggs. At a best estimate, the spawning grounds found would produce only 200 million eggs over the entire spawning period. Clearly, more spawning sites remain to be identified.

Nevertheless, given the decline in catch over the last 50 years, efforts should be made to protect known spawning grounds. The greatest threat to these sites comes from stock grazing, a problem which was first discussed by Hayes over 50 years ago (McDowall 1984).

A priority is to protect from further development and grazing those areas already identified as important for whitebait spawning. Secondly, the areas found by Hayes in 1931 could be restored. Initially, this would take the form of fencing stream margins at sites 67, 23, 24, and 32. Fences should extend one chain either side of the stream outlet to the Waikato, back to the limits of the tidal push. Replanting with alder and tall fescue could be considered on heavily modified sites.

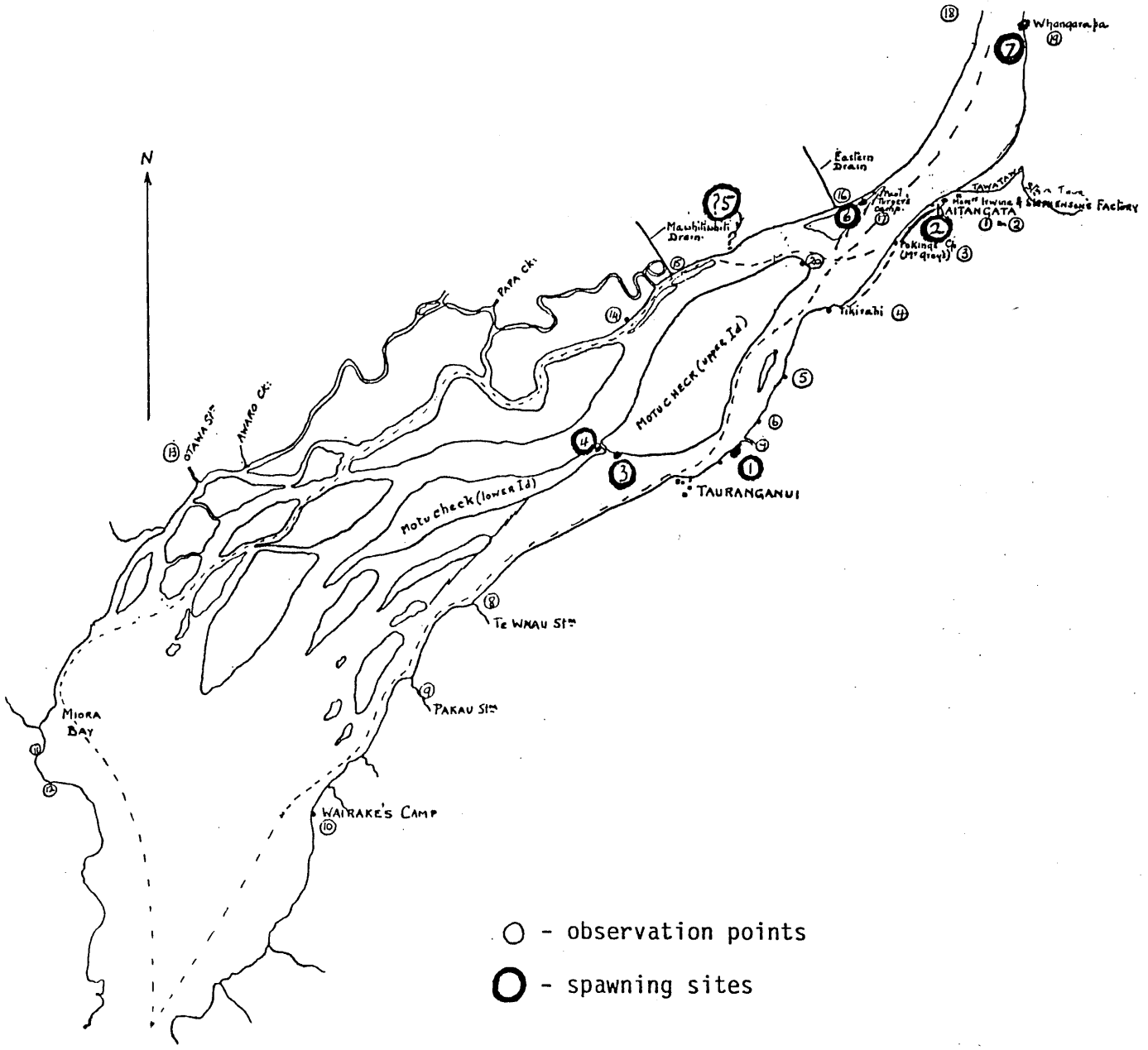

FIGURE 3. Spawning sites recorded on the Waikato River in 1931 by Captain Hayes of the N.Z. Marine Department.

6. RECOMMENDATIONS

- Immediate steps should be taken to protect known whitebait spawning grounds from further grazing, by fencing and agreement with the adjacent landowner.

- Former spawning grounds should be restored. These areas should be fenced and replanted with appropriate vegetation.

- Further investigations into spawning areas are required. In particular, the area from the Elbow up to Mercer should be explored. The Aka Aka system should be re-surveyed to identify spawning grounds.

7. ACKNOWLEDGEMENTS

I would like to thank the following people who, almost without complaint, were prepared to spend hours of their time crouched amongst damp vegetation searching for tiny little whitebait eggs: A. Adams, J. Boubee, S. Hanchet, A. Stancliff, and R. Strickland.

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