NIWA

Taihoro Nukurangi

AN UNEXPLOITED MIXED SPECIES EEL STOCK (*ANGUILLA AUSTRALIS* & *A. DIEFFENBACHII*) IN A WAIKATO PASTORAL STREAM, AND ITS MODIFICATION BY FISHING PRESSURE

by

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INTRODUCTION

Advice was sought by the Department of Conservation (Hamilton) to answer the following questions:

1. What comprises an unexploited mixed species eel population in a pastoral stream?

2. What are the effects of repeated removal of commercial sized eels on a previously unfished eel population ?

A study to validate aging techniques for eels completed for MAF Fisheries in a Waikato lowland pastoral stream (Chisnall & Kalish 1993), has provided information on the structure of an unexploited mixed species eel population (shortfinned eel, *Anguilla australis* and longfinned eel, *A. dieffenbachii*). Most of the resident population was then removed after one year, and for the three following years sampling was carried out to assess the population and to remove marketable sized eels (> 220 g). The data gathered over these five consecutive years (1988-1992) has provided information on the recovery of the eel stock after intensive fishing.

Site Description

The Ahirau stream in which the study was undertaken drains incised pastoral hill country and is a minor tributary to the Waipa River (Fig. 1). Ahirau stream has a mean width of 2 m and a mean pool depth of 0.5-m, and is typical of many pastoral streams in the lower Waikato River basin. The section studied began 5 m above the point of confluence with another minor tributary, and encompassed 200 m of lowland meander followed by 220 m of higher gradient with more glide and riffle content culminating at a cascade-waterfall. At the time of this study, the stream had not been commercially fished for more than 20 years according to the landowners.

Note: It is intended to formally publish a more detailed presentation of the material used for this advice.

METHOD

Tagging of individual eels for the study enabled observation of movement of the two species. The 420-m section of Ahirau Stream described above was marked with wooden pegs placed at 20-m intervals along the stream bank to delimit 21 sampling sites. Eels were captured for tagging in these sites by fyke net and electric-fishing in August of 1988. Two unbaited fyke nets (one 6-mm and one 12-mm stretched-mesh) were set to fish overnight at either end of each 20-m site. The leaders of the fyke nets blocked the channel, preventing movement of eels into or out of each site. The nets were left in place while the stream was electric-fished during the following morning. Electric-fishing was carried out with a back-pack machine powered by a 12-volt battery. Captured eels were anaesthetised in benzocaine solution, weighed and measured, marked and tagged. After recovery, eels were returned to their original capture sites.

The study stream was sampled more intensively in August of 1989, 1990, and early September of 1991 and 1992. Every eel caught in 1989 was killed and inspected for tags. In 1990, 1991, and 1992, all eels were measured and examined for marks, but only larger eels (> 220 g) were killed to inspect for tags. During sampling carried out in 1989, 1990, and 1992, the study stream was also electric-fished for 200 m above and 500 m below the study section, to check for movement of tagged eels.

Records of eels taken from each 20 m site in each year (1989-1992) provided a record of population changes occurring as a direct result of harvest. The data was combined into four groups of five sites each to expedite presentation for this report.

RESULTS & DISCUSSION

Movement of tagged eels

Recaptured shortfinned and longfinned eels (40% and 68% of each species tagged, respectively) had very limited home ranges during the 1 to 3 years they were at liberty. All recaptured eels had remained within 140-m of their original capture sites (Chisnall & Kalish 1993).

The fate of tagged eels that were not recaptured is not known. Some eels may have died, either of natural causes or as a result of tagging. Some tagged eels may still remain in the stream as fishing methods were not 100% efficient. Some may have moved out of the study section, however, there were no tagged eels caught 200-m above or 500-m below the study reach. Finally, some may have matured between 1988-1991 and moved downstream as they began their spawning migration.

1. Unexploited eel population in a pastoral stream (1988-1989)

The pools in each site were almost exclusively inhabited by large longfinned eels whilst shortfinned eels occupied mainly glides and riffles. There was a greater biomass of longfinned eels than shortfinned eels at each site throughout the stream in 1988 (Fig. 2B). This was because of the larger mean size of longfinned eels (Fig. 3). In contrast, shortfinned eels were present in greater numbers than longfinned eels at all sites (Fig. 2A), and were generally smaller (Fig. 3). Eels smaller than 200 mm in length were recorded as elvers (minimum size 110 mm present in the stream). Longfinned elvers were absent throughout the study section in 1989.

A considerable biomass of eels was apparent at upstream sites despite the reduced number of resident eels (groups 3 & 4 in Fig. 2A & B). The reduction in fish numbers in part reflects the increased gradient, which was associated with a depletion in cover and productive habitat available to eels. The decreased percentage of pool habitat available in the upstream sites (percentage pool in grouped sites; 1=43%, 2=42%, 3=12%, 4=26%), is a direct result of increased gradient (e.g., Chisnall & Hicks 1993).

In summary, the general eel population structure found in an unexploited pastoral stream is one of moderate numbers of small shortfinned eels, particularly in glides and riffles, dominated by fewer but much larger longfinned eels. It is likely that aggressive territorial behaviour by these longfinned eels excludes shortfinned eels from the pools, and cannibalism by these large predators must also contribute to the low frequency of small eels and elvers in the population. Longfinned eels from this stream were growing relatively quickly (Chisnall & Hicks 1993),

and at a considerably faster rate than coexisting shortfinned eels. In comparison, the population structure of eels in unexploited streams under indigenous forest comprises a much lower density and biomass of medium to large longfinned eels with comparatively slow growth, and very few shortfinned eels (Chisnall & Hicks 1993).

2. Modified resident eel population structure (1990-1992)

During the first year after removal of most eels from the study section (in 1989) there was a large immigration of small eels mainly into the downstream sites. However, a proportion of the catch in 1990 may be part of the original population, as neither electrofishing or netting methods used were 100% efficient (Chisnall & Kalish 1993). The bulk of this influx was comprised of small shortfinned eels (Figs 2 & 3), consistent with the known upstream migration of juveniles in summer (Jellyman 1977). Subsequent annual removals of marketable sized eels (1990-1992), coincided with an apparent further upstream penetration by the shortfinned eel population, particularly elvers (Fig. 3). Very few longfinned eels were caught after the initial removal (1989). Those that were caught in later years, particularly the large ones, were probably escapees from the original population. Alternatively, they had moved into the section from immediately up-or-downstream.

Another distinctive feature of the eel population structure after 1989 was the increasing abundance and upstream penetration of shortfinned elvers (Fig. 2A). Once again there was a distinct absence of longfinned elvers in the catches. Perhaps an indication of poor elver recruitment by this species ??

Throughout 1990-92, each 20 m site occupied by medium to large eels (i.e. over 500 mm and therefore piscivorous) had fewer small eels than sites without such medium to large eels. This ¡mplies an exclusion effect (i.e. interactive vs selective segregation). In addition, the sites to which longfinned eels were subsequently recruited, shortfinned eel number and biomass declined, suggesting interspecific competition favouring the longfinned eels. Site 'carrying capacity,' defined in terms of limiting physical factors (depth, cover, substrate and food supply), ultimately limits the total biomass of eels whatever the mechanism(s) which apportion it to species and sizes of eels.

Implications for conservation/management

Heavy commercial fishing pressure on natural eel populations in streams can be expected to reduce the density and biomass of longfinned eels. Within such confined habitats, this species territorial behaviour, larger size and affinity for pools (where nets are more likely to be set), make it more vulnerable to capture than the shortfinned eel.

The results presented from the stream study suggest that longfinned eels could have once dominated the eel populations throughout the Waikato. The two eel species are thought to have distinct habitat preferences, shortfinned eels being more abundant in the lowland waterways and longfinned eels more commonly found in more oxygenated upstream reaches (e.g., Jellyman 1977, Jellyman & Todd 1982). However, this situation may not always have been so clear. Since the 1970's, biologists have only been able to observe modified eel populations. The wild eel populations existing in the Waikato River basin during the 1930's and 1940's are purported to have been predominantly longfinned eels (yes, even the shallow lakes) (extensive anecdotal information). The coincidence of large scale wetland destruction alongside fishing efforts must have discriminantly impacted the longfinned eel. With the continued heavy commercial pressure on wild eel populations, longfinned eels are mostly unable to attain sufficient size to dominate the population.

Eel production from pastoral streams after fishing

A natural population of eels dominated by large fast-growing longfinned eels, may have been more productive in terms of eel biomass than the harvested population of predominantly shortfinned eels. Certainly, biomass was greater, and growth rates of the longfinned eels were faster. The removal of large eels from the stream population allows colonisation almost exclusively by small shortfinned eels. Preliminary growth information following the removal efforts suggests that over the first two years rapid growth occurred as a result of reduced competition. Eel production from this stream could theoretically increase with continued harvest if the biomass of shortfinned eels continues to increase along with growth unaltered. However, as the habitat becomes populated by increasingly large numbers of small eels, I suspect that growth will be suppressed (e.g., Chisnall 1989).

Clearly, colonisation of habitats where densities of eels are low is not only confined to juveniles. With fishing activity in the wild, removal of the larger eels from the population will be followed by a compensatory movement by individuals from inside the fished areas into the vacated niches. This observation has implications for management of the fishery. The false confidence by eel fishermen in growth of eels from areas where stocks are harvested intensively seems to arise from this ongoing natural 'replenishment', which is obviously not inexhaustible.

Although longfinned elvers were not recorded in the study, the sites were colonised sporadically by a few non-juvenile longfinned eels. Despite this limited recruitment, the absence of fishing pressure will probably allow the population to revert to its pre-fishing structure of a few large longfinned eels dominating the more numerous but smaller shortfinned eels.

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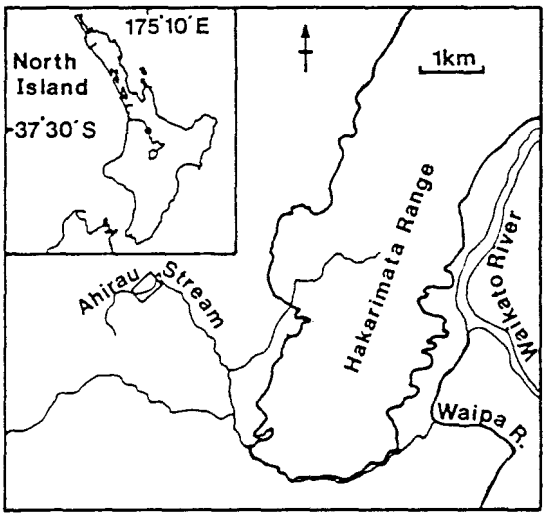

Fig. 1 Location of the study site on the pastoral Ahirau stream in the Waikato Riper basin. North Island. New Zealand.

(Reproduced from Chisnall & Kalish 1993)

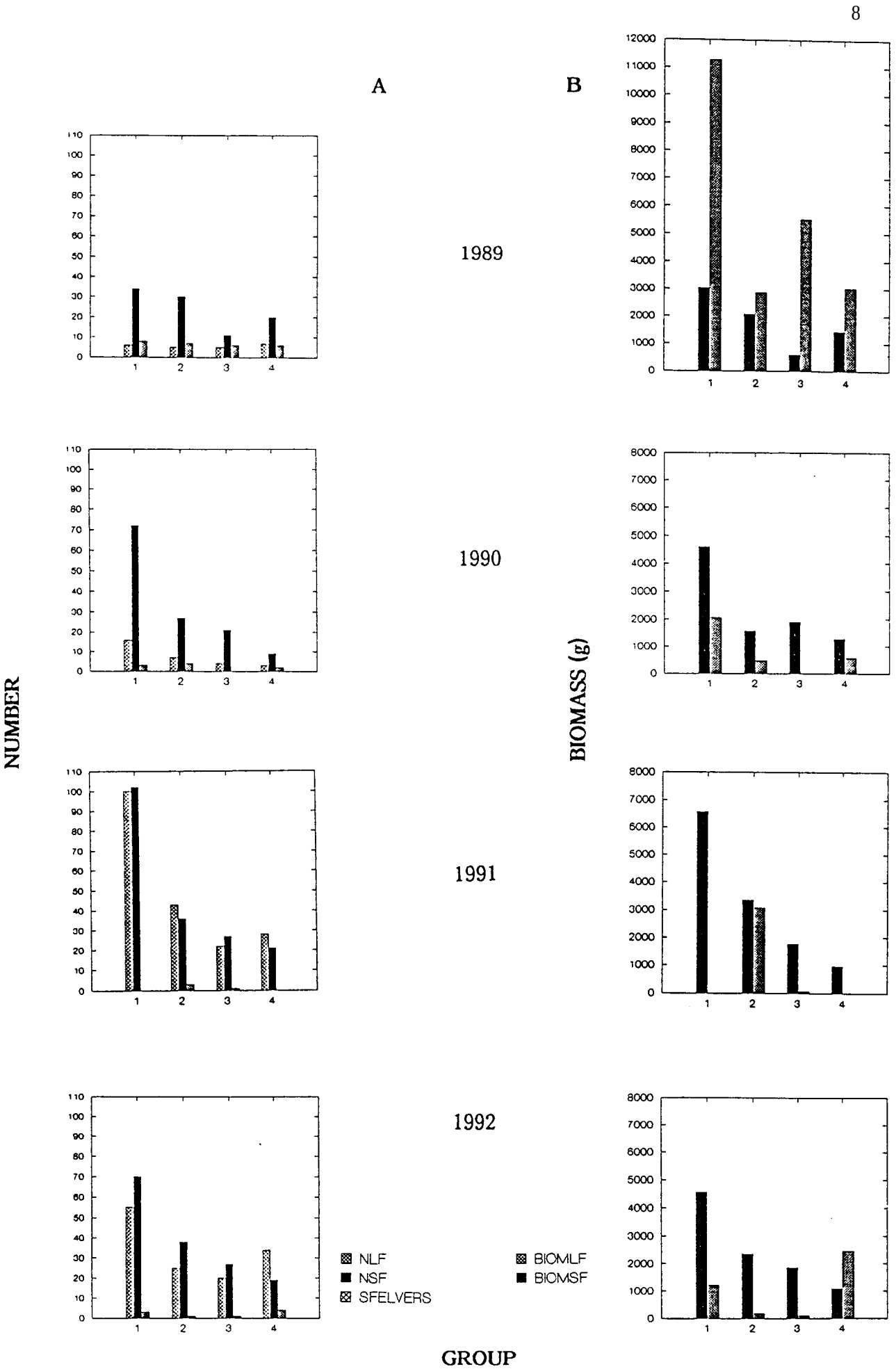

Figure 2. Number (A) and Biomass (B) histograms of 4 annual eel catches taken from the pastoral Ahirau stream 1989-1992. Twenty 20 m long sites combined into four groups of five; 1-4, lower to upper stream sites.

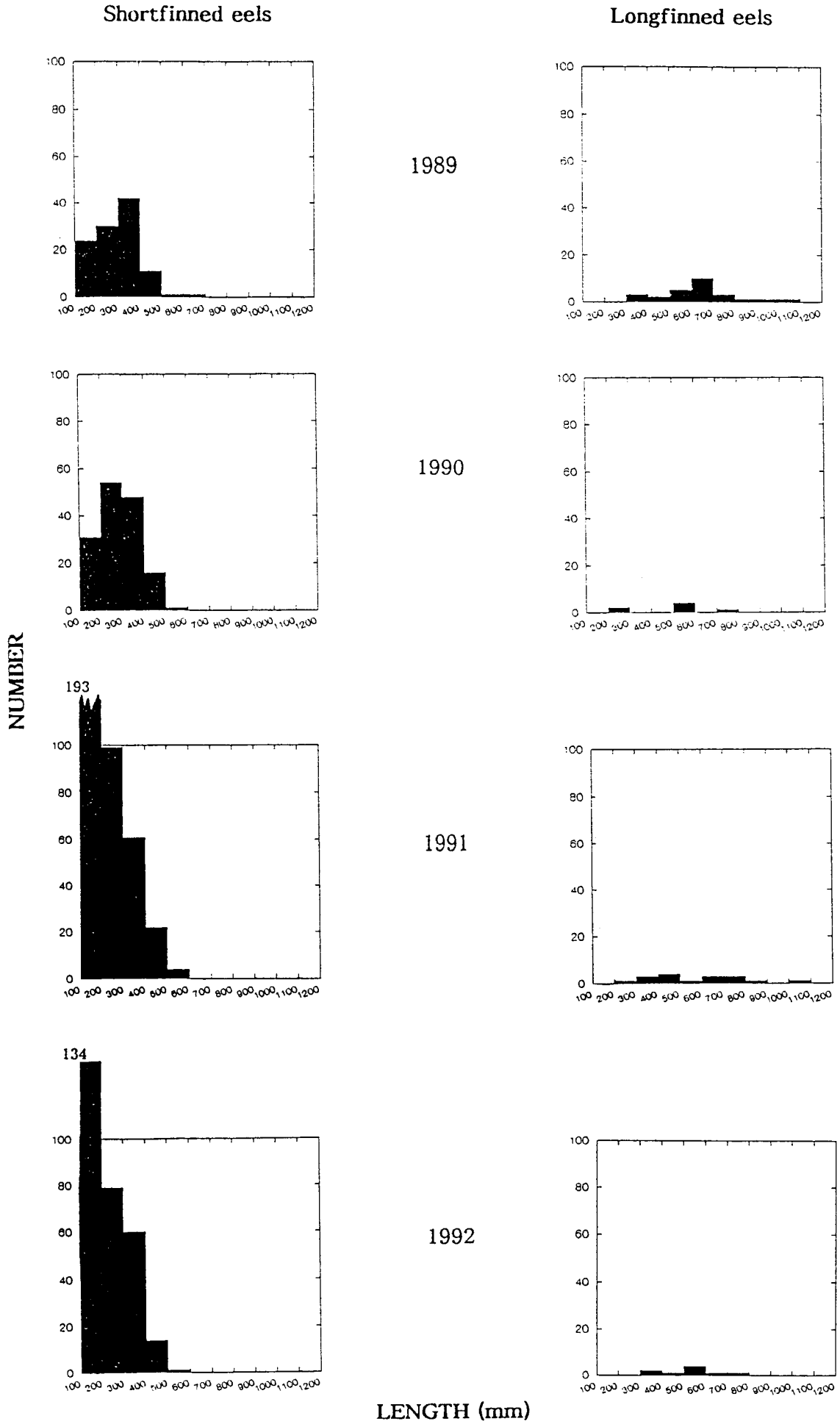

Figure 3. Length frequency histograms of 4 annual eel catches taken from the pastoral Ahirau stream. Twenty 20 m long sites combined into four groups of five; 1989-1992.