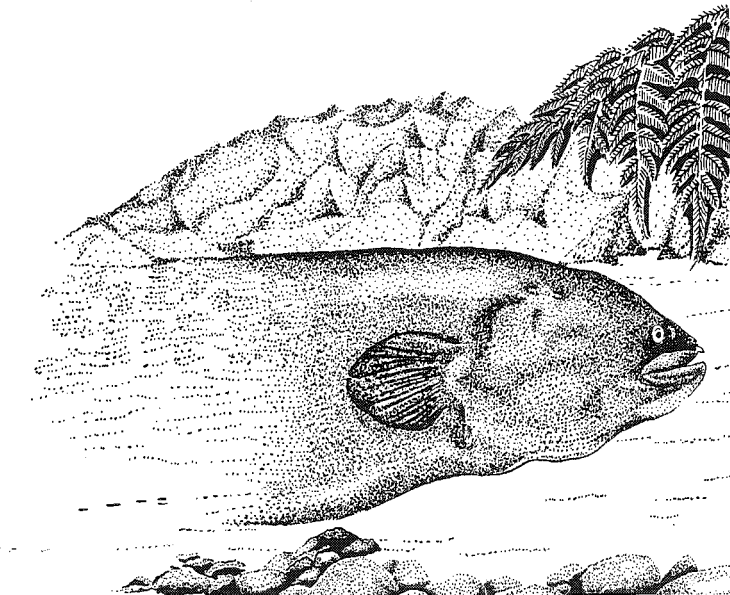


**Size, age, and species composition of commercial
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**B. L. Chisnall
C. Kemp**



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Abstract

Chisnall, B. L. & Kemp, C. 2000: Size, age, and species composition of commercial eel catches from market sampling in the North Island, 1997–98.

NIWA Technical Report 87. 67 p.

This report presents the results of the third consecutive season (1997–98) of market sampling of commercial freshwater eel (*Anguilla australis*, *A. dieffenbachii*) landings from throughout the North Island. Sixty-four landings from 44 strata were sampled and length and weight were recorded for 1738 longfins and 4568 shortfins. Of these, 229 longfins and 661 shortfins were aged, mostly in the two chosen size categories of minimum legal size (250 g or less) and well above (500 g or more). Shortfins made up 81% of the total sampled weight landed in the North Island (excluding one landing from the South Island, which was 23% shortfin). Shortfins also made up over 50% of landings in 30 of 44 strata. Longfins were present in 36 strata and shortfins in all 44 strata. Longfins were more common in landings from upland areas and main stems of rivers, but virtually absent from catches in lowland lakes and the sea. Size ranges and species compositions were similar to those reported previously, and described a fishery primarily based on immature females over 50 cm long.

There was rapid growth to market size in the sea and estuaries, which reduced in fresh waters with increasing distance upstream. Eels in lowland lakes mostly grew faster than in rivers. Longfins also grew more rapidly than shortfins in productive waters, such as in Northland-Waikato rivers from estuary to mid catchment. In less productive waters, shortfins generally grew faster than longfins. Overall, mean age near market size (250 g or less) for shortfins was 12 y, at a weight of 224 g and a length of 49 cm, and for longfins was 14 y (mean weight of 208 g and length of 45 cm). Mean age at 500 g or over for shortfins was 17 y, (mean weight of 648 g and length of 68 cm), and for longfins was 19 y (mean weight of 640 g and length of 63 cm).

Landings sampled during market sampling programmes between 1995 and 1998 were largely confined to the central and northern parts of the North Island; most samples came from the Waikato, Northland, and Hauraki, and future sampling should be targeted in the Taranaki, Hawke's Bay, Wairarapa, Manawatu, and Wellington regions.

Longfins appear to be particularly vulnerable to the fishery. The proportion of longfins in catches reduced with increasing fish size, e.g., at length less than 50 cm both species formed about 50% of the catch by number, but at 60 cm longfins made up less than 20%.

From the 1995–98 data, the mean age of eels entering the North Island fishery, although variable, was typically greater than 11 y for both species. Occasionally, this was considerably reduced, reflecting rapid growth. These mean ages are older than the estimates from regression models and give good reason for caution regarding management of the eel fishery as a whole, which should be geared towards long-term goals rather than short. The catchment-based database will provide valuable data for managing the fishery by catchment.

Introduction

This report presents the results of the third consecutive season (1997–98) of catch sampling of commercial freshwater eel (*Anguilla australis*, *A. dieffenbachii*) landings from selected parts of the North Island. This year's sampling programme sought to build on experience from previous sampling in the North and South Islands (Beentjes & Chisnall 1997, 1998), while expanding the areas sampled in the North Island.

Continued sampling of commercial catches aims to provide baseline information on eel stocks, particularly in priority fishing areas, that can be compared in the future. Collection of data on eel size, species composition, age, and growth provides for assessment of stocks by catchment, which is desirable in terms of the independence of stocks and future management. Growth rates can provide an index of productivity and allow monitoring of changes over time.

A pilot programme to monitor the size and species composition of commercial eel stocks within catchments was implemented during the 1995–96 fishing year in the South and North Islands. The main goal was to initiate a time-series database on size and species composition. Sampling methodology was practical for the processors/fishers and met the objectives of the programme. Key areas for sampling were determined through a questionnaire sent to all commercial eel fishers in 1995–96 (Beentjes & Chisnall 1997). In the 1997–98 catch sampling programme, the objectives were essentially the same as for previous years but more specific, with requirements on landing numbers to be sampled, areas to be covered (North Island), and the size of eels to be targeted for otolith sampling.

This research was carried out by NIWA under contract to the Ministry of Fisheries Project No. EEL9701.

Programme objectives for 1997–98

To assess and monitor commercial eel fisheries.

To monitor the species composition, size structure, and age at the minimum legal size and well above minimum legal size of priority commercial eel fisheries by sampling 60 landings from North Island fish processing sheds.

Methods

The 1997–98 sampling programme began at Levin, Te Kauwhata, and Auckland processing factories. The Central Eel Enhancement Co. Ltd (CEEC) wished to be involved in the sampling, and tried to provide at least one staff member on location to assist with sampling. The sampling strategy aimed to provide species, size (length and weight), age (at “minimum legal size and well above minimum legal size”), and sex for specific locations (identified by stratum codes).

Areas sampled and stratification

Sampling was generally opportunistic, and focused on previously unsampled and sampled areas to complement existing data. Identification of source sites for landings was totally dependent on the co-operation of operators and managers at factories or the depot, and their rapport with eelers landing catches at their plants.

The stratification scheme used in the North Island identifies the principal habitat type from which the sample is derived with up to 10 strata and habitat types within a catchment (Appendix 1). A record sheet provided for the processor and fishers to complete for each landing facilitated location identification and included a section describing the catch-effort for the landing being sampled (*see* Appendix 1).

The data are reported by region and data from different locations within major river systems are combined by stratum code. The “other river” stratum number is used to describe hydraulically small order streams (*see* Appendix 1). All landing locations are identified on the Empress database.

Catch sampling and liaison with industry indicates that the North Island fishery is less constrained by water temperature than that in the South Island. This has a major bearing on the window for effective sampling. Several major North Island fisheries operate mainly in spring and winter so it is important to be sampling during these seasons, but this is practically difficult to accomplish. In practice, the project gets underway by December, and sampling needs to be completed by June at the latest to allow time for analyses and reporting (fisheries reporting year 1 October–30 September).

Sampling procedure

Sampling was based at the Levin Eel Trading Co. Ltd. (Levin), New Zealand Eel Processing Co. Ltd. (Te Kauwhata), and Thomas Richards (Whenuapai, and their depot at Kamo Kamo). The sampling techniques used were similar to those used over the preceding 2 years at Levin and Te Kauwhata, with minor variations (*see* Beentjes & Chisnall 1997, 1998): sampling at Kamo Kamo did not include otolith removal because eels were sent live to Whenuapai for processing. Landings were measured at Kamo Kamo using anaesthetic (AQUI-S), and sub-samples were put in labelled bags to be otolithed at Whenuapai. All sampling at Te Kauwhata, Whenuapai, and Kamo Kamo was undertaken outside the plant near holding tanks. At Levin, eels were sampled after desliming, a process that resulted in 3% weight loss.

At all sites, landing weight (species unsorted) was recorded and a sample taken by randomly selecting several of the holding bags, or by dip netting 100–200 free-swimming eels from the holding tanks. For smaller landings, the entire catch was sampled. Care was taken to ensure that samples were representative of the landing. Species, length, weight, sex, and maturity (where possible) were recorded for all eels in the sample. The proportion of each species by weight in the total landing was calculated from the proportion by weight of that species within the sample.

Otolith collection and preparation

Before this year, otoliths were collected from length-stratified samples over the entire size range landed. The contract for 1997–98 stipulated age at minimum legal size (MLS, 220 g) and well above MLS. Weight categories sampled were 250 g or less and 500 g and over. However, for many landings eels were not available in these size ranges so those nearest in weight to the target weights were sampled. To avoid possible bias to results caused by variation in condition, the average length of targeted weights was estimated from measured eels for each landing, and used to determine the selection of eels for otolith sampling. For each landing sampled, 20 otoliths per size class were recommended for collection (Francis 1998). Francis (1998) indicated that sampling of otoliths should also be spread over as many landings as possible to more accurately define the variance in age within the fishery. Where fishing locations had been sampled previously and sufficient otoliths collected, no further otoliths were taken.

Otoliths were prepared using the crack-and-burn method (Hu & Todd 1981). Otolith halves were mounted in silicone rubber sealant on microscope slides and observed at X10–50 magnification under

a stereomicroscope using transmitted light. Hyaline zones or winter rings were counted and age was expressed as years spent in fresh water, ignoring the central area of oceanic larval growth (Jellyman 1979).

Sex

It is difficult to sex non-migratory eels without inspecting the gonad. Four categories have been used to record sex in the catch-sampling programme over the last two years; unsexed, immature or unable to determine, male, and female. A four level stage of gonad development was assigned to differentiated males or females (*see* Beentjes & Chisnall 1997, 1998). Most eels from sampling stations in the North Island during the 1997–98 fishing year were exported live, so identification of sex was mainly limited to those killed for otolith extraction.

Length-weight relationship and condition index

The length-weight relationship for each species within each stratum was determined from

$$\ln W = b (\ln L) + (a)$$

where W is weight (g) and L is length (cm). A condition index was defined as the weight of a 45 cm eel calculated from the length weight relationship (45 cm roughly corresponds to the minimum legal size of 220 g).

No adjustment was made for the estimated 3% weight loss resulting from the desliming process at Levin.

Age at market size and well above

Mean ages were calculated for the two size categories sampled 250 g and under and 500 g and over and for eels of 249–499 g.

Data summary

All data collected between 1995 and 1998 were pooled to provide a summary of species, size compositions, and mean age at MSL by stratum code and area.

Results

Landings

In 1998, a strong El Niño weather pattern resulted in a long dry summer and severely restricted the fishery in the North Island. As a consequence, only two landings were sampled at Levin, which was most affected by the drought conditions which persisted throughout the lower and eastern North Island. Sampling at Te Kauwhata, Whenuapai, and Kamo Kamo was restricted to the late summer-autumn months.

In total, 64 landings were sampled from three North Island processors and one depot between 30 September 1997 and 8 July 1998. Most landings sampled were from Northland, Auckland, and the Waikato (Figure 1, Table 1). The data were grouped by stratum code (*see* Appendix 1) and provided with a group number for order of presentation within tables and figures (*see* Table 1).

Landed weights of longfins and shortfins sampled were 5.5 and 23.6 t, respectively. The percentage of landed weights sampled (sum of landed weights/sum of sample weights per species) was 20.5% for longfins and 15.5% for shortfins.

Shortfins made up 81.2% of the total sampled weight landed in the North Island (excluding the single landing from Marlborough in the South Island – 239.9 kg, 67% longfin). Length and weight were recorded from 1738 longfins and 4568 shortfins (Tables 1–3). The ages of 229 longfins and 661 shortfins were determined from otolith examination (Tables 4 and 5).

Shortfins made up over 50% of landings in 30 of 44 strata. Longfins were present in 36 strata and shortfins in all strata. Longfins were the predominant species in the upland rivers of Northland, the Waikato River basin, the mid and upper mainstem of the Hauraki Plains rivers, and in the lower mainstem of the Manawatu River. Few longfins were obtained from fishing lowland waters in the North Island, but their occurrence increased in the mainstems of rivers and increased substantially in the upper catchments. Eels captured from harbours and the sea, ponds and dams were predominantly (mostly over 90%) shortfins.

Anguilla reinhardtii, the Australian longfin eel (now Australasian longfin (Jellyman *et al.* 1996)) was found very infrequently in this year's landings from Northland and Hauraki compared with landings from 1996–97. However, many were reported from landings made during flooding in Northland immediately after sampling finished in June 1998 (John Jameson, pers. comm.)

Length frequency distribution and species composition

Length frequency distributions of longfins and shortfins are given by region and stratum (Figures 2–16) and mean lengths, weights, and ranges are also given by stratum (*see* Tables 2, 3). Shortfins ranged between 38 and 102 cm in length and 76 and 2626 g in weight, whereas longfins ranged between 32 and 122 cm in length and 77 and 7200 g in weight.

Size distributions from the different strata were comparable throughout the North Island regions. At sea and in harbours, shortfins generally made up 99% of the catches and had a length mode of 50 cm with a wide size distribution and many large eels (70–80 cm). For shortfins in fresh water, most landings showed a length mode of 55–60 cm, but became skewed towards larger size in the upper catchments (60–65 cm). Longfins were virtually absent from sites in the lower rivers and lakes, particularly in Northland; they were distributed throughout a wide size range (32–122 cm) but had a low length mode of 50 cm. Longfins were predominant in catches from upper main stems of tributaries, and had a larger length mode of 60 cm.

The single landing from the South Island, from the lower Wairau River, was predominantly longfins, with a length mode of about 50 cm for both species (Figure 16).

Weight and condition

Mean weight, regression coefficients for length–weight relationships, and condition indices are given by stratum for shortfins and longfins (*see* Tables 2 and 3). The overall mean shortfin weight for the North Island was 483 g, the lowest mean weight coming from the lower main stem of Hauraki Plains rivers (group 26, mean weight 276 g) and the highest from Tauranga Harbour (group 39, mean weight, 1292 g). The overall mean weight for longfins was 628 g, the lowest mean weight coming from the Waikato River estuary (group 29, mean weight 265 g) and the highest mean weight from Raglan Harbour (group 28, mean weight 3181g).

Shortfins with the best condition index were from the lower main stem of Northland rivers, Waitemata Harbour, and the upper main stem of Waikato River tributaries (condition index 205–227 g) and shortfins with the poorest condition index were from the South Island (Wairau River), Northland (Maungaturoto Estuary and ponds/dams), and Waikato (Lake Whangape) (condition index 159–165 g) (*see* Table 2).

Longfins with the best condition index were from the lower main stem of Hauraki Plains rivers, lower main stem of Wairoa River minor tributaries, and upper main stem of other Northland rivers (232–250 g). Those with the poorest condition were from the lower main stem of the South Island (Wairau River), Tauranga Harbour, and Lake Whangape (condition index 183–197 g).

Age at market size and above

As the size categories selected for sampling were disjointed, growth rates are not presented (generally only small and large eels were sampled, i.e., age distributions were inadequate to establish meaningful growth rates). Rather, age at each of the three size categories (A, less than or equal to 250 g; B, 251–499 g; and C, greater than or equal to 500 g) are given with ranges in length and weight and standard errors of mean age for each (*see* Tables 4 and 5).

For several landings, few eels were available from categories A and C, but category B eels gave an indication of growth for those sites.

Overall, 661 shortfins (SF) and 229 longfins (LF) were aged. Mean size and age is summarised for each species by size category (*from* Tables 4 & 5);

	< 250 g (A)		251–499 g (B)		> 500 g (C)	
	SF	LF	SF	LF	SF	LF
Number	190	78	260	89	211	62
Length (cm)	49	45	55	52	68	63
Weight (g)	224	208	332	354	648	640
Age (y)	12	14	14	15	17	19

Shortfins were both larger and younger than longfins after entry to the fishery (category A). Highlights of mean age in size categories for Northland, Auckland, and Waikato are summarised (*from* Tables 4 & 5):

Region	Stratum	Species	≤ 250 g (A)		≥ 500 g (C)	
			Age (y)	Weight (g)	Age (y)	Weight (g)
Northland & Auckland	Sea & estuaries	SF	7–9	211–230	10–15	519–1093
	Mid catchment & tributaries	SF	11–16	229–234	16–25	526–654
		LF	11–13	219–229	15–20	521–673
	Upper catchment & tributaries	SF	7	235	9–22	526–585
LF		17–19	226–239	14–22	532–560	
Waikato	Estuary	SF	13	227	16	757
		LF	10	228	–	–
	Mid catchment & tributaries	SF	14	221	12	760
		LF	13	202	20	673
	Lowland lakes	SF	13	232–244	–	–
	Upper catchment & tributaries	SF	18	217	23	750
		LF	11	200	–	610
	Hydro lakes & ponds	SF	4–6	267	7	848
LF		8	228	9	610	

In general, mean age of both eel species at either 250 g or less or 500 g and over, was lowest (corresponding to faster growth) in the sea and estuaries, and increased further upstream. Upper catchment hydro lakes and ponds were an exception, with low mean ages in both size categories for both species.

Sexual differentiation

Gonads were examined in 244 of the 896 eels killed for otolith removal, but only 45 could be sexed, all of them in the initial stages of development (1 or 2) (Table 6). Of 33 shortfins, 10 were males and 23 females: only 9 longfins were identified as male and 3 as female.

Age and size for each species and sex varied between locations. Average ages of shortfin females ranged from 7 y (corresponding to 62 cm and 531 g) in the Firth of Thames to 24 y (79 cm and 972 g) in the lower main stem of the Wairau River (Marlborough, South Island), whereas males ranged from 5.5 y (59 cm, 464 g) in Waikato ponds and dams to 20 y (66 cm and 522 g) in Raglan Harbour. Average ages of longfin males ranged from 9 y (62 cm, 646 g) in the Waikato hydro lakes to 23 y (59 cm, 529 g) in the lower main stem of Waikato River tributaries. Females were recorded only from the Waikato River hydro lakes at 10 y (63 cm, 633 g) and in the lower main stem of the Wairau River at 19 y (80 cm, 1074 g).

Catch per unit effort

The continued high level of cooperation from fishers enabled compilation of catch per unit effort (catch weight per net per night, CPUE) for 98% of North Island landings sampled in 1997–98 (Table 7). Catch rates varied enormously between locations, but some trends were apparent and associated with habitat. Catches in upper catchment sites were predominantly longfins (mostly 50% or more by weight), and shortfins were more abundant in lowland waters. Generally, the highest catch rates were made in estuaries of Northland and the Hauraki Plains (10–15 kg per net per night). Catch rates from the sea and in harbours from Northland to Hauraki were considerably lower at about 1.7 kg per net per night. Catch rates in the river systems of the North Island were about 4 kg per net per night. Catch rates in lowland lakes were about 5 kg per net per night, and in ponds or dams 14 kg per net per night (with large variance). The lowest catch rate was recorded from the Waikato hydro lakes at 0.4 kg per net per night.

Data summary 1995–98

Landings sampled in market sampling programmes between 1995 and 1998 were largely confined to the mid to northern regions of the North Island (*see* Figure 1). Very few landings were from the west (Taranaki) or south (Hawke's Bay, Wairarapa, Manawatu, Wellington).

All eels measured during these programmes were grouped by species and stratum code (*see* Appendix 1) (Tables 8, 9, Figures 17–19). A cursory examination of these data revealed the following: size distributions and species compositions changed substantially throughout the strata; in the sea, shortfins constituted 98% of catches, had a length mode of 60 cm, and 50% of the catch was larger than this. In the estuary, shortfins also dominated the catches, but the length mode was reduced to 55 cm and fewer larger eels were caught than in the sea. In the river courses, lowland strata (6 and 5) landings comprised about 60% shortfin and 40% longfin, with length distributions of both species predominantly 70 cm or less, and length modes of 50–55 cm (the smallest yet). In the upper reaches of catchments (strata 4–1), longfins predominated in catches (51% in minor tributaries, strata 2), length modes were still about 55 cm for both species, and a large proportion of the longfin catch was 70 cm and over.

Shortfins were the main eel caught in lowland lakes (87%), with a length mode of 50 cm and most of the catch 60 cm or less. Shortfins were not as abundant in landings from ponds or dams (68%), and the length mode was larger at 55 cm with more than 50% of the catch 60 cm and over.

The overall size distribution of North Island eels reveals distinct differences between the two species (Figure 20). Longfins had a wider size range than shortfins. The length mode for longfins was 50 cm and most eels caught were 58 cm or less. The length mode for shortfins was 52 cm and much of the catch ranged to 75 cm (Figure 19). The proportion of longfins was only 26% by number or 33% by weight. However, the proportion of longfins in the catch was considerably greater at smaller size and reduced with increasing size, e.g., at 50 cm and under both species formed around 50% of the catch by number, but at 60 cm longfins made up 20% or less (Figure 20).

The areas most intensively sampled and the principal species being fished from each area are shown in Table 9. Most samples came from the Waikato, Northland and Hauraki, where longfins made up 14–47% of landings. Landings from the Wairarapa and Taranaki were dominated by longfins (55–79%) and longfins were virtually absent from Hawke's Bay landings.

To describe age at market size (AMS) from these data, we used eels 240 g and under. At sea and in the harbour, AMS for shortfins was 11 y and 15 y for longfins; in the estuary, AMS for shortfins was 12 y and 9 y for longfins. In the lowland reaches of water courses, AMS for shortfins ranged between 10 and 11 y and was 12 y for longfins; in upper reaches shortfins at AMS ranged between 9 and 13 y, and longfins were 14 y.

AMS for shortfins from lowland lakes was 15 y and for longfins was 12 y, and from ponds and dams AMS was 15 y for both species.

Mean landed weight was highest in highland tributaries (18 409 kg) followed by lowland lakes (7194 kg) and river mid catchment (6268 kg) (*see* Table 8). Mean landed weight in Northland, Auckland, Waikato, Hauraki, Coromandel, and Bay of Plenty was 200–300 kg, which was lower than for Taranaki, Manawatu, Wairarapa, (400–1000 kg), and substantially lower than for East Cape-Hawke's Bay and Marlborough (2000–8000 kg).

Discussion

Results from this year's sampling are generally similar to those of the last 2 years, and include some new habitats; the sea, harbours, and ponds and dams. Shortfin eels remain the predominant species landed by commercial fishers in the North Island, and the percentage of longfins landed again varied seasonally corresponding to the fishing of upper catchments during the summer. The seasonality of the North Island fishery was again evident in the changing source of landings during the sampling programme. When the dry weather finally changed to wet in May (usually March), catches increased dramatically and came mainly from the lowland waterways. The Firth of Thames (sea) and estuaries of the Hauraki Plains were fished only during the winter and the western King Country rivers and tributaries (Waikato upper catchment) only during the summer when water levels were low elsewhere. Occasional landings from the South Island were processed in North Island factories.

Size and species composition

General trends in size frequency distribution and species composition recorded for new areas were mostly similar to those reported previously (Beentjes & Chisnall 1997, 1998); eels from lowland habitats were smaller than those from upper catchments; shortfins dominated lowland catches and longfins upland catches. Harbours and ponds or dams supported almost exclusively shortfin fisheries.

The abundance of small eels and paucity of longfins in lower catchments probably reflects the intensity of exploitation (upper catchments fished less frequently because of generally lower productivity and more difficult access), along with the greater penetration of catchments by longfins.

Length-weight relationships may be useful for future comparisons. However, as condition indices can vary seasonally, comparisons will require similar sampling dates and should be treated with caution.

The limited data on size at maturity and reported ranges for North Island eels (e.g., Todd 1980) indicate that the fishery is based primarily upon immature females of both species.

Growth

Growth compared well with published information (e.g., Burnet 1969, Chisnall 1989, 1993, Chisnall & Hayes 1991, Chisnall & Hicks 1993, Jellyman *et al.* 1995, Horn 1996). Several values for mean age (A) were older than age at minimum legal size estimated for the same locations using models derived from 1995–97 data (Beentjes & Chisnall 1998), e.g., shortfins from Lake Whangape were estimated to enter the fishery at 5 y, whereas this year's data estimates 13 y. Older mean age (A) could be expected from category A eels in 1998. Fewer small eels in the datasets (1995–97) used in the models derived from length stratified samples probably also contributed to the younger age estimate.

The variable ages of larger eels indicated longer term growth patterns in the various locations. Older ages of larger eels in some locations probably indicate a poorer food supply for the larger size classes, because longer eels (over 45 cm) eat more fish (Jellyman 1989).

Overall, catchment trends in growth were similar to those reported by Beentjes & Chisnall (1998). There was rapid growth to market size and beyond in the sea and estuaries: growth generally reduced in fresh waters with increasing distance upstream. Growth in lowland lakes was mostly faster than in rivers. In Northland-Auckland landings, shortfins grew faster in the upper catchment than in mid catchment. Growth to market size varied considerably in ponds or dams probably reflecting the various stock densities and food availability of each site.

Most variation in eel growth can generally be attributed to the interplay between stock density and food availability (e.g., Jellyman 1997). This year's samples from Hauraki Plains estuaries, where there is abundant food, once again showed very rapid growth. Within waterways where food is not as abundant and stock densities are high, growth is slower, such as in the lower Waikato or Wairoa Rivers.

It was also again clear that longfins grew more rapidly than shortfins in productive waters, such as in Northland-Waikato rivers from estuary to mid catchment, but in less productive waters the growth rate of shortfins generally exceeded that of longfins, as in Northland river upper catchments. However, in minor tributaries growth of longfins generally exceeded that of shortfins, such as in the highland reaches of Waikato waters. The latter may be the result of limited space and consequent longfin predation or shortfins.

The considerable variation in growth, both between and within catchments, once again emphasises that yield-per-recruit models should be using catchment-based information as soon as it becomes available.

Sexual maturity

The meagre data on eel size at maturity from North Island landings to date (Beentjes & Chisnall 1998) show a larger variation in size and age at maturity than previously reported. This year's sampling made a minor contribution to the database, particularly in that all were only stages 1 or 2.

Catch per unit effort

The growing time series of CPUE data for individual catchments will provide important indicators of levels of stress on the fishery and could become a means of monitoring the effect of future management strategies.

This year's findings were similar to those of previous years. Larger proportions of longfins caught with increasing distance upstream, probably reflected increasing capture efficiency by fyke nets in more confined spaces and habitat selectivity for upstream areas by longfins. The commercial fishery also appears to be more selective for longfins than shortfins, so fewer longfins in lowland waters may reflect the intensive exploitation of these areas (e.g., Jellyman *et al.* 1995, Chisnall *et al.* 1998).

Despite low catch rates, the sea (including harbours) is a substantial component of the North Island eel fishery, as are ponds and dams with high returns. Catch rates were again greatest in estuaries, but were not greater in upper catchment sites than lower as found previously (Beentjes & Chisnall 1998).

Summary 1995–1998

Most landings sampled between 1995 and 1998 were drawn from Northland, Waikato, and Hauraki. Very few landings were sourced from the west (Taranaki) or south (Hawke's Bay, Wairarapa, Manawatu, Wellington). Information on eel stocks in these regions remains limited, and they should be targeted in future market sampling.

The variance in mean landing weight throughout catchments and amongst regions will have partly reflected eel abundance. However, "abundance" is integrally linked with the average size of eel in each location, i.e., where eels were generally larger, fewer eels could have provided the same landing weight as from an area with higher stock density but smaller average eel size. The variance in catch weights probably also reflected the combination of fishing practices and factory management, i.e., large catches made in highland tributaries suggest that eelers accumulate catches whilst fishing upper reaches before making the effort to sell them: similarly with large catches made in regions where the processing factories are isolated from the fisheries, such as in Taranaki and Marlborough.

Overall size distribution and species composition of both species landed in the North Island indicate that longfins are distinctly more vulnerable to fishing than shortfins (Figure 20). Shortfins dominate most North Island catches but the proportion of both species of eels greater than 50 cm is similar. The larger body weight to length ratio make longfins more physically susceptible to netting at a smaller length (younger age). Longfins are also known to be more aggressive and territorial than shortfins, which probably adds to their vulnerability to fishing. This may explain why the mean weight of longfins in category A for 1998 data was below market weight – sub-commercial sized longfins are more easily retained in fyke nets despite escapement tubes. This finding, along with the previously documented decline of longfins over 20 years of fishing (Beentjes & Chisnall 1997), gives rise for concern for the species.

The mean age of eels entering the North Island fishery, although variable, was typically 11 y or more for both species. In a few locations this mean age was considerably reduced, reflecting rapid growth. These mean ages are older than the estimates provided from regression models previously reported and give good reason for caution in management of the eel fishery as a whole. Therefore, management of the eel fishery must consider long term, rather than short term, goals. Now that the catch sampling database contains 3 years' data, for the North Island representing 116 landings, a more thorough examination of spatial and temporal trends in size, species composition, and growth rates would be of particular benefit for informed management of the fishery.

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References

- Beentjes, M.P. & Chisnall, B.L. 1997: Trends in size and species composition and distribution of commercial eel catches. *New Zealand Fisheries Data Report No. 89*. 71 p.
- Beentjes, M.P. & Chisnall, B.L. 1998: Size, age, and species composition of commercial eel catches from market sampling, 1996-97. *NIWA Technical Report 29*. 124 p.
- Beentjes, M.P., Chisnall, B.L., Boubée, J.A.T., & Jellyman, D.J. 1997: Enhancement of the New Zealand eel fishery by elver transfers. *New Zealand Fisheries Technical Report 45*. 44 p.
- Burnet, A.M.R. 1969: The growth of New Zealand freshwater eels in three Canterbury streams. *New Zealand Journal of Marine and Freshwater Research* 3: 376–384.
- Chisnall, B.L. 1989: Age, growth, and condition of freshwater eels (*Anguilla* sp.) in backwaters of the lower Waikato River, New Zealand. *New Zealand Journal of Marine and Freshwater Research* 23: 459–465.
- Chisnall, B.L. 1993: Age and growth of freshwater eels in the Waikato River. Report to Electricity Corporation of New Zealand Ltd. NIWA Consultancy Report No. ELE113/1. 22 p.
- Chisnall, B.L. 1994: An unexploited mixed species eel stock (*Anguilla australis* and *A. dieffenbachii*) in a Waikato pastoral stream, and its modification by fishing pressure. *Conservation Advisory Science Notes, No. 69*. Wellington, New Zealand. 12 p.
- Chisnall, B.L. & Hayes, J.W. 1991: Age and growth of shortfinned eels (*Anguilla australis*) in the lower Waikato basin, North Island, New Zealand. *New Zealand Journal of Marine and Freshwater Research* 25: 71–80.
- Chisnall, B.L. & Hicks, B.J. 1993: Age and growth of longfinned eels (*Anguilla dieffenbachii*) in pastoral and forested streams in the Waikato River basin, and in two hydro-electric lakes in the North Island, New Zealand. *New Zealand Journal of Marine and Freshwater Research*. 27: 317–332.

- Chisnall, B.L., Beentjes, M.P., Boubée, J.A.T., & West, D.W. 1997: Enhancement of the New Zealand eel fishery by elver transfers. *New Zealand Fisheries Technical Report No.45*. 44 p.
- Francis, R.I.C.C. 1999: Optimum design for shed sampling of eels. New Zealand Fisheries Assessment Research Document 99/3. 28 p. (Draft report held in NIWA library, Wellington.)
- Horn, P.L. 1996: A review of age and growth data for New Zealand freshwater eels (*Anguilla* spp.). New Zealand Fisheries Assessment Research Document 96/6. 23 p. (Draft report held in NIWA library, Wellington.)
- Hu, L.C. & Todd, P.R. 1981: An improved technique for preparing eel otoliths for aging. *New Zealand Journal of Marine and Freshwater Research* 15: 445–446.
- Jellyman, D.J. 1979: Scale development and age determination in New Zealand freshwater eels (*Anguilla* spp.). *New Zealand Journal of Marine and Freshwater Research* 13: 23–30.
- Jellyman, D.J. 1989: Diet of two species of freshwater eel (*Anguilla* spp.) in Lake Pounui, New Zealand. *New Zealand Journal of Marine and Freshwater Research* 23: 1–10.
- Jellyman, D.J. 1997: Variability in growth rates of freshwater eels (*Anguilla* spp.) in New Zealand. *Ecology of Freshwater Fish* 6: 108–115.
- Jellyman, D.J., Chisnall, B.L., Dijkstra, L.H., & Boubée, J.A.T. 1996: First record of the Australian longfinned eel, *Anguilla reinhardtii*, in New Zealand. *Marine and Freshwater Research* 47: 1037–1040.
- Jellyman, D.J., Chisnall, B.L., & Todd, P.R. 1995: The status of the eel stocks of Lake Ellesmere. *NIWA Science and Technology Series* 26. 62 p.
- Todd, P.R. 1980: Size and age of migrating New Zealand freshwater eels (*Anguilla* spp.). *New Zealand Journal of Marine and Freshwater Research* 14: 283–293.

Table 1 – continued

Region	Location	Stratum definition	Group 1998	No. of landings	Longfinned eel			Shortfinned eel			
					Landed wt (kg)	% wt Sampled	No. eels sampled	Landed wt (kg)	% wt Sampled	No. eels sampled	
	Rivers, other	Lower main stem (lowland meander)	12	3	157.7	31.5	107	277.0	32.6	217	36.3
		Lower main stem (mid catchment meander)	13	1	330.1	16.3	78	40.8	16.2	12	89.0
		Upper main stem (predominantly pasture)	14	2	245.9	30.0	93	106.9	56.6	107	69.7
		Upper main stem (highland trib)	15	3	482.0	43.7	190	105.8	25.7	60	82.0
	Northland lowland lakes	Lake Awanui	16	1	4.7	48.9	6	105.2	50.8	114	4.3
		Lake Tomarata	17	1	40.5	8.4	8	370.9	8.5	66	9.8
	Northland ponds and dams	Farm dam (Mangawari)	18	1	0.8	25.0	1	209.1	24.8	123	0.4
Auckland	Manukau Harbour	Sea	19	1	0.0	0.0	0	162.0	39.2	100	0.0
	Waitemata Harbour	Sea	20	2	2.1	47.6	1	302.9	32.7	162	0.7
	Rivers, other	Upper main stem (highland trib)	21	2	340.8	39.8	146	131.1	39.7	124	72.2
	Auckland ponds and dams	Farm dams (Karaka)	22	1	25.2	6.0	2	305.7	6.1	34	7.6
Hauraki-	Firth of Thames and	Firth-sea	23	1	0.0	0.0	0	183.0	11.1	31	0.0

Table 1 – continued

Region	Location	Stratum definition	Group 1998	No. of landings	Longfinned eel			Shortfinned eel			
					Landed wt (kg)	% wt Sampled	No. eels sampled	Landed wt (kg)	% wt Sampled	No. eels sampled	% Landed weight LFE
Coromandel	Hauraki Plains rivers	Estuary	24	1	0.0	0.0	0	436.0	13.1	90	0.0
		Lower main stem (lowland meander)	25	2	63.0	10.2	12	143.9	10.5	38	30.4
		Lower main stem (mid catchment meander)	26	1	61.6	16.7	33	99.3	16.7	42	38.3
		Lower main stem (lowland trib)	27	1	8.9	25.8	8	86.0	26.6	83	9.4
Waikato Region	Raglan Harbour	Sea	28	1	6.3	100.0	2	3.4	100.0	7	64.9
	Waikato River	Estuary	29	1	21.0	16.7	13	291.2	16.7	124	6.7
	Waikato River tributaries	Lower main stem (mid catchment meander)	30	2	861.3	12.5	187	455.7	14.1	209	65.4
		Upper main stem (predominantly pasture)	31	1	109.4	10.6	24	170.6	10.6	50	39.1
		Lower main stem (lowland trib)	32	2	298.5	13.1	66	231.4	10.2	25	56.3
		Upper main stem (highland trib)	33	2	172.8	10.5	24	301.0	12.8	77	36.5
	Waikato lowland lakes	Lake Waikare	34	2	307.8	10.5	3	362.2	9.6	88	45.9
		Lake Whangape	35	1	15.3	100.0	18	7.1	100.0	14	68.3

Table 1 – continued

Region	Location	Stratum definition	Group 1998	No. of landings	Longfinned eel			Shortfinned eel			
					Landed wt (kg)	% Sampled	No. eels sampled	Landed wt (kg)	% Sampled	No. eels sampled	
	Waikato ponds and dams	Pond	36	1	0.0	0.0	0	73.0	11.4	21	0.0
	Waikato hydro lakes	Lake Arapuni and Waipapa (combined)	37	1	123.1	11.5	28	41.9	11.5	10	74.6
East Cape-Hawke's Bay	Lowland lakes	Lake Rapongaere	38	1	2.5	12.0	1	1 3672.5	12.1	400	0.0
Bay of Plenty	Tauranga Harbour	Sea	39	1	106.5	5.6	4	161.5	5.6	7	39.7
	Kaituna River	Lower main stem (lowland meander)	40	1	77.7	23.0	40	119.2	23.0	57	39.5
Taranaki	Wanganui River tributaries	Lower main stem (lowland meander)	41	1	269.7	11.3	45	146.2	11.3	24	64.8
		Upper main stem (highland trib)	42	1	290.0	10.5	76	0.0	0.0	0	100.0
Manawatu	Manawatu ponds and dams	Farm dams (Marton)	43	1	439.1	5.6	29	451.8	5.6	41	49.3
Marlborough	Wairau River	Lower main stem (mid catchment meander)	44	1	165.2	51.3	300	74.7	51.3	99	68.9
Totals				64	5 597.3		1738	2 3579.3		4 568	

Table 2: Length, weight, regression coefficients, and condition index for shortfinned eels from North Island locations. s.e., standard error; -, insufficient data; Group definitions in Table 1

Location	Group	N	Mean±s.e. length (cm)	Range (cm)	Mean±s.e. weight (g)	Range (g)	a	b	r ²	Condition Index (g)
Kairapara Harbour	1	215	56.0±0.61	39–84	429.7±18.80	110–1890	7.46	3.33	0.95	184
	2	107	60.4±0.82	50–91	453.5±25.12	235–1781	7.00	3.18	0.96	165
Wairoa River	3	100	56.5±0.62	48–79	368.0±15.28	213–953	6.28	3.01	0.87	177
	4	100	57.8±0.57	50–71	412.8±13.47	235–765	6.58	3.10	0.93	185
	5	477	63.0±0.39	47–101	531.2±12.5	204–2233	7.10	3.21	0.94	167
	6	485	62.8±0.43	47–102	543.3±14.44	192–2626	7.14	3.22	0.93	167
	7	99	60.5±0.76	50–81	485.9±20.54	250–1104	6.25	3.02	0.96	190
	8	29	65.3±1.61	51–84	678.2±55.44	272–1493	6.70	3.15	0.96	199
	9	224	60.8±0.58	46–98	468.0±15.21	177–1412	6.61	3.09	0.95	173
Hotea River	10	16	63.8±1.96	53–81	576.7±54.51	306–1062	5.73	2.90	0.97	202
	11	60	59.4±1.12	43–76	470.6±29.10	147–1069	7.15	3.24	0.94	178
Northland rivers, other	12	217	57.6±0.57	45–97	416.5±15.50	195–1809	5.92	2.93	0.91	187
	13	12	63.1±2.48	52–76	555.0±55.33	305–811	4.36	2.57	0.97	227
	14	107	63.5±0.81	48–85	565.9±23.75	215–1307	6.96	3.19	0.96	178
	15	60	58.8±1.14	45–90	454.4±35.97	208–1834	6.67	3.12	0.92	183
	16	114	60.2±0.95	42–93	468.5±24.57	135–1542	6.35	3.03	0.94	178
Lake Tomarata	17	66	61.5±1.15	44–83	480.0±30.08	194–1151	6.58	3.08	0.97	171
Northland ponds and dams	18	123	59.5±0.60	49–76	421.2±15.89	232–1018	7.17	3.22	0.94	162

Table 2 – continued

Location	Group	N	Mean±se length (cm)	Range (cm)	Mean±s.e. Weight (g)	Range (g)	a	b	r ²	Condition index(g)
Manukau Harbour	19	100	64.4±1.12	44–91	635.6±35.51	207–1810	6.58	3.11	0.95	192
Waitemata Harbour	20	162	63.8±0.87	45–90	610.6±23.68	202–1454	5.68	2.89	0.97	205
Auckland rivers, other	21	124	58.0±0.62	38–77	427.8±15.46	76–1108	5.01	2.71	0.67	202
Auckland ponds and dams	22	34	61.7±1.62	50–92	544.6±63.44	219–1900	7.58	3.34	0.97	170
Firth of Thames and Hauraki Plains rivers	23	31	66.1±0.93	56–77	658.5±30.05	415–1031	6.52	3.10	0.92	196
	24	90	64.2±0.69	52–77	595.7 ± 19.12	270–1000	6.60	3.11	0.94	188
	25	38	57.4±1.14	45–71	397.8±24.64	199–810	5.63	2.86	0.96	192
	26	42	55.2±1.78	43–97	396.5±56.14	144–2040	7.10	3.22	0.98	174
	27	83	50.8±0.84	40–75	276.4±16.04	115–792	6.41	3.05	0.94	181
Raglan Harbour	28	7	63.0±3.45	51–80	498.6±90.87	273–1007	5.78	2.88	0.97	178
Waikato River	29	124	55.2±0.86	43–93	391.9 ± 27.44	180–2230	6.72	3.14	0.97	187
	30	209	63.2±0.67	42–89	579.6±20.37	187–1703	5.98	2.96	0.92	198
	31	50	55.2 ± 0.72	47–66	361.8±13.86	248–614	4.68	2.63	0.92	207
	32	25	72.0±2.29	52–97	954.2±90.45	250–2043	6.60	3.13	0.95	203
	33	77	60.6±1.00	42–79	504.6±27.05	150–1050	7.21	3.25	0.92	174
Lake Waikare	34	88	57.0±0.99	45–99	394.0±31.06	188–2400	6.60	3.09	0.97	175
Lake Whangape	35	14	62.9±2.44	51–77	507.6±62.85	241–864	6.94	3.16	0.89	162

Table 2 – continued

Location	Group	N	Mean±s.e. length (cm)	Range (cm)	Mean±s.e. weight (g)	Range (g)	a	b	r ²	Condition index(g)
Waikato ponds and dams	1998	36	57.2±1.96	48–83	397.2±50.73	240–1160	5.38	2.79	0.96	189
Lake Arapuni and Waipapa (combed)		37	62.0±2.40	51–73	479.5±55.77	287–732	5.80	2.89	0.94	181
Lake Rapongaere		38	56.5±0.32	44–82	376.5±7.01	175–972	5.62	2.85	0.94	187
Tauranga Harbour		39	78.4±6.09	52–95	1292.1±288.72	302–2200	7.20	3.26	0.97	183
Kaituna River		40	58.7±1.43	44–98	482.2±42.05	165–1840	6.26	3.03	0.97	195
Wanganui River		41	66.4±1.91	50–86	688.1±61.98	225–1463	6.17	3.01	0.95	198
Manawatu ponds and dams		43	66.0±1.09	55–82	622.7±32.9	352–1212	6.57	3.10	0.95	187
Wairau River		44	58.1±0.86	41–86	387.6	115–1268	6.92	3.15	0.95	159

Table 3: Catch sampling length, weight, regression coefficients, and condition index for longfinned eels from North Island locations. s.e., standard error; —, insufficient data; Group definitions in Table 1

Location	Group 1998	N	Mean±s.e. length (cm)	Range (cm)	Mean weight (g)±s.e.	Range (g)	a	b	r ²	Condition index(g)
Wairoa River	4	1	—	50–50	—	331–331	—	—	—	—
	5	27	56.5±1.68	46–91	520.9±81.1	219–2466	8.11	3.53	0.98	206
	6	35	52.7±1.50	43–75	391.1±43.4	193–1209	6.37	3.08	0.93	212
	7	4	54.5±3.93	49–66	418.3 ± 121.6	273–782	—	—	—	—
	8	77	66.0±1.48	46–103	953.9±75.8	226–3786	7.02	3.28	0.97	236
	9	29	52.6±1.36	43–77	397.4±43.1	208–1291	7.08	3.28	0.98	223
	10	18	58.3±2.83	44–94	651.4±140.2	220–2780	7.15	3.31	0.98	233
	11	2	56.5±4.50	52–61	429.0±103.0	326–532	—	—	—	—
	12	107	54.9±0.93	39–92	465.4±32.2	120–2063	6.57	3.15	0.96	226
Northland rivers, other	13	78	59.8±1.54	45–97	689.5±71.2	220–3107	7.26	3.32	0.99	217
	14	93	61.5±1.64	45–117	793.3±92.4	220–6049	6.93	3.24	0.97	222
	15	190	67.9±1.22	35–122	1108.0±70.1	89–5120	6.81	3.22	0.97	232
Lake Awanui	16	6	52.5±4.73	44–75	397.8±139.9	192–1078	6.82	3.19	0.94	205
Lake Tomarata	17	8	55.8±2.89	48–70	432.9±83.5	251–903	7.17	3.28	0.98	204
Northland ponds and dams	18	1	—	44	—	214	—	—	—	—
Waitemata Harbour	20	1	—	75	—	1026	—	—	—	—
Auckland rivers, other	21	146	64.6±1.31	41–117	928.7±79.6	148–5800	6.92	3.24	0.98	224

Table 3 – continued

Location	Group 1998	N	Mean±s.e. length (cm)	Range (cm)	Mean weight (g)±s.e.	Range (g)	a	b	r ²	Condition index(g)
Auckland ponds and dams	22	2	65.0±1.00	64–66	764.0±21.0	743–785	–	–	–	–
Firth of Thames and Hauraki Plains rivers	25	12	56.8±2.88	45–77	533.4±82.5	200–1114	5.29	2.84	0.82	250
	26	33	48.4±1.43	32–68	313.4±33.6	77–838	7.13	3.29	0.98	220
	27	8	49.5±2.90	41–64	297.1±52.4	157–558	5.91	2.96	0.98	212
	28	2	96.5±8.50	88–105	3181.5±1180.5	2 001–4362	–	–	–	–
Waikato River	29	13	47.0±1.12	43–57	265.4±21.6	190–490	5.33	2.83	0.88	231
	30	187	56.9±0.91	40–119	583.9±52.2	155–7200	6.8	3.21	0.95	226
	31	24	55.5±1.47	47–77	483.1±49.1	265–1300	6.79	3.21	0.96	228
	32	66	59.0±1.28	43–92	592.3±46.7	202–2160	6.29	3.08	0.97	229
	33	24	63.5±3.20	41–107	758.0±131.9	200–3200	6.04	3.01	0.98	225
	34	3	64.0±2.65	59–68	631.3±31.9	595–695	–	–	–	–
Lake Whangape	35	18	65.6±3.83	51–115	851.1±228.4	304–4200	7.01	3.23	0.98	197
Lake Arapuni and Waipapa (combined)	37	28	57.2±1.72	45–84	503.3±57.0	209–1700	6.67	3.16	0.98	213
Lake Ropongaere	38	1	–	48	–	280	–	–	–	–
Tauranga Harbour	39	4	76.5±4.91	62–83	1 504.8±304.7	625–2000	9.52	3.87	0.99	183
Kaituna River	40	40	53.9±1.22	44–74	448.2±38.0	197–1165	7.18	3.31	0.96	226

Table 3 – continued

Location	Group 1998	N	Mean±s.e. length (cm)	Range (cm)	Mean weight (g)±s.e.	Range (g)	a	b	r ²	Condition index(g)
Wanganui River	41	45	60.4±0.00	45–100	676.7±0.0	231–2 860	7.29	3.33	0.97	218
	42	76	52.7±0.61	43–74	399.8±17.6	221–1 142	6.86	3.23	0.92	229
Manawatu ponds and dams	43	29	66.0±2.35	47–108	855.6±136.8	262–4 200	6.64	3.16	0.97	219
Wairau River	44	300	50.1±0.33	36–80	282.9±8.6	78–1 285	7.39	3.32	0.93	190

Table 4: Mean age of shortfinned eels in weight ranges ≤ 250 g, 251–499 g, and ≥ 500 g, from 1997–98 sampling. s.e. , standard error; –, insufficient data; group definitions in Table 1

Region	Location	Stratum definition	Group 1998	No. of Landings	Size (g)	No. Aged	Length range (mm)	Mean length \pm s.e. (g)	Weight range (g)	Mean weight \pm s.e. (g)	Age range (y)	Mean age \pm s.e. (y)
Northland	Kaipara Harbour	Sea	1	1	≤ 250	32	39–52	47.2 \pm 0.5	120–250	210.9 \pm 5.9	6–13	9.3 \pm 0.3
					251–499	2	49–50	49.5 \pm 0.5	260–260	260.0 \pm 0.0	9–10	9.5 \pm 0.5
					≥ 500	3	70–84	79.0 \pm 4.5	890–1220	1093.3 \pm 102.7	8–13	10.3 \pm 1.4
	Maungaturoto	Estuary	2	1	≤ 250	1	51–51	51.0 \pm 0.0	235–235	235.0 \pm 0.0	13–13	13.0 \pm 0.0
					251–499	14	50–63	52.6 \pm 0.9	256–483	292.9 \pm 15.2	12–22	14.0 \pm 0.7
					≥ 500	5	64–69	66.8 \pm 1.9	559–633	601.2 \pm 14.4	14–16	14.8 \pm 0.4
	Wairoa River	Lower main stem (lowland meander)	3	1	≤ 250	7	49–52	50.6 \pm 0.4	213–248	234.1 \pm 4.8	8–14	11.0 \pm 0.7
					251–499	8	48–52	49.9 \pm 0.5	251–292	270.1 \pm 5.5	6–12	8.0 \pm 0.8
					≥ 500	5	60–68	64.6 \pm 1.4	527–612	546.8 \pm 16.3	11–14	12.4 \pm 0.5
	Wairoa River tributaries	Lower main stem (mid catchment meander)	5	4	≤ 250	11	47–53	50.4 \pm 0.5	204–248	237.0 \pm 3.8	7–18	12.9 \pm 1.2
					251–499	26	49–66	53.2 \pm 0.8	258–480	301.3 \pm 11.4	8–20	13.4 \pm 0.7
					≥ 500	44	63–69	67.0 \pm 0.2	500–702	594.5 \pm 8.3	8–34	20.1 \pm 1.0
		Upper main stem (predominantly pasture)	6	3	≤ 250	18	47–53	50.4 \pm 0.3	213–250	235.3 \pm 2.8	5–23	14.8 \pm 1.3
					251–499	18	49–58	52.3 \pm 0.6	251–339	279.2 \pm 6.7	6–22	13.4 \pm 1.2
					≥ 500	30	50–74	68.4 \pm 0.8	524–888	653.7 \pm 19.3	6–30	16.6 \pm 1.3

Table 4 – continued

Region	Location	Stratum definition	Group 1998	No. of Landings	Size (g)	No. Aged	Length range (mm)	Mean length±s.e. (g)	Weight range (g)	Mean weight±s.e. (g)	Age range (y)	Mean age±s.e. (y)
		Lower main stem (lowland trib)	8	1	251–499	3	51–62	57.7±3.4	272–499	412.7±70.9	18–24	21.3±1.7
					≥ 500	2	61–63	62.0±1.0	513–539	526.0±13.0	19–30	24.5±5.5
		Upper main stem (highland trib)	9	1	≤ 250	11	50–52	50.0±0.2	220–245	235.0±2.4	5–9	6.7±0.4
					251–499	4	51–64	58.0±3.5	251–480	369.5±60.1	5–8	6.0±0.7
					≥ 500	11	64–69	66.4±0.5	526–678	585.0±15.0	7–13	9.0±0.6
		Lower main stem (lowland meander)	12	3	≤ 250	11	45–50	48.2±0.5	200–250	229.3±5.2	12–22	16.5±0.9
					251–499	14	47–64	52.4±1.6	253–497	320.3±24.1	11–21	14.5±0.8
					≥ 500	6	63–67	65.0±0.7	539–608	571.8±12.6	14–20	17.5±1.1
		Lower main stem (mid catchment meander)	13	1	251–499	3	52–62	55.3±3.3	305–482	375.0±54.3	15–19	17.3±1.2
		Upper main stem (predominantly pasture)	14	1	251–499	1	54	–	378	–	19	–
					≥ 500	2	64–66	65.0±1.0	588–595	591.0±3.5	14–17	15.5±1.5
		Upper main stem (highland trib)	15	2	≤ 250	1	48	–	241	–	13	–
					251–499	5	48–60	52.0±2.2	262–483	308.2±43.7	14–18	16.6±0.7
					≥ 500	2	59–61	60.0±1.0	559–578	568.5±9.5	13–17	15.0±2.0

Table 4 – continued

Region	Location	Startum definition	Group 1998	No. of Landings	Size (g)	No. Aged	Length range (mm)	Mean length±s.e. (g)	Weight range (g)	Mean weight±s.e. (g)	Age range (y)	Mean age±s.e. (y)
Northland	Lowland Lakes	Lake Awanui	16	1	≤ 250	12	43–51	47.8±0.8	141–250	203.8±9.5	8–16	11.7±0.6
					251–499	16	48–65	56.1±1.2	253–486	345.3±20.4	9–20	14.0±0.7
					≥ 500	7	63–74	67.9±1.7	506–917	662.3±53.8	14–23	16.9±1.2
Northland	ponds and dams	Lake Tomarata	17	1	≤ 250	5	44–52	48.8±1.5	194–246	226.8±8.8	10–16	13.4±1.0
					251–499	10	52–63	55.6±1.2	257–499	317.3±26.9	11–23	17.2±1.3
					≥ 500	2	66–67	66.5±0.5	549–550	549.5±0.5	23	23.0±0.0
Northland	ponds and dams	Farm dam (Mangawari)	18	1	≤ 250	4	49–51	50.0±0.4	232–246	238.3±3.4	9–15	10.8±1.4
					251–499	12	50–65	54.4±1.5	252–473	301.2±22.6	9–18	12.9±0.8
					≥ 500	8	64–70	62.1±0.8	512–674	581.0±24.3	13–18	16.0±0.6
Auckland	Manukau Harbour	Sea	19	1	≤ 250	3	49–51	50.3±0.7	238–246	243±2.5	8–9	8.3±0.3
					251–499	3	48–50	48.7±0.7	251–260	255.3±2.6	6–12	8.7±1.8
					≥ 500	2	60–64	62.0±2.0	509–528	518.5±9.5	8–11	9.5±1.5
Auckland	Waitemata Harbour	Sea	20	2	≤ 250	2	45–47	46.0±1.0	223–237	230.0±7.0	6–7	6.5±0.5
					251–499	14	48–63	51.3±1.2	251–489	299.6±21.5	6–19	11.1±1.3
					≥ 500	2	59–60	59.5±0.5	513–578	545.5±32.5	6–13	9.5±3.5
Northland	Rivers	Other	21	2	≤ 250	2	50–52	51.0±1.0	233–247	240.0±7.0	10–11	10.5±0.5
					251–499	8	50–61	55.9±1.8	253–487	346.4±36.6	11–20	13.9±1.2
					≥ 500	4	60–62	60.8±0.5	501–530	512.0±6.3	14–40	22.3±6.0

Table 4 -- continued

Region	Location	Stratum definition	Group 1998	No. of landings	Size (g)	No. Aged	Length range (mm)	Mean length±s.e. (g)	Weight range (g)	Mean weight±s.e. (g)	Age range (y)	Mean age±s.e. (y)
	Auckland ponds and Farm dams	dams (Karaka)	22	1	≤ 250	1	50	—	219	—	19	—
					251–499	10	52–63	57.4±1.5	261–498	381.4±31.2	12–28	17.6±1.5
					≥ 500	2	63–64	63.5±0.5	526–535	530.5±4.5	15–16	15.5±0.5
Hauraki–Coromandel	Firth of Thames and Hauraki Plains rivers	Firth–sea	23	1	251–499	3	60–63	61.3±0.9	454–496	473.0±12.3	5–12	8.0±2.1
					≥ 500	2	63	63.0±0.0	565–598	581.5±16.5	9–13	11.0±2.0
		Estuary	24	1	251–499	1	58	—	400	—	9	—
					≥ 500	10	62–69	65.5±0.7	550–700	640.0±14.5	6–9	8.0±0.3
		Lower main stem (lowland meander)	25	1	≤ 250	1	47	—	221	—	13	—
					251–499	2	51–61	56.0±5.0	262–466	364.0±102.0	12–14	13.0±1.0
					≥ 500	2	64–65	64.5±0.5	527–535	531.0±4.0	15–16	15.5±0.5
Waikato Region	Raglan Harbour	Sea	28	1	251–499	4	56–66	62.3±2.3	335–498	453.5±39.5	12–23	17.8±2.4
	Waikato River	Estuary	29	1	≤ 250	20	45–50	47.7±0.3	200–250	226.5±3.9	9–16	12.6±0.5
					251–499	4	48–51	50.0±0.7	260–330	282.5±16.0	10–14	11.3±0.9
					≥ 500	4	68–77	72.3±1.9	660–860	757.5±41.3	12–21	16.3±2.2

Table 4 – continued

Region	Location	Stratum definition	Group 1998	No. of Landings	Size (g)	No. Aged	Length range (mm)	Mean length±s.e. (g)	Weight range (g)	Mean weight±s.e. (g)	Age range (y)	Mean age±s.e. (y)
	Waikato River tributaries	Lower main stem (mid catchment meander)	30	1	≤ 250	5	42–49	46.8±1.3	187–248	220.6±10.9	12–16	14.2±0.8
					251–499	38	48–67	57.3±0.8	267–491	375.1±12.2	9–22	15.1±0.6
					≥ 500	1	64		535		13	
		Lower main stem (lowland trib)	32	1	≥ 500	2	58–71	64.5±6.5	552–969	760.5±208.5	9–15	12.0±3.0
		Upper main stem (highland trib)	33	1	≤ 250	6	45–50	46.8±0.8	200–250	216.7±10.5	12–20	17.8±1.2
					≥ 500	10	63–71	67.1±0.9	550–850	750±30.2	17–31	23.1±1.4
	Waikato lowland lakes	Lake Waikare	34	2	≤ 250	6	50–52	50.8±0.3	225–237	232.3±1.8	10–17	13.7±0.9
					251–499	9	50–61	53.8±1.4	256–479	312.7±31.0	8–18	12.8±0.9
					≥ 500	4	60–78	66.8±3.9	504–1120	660.8±153.1	12–22	17.3±2.1
		Lake Whangape	35	1	≤ 250	2	51–55	53.0±2.0	241–247	244.0±3.0	12–14	13.0±1.0
					251–499	3	54–64	60.7±3.3	253–493	403.3±75.6	12–26	21.0±4.5
					≥ 500	2	68–69	68.5±0.5	506–816	661.0±155.0	12	12.0±0.0
	Waikato ponds and dams	Pond	36	1	≤ 250	1	49		240		4	
					251–499	3	50–52	51.3±0.7	256–323	282.3±20.6	4–6	5.0±0.6
					≥ 500	2	65–83	74.0±9.0	536–1160	848.0±312.0	6–8	7.0±1.0
	Waikato hydro lakes	Lake Arapuni and Waipapa (comb.)	37	1	251–499	2	51–53	52.0±1.0	274–284	279.0±5.0	6–7	6.5±0.5
					≥ 500	1	68		562		5	

Table 4 – continued

Region	Location	Stratum definition	Group 1998	No. of Landings	Size (g)	No. Aged	Length range (mm)	Mean length \pm s.e. (g)	Weight range (g)	Mean weight \pm s.e. (g)	Age range (y)	Mean age \pm s.e. (y)
East Cape– Hawke's Bay	Lowland lakes	Lake Rapongaere	38	1	≤ 250	5	44–49	47.4 \pm 0.9	202–234	219.2 \pm 6.1	4–6	4.6 \pm 0.4
					251–499 ≥ 500	13 19	46–63 60–82	55.3 \pm 1.2 70.5 \pm 1.4	252–491 500–907	346.0 \pm 19.4 705.3 \pm 33.4	5–9 5–16	6.5 \pm 0.4 10.9 \pm 0.7
Taranaki	Wanganui River tributaries	Lower main stem (lowland meander)	40	1	≤ 250	1	50		225		13	
Manawatu	Manawatu ponds and dams	Farm dams (Marton)	43	1	251–499 ≥ 500	5 3	46–57 56–95	50.6 \pm 2.4 69.3 \pm 12.8	251–474 506–1850	344.8 \pm 50.2 963.8 \pm 443.4	23–33 32–54	27.4 \pm 2.1 43.0 \pm 6.4
Marlborough	Wairau River	Lower main stem (mid catchment meander)	44	1	≤ 250	21	41–51	48.9 \pm 0.5	115–248	213.8 \pm 6.5	9–20	15.8 \pm 0.5
					251–499 ≥ 500	1 9	50 70–86		259 636–1268	915.8 \pm 70.7	15 17–35	24.0 \pm 2.1

Table 5: Mean age of longfinned eels in weight ranges ≤ 250 g, 251–499 g, and ≥ 500 g, from 1997–98 sampling. s.e., standard error; –, insufficient data; group definitions in Table 1

Region	Location	Stratum definition	Group 1998	No. of Landings	Size (g)	Sample No.	Length range (mm)	Mean length \pm s.e. (g)	Weight range (g)	Mean weight \pm s.e. (g)	Age range (y)	Mean age \pm s.e. (y)	
Northland	Wairoa River Tributaries	Lower main stem (mid catchment meander)	5	3	≤ 250	1	46	–	219	–	11	–	
					251–499	6	48–52	50.2 \pm 0.6	268–364	307.8 \pm 14.3	10–17	12.5 \pm 1.1	
					≤ 250	12	43–49	46.3 \pm 0.5	193–247	229.4 \pm 5.1	10–17	13.0 \pm 0.5	
			Upper main stem (predominantly pasture)	6	2	251–499 ≥ 500	3	48–49	48.7 \pm 0.3	256–286	267.0 \pm 9.4	8–12	10.0 \pm 1.2
					≥ 500	2	62–68	67.0 \pm 1.0	546–768	657.0 \pm 111.0	12–17	14.5 \pm 2.5	
			Lower main stem (lowland trib)	8	1	≤ 250	3	46–48	46.7 \pm 0.7	226–246	237.3 \pm 5.9	10–13	11.0 \pm 1.0
Rivers Other	Lower main stem (mid catchment meander)			251–499 ≥ 500	8	48–60	54.6 \pm 1.7	269–497	402.1 \pm 35.8	10–21	14.1 \pm 1.3		
				≥ 500	4	58–61	58.8 \pm 0.8	508–556	520.5 \pm 11.8	14–17	15.3 \pm 0.8		
				≤ 250	1	47	–	249	–	15	–		
				251–499 ≥ 500	2	48	48.0 \pm 0.0	281–284	282.5 \pm 1.5	12–14	13.0 \pm 1.0		
				≥ 500	1	59	–	516	–	14	–		

Table 5 – continued

Region	Location	Stratum definition	Group 1998	No of Landings	Size (g)	Sample No.	Length range (mm)	Mean length±s.e. (g)	Weight range (g)	Mean weight±s.e. (g)	Age range (y)	Mean age±s.e. (y)
		Upper main stem (predominantly pasture)	14	1	≤ 250	3	45–48	46.3±0.9	220–237	226.0±5.5	15–19	17.3±1.2
					251–499	13	47–53	49.8±0.5	267–394	307.3±10.3	12–20	16.0±0.5
					≥ 500	8	58–66	63.8±1.0	530–819	673.4±34.8	18–23	20.1±0.7
		Upper main stem (highland)	15	3	≤ 250	6	44–45	44.7±0.2	232–247	238.7±2.7	19–20	19.3±0.2
					251–499	6	46–57	53.0±1.6	284–483	444.3±32.1	18–24	20.5±1.0
					≥ 500	12	57–61	59.4±0.4	500–715	560.2±20.6	15–27	21.6±1.1
Northland Lowland Lakes		Lake Awanui	16	1	≤ 250	3	44–52	46.7±2.7	192–247	213.3±17.0	9–21	13.0±4.0
		Lake Tomarata	17	1	251–499	2	48–52	50.0±2.0	256–413	334.5±78.5	18–23	20.5±2.5
					≥ 500	1	75		1078		39	
		Farm dam (Mangawari)	18	1	≤ 250	1	44	–	214	–	12	–
Auckland	Rivers Other	Upper main stem (highland)	21	2	≤ 250	2	46	46.0±0.0	246–248	247.0±1.0	16–19	17.5±1.5
					251–499	4	55–58	56.5±0.6	448–479	459.0±6.8	10–20	15.0±20.1
					≥ 500	4	57–59	58.5±0.5	508–556	532.3±11.0	10–17	14.3±1.5

Table 5 – continued

Region	Location	Stratum definition	Group 1998	No of Landings	Size (g)	Sample No.	Length range (mm)	Mean length±s.e. (g)	Weight range (g)	Mean weight±s.e. (g)	Age range (y)	Mean age±s.e. (y)
Manawatu	Manawatu ponds and dams	Farm dams (Marton)	43	1	251–499	3	47–60	54.7±3.9	262–490	410.7±74.4	16–34	22.0±6.0
					≥ 500	1	59	--	513	--	21	--
Marlborough	Wairau River	Lower main stem (mid catchment meander)	44	1	≤ 250	20	36–47	43.5±0.7	78–225	169.7±8.7	9–18	15.0±0.5
					251–499	4	44–53	48.8±1.8	257–362	297.8±23.7	12–19	15.8±1.4
					≥ 500	12	61–80	69.9±1.8	522–1285	863.0±67.7	11–25	19.5±1.1

Table 6: Length weight, and age of sexed shortfinned (SFE) and longfinned (LFE) eels. M, male; F, female, s.e., standard error; –, insufficient data; *, outside the previous size range of migrating eels, and hence identification of sex is uncertain

Region	Location	Stratum definition	Group 1998	Species	Sex	N	Length range (cm)	Mean length (cm) \pm s.e.	Weight range (g)	Mean weight (g) \pm s.e.	Age Range (y)	Mean age (y) \pm s.e.
Northland	Kaipara Harbour	Sea	1	SFE	F	1	83	–	1190	–	13	–
Hauraki–Coromandel	Firth of Thames and Hauraki Plains rivers	Firth-sea	23	SFE	F	2	61–63	62.0 \pm 1.0	496–565	530.5 \pm 34.5	5–9	7.0 \pm 2.0
		Lower main stem (lowland meander)	25	SFE	M	1	66*	–	522	–	16	–
Waikato Region	Raglan Harbour	Sea	28	SFE	M	2	62–65*	63.5 \pm 1.5	490–491	490.5 \pm 0.5	16–23	19.5 \pm 3.5
			28	SFE	F	1	66	–	498	–	12	–
	Waikato River tributaries	Lower main stem (mid catchment meander)	30	LFE	M	1	59	–	529	–	23	–
		Lower main stem (lowland trib)	32	SFE	M	1	71*	–	969	–	15	–
	Waikato lowland lakes	Lake Waikare	34	SFE	F	1	61*	–	473	–	11	–

Table 6 – continued

Region	Location	Stratum definition	Group 1998	Species	Sex	N	Length range (cm)	Mean length (cm) \pm s.e.	Weight range (g)	Mean weight (g) \pm s.e.	Age range (y)	Mean age (y) \pm s.e.
Waikato Region	Waikato lowland lakes	Lake Whangape	35	LFE	M	5	58–60	59.2 \pm 0.5	471–557	515.8 \pm 15.3	10–17	14.0 \pm 1.4
			35	SFE	F	2	64–69	66.5 \pm 2.5	493–506	499.5 \pm 6.5	12–26	19.0 \pm 7.0
		Pond	36	SFE	M	6	49–83*	58.5 \pm 5.5	240–1160	463.8 \pm 146.2	4–8	5.5 \pm 0.6
Waikato Region	Waikato ponds and dams											
Waikato Region	Waikato hydro lakes	Lake Arapuni and Waipapa (combined)	37	LFE	M	2	59–65	62.0 \pm 3.0	537–755	646.0 \pm 109.0	7–11	9.0 \pm 2.0
			37	LFE	F	2	62–63	62.5 \pm 0.5	590–675	632.5 \pm 42.5	9–11	10.0 \pm 1.0
East Cape–Hawke’s Bay	Lowland lakes	Lake Rapongare	38	SFE	F	10	66–78	71.8 \pm 1.4	532–907	728.6 \pm 40.5	9–16	11.9 \pm 0.8
Marlborough	Wairau River	Lower main stem (mid catchment meander)	44	LFE	M	1	49	–	257	–	16	–
			44	LFE	F	1	80	–	1074	–	19	–
			44	SFE	F	6	71–86	79.0 \pm 2.5	766–1268	972.2 \pm 91.3	17–29	23.8 \pm 2.1

Table 7: Catch per unit effort from North Island landings sampled in 1997–98

Region	Location	Group 1998	No. of samples	%LF by weight	Total landing weight (kg)	Mean weight/net/night (kg)
Northland	Kaipara Harbour	1	2	0.0	458.0	1.9
		2	1	0.0	117.0	14.6
	Maungaturoto estuary	3	1	0.0	131.0	5.9
		4	1	2.0	690.0	10.0
	Wairoa River tributaries	5	4	4.0	1 066.0	2.0
		6	4	4.2	575.0	1.3
		7	1	8.0	103.0	6.4
		8	1	75.0	341.0	4.5
		9	2	10.0	355.0	6.8
Hotea River	10	1	52.9	267.0	3.5	
	11	1	3.2	421.0	5.2	
Rivers, other	12	2	40.0	308.0	2.5	
	13	1	70.0	371.0	5.3	
	14	2	47.5	353.0	—	
	15	3	77.1	590.3	1.8	
	16	1	4.0	110.0	5.5	
Northland lowland lakes	17	1	10.8	411.5	2.7	
	18	1	1.0	210.0	8.7	

Table 7 – continued

Region	Location	Group 1998	No. of samples	%LF by weight	Total landed weight (kg)	Mean weight/net/night (kg)
Auckland	Manukau Harbour	19	1	0.0	162.0	2.7
	Waitemata Harbour	20	2	0.6	305.0	1.9
	Rivers, other	21	2	50.7	472.0	2.2
	Auckland ponds and dams	22	1	5.5	331.0	5.5
	Firth of Thames and Hauraki Plains rivers	23	1	0	183.0	0.6
Hauraki–Coromandel		24	1	0	436.0	10.9
		25	2	27.0	207.0	–
		26	1	44.0	161.0	4.0
		27	1	8.7	95.0	2.7
		28	1	0.0	9.9	1.0
		29	1	9.4	313.0	1.7
		30	2	75.8	1 317.0	–
Waikato	Waikato River tributaries	31	1	39.0	280.0	9.3
		32	2	47.8	530.0	1.9
		33	2	28.4	475.0	1.7
	Waikato lowland lakes	34	2	4.9	380.0	–
		35	1	68.3	22.4	2.2
	Waikato ponds and dams	36	1	0.0	73.0	36.5
	Waikato hydro lakes	37	1	74.6	165.0	0.4

Table 7 – continued

Region	Location	Group 1998	No. of samples	%LF by weight	Total landing weight (kg)	Mean weight/net/night (kg)
East Cape–Hawke’s Lowland lakes Bay		38	1	0.2	15 042.5	7.7
		39	1	39.7	268.0	0.9
Bay of Plenty	Tauranga Harbour	40	1	41.2	197.0	1.3
		41	1	65.2	416.0	4.5
Taranaki	Wanganui River tributaries	42	1	100.0	290.0	–
		43	1	41.4	891.0	3.7
Manawatu	Manawatu ponds and dams	44	1	75.1	264.0	–
Marlborough	Wairau River					

Table 8: Mean weight (kg) of shortfinned (SFE) and longfinned (LFE) eels in North Island landings sampled in 1995–98 grouped by stratum type (see Appendix 1)

Stratum code	Definition	No. of landings	Mean weight landed (kg)			%LFE
			SFE	LFE	Mean total	
Minor tributary						
1	upper main stem (highland trib)	18	1 5314	3 095	18 409	17
2	lower main stem (lowland trib)	7	734	768	1 502	51
River						
3	upper main stem (at least partially forested)	1	99	4	103	4
4	upper main stem (predominantly pasture)	10	1 129	722	1 851	39
5	lower main stem (mid catchment meander)	18	3 598	2 670	6 268	43
6	lower main stem (lowland meander)	19	2 866	1 828	4 694	39
7	estuarine	8	2 431	25	2 456	1
8	sea other than harbour	4	4 321	68	4 389	2
81	harbour	7	1 088	115	1 203	10
Lake						
9	lake	18	6 259	935	7 194	13
Pond dam						
10	pond dam	6	1 026	479	1 505	32
	Total					
		116				

Table 9: Number of landings, total and mean landed weights, and percent longfin from North Island sampling, 1995–98

Region	No. of landings	Total landed weight (kg)		Mean landed weight (kg)		%LFE
		SFE	LFE	SFE	LFE	
Northland	31	5 166	1 830	167	70	26
Auckland	6	902	368	150	92	29
Coromandel	7	2 142	62	306	62	3
Waikato	47	5 580	4 876	119	152	47
Hauraki	10	1 437	225	144	28	14
Taranaki	2	146	560	146	280	79
Bay of Plenty	4	800	199	200	66	20
East Cape-Hawke's Bay	2	16 214	12	8 107	6	0
Manawatu	3	2 025	1 148	675	383	36
Wairarapa	2	979	1 196	490	599	55
Marlborough (South Island)	2	3 474	233	1 737	117	6
Total	116					29

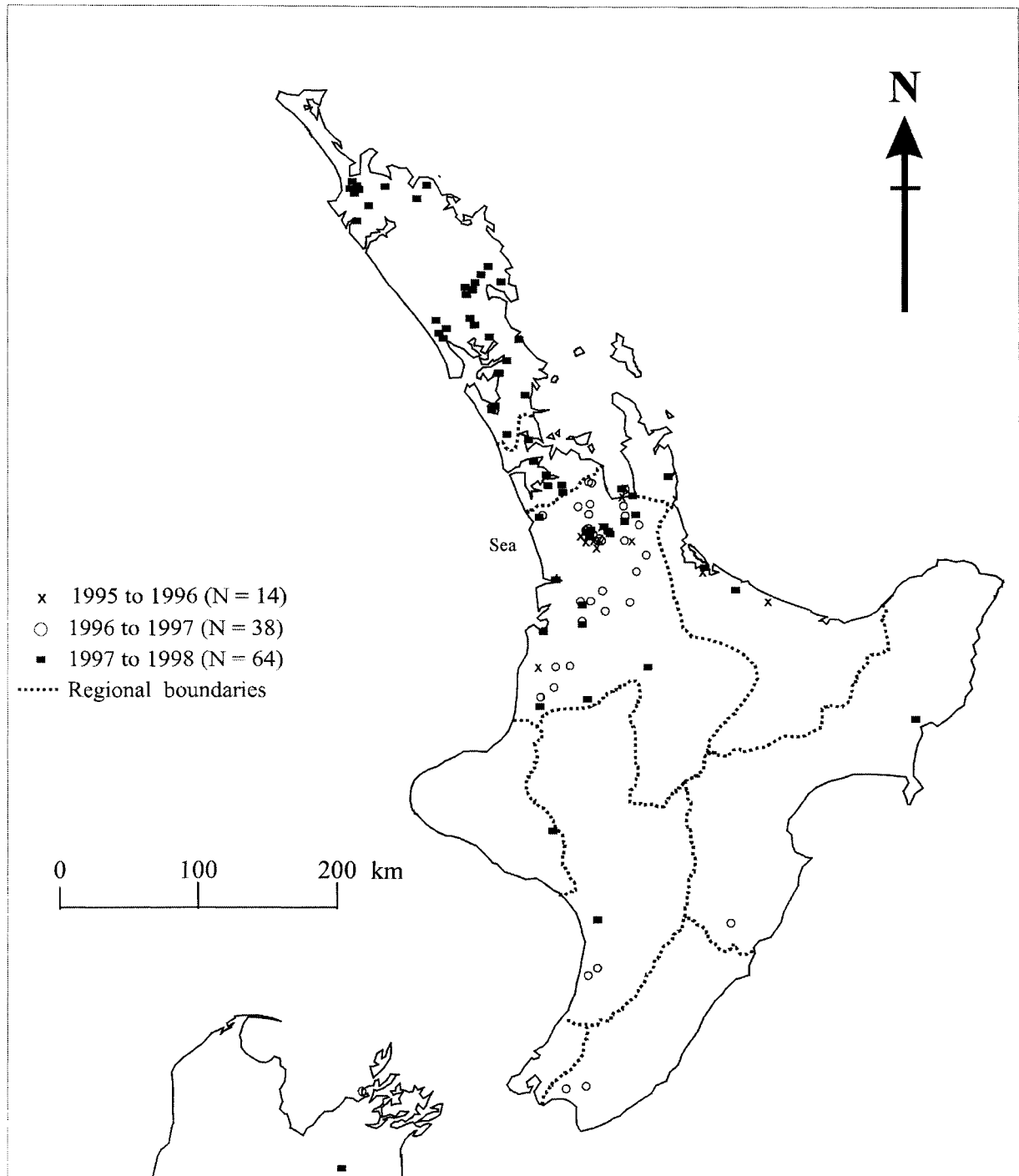


Figure 1: Locations of landings sampled at the North Island eel processors at Levin, Te Kauwhata, Whenuapai, and Kamo Kamo depot, between 1995 and 1998. Regional boundaries are based on catchments.

Northland

Shortfinned eels

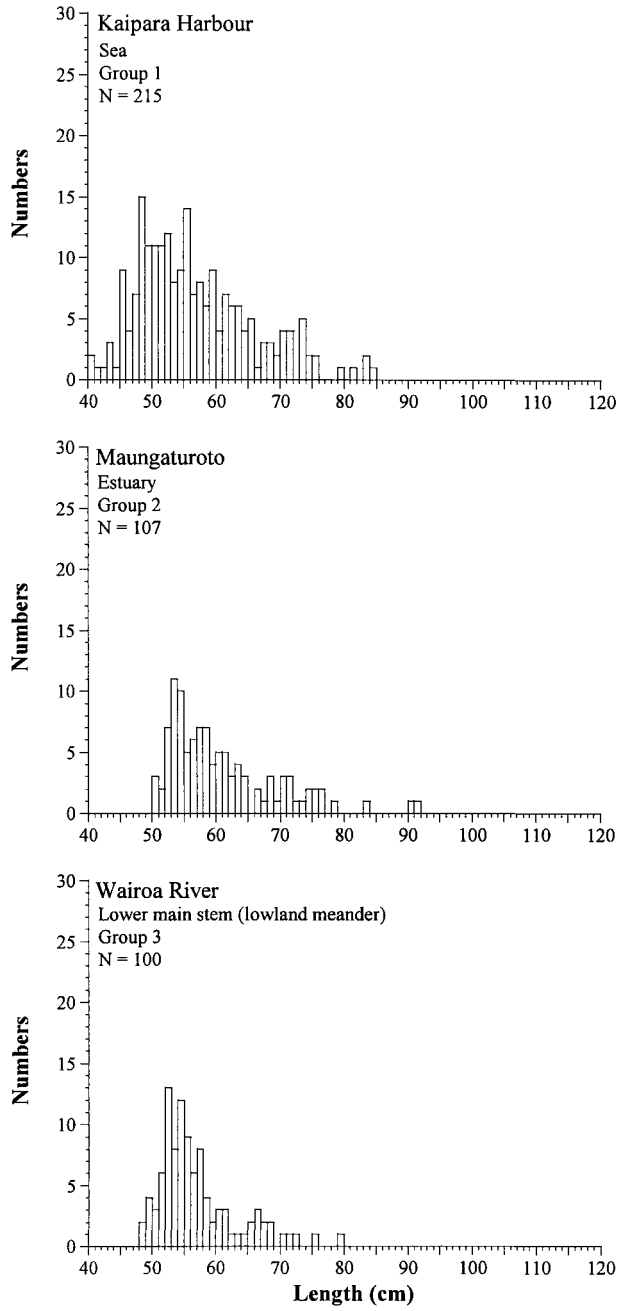


Figure 2: Length distribution of Northland shortfinned eels; sea to lower river.

Northland

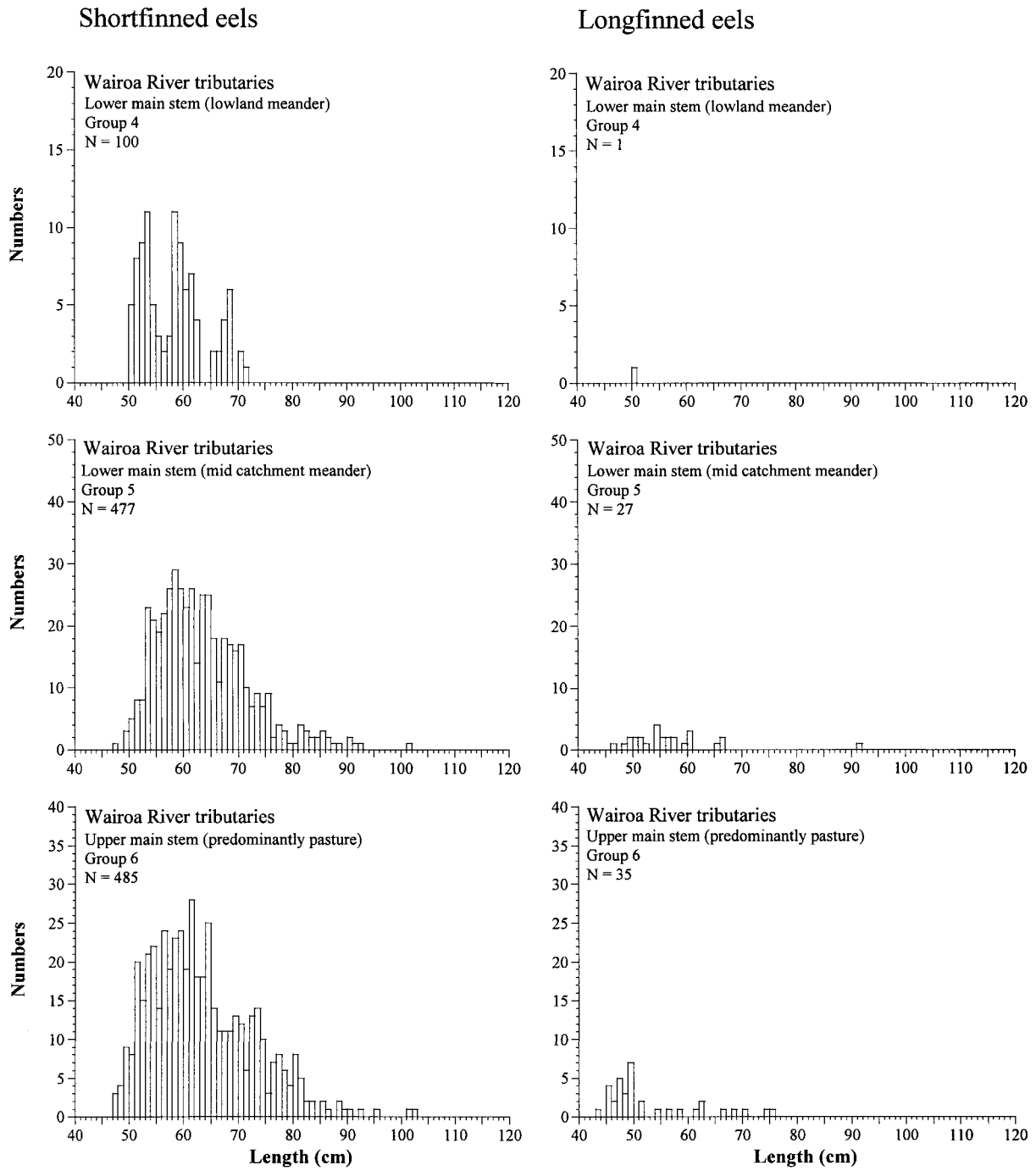
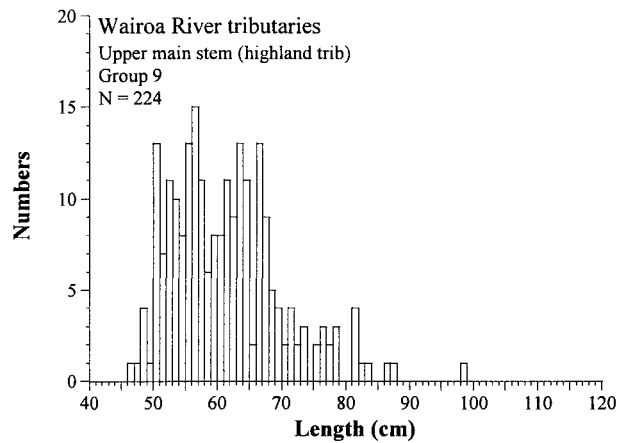
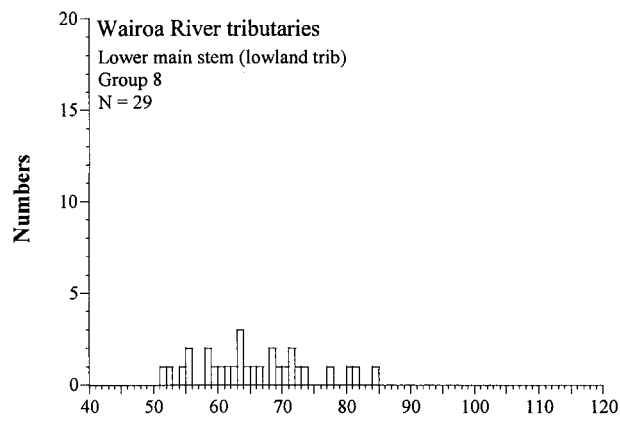
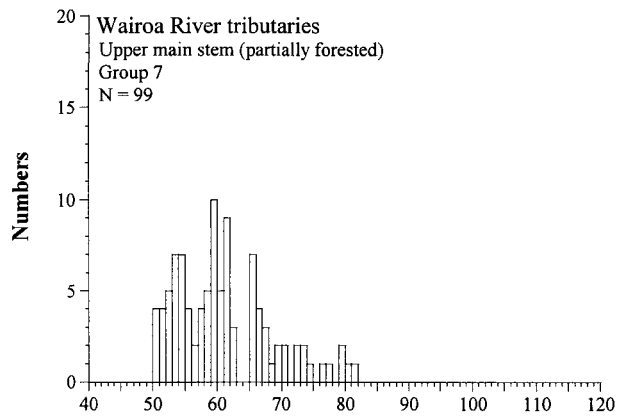


Figure 3: Length distribution of Northland shortfinned and longfinned eels; Wairoa river tributaries, lowland.

Northland

Shortfinned eels



Longfinned eels

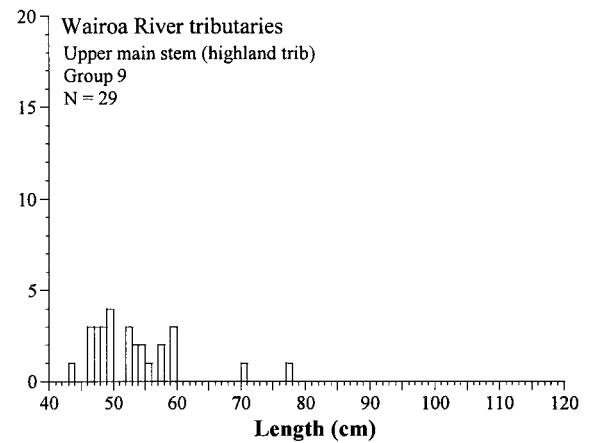
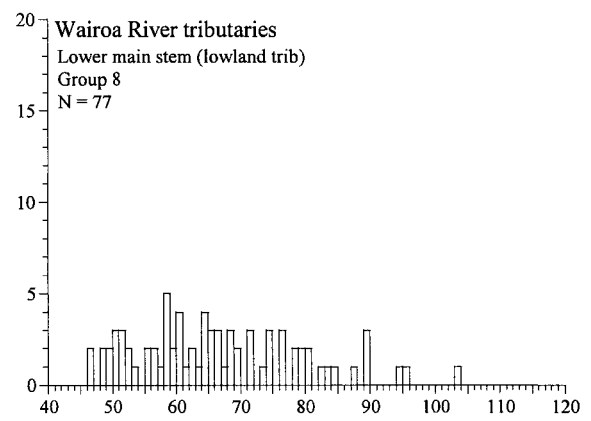
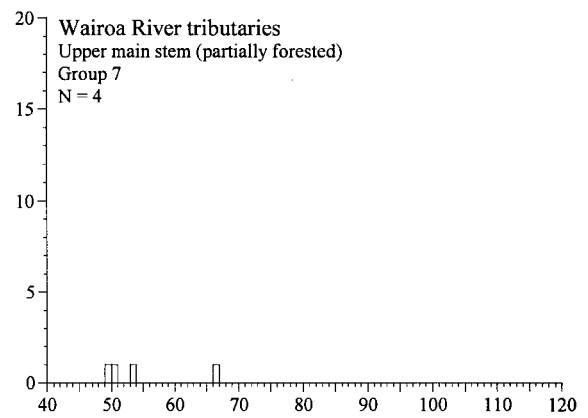


Figure 4: Length distribution of Northland shortfinned and longfinned eels; Wairoa river tributaries, upper reaches.

Northland

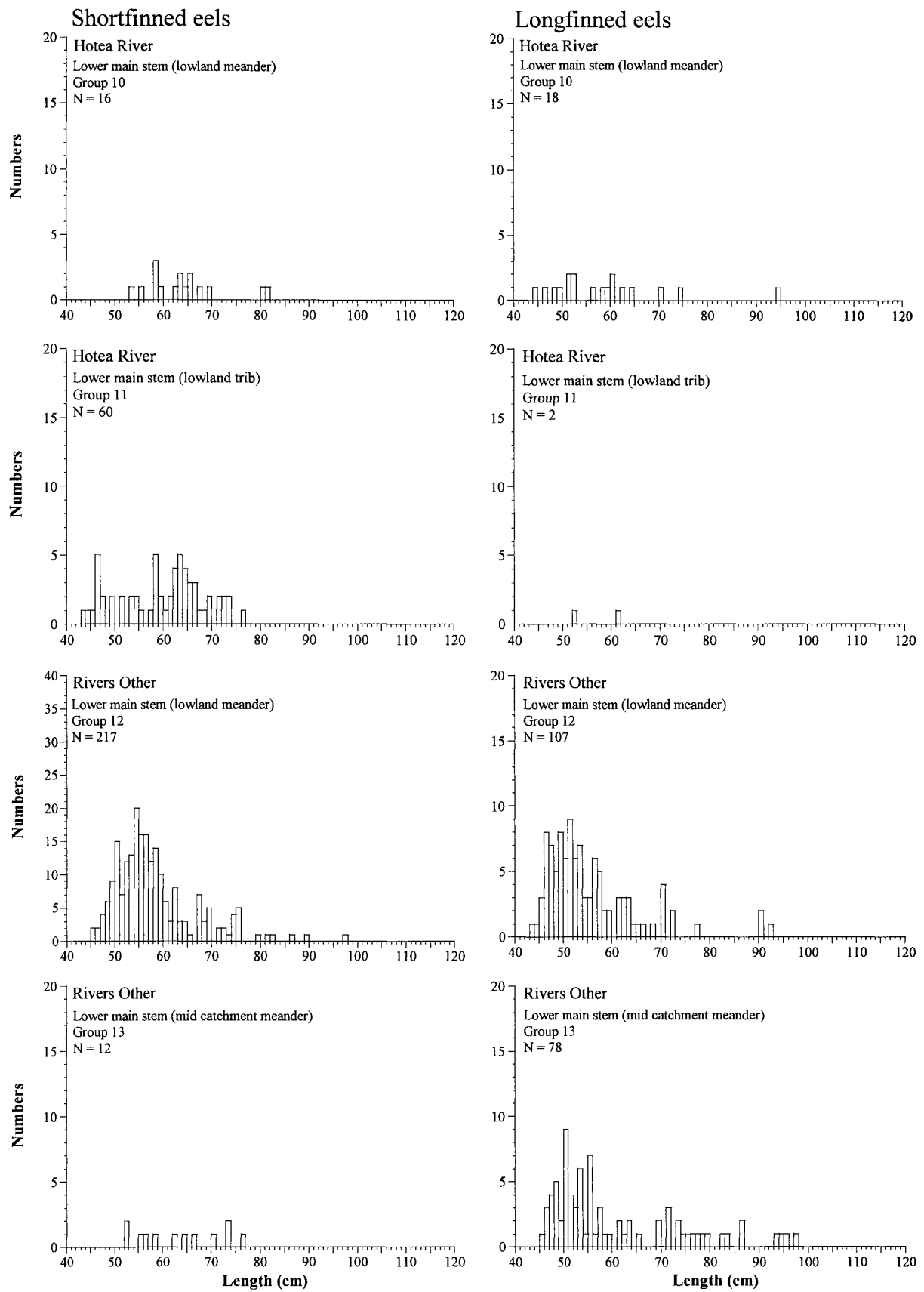


Figure 5: Length distribution of Northland shortfinned and longfinned eels; Hotea and other rivers, lowland to mid catchments.

Northland

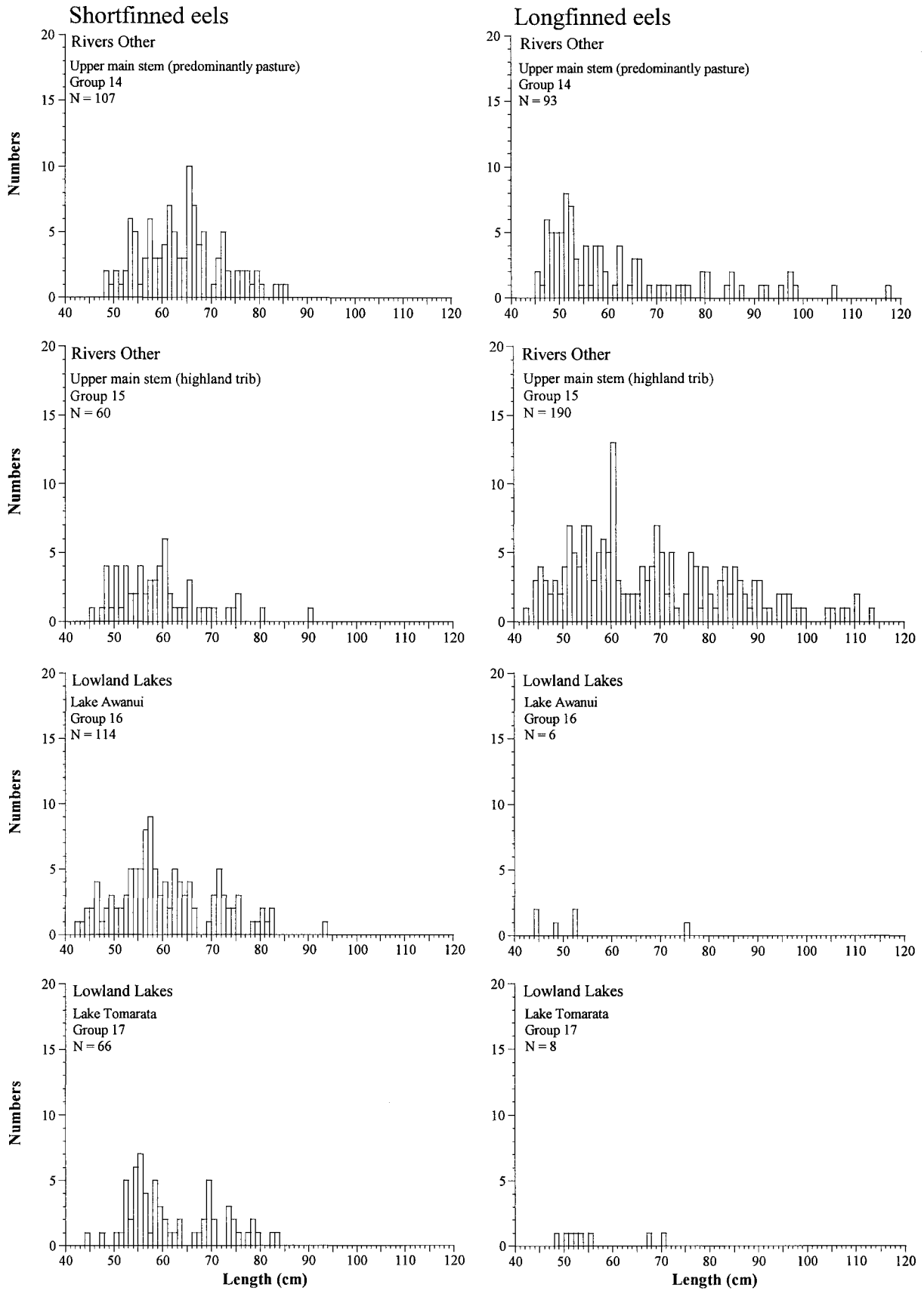


Figure 6: Length distribution of Northland shortfinned and longfinned eels; other rivers, upper catchments and lowland lakes.

Northland

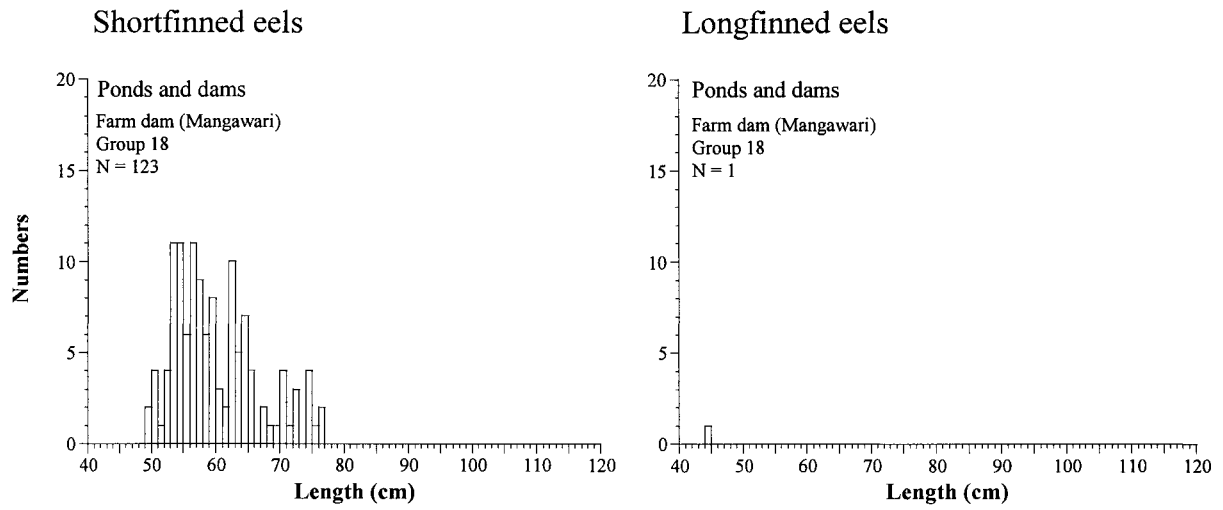


Figure 7: Length distribution of Northland shortfinned and longfinned eels; ponds and dams.

Auckland

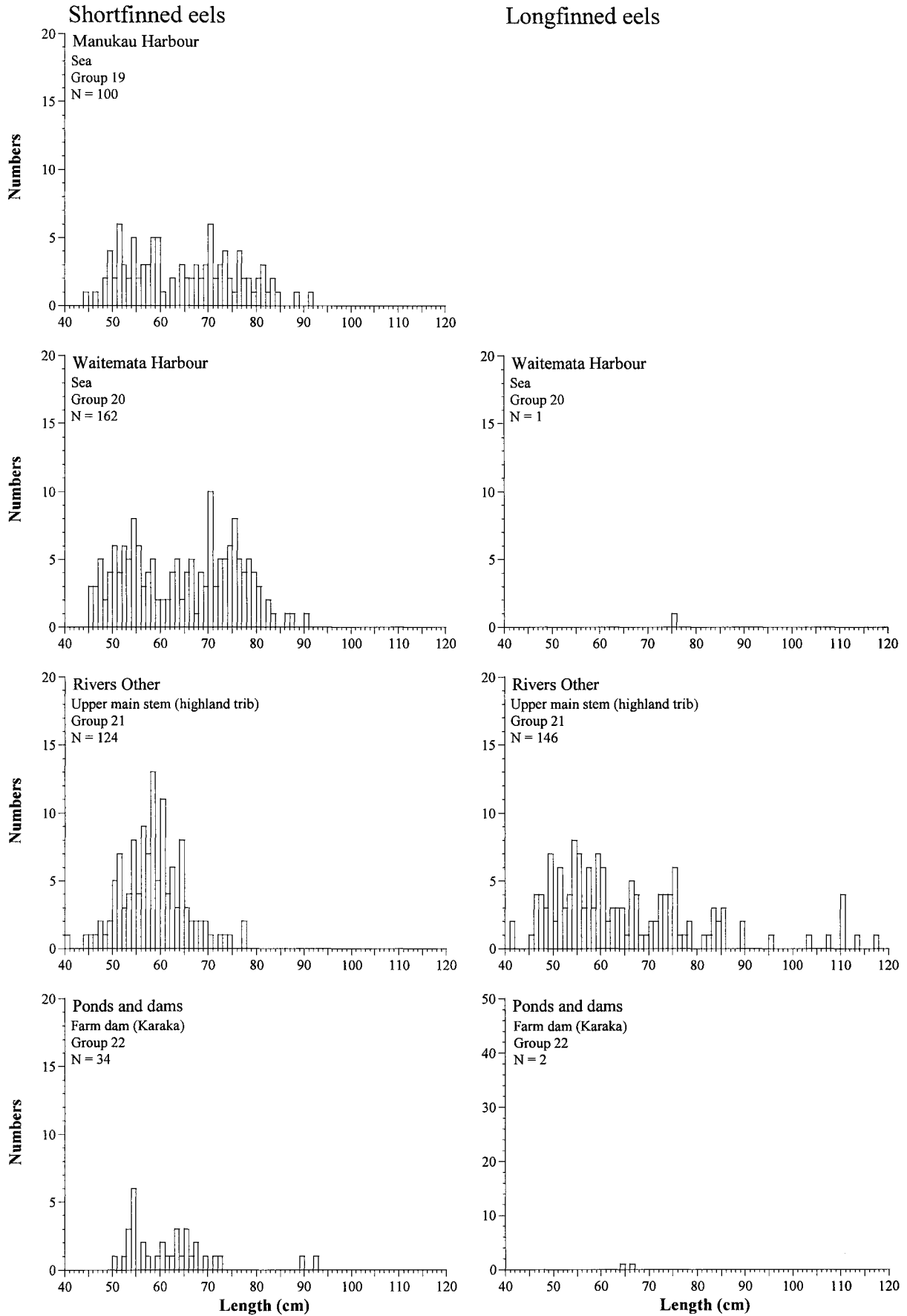


Figure 8: Length distribution of Auckland shortfinned and longfinned eels; sea to upper catchments, ponds and dams.

Hauraki - Coromandel

Shortfinned eels

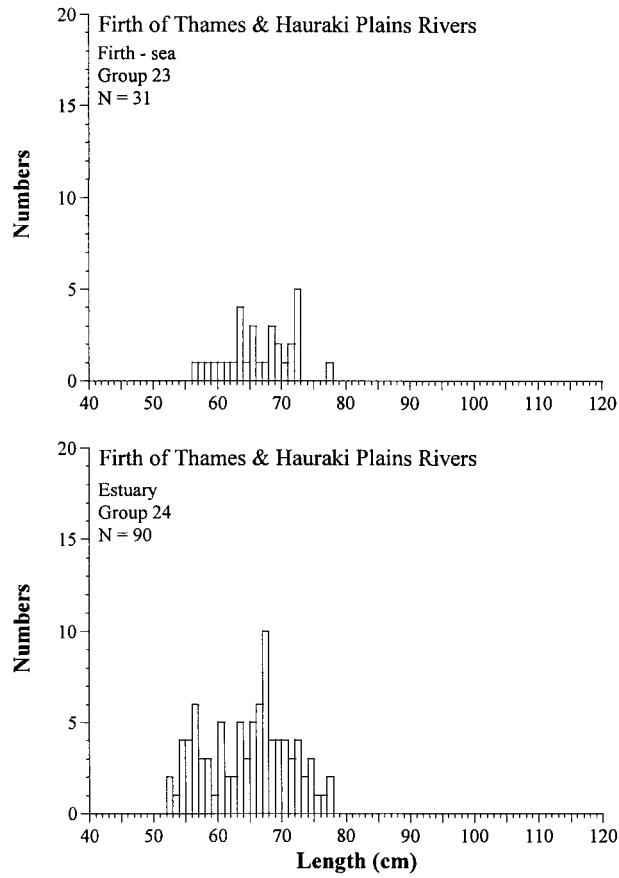


Figure 9: Length distribution of Hauraki-Coromandel shortfinned eels; sea to river estuary.

Hauraki - Coromandel

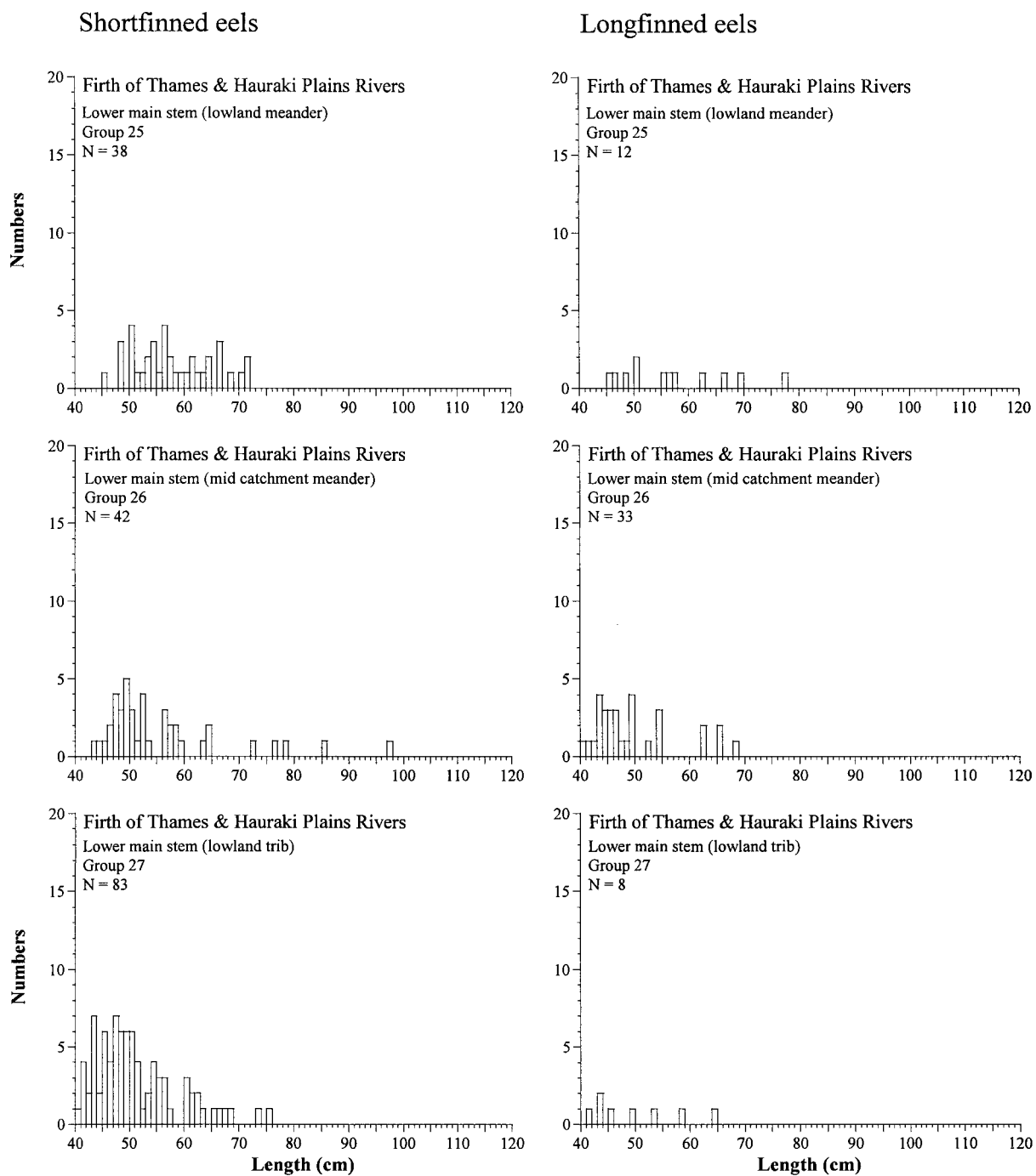


Figure 10: Length distribution of Hauraki-Coromandel shortfinned and longfinned eels; lowland to mid catchment rivers.

Waikato

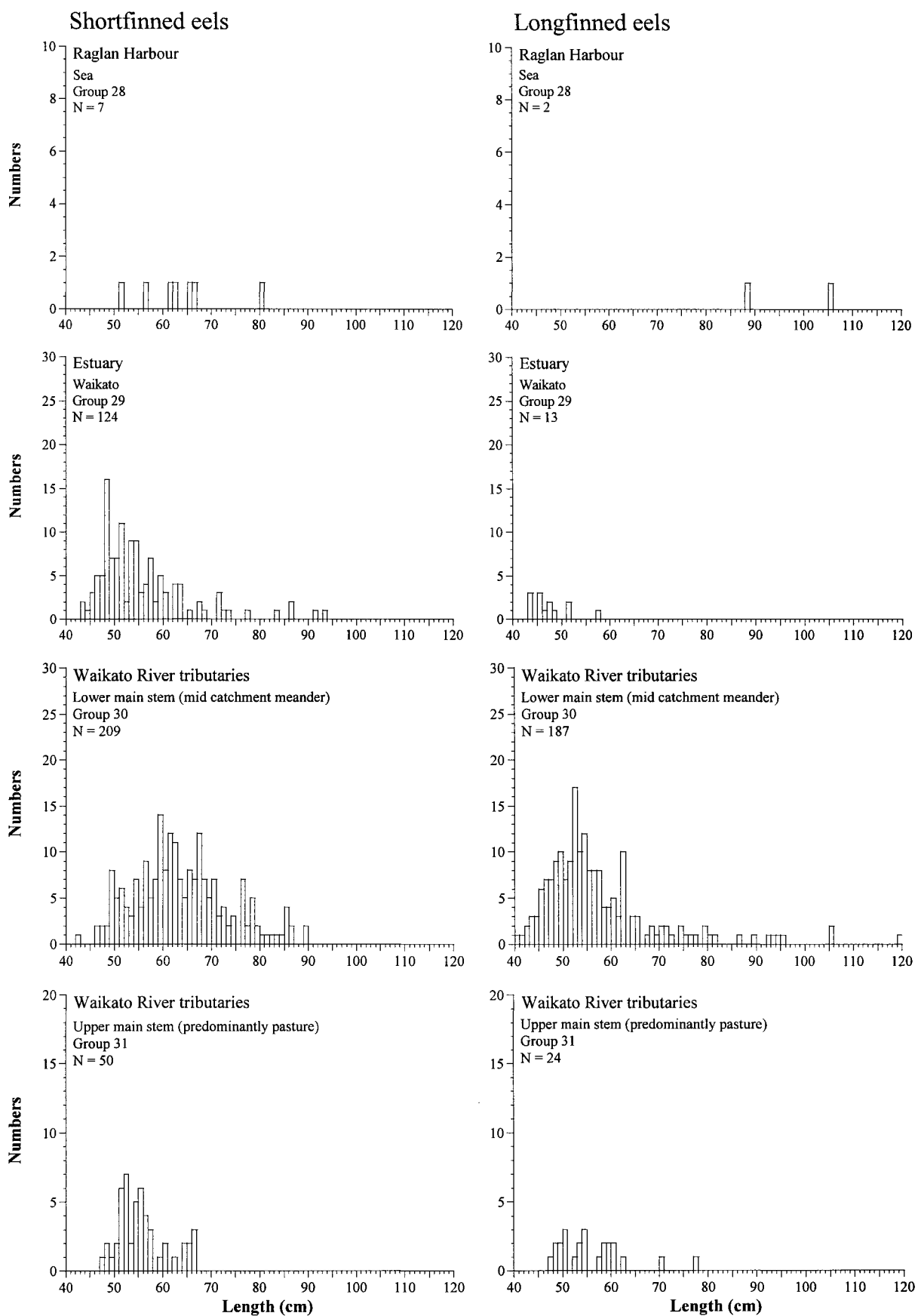
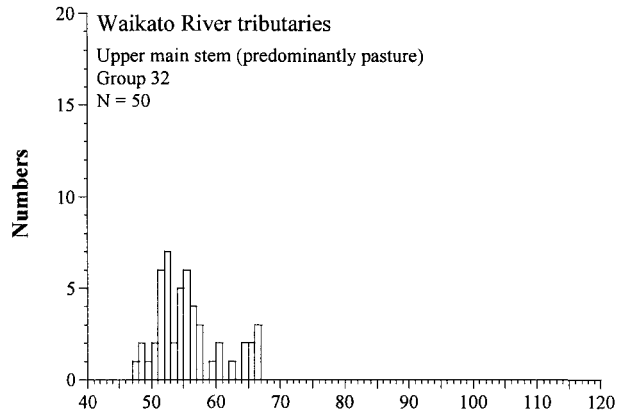


Figure 11: Length distribution of Waikato shortfinned and longfinned eels; sea to mid catchment Waikato river tributaries.

Waikato

Shortfinned eels



Longfinned eels

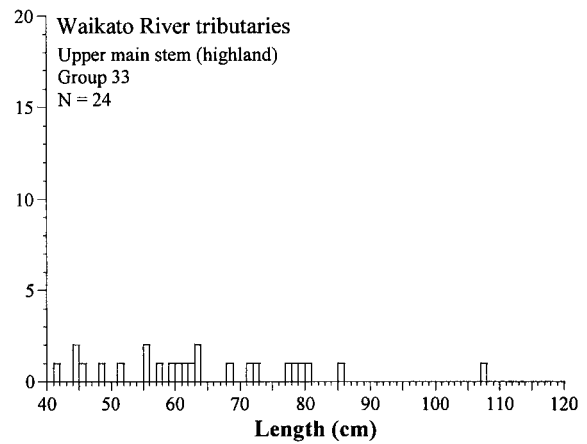
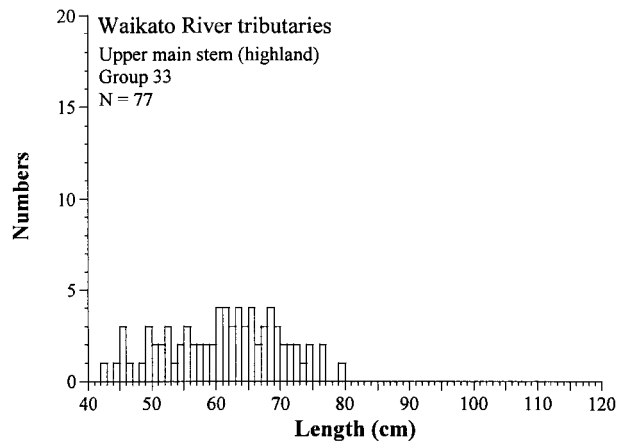
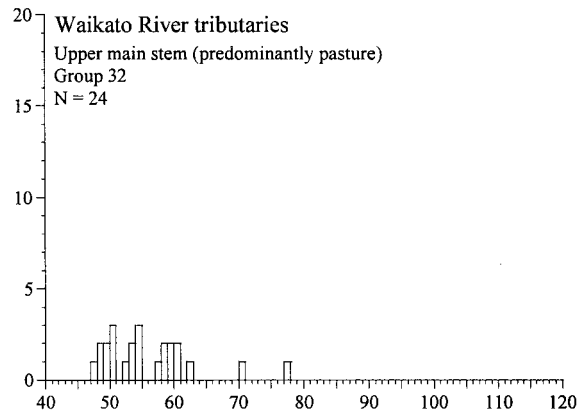


Figure 12: Length distribution of Waikato shortfinned and longfinned eels; upper catchment of Waikato river tributaries.

Waikato

Shortfinned eels

Longfinned eels

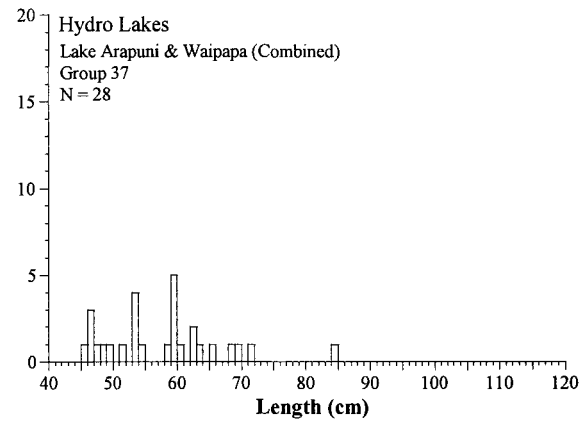
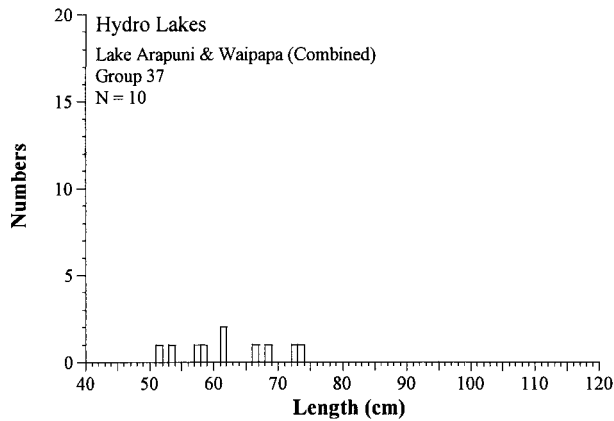
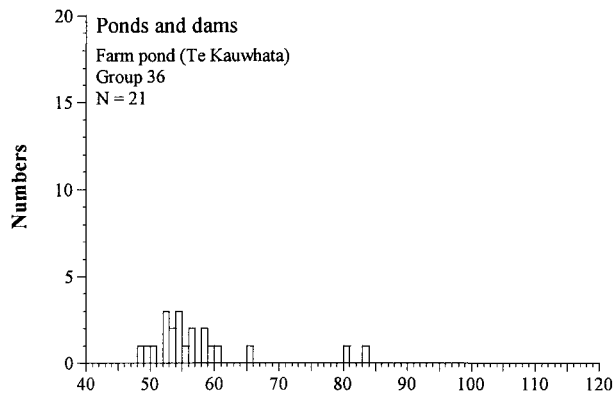
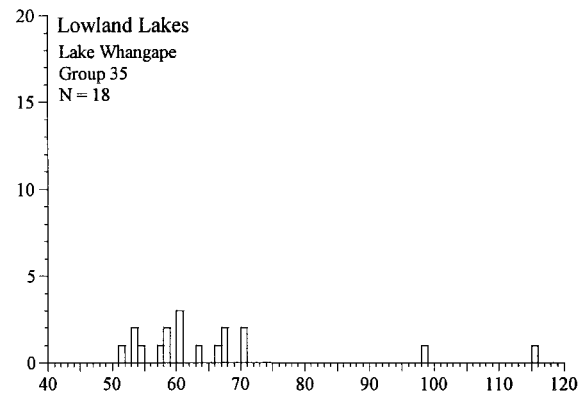
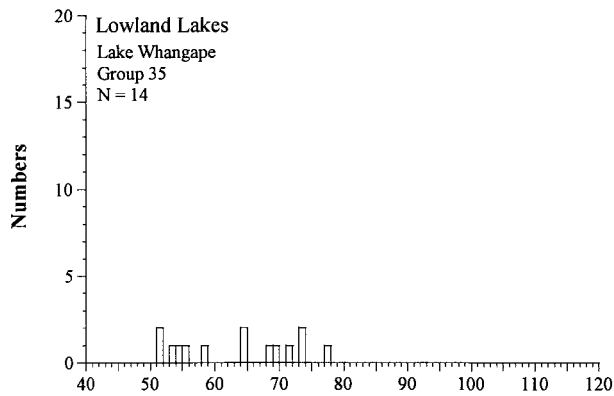
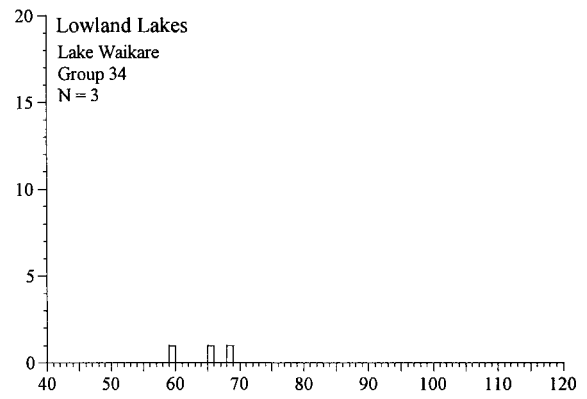
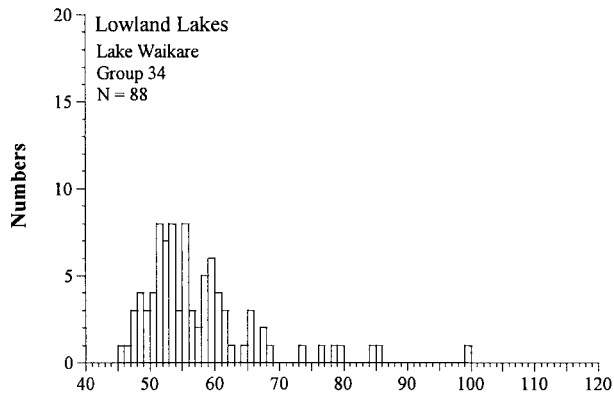
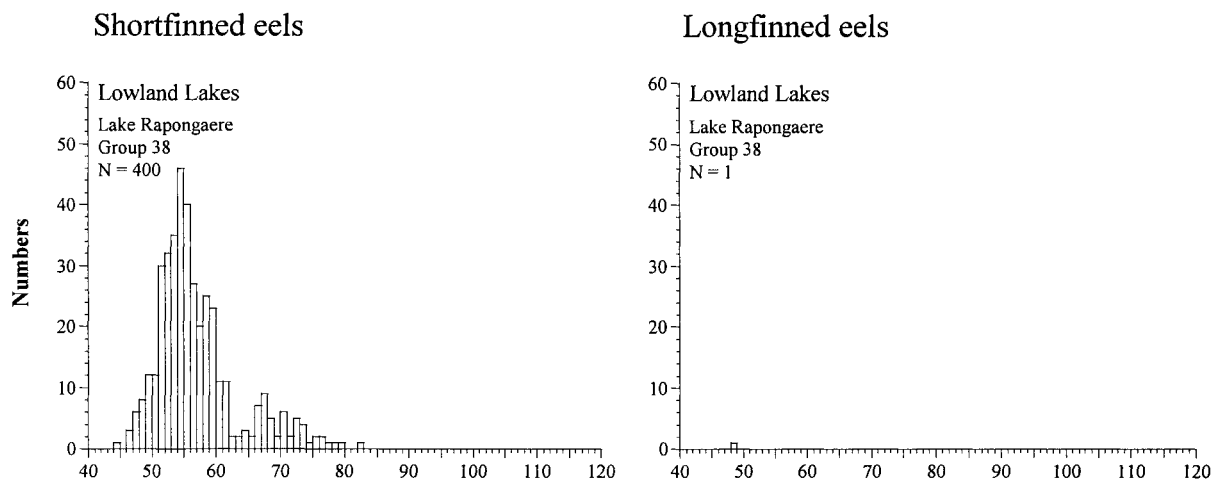


Figure 13: Length distribution of Waikato shortfinned and longfinned eels; lowland lakes, ponds and dams and Waikato river hydro lakes.

East Cape – Hawke’s Bay



Bay of Plenty

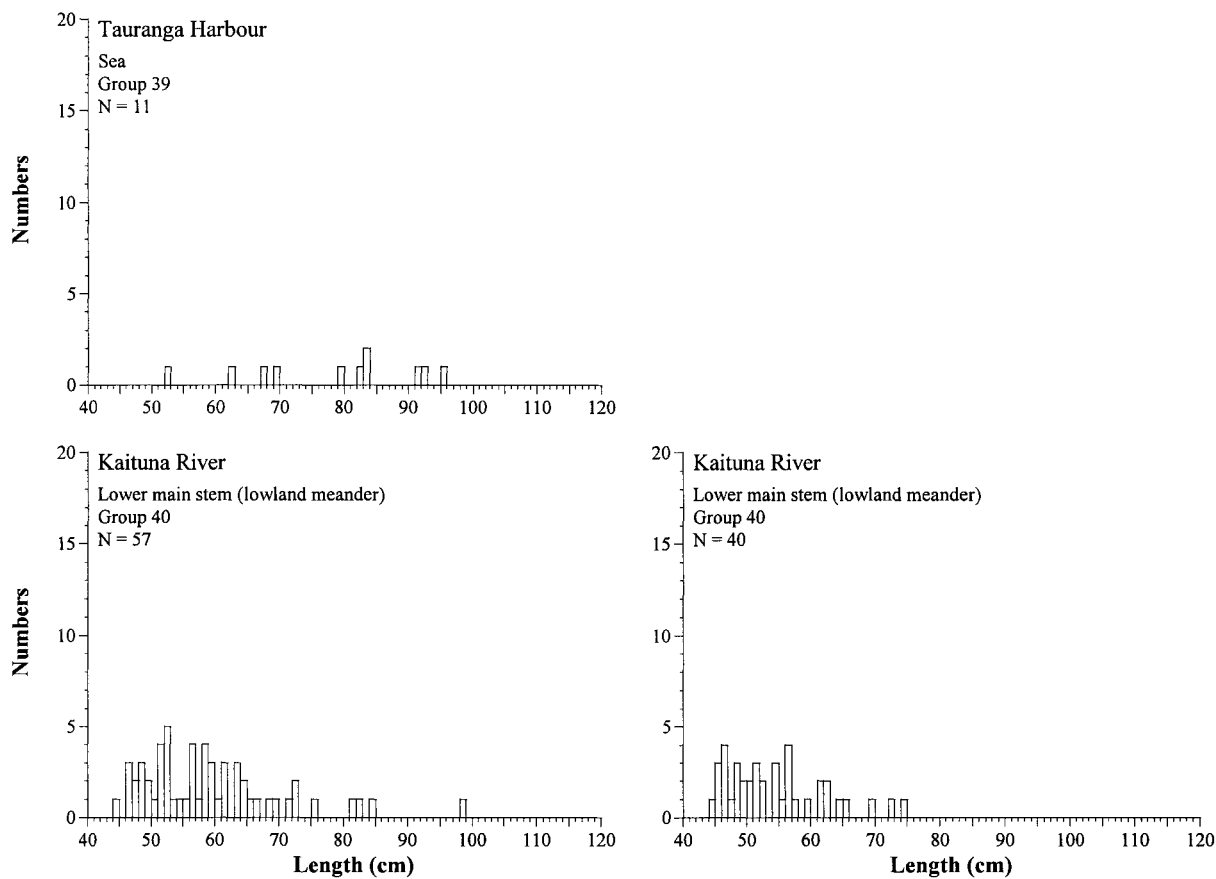
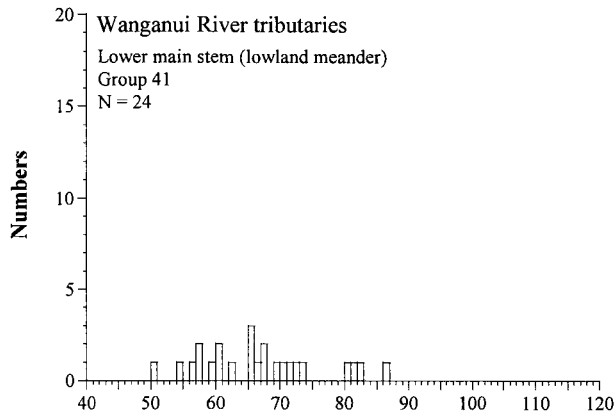


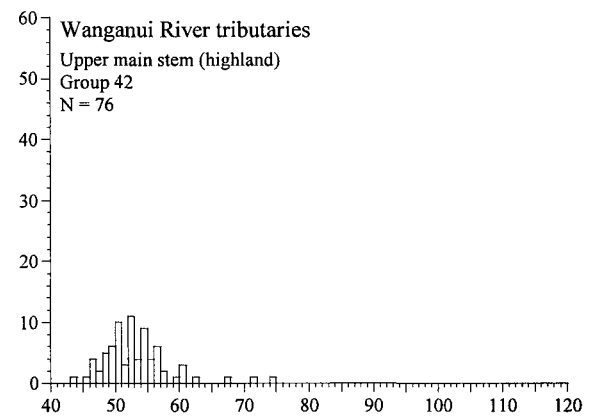
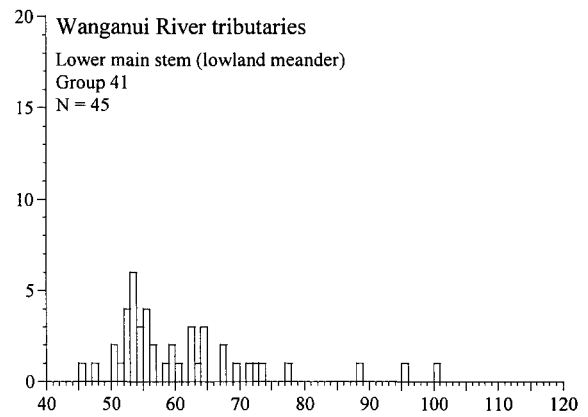
Figure 14: Length distribution of East Cape – Hawke’s Bay and Bay of Plenty shortfinned and longfinned eels; lowland lakes, sea and lower river.

Taranaki

Shortfinned eels



Longfinned eels



Manawatu

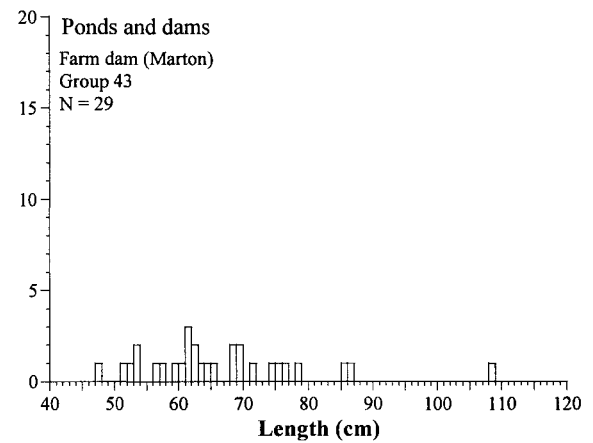
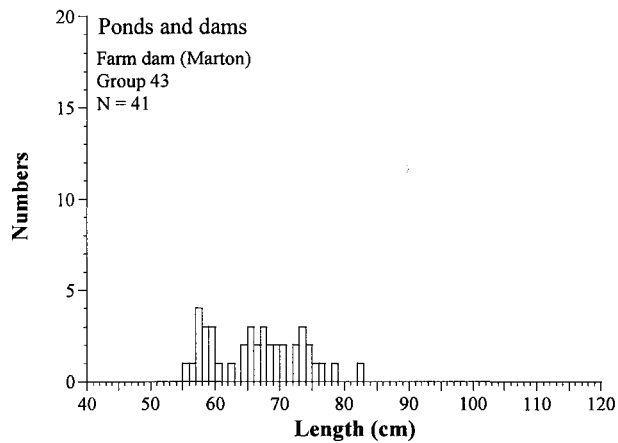
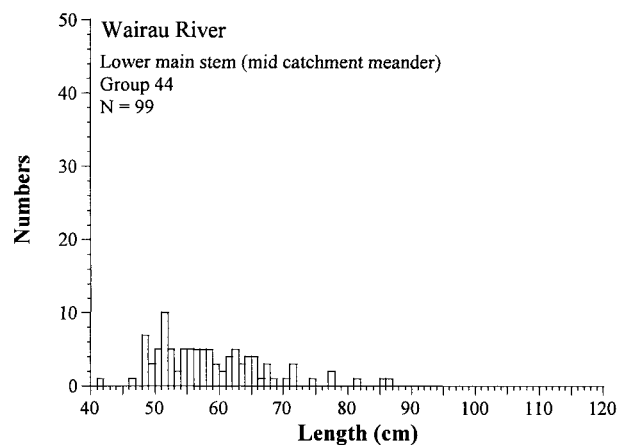


Figure 15: Length distribution of Taranaki and Manawatu shortfinned and longfinned eels; Wanganui river tributaries, lowland and ponds and dams.

Marlborough

Shortfinned eels



Longfinned eels

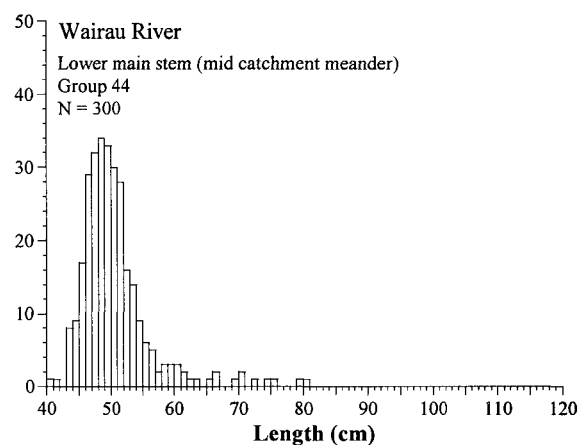


Figure 16: Length distribution of Marlborough shortfinned and longfinned eels; Wairau river lowland.

Shortfinned eels

Longfinned eels

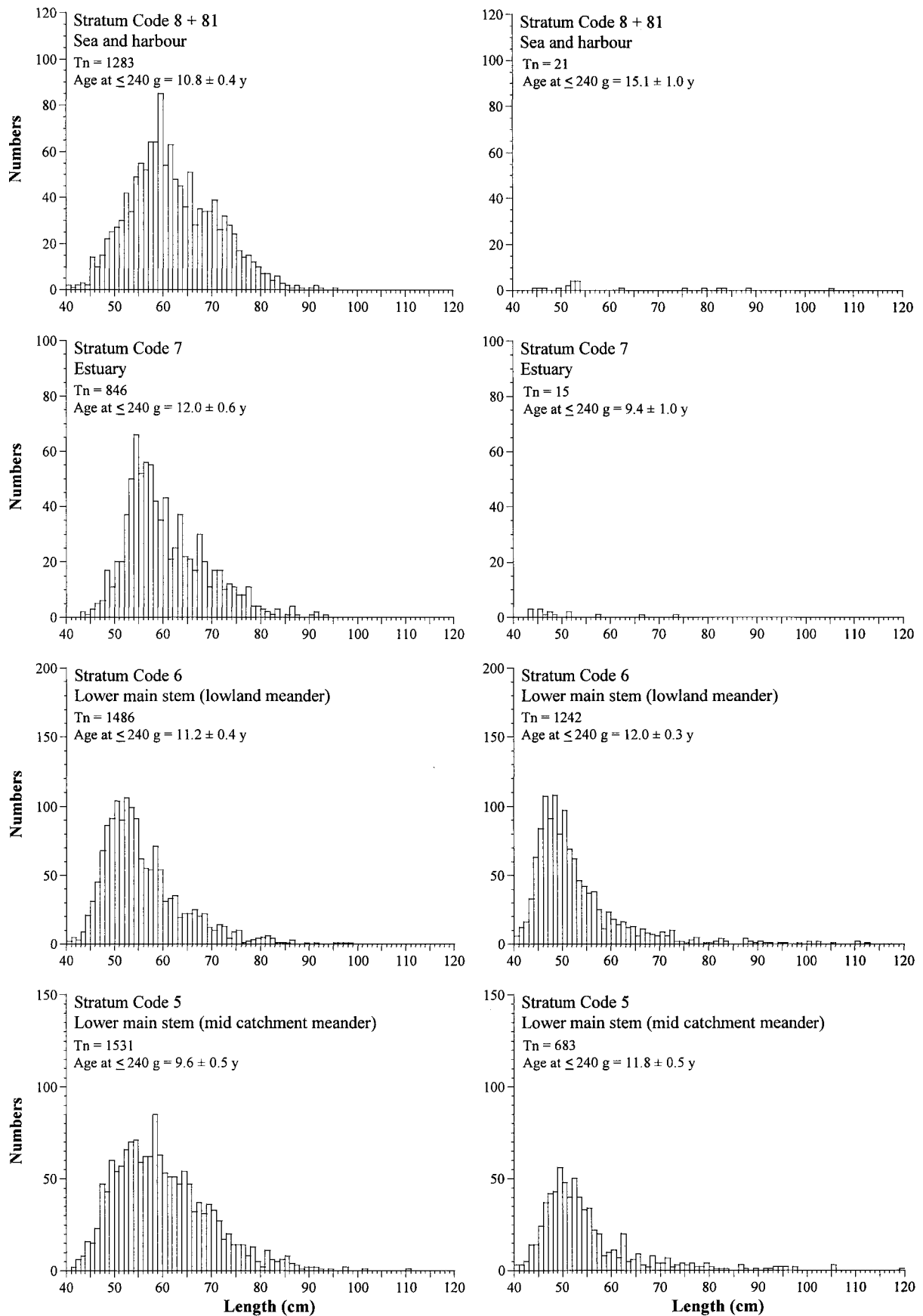
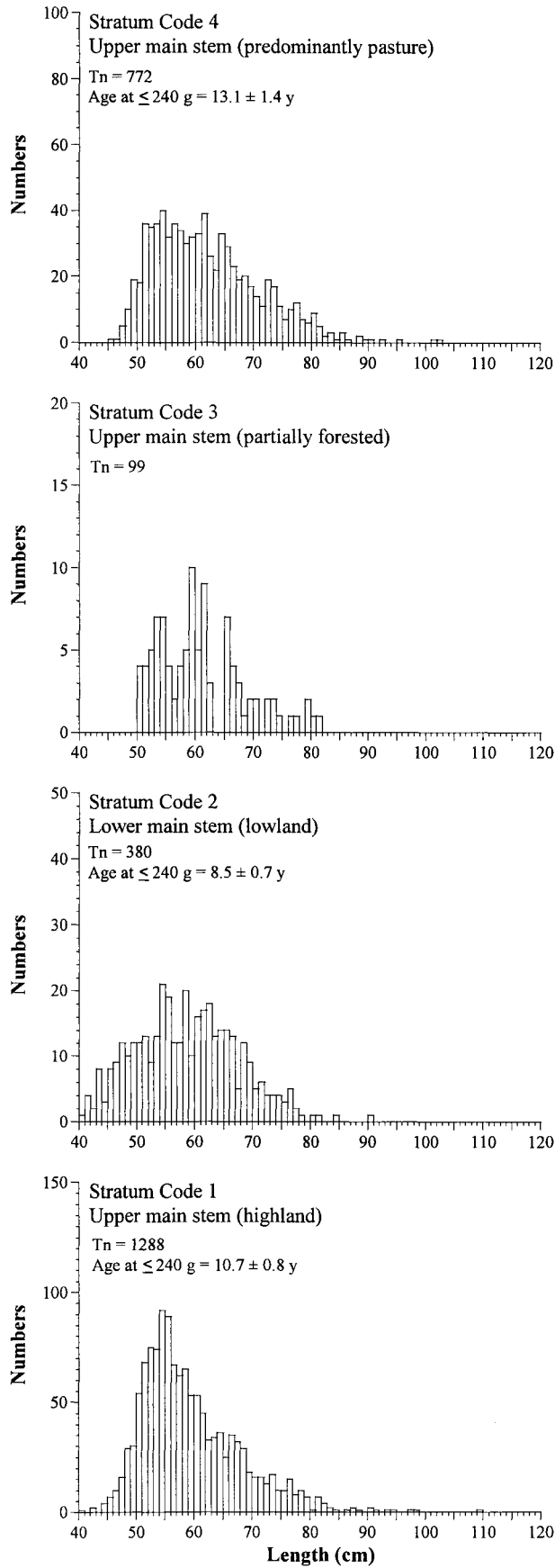


Figure 17: Length distributions and mean age at ≤ 240 g in years \pm s.e. of all North Island eels sampled from landings during 1995–1998 from the sea to mid catchment. Tn, total number measured.

Shortfinned eels



Longfinned eels

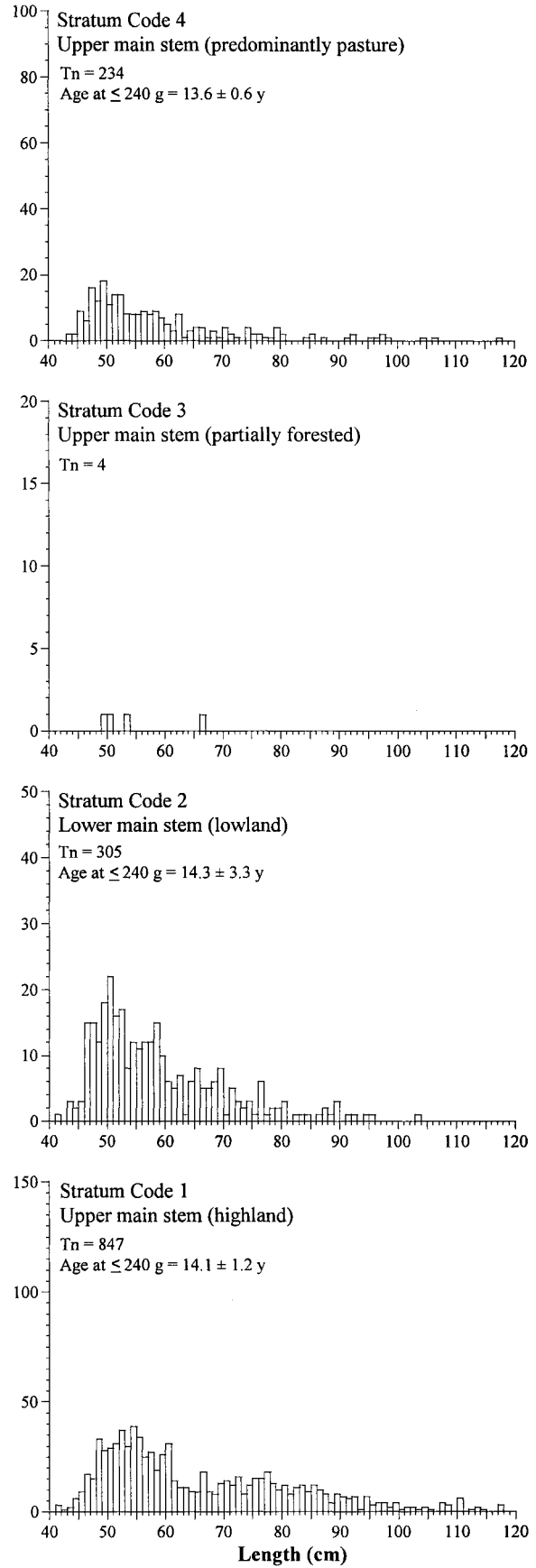


Figure 18: Length distributions and mean age at ≤ 240 g in years \pm s.e. of all North Island eels sampled from landings during 1995–1998; upper main stem of rivers to upper main stem of minor tributaries. Tn, total number measured.

Shortfinned eels

Longfinned eels

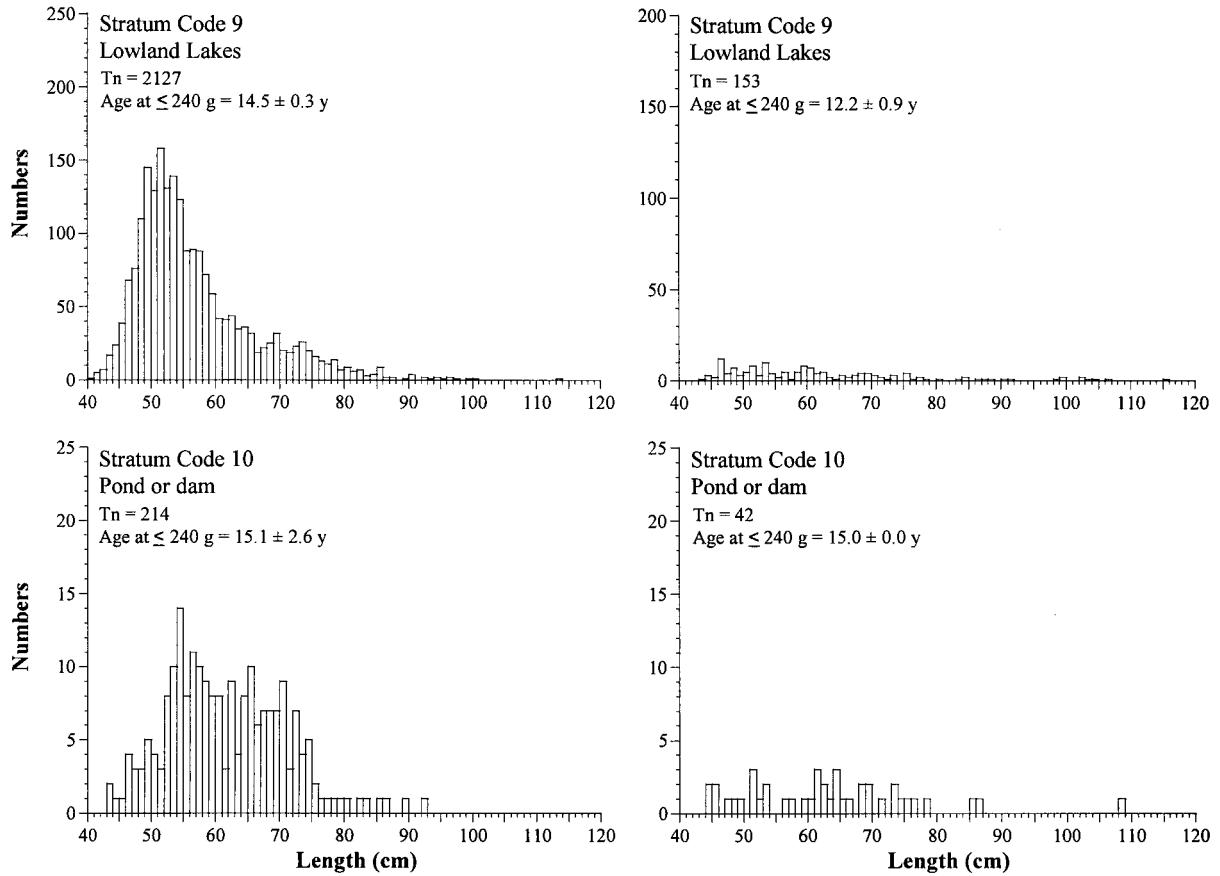


Figure 19: Length distributions and mean age at ≤ 240 g in years \pm s.e. of all North Island eels sampled from landings during 1995–1998; lowland lakes and ponds or dams. Tn, total number measured.

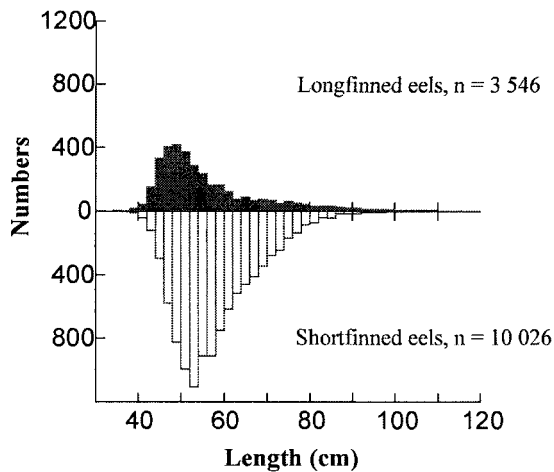


Figure 20: Length distributions of shortfinned and longfinned eels sampled from North Island landings 1995–1998 (excluding 2 landings from the South Island).

Appendix 1: Procedures for catch sampling at eel processing factories

1. **Identify catch source:** review information sheet provided by processor (re eeler) to code source based on area/catchment & habitat type/specific location & habitat. See the stratum number list provided and add to this as necessary to allow the assigning of specific location numbers (B. below, and use 1:50 000 NZMS Top. maps). This is followed by a stratum code to further differentiate sites and habitats described below in C.

A.

Each **Area** is given a discreet label underlined for each on the attached list.

e.g., If Area = Waikato..

then fill in "Area" as WAIK (first four letters)

B.

Stratum numbers are required to identify the main location habitat and these are given on the attached list. This list can be added to numerically, e.g., If location = Lake Kimihia, then this site is a lake (5) within the Waikato Area and requires a specific number, the next number after the last lake sampled is 5, i.e. stratum number = 55. Do similarly with other categories such as ponds/dams and rivers that are not specified on the list.

C.

Stratum codes are required for specific identification of habitats.

If location = Minor tributary (such as to a major river tributary to the Waikato River) then 2 stratum codes are available; 1. upper mainstem (highland), 2. lower mainstem (lowland).

If location = River (such as the Maramarua River tributary to the Waikato River) then there are up to five stratum codes available: 3. = upper mainstem (at least partially forested), 4. = upper mainstem (predominantly pasture), 5. = lower mainstem (mid catchment meander), 6. = lower mainstem (lowland meander), 7. = estuarine.

If location = Sea other than harbour then code = 8, if harbour then code = 81

If location = Lake, and the entire lake was fished (or details are unknown) then stratum code = 9. but if the lake is large (e.g., L. Wairarapa) and further details of fishing are known, then there are a further possible 4 directional stratum codes (1. North, 2. East, 3. South, 4. West), with additional descriptor codes where necessary e.g., add to stratum code numerically, for western "wetland" then use 941 (if this was the first additional stratum code descriptor).

If location = pond or dam AND this category is NOT on the stratum numerical list, then give it a stratum code of 10.

PROCESSOR Record sheet

Information obtained from eelers

Factory and name of eeler:

1. **Location, as specific as possible:** e.g. North end Lake Wairarapa, or Northern wetland Lake Wairarapa; Ruamahanga River near Featherston.

(All sites will be given specific habitat codes when sampled i.e., Large rivers will be broken into up-to 5 segments based on the catch source...upper mainstem 3 and 4, lower mainstem 5 & 6, and estuarine 7).

=

2. **Total landed weight** (we need this for each species, which may have to be done at the factory only).

=

3. If at all possible, **catch effort used to obtain the landed weight; net nights.**

* How many nets does the eeler use usually per day?=
=

* How many days effort to obtain the landing?=
=

4. **Dates of catch:**

=

NIWA Staff

Graeme Mackay or Rob Tasker;
Whangarei Work 06 438 0185

Bruce Hartill or Cameron Walsh;
Auckland Work 09 375 2067

Corina Kemp; Hamilton Work 07 856 1777

Ben Chisnall; Hamilton Work 07 856 1772

**Stratum numbers (revised 5 June 1998):
for locations within catchments, stratum codes as defined by site specifics as described
under procedures (1).**

Northland

- 1 Lakes/ponds North of Kaikohe eg, Lake Omapere
- 2 Lakes/ponds south of Kaikohe
 1. Farm dam Mangawari
- 3 Harbour Rangaunu
- 4 Harbour Whangaroa
- 5 Harbour Hokianga
- 6 Harbours other eg, Whangape
- 7 Rivers other
 1. Mokau River
 2. Rotokakahi River
 3. Kaeo River
 4. Awanui River
 5. Waima River
 6. Puhoi River
- 8 Wairoa River
 1. Pariheka stream
 2. Waitu swamp
- 9 Harbour Whangarei
- 10 Harbour Kaipara
- 11 Rivers Arapaoa
- 12 Rivers Oruawharo
- 13 Rivers Kaipara
 1. Otamatea River

Auckland = AKLD

- 1 Harbour Waitemata
- 2 Harbour Manukau
- 3 River Waiuku
- 4 Rivers/Streams other

Coromandel

- 1 Rivers/Streams eg, Waikarau, Tairua
- 2 Firth of Thames

Hauraki Plains

- 1 River Waihou
- 2 River Piako/Waitoa
- 3 Other

Bay of Plenty = BOP

- 1 Harbours eg, Tauranga, Ohiwa
- 2 River Kaituna
- 3 River Rangitaiki - Mainstream
- 4 River Rangitaiki - Hydro impoundments
- 5 River Whakatane
- 6 Rivers Other

East Cape/Hawke's Bay

- 1 River Waiapu
- 2 River Waipaoa
- 3 River Wairoa
- 4 River Waiau
- 5 River Mohaka
- 6 River Ngaruroro
- 7 River Tukituki
- 8 Rivers Other
- 9 Lakes
 1. Lake Purimu

10 Ponds/dams

Waikato Area

- 1 River Waikato estuary
- 2 River Waikato mainstream
- 3 River Waikato Hydro impoundments
- 4 River Waikato tributaries
 - 1 Mangatawhiri R.
 - 2 Whangamarino R.
 - 3 Maramarua R.
- 5 Lakes
 - 1 Waikare
 - 2 Rotongaro
 - 3 Ngaroto
 - 4 Whangape
- 6 Swamp Whangamarino
- 7 River Waipa
- 8 River Mokau
- 9 River Awakino
- 10 Ponds/dams
- 11 Harbour Raglan
- 12 Harbour Kawhia
- 13 Rivers Other eg, Waingaru

Taranaki/Wanganui

- 1 River Waitara
- 2 Rivers ringplain
- 3 River Patea mainstream
- 4 River Patea Hydro impoundment Rotorangi
- 5 River Wanganui
- 6 River Waitotara
- 7 River Whangaehu
- 8 River Turakina
- 9 Rivers Other
- 10 Lakes/ponds

Manawatu

- 1 River Rangitikei
- 2 River Oroua
- 3 River Manawatu
- (4 Lake Horowhenua)
- 5 Lakes/Ponds
- 6 River Otaki
- 7 Other

Wairarapa

- 1 River Manawatu
- 2 River Ruamahanga
- 3 Lake Wairarapa
- 4 Lake Onoke
- 5 Rivers Other
- 6 Ponds/dams

Wellington

- 1 Harbour Wellington
- 2 River Hutt
- 3 Other