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Size, age, and species composition of commercial eel catches from North Island market sampling (1997–1998)

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7. Executive Summary

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 2 chosen size categories of minimum legal size (≤ 250 g) and well above (≥ 500 g). Shortfins comprised 81% of the total sampled weight landed in the North Island (excluding one landing from the South Island, which was 23% shortfin). Shortfins also comprised over 50% of landings in 30 of 44 strata. Longfins were present in 36 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 made in lowland lakes and the sea. Size ranges and species compositions were similar to that reported previously, and described a fishery primarily based on immature females of length > 50 cm.

General catchment trends showed rapid growth to market size in the sea and estuaries, which reduced in fresh waters with increasing distance upstream. Growth of eels in lowland lakes was mostly 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, the growth rate of shortfins generally exceeded that of longfins. Overall, mean age near market size (≤ 250 g) for shortfins was 12 y, at a weight 224 g and a length 49 cm, and for longfins was 14 y (mean weight 208 g and length 45 cm). Mean age at ≥ 500 g for shortfins was 17 y, (mean weight 648 g and length 68 cm), and for longfins was 19 y (mean weight 640 g and length 63 cm).

Landings sampled during market sampling programmes 1995–1998 were largely confined to the central through to northern sectors of the North Island; most samples have come from the Waikato, Northland and Hauraki, and future sampling should be targeted in the Taranaki, Hawkes Bay, Wairarapa, Manawatu, and Wellington regions.

Longfins appear to be particularly vulnerable to the fishery. The proportion of longfins in catches was considerably greater at smaller eel size but reduced with increasing fish size, e.g., at length < 50 cm both species formed around 50% of the catch by number, but at 60 cm longfins comprised < 20%.

For 1995–1998 data, mean age of eels entering the North Island fishery, although variable, was typically >11 y for both species. Occasionally, this 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 when 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 baseline data for the implementation of management strategies by catchment.

8. Objectives

1. To develop an optimal sampling design for the determination of size frequency of eels caught in commercial eel fisheries and the age of eels at the minimum legal size

2. 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 100 landings from the Waikato catchment in the fish processing sheds.

3. 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 from 100 landings at the major eel processing shed in the South Island.

4. To determine the most appropriate measures of fishing effort for the collection of commercial catch and effort data.

5. *To assess the feasibility of determining the current status of eel stocks in the priority commercial fisheries by analysis of size frequency data.*

This report addresses only objective 2, other objectives are reported elsewhere. The content of objective 2 was renegotiated with MFish prior to commencement to broaden the area being sampled and reduce the number of landings required from the North to 60; sampling was continued at Levin (Manawatu); the efforts at Tekauwhata (Waikato) were reduced; and sampling was established at Kamo Kamo (a depot belonging to Thomas Richards, Whenuapai, Auckland) in addition to Whenuapai.

This year, a strong El Nino weather pattern resulted in a long dry summer severely restricting the fishery in the North Island. As a consequence, only 2 landings were sampled at Levin, which was most affected by the drought conditions throughout the lower and eastern North Island. Sampling at Te-Kauwhata, Whenuapai and Kamo Kamo was restricted to the late summer-autumn months. The most intensively sampled areas reflected this constraint and focused in Northland.

In total, 64 landings were sampled from 3 North Island processors and one depot between 30th September 1997, and 8th July 1998. Most landings sampled were from Northland, Auckland, and the Waikato (Figure 1, Table 1).

9. Methods

Refer to Technical Report attached

10. Results

Refer to Technical Report as attached

11. Conclusions

Refer to Technical Report as attached

12. Publications

Technical Report as attached

13. Data Storage

The electronic data are stored within NIWA's Empress age database, and otoliths are archived at NIWA Greta Point, Wellington.

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 years sampling programme sought to build on experience gained from the two previous years sampling that took place in both the North and South Islands (Beentjes & Chisnall 1997, 1998), while expanding the areas sampled in the North.

Continued sampling of commercial catches aims to provide baseline information on eel stocks, particularly in priority fishing areas, that can be used to make future comparisons. Collection of data on eel size, species composition, age and growth, provide for assessment of stocks by catchment. Stock assessment advice on a catchment basis is desirable, as the New Zealand populations of both species are comprised of many discrete catchment-limited stocks, which will be the basis of future management. Growth rates can provide an index of productivity and changes can be monitored 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 both the South and North Islands. The main goal of this was to initiate a time-series database on size and species composition. A sampling methodology was designed and implemented that was practical to the processors/fishers, and met the objectives of the programme. To determine priority areas that the catch sampling programme should target, key areas were determined through a survey questionnaire sent to all commercial eel fishers in 1995–96 (Beentjes & Chisnall 1997). In the 1997–98 catch sampling programme, the objectives were more specific, with requirements on the number of landings to be sampled, which 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 as part of Monitoring of eel fisheries (MFish Project No. EEL9701).

Methods

The 1997–98 sampling programme was planned to commence at Levin, Te Kauwhata, and Auckland processing factories. The Central Eel Enhancement Co. Ltd (CEEC) showed a strong desire to be involved in the sampling, and endeavoured to provide at least one staff member on location to assist NIWA 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

Areas and locations sampled were generally on an opportunistic basis but focused on previously un-sampled priority contributing areas and repeats of previously targeted areas to complement existing data. Identification of source sites for landings was totally dependent on the co-operation of operators and managers at factories/depot, and their rapport with eelers fishing to them.

The stratification scheme used in the North Island defines the principal habitat type from which the sample is derived with up to 10 strata and habitat types within a catchment (Appendix 1). This coding system identifies specific locations, and groups the samples on a hydrological basis. New sites fished are added to the master list each year, whilst conforming to the broader classifications of stratum number and area previously established (Beentjes & Chisnall 1997, 1998). This format is flexible, allows for the coding of additional strata as they are landed (e.g., additional Waikato lowland lakes), and provides for future assessment and historical comparison of specific locations from the database. A standardised 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 is reported by region and combines data from different locations within major river systems using the stratum code. The "other river" stratum number is used to describe hydraulically small order streams (*see* Appendix 1). We note that all landing locations are specifically identified on the Empress database.

Catch sampling and liaison with industry indicates that the North Island fishery is less constrained by temperature than in the South Island. This has a major bearing on the window for effective sampling. Ultimately it is important to be sampling during both the spring and winter months for several significant fisheries in the North Island. However, the fisheries reporting year (1 October-30 September) does not provide for sampling during spring.

Sampling procedure

Sampling for 1997–98 was based at 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 basic sampling techniques implemented 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 as eels were sent live to Whenuapai for processing. Landings were measured at Kamo Kamo using anaesthetic (AQUI-S), and sub-samples in the correct size categories put aside in labeled bags to be otolithed later 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 around 3% weight loss.

At each factory (and depot), 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 individual eels in the sample. The sample usually contained a mix of the two species and these were sorted before the sample was analysed. The proportion of each species by weight in the total landed weight was calculated from the proportion by weight of that species within the sample.

Otolith collection and preparation

Prior to this year, otoliths have been 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 to accomplish this were ≤ 250 g and ≥ 500 g. However, for many landings, eels were not available in these size ranges (either nothing near MLS or nothing larger than 500 g), and those nearest in weight to these target weights were sampled. To avoid possible bias to results caused by variance in condition (e.g., long skinny eels sampled more frequently where condition is poor at our selected weights), 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, a sample number of twenty otoliths per size class was recommended for collection (Francis 1998). Preliminary results from 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 under X10–50 magnification under a stereo-microscope 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

Differentiation of sex is difficult to accomplish for non-migratory eels without visual inspection of the gonad through killing of the eel. Four categories have been used to assess sex in the catch sampling programme over the last 2 years; unsexed, immature or unable to determine, male, and female. A 4 level stage of gonad development was also 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 meaning that identification of sex was mostly limited to those killed for otolith extraction.

Length-weight relationship and condition index

The length-weight relationship for each species with each stratum was determined from $ln\ W = b\ (ln\ L) + (a)$, where W = weight (g) and L = length (cm). An index of condition was defined as the weight of an individual eel at a length of 45 cm calculated from the length

weight relationship (45 cm length approximately corresponds to the minimum legal size of 220 g).

No adjustment was made for the estimated 3% weight loss resulting from the desliming process that occurred at Levin prior to our sampling.

Age at market size and well above

Mean ages for the two size categories sampled (≤ 250 g and ≥ 500 g) along with eels of weight between the two categories (249–499 g) were calculated. Mean size ranges for each category are given.

Data summary

All data collected between 1995–1998 for all North Island landings sampled were pooled to provide a summary of species and size compositions, and mean age at MSL, by stratum code and area. A map showing all landings sampled to date is also given.

Results

Landings

This year, a strong El Nino weather pattern resulted in a long dry summer, and severely restricted the fishery in the North Island, i.e., high water temperatures causing eels to become sluggish and minimal rainfall causing low water levels; lack of freshes/floods to stimulate eel movement. As a consequence, only 2 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 constrained into the late summer-autumn months.

In total, 64 landings were sampled from 3 North Island processors and one depot between 30th September 1997, and 8th July 1998. Most landings sampled were from Northland, Auckland, and the Waikato (Figure 1, Table 1). The data were grouped by stratum code for presentation (*see* Appendix 1), and provided with a group number for order of presentation within tables and figures (*see* Table 1).

Landing weights of longfins and shortfins sampled totaled 5.5 and 23.6 t, respectively. The overall proportions of landing weights sampled (sum of landing 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 (Table 1, 2, 3). Ages of 229 longfins and 661 shortfins were determined by otolith examination (Tables 4, 5).

Shortfins made up over 50% of landings in 30 of 44 strata. Longfins were present in 36 strata and shortfins present 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. Generally few longfins were

obtained from fishing lowland waters in the North Island, but occurrence increased in the mainstems of rivers and increased substantially in the upper catchments. Eels captured from harbours and the sea were predominantly shortfins. Landings from most ponds and dams were predominantly shortfins with the odd exception where longfins comprised up to 10% of catches.

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

Length frequency distribution and species composition

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

Eel size distributions from the different strata were comparable throughout the North Island regions. At sea and in harbours, shortfins generally comprised 99% of the catches and had a length mode of 50 cm but had a wide size distribution with many large eels captured (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, the lower Wairau River was predominantly longfins, with a length mode of around 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 (Tables 2 and 3, respectively). The overall mean shortfin weight for the North Island was 483 g, the smallest mean weight coming from the lower main stem of Hauraki Plains rivers (group 26, mean weight 276 g) and the largest mean weight from Tauranga Harbour (group 39, mean weight, 1292 g). The overall mean weight for longfins was 628 g, the smallest mean weight coming from the Waikato River estuary (group 29, mean weight 265 g) and the largest mean weight from the 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) (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 this year, growth rates are not presented (generally only small and large eels were sampled, i.e., age distributions to establish meaningful growth rates were inadequate). Rather, age at each of the three size categories (A ≤ 250 g; B 251–499 g; and C ≥ 500 g) are given with ranges in length and weight and standard errors of mean age for each (Tables 4, 5).

For several landings, few eels were available from the 2 chosen size categories (A and C), but eels sampled in between these sizes (B, 251–499 g) give an indication of growth for those sites.

Overall, 661 shortfins and 229 longfins were aged. In size category A, 190 shortfins ranged between 4–25 y (mean of 12 y), length 39–55 cm (mean of 49 cm) weight 115–250 g (mean of 224 g); and 78 longfins ranged between 7–21 y (mean of 14 y), length 36–52 cm (mean of 45 cm) weight 78–250 g (mean of 208 g). In size category B, 260 shortfins ranged between 4–33 y (mean of 14 y), length 46–67 cm (mean of 55 cm) weight 251–499 g (mean of 332 g); and 89 longfins ranged between 6–34 y (mean of 15 y), length 44–62 cm (mean of 52 cm) weight 251–497 g (mean of 354 g). In size category C, 211 shortfins ranged between 5–54 y (mean of 17 y), length 50–95 cm (mean of 68 cm) weight 500–1850 g (mean of 648 g); and 62 longfins ranged between 7–39 y (mean of 19 y), length 56–80 cm (mean of 63 cm) weight 500–1285 g (mean of 640 g).

To compare growth between regions, we focus mainly on the mean age attained at market size (220g, size category A) as an index of growth.

Northland and Auckland.
Several landings from the sea and harbours were sampled from these regions. Here mean age (A) of shortfins ranged between 7–9 y (mean weight 211–230 g)(small longfins were not caught). Mean age (A) increased upstream; mid catchment of main stem and tributaries ranged between 11–16 y for shortfins (mean weight 229–234 g) and between 11–13 y for longfins (mean weight 219–229 g). Faster growth of shortfins at (A) occurred in highland sites in Northland at 7 y (mean weight 235 g), but longfins grew more slowly in the upper catchments, with mean age (A) at between 17–19 y (mean weight 226–239 g).

In lowland lakes, mean age (A) was around 12 y for shortfins (mean weight 215 g) and 13 y for longfins (mean weight 213 g). In ponds and dams, mean age (A) was around 11 y for shortfins (mean weight 238 g).

For eels from harbours in the larger size category weight ≥ 500 g (C), mean age (C) was 10 y for shortfins (mean weight 519–1093 g). In estuaries, shortfins were older at 15 y (mean weight 601 g). In the lower river and tributaries through to the upper main stem in pasture, mean age (C) of shortfins ranged between 16–25 y (mean weight 526–654 g), and longfins between 15–20 y (mean weight 521–673 g). In the upper catchment (highland), mean age (C)

of shortfins was generally lower and ranged between 9–22 y (mean weight 526–585 g), but longfins generally higher at 14–22 y (mean weight 532–560 g).

In lowland lakes and ponds, mean age (C) of shortfins ranged between 16–23 y (mean weight 549–662 g).

Hauraki-Coromandel.
Few eels from landings within this region had eels in the smallest size category (A). Shortfins of size (B) (mean weight 473 g) were 8 y in the Firth of Thames and river estuaries of the Hauraki Plains. An increase in mean age (A and B) occurred in the lower main stem of these rivers, to 13 y. Insufficient numbers of longfins were caught to warrant sampling.

Mean age (C) of shortfins from these sites was not much older at between 8–11 y (mean weight 582–640 g).

Waikato Region.
In the estuary of the Waikato River, mean age (A) of shortfins was 13 y (mean weight 227 g) and longfins 10 y (mean weight 228 g). Poorer growth occurred in the lower main stem of tributaries to the Waikato River; mean age (A) of shortfins was 14 y (mean weight 221 g) and longfins 13 y (mean weight 202 g). Growth reduced further for shortfins in the upper catchments at 18 y (mean weight 217 g), but improved for longfins at 11 y (mean weight 200 g). In lowland lakes mean age (A) of shortfins was around 13 y (mean weight 232–244 g). Fast growth was attained by shortfins in both pond/dams and hydro lakes; mean age (A and B) at 4–6 y (mean weight 267 g)[1]. Similarly, the mean age (A) of longfins from hydro lakes was 8.5 y (mean weight 228 g).

For larger eels, mean age (C) of shortfins from the Waikato River estuary was 16 y (mean weight 757 g). Throughout the lowland to mid catchment of the Waikato waterways, shortfins at this size were around 12 y (mean weight around 760 g) and longfins 20 y (mean weight 673 g). In Waikato ponds, shortfins attained rapid growth, with mean age (C) at 7 y (848 g). In contrast, in the upper catchment waters (highland) the mean age (C) of shortfins was 23 y (mean weight 750 g) – here 1 longfin was aged at 14 y (weight 600g). Longfins were 9 y (mean weight of 610 g) in the hydro lakes.

Other Regions.
There were few landings made from other regions. For East Cape-Hawkes Bay, in Lake Rapongaere mean age (A) of shortfins was 5 y (mean weight 219 g). For Taranaki, in highland tributaries of the Wanganui River, age (A) of shortfins was 18 y (n = 1, weight 245 g) or age (B) was 27 y (mean weight 345 g), and for longfins age (A) was 21 y (n = 1, weight 254 g). For Manawatu farm dams, mean age (B) was 22 y (mean weight 443 g) for both shortfins and longfins. For Marlborough, in the mid catchment of the Wairau River, mean age (A) of shortfins was 16 y (mean weight 214 g) and for longfins, 15 y (mean weight 170 g).

Few eels were available in the large size category (≥ 500 g, C) from these areas; shortfins from Lake Rapongaere attained 705 g at 11 y. In the highland tributaries of the Wanganui River, shortfins attained 946 g at 43 y. In the Wairau River, Marlborough, shortfins attained 916 g at 24 y and longfins 863 g at 20 y.

[1] We note that eels from hydro lakes exhibit narrow central growth bands on otoliths, as previously found to correspond to growth of elvers before entering the upper hydro lakes (Beentjes *et al.* 1997), i.e., total age estimates given here include these narrow bands.

Sexual differentiation

Gonads were examined in 244 of the 896 eels killed for otolith removal. Of these, staff could confidently assign sex to only 45 eels, all of which were in the initial stages of development (stages 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 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 only recorded 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 almost all North Island landings; i.e., 98% of 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% by weight), whilst shortfins were more abundant in lowland waters. Generally, the highest catch rates were made in estuaries of Northland and the Hauraki Plains rivers (10–15 kg per net per night). Catch rates from the sea and in harbours from Northland through to Hauraki were considerably lower at around 1.7 kg per net per night. Catch rates throughout the river systems of the North Island were higher at around 4 kg per net per night. Catch rates in lowland lakes were around 5 kg per net per night, and in ponds or dams around 14 kg per net per night (with large variance). The lowest catch rate was recorded for the Waikato hydro lakes at 0.4 kg per net per night.

Data summary 1995–1998

Landings sampled during market sampling programmes between 1995–1998 were largely confined to the mid to northern regions of the North Island (Figure 1). Very few landings were from the west (Taranaki) or south (Hawkes Bay, Wairarapa, Manawatu, Wellington).

All eels measured during these North Island catch sampling 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 comprised 98% of catches, had a length mode of 60 cm, with > 50% of the catch 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 around 60% shortfin and 40% longfin, with length distributions of both species predominantly < 70 cm, and length modes of 50–55 cm (smallest yet). In the upper reaches of catchments (strata 4–1), longfins predominate in catches (51% in minor tributaries, strata 2) and while length modes were still around 55 cm for both species, a large proportion of the longfin catch were > 70 cm.

Shortfins were the principal eel caught in lowland lakes (87%), with a length mode of 50 cm and most of the catch < 60 cm. 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.

The overall size distribution of eels from North Island landings 1995–1998 reveals distinct differences between the 2 species (Figure 20). Longfins caught had a wider size range than shortfins. The length mode for longfins was 50 cm and most eels caught were < 58 cm. In contrast, the length mode for shortfins was 52 cm and much of the catch ranged to 75 cm (Figure 19). The proportion of longfins was, in total, 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 length < 50 cm both species formed around 50% of the catch by number, but at 60 cm longfins comprised < 20% (Figure 20).

Catches by region show the areas most intensively sampled to date and reveal the principal species being fished from each area (Table 9). Most samples have come from the Waikato, Northland and Hauraki, where longfins comprise between 14–47% of landings. Other areas are generally poorly represented; landings from the Wairarapa and Taranaki were dominated by longfins (55–79%), whereas longfins were virtually absent from Hawkes Bay landings.

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

Mean age (MS) for shortfins from lowland lakes was 15 y and longfins 12 y, and from ponds/dams mean age was 15 y for both species.

Mean landing weight was greatest in highland tributaries (18409 kg) followed by lowland lakes (7194 kg) and river mid catchment (6268 kg) (Table 8). Mean landing weight did not vary greatly in Northland, Auckland, Waikato, Hauraki, Coromandel and Bay of Plenty at around 200–300 kg, which was lower than for Taranaki, Manawatu, Wairarapa, (400–1000 kg), and substantially lower than for East Cape-Hawkes Bay and Marlborough (2000–8000 kg).

Discussion

Landings

The sampling methodology established at 4 eel processing plants in the North Island has accommodated the restrictions and limitations imposed by processors and fishers, and enabled the sampling of an extensive proportion of the fishery.

The North Island fishery differs considerably from that in the South as there is a greater diversity of distinctive habitat types as highlighted by catch sampling programmes to date (Beentjes & Chisnall 1997, 1998). Further, a high proportion of catches are exported live, as was the case this year, and the fishery operates year round (particularly in Northland).

Otolith removal requires death of the eel, and processors are therefore reluctant to allow killing of eels that are destined for live export. All sampling required anaesthetising for measurement, which increased the amount of effort required over that afforded by electrocution of eels (*see* Beentjes & Chisnall 1998). These differences and processors procedures meant that, unlike the South Island where areas were pre-stratified, North Island landings were sampled only when identification of a specific location was possible and areas were post-stratified based on reported locations. Substantially more eels of both species were sampled in 1997–1998 than in the previous 2 years (Table 1, Figure 1). This years data collection has both consolidated that collected over the preceding 2 years, particularly in the Waikato region and Hauraki Plains, and expanded the knowledge base of the fishery into Northland.

Results from this years sampling are generally similar to those of the last 2 years, but also sampled new habitats; i.e., the sea, harbours, and ponds/dams. Shortfin eels remain the predominant species landed by commercial fishers in the North Island, and the percentage of longfins landed still varied seasonally corresponding to the fishing of upper catchments during the summer – particularly during this last years dry El Nino weather, when low water levels caused eelers to fish in waters seldom fished. The seasonal nature of the North Island fishery was again evident in the changing source of landings during the sampling programme (Beentjes & Chisnall 1997, 1998). When the dry weather finally changed to wet, in May (usually March), the eel fishery increased dramatically and catches came mainly from the lowland waterways. Exploitation of the Firth of Thames (sea) and estuaries of the Hauraki Plains occurred exclusively during the winter and fishing of the western King Country rivers and tributaries (Waikato upper catchment) during the dry summer when water levels were low elsewhere. Occasional landings from the South Island processed in North Island factories (e.g., Wairau River in Marlborough, South Island).

Size and species composition

General trends in size frequency distributions and species compositions recorded for new areas this year were mostly similar to those reported for previous catch sampling (Beentjes & Chisnall 1997,1998); smaller size was more common for eels from lowland habitats than in upper catchments; shortfins dominated lowland catches and longfins upland catches. Harbours and ponds or dams were almost exclusively shortfin fisheries.

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

Length-weight relationships may provide useful references for future comparisons. However, as condition indices can have large seasonal variance (i.e., dependant on time of sampling as well as good habitat), any comparisons made will require similar sampling dates and be treated with caution.

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

Growth

Growth described in this report once again generally compares well with the published information (e.g., Burnet 1969; Chisnall 1989; Chisnall & Hayes 1991; Chisnall 1993; Chisnall & Hicks 1993; Jellyman *et al.* 1995; Horn 1996). Several values for mean age (A) were older than age at minimum legal size (MLS) reported for the same locations estimated 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 years data estimates 13 y. Older mean age (A) could be expected from the targeted size grouping ≤ 250 g in 1998. Fewer small eels present in datasets (1995–97) used in the models derived from length stratified samples probably also contributed to the younger age estimate.

Age of eels in larger size categories provided some indication of the longer term growth patterns of stocks in different locations. Old ages attained by larger eels sampled from some locations probably indicate a poorer food supply for the larger size classes, because eel diet changes with increasing size to become more piscivorous (e.g., > 45 cm, Jellyman 1989).

Overall, catchment trends in growth this year were similar to those previously reported (Beentjes & Chisnall 1998); new regions sampled showed rapid growth to market size and beyond in the sea and estuaries, and growth generally reduced in fresh waters with increasing distance upstream. Growth of eels 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 from the most rapid to very poor, which probably reflected the variable 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; Chisnall *et al.* in prep.). This years samples from estuarine habitats in the Hauraki Plains, 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, such 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 of 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 sex of few eels was identified this year. There are several reasons for the low numbers of sexually differentiated eels from this years sampling; the necessity to kill eels for gonad inspection confined gonad examination to only those used in samples for age (constrained by size categories) and almost 100% of landings were destined for live export; a long dry summer followed by the onset of rain in very late autumn (May), which triggers the downstream migration of mature eels, limited any occurrence of migrants in catches sampled. Operator inexperience no-doubt also contributed to the limited number of differentiated eels identified this year.

The meagre data on eel size at maturity from North Island landings to date (Beentjes & Chisnall 1998), shows 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.

Although sparse, added to the growing database, the 1998 data will be useful for understanding the age and associated size required to reach maturity from specific catchments.

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 years similar findings to previous years sampling showing larger proportions of longfins being caught with increasing distance upstream, probably reflects a combination of 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) appears to be a substantial component of the North Island eel fishery. So too are the ponds and dams that have comparatively high returns. Catch rates were again found to be 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 1995–1998 were drawn from Northland, Waikato, and Hauraki. Very few landings were sourced from the west (Taranaki) or south (Hawkes 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 varying 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 more distinctly more vulnerable to fishing than shortfins (Figure 20). Shortfins dominate most North Island catches but the proportion of both species of eels < 50 cm is equivalent. 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 consideration may explain why the mean size of longfins in category A for 1998 data was below market size- more commonly captured in fishing practices. 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.

Mean age of eels entering the North Island fishery (≤ 240 g), although variable, was typically ≥ 11 y for both species. In a few locations this mean age was considerably reduced reflecting rapid growth, but this was uncommon. These mean ages are older than the estimates provided from regression models previously reported and give good reason for caution when regarding management of the eel fishery as a whole. Therefore, management of the eel fishery must gear towards long term goals 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 enable a more informed management of the fishery.

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Appendix 1:

1997/98: 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 pages 5–8. 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 numerical 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, i.e.;

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

If location = River ..(such as the Maramarua River trib. to the Waikato R.)
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 detail of fishing is known, then there are a further possible 4 directional stratum codes (**1.** North, **2.** East, **3.** South, **4.** West), with additional descriptors 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.**

PROCCESSOR 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 Featherstone.

(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**:

=

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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
7.

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
Code
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/Hawkes 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

Code

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

Code

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

Wairarapa

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

Wellington

Code	
1	Harbour Wellington
2	River Hutt
3	Other

Table 1: **Catchments and strata sampled in 1997-98 with associated number of samples, landing weights, percent of the landing weight sampled, numbers of eels measured for length and weight, and the proportion of the total weight that was longfinned eel (LFE). Group 1998, assigned reference numbers for groups based on stratum codes. For identification of specific landing sources see Appendix 1 and Empress database**

					Longfinned eel			Shortfinned eel			
Region	Location	Stratum definition	Group 1998	Number landings	Landing wt (kg)	% wt Sampled	No. eels sampled	Landing wt (kg)	% wt Sampled	No. eels sampled	% Landing weight LFE
Northland	Kaipara Harbour	Sea	1	2	0.0	0.0	0	458.0	20.2	215	0.0
	Maungaturoto	Estuary	2	1	0.0	0.0	0	117.0	41.5	107	0.0
	Wairoa River	Lower main stem (lowland meander)	3	1	0.0	0.0	0	131.0	28.0	100	0.0
	Wairoa River Tributaries	Lower main stem (lowland meander)	4	1	5.4	5.6	1	684.5	6.0	100	0.8
		Lower main stem (mid catchment meander)	5	4	45.2	30.5	27	1020.4	24.8	477	4.2
		Upper main stem (predominantly pasture)	6	4	40.3	33.7	35	529.8	49.6	485	7.1
		Upper main stem (at least partially forested)	7	1	3.4	47.1	4	99.5	48.3	99	3.3
		Lower main stem (lowland trib)	8	1	268.9	27.3	77	72.0	27.2	29	78.9
		Upper main stem (highland trib)	9	2	42.8	26.9	29	312.1	33.5	224	12.1
	Hotea River	Lower main stem (lowland meander)	10	1	149.4	7.8	18	117.5	7.8	16	56.0
		Lower main stem (lowland trib)	11	1	12.4	6.5	2	408.5	6.9	60	2.9

Table 1 – *continued*

Region	Location	Stratum definition	Group 1998	Number landings	Longfinned eel			Shortfinned eel			
					Landing wt (kg)	% wt Sampled	No. eels sampled	Landing wt (kg)	% wt Sampled	No. eels sampled	% Landing weight LFE
	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	Number landings	Longfinned eel			Shortfinned eel			% Landing weight LFE
					Landing wt (kg)	% wt Sampled	No. eels sampled	Landing wt (kg)	% wt Sampled	No. eels sampled	
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	Number landings	Longfinned eel			Shortfinned eel			% Landing weight LFE
					Landing wt (kg)	% wt Sampled	No. eels sampled	Landing wt (kg)	% wt 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
EastCape-Hawkes Bay	Lowland lakes	Lake Rapongaere	38	1	2.5	12.0	1	13672.5	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	5597.3		1738	23579.3		4568	

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

Location	Group 1998	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
Manungaturoto estuary	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
Lake Awanui	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*

Catchment	Group 1998	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*

Catchment	Group 1998	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	36	21	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	10	62.0±2.40	51–73	479.5±55.77	287–732	5.80	2.89	0.94	181
Lake Rapongaere	38	400	56.5±0.32	44–82	376.5±7.01	175–972	5.62	2.85	0.94	187
Tauranga Harbour	39	7	78.4±6.09	52–95	1292.1±288.72	302–2200	7.20	3.26	0.97	183
Kaituna River	40	57	58.7±1.43	44–98	482.2±42.05	165–1840	6.26	3.03	0.97	195
Wanganui River	41	24	66.4±1.91	50–86	688.1±61.98	225–1463	6.17	3.01	0.95	198
Manawatu ponds and dams	43	41	66.0±1.09	55–82	622.7±32.9	352–1212	6.57	3.10	0.95	187
Wairau River	44	99	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 definition in Table 1

Catchment	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
Hotea River	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	–	–	–	–
Northland rivers Other	12	107	54.9±0.93	39–92	465.4±32.2	120–2063	6.57	3.15	0.96	226
	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*

Catchment	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
Raglan Harbour	28	2	96.5±8.50	88–105	3181.5±1180.5	2001–4362	–	–	–	–
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
Lake Waikare	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 Rapongaere	38	1	–	48	–	280	–	–	–	–
Tauranga Harbour	39	4	76.5±4.91	62–83	1504.8±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*

Catchment	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	231–2860	7.29	3.33	0.97	218
	42	76	52.7±0.61	43–74	399.8±17.6	221–1142	6.86	3.23	0.92	229
Manawatu ponds and dams	43	29	66.0±2.35	47–108	855.6±136.8	262–4200	6.64	3.16	0.97	219
Wairau River	44	300	50.1±0.33	36–80	282.9±8.6	78–1285	7.39	3.32	0.93	190

Table 4: **Mean age of shortfinned eels in 3 weight ranges - ≤ 250g, 251–499g, and ≥ 500g, from 1997-98 sampling. s.e. , standard error; –, insufficient data; group definition in Table 1**

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

Table 4 – *continued*

Region	Location	Stratum definition	Group 1998	No. of Landings	Size	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	251–499g	3	51–62	57.7±3.4	272–499	412.7±70.9	18–24	21.3±1.7
					≥ 500g	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	≤ 250g	11	50–52	50.0±0.2	220–245	235.0±2.4	5–9	6.7±0.4
					251–499g	4	51–64	58.0±3.5	251–480	369.5±60.1	5–8	6.0±0.7
					≥ 500g	11	64–69	66.4±0.5	526–678	585.0±15.0	7–13	9.0±0.6
	Rivers Other	Lower main stem (lowland meander)	12	3	≤ 250g	11	45–50	48.2±0.5	200–250	229.3±5.2	12–22	16.5±0.9
					251–499g	14	47–64	52.4±1.6	253–497	320.3±24.1	11–21	14.5±0.8
					≥ 500g	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	251–499g	3	52–62	55.3±3.3	305–482	375.0±54.3	15–19	17.3±1.2
					≥ 500g	2	64–66	65.0±1.0	588–595	591.0±3.5	14–17	15.5±1.5
		Upper main stem (predominantly pasture)	14	1	251–499g	1	54	–	378	–	19	–
					≥ 500g	2	65–66	55.5±0.5	571–711	641.0±70	18–21	19.5±1.5
		Upper main stem (highland trib)	15	2	≤ 250g	1	48	–	241	–	13	–
					251–499g	5	48–60	52.0±2.2	262–483	308.2±43.7	14–18	16.6±0.7
					≥ 500g	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	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	≤ 250g	12	43–51	47.8±0.8	141–250	203.8±9.5	8–16	11.7±0.6
					251–499g	16	48–65	56.1±1.2	253–486	345.3±20.4	9–20	14.0±0.7
					≥ 500g	7	63–74	67.9±1.7	506–917	662.3±53.8	14–23	16.9±1.2
		Lake Tomarata	17	1	≤ 250g	5	44–52	48.8±1.5	194–246	226.8±8.8	10–16	13.4±1.0
					251–499g	10	52–63	55.6±1.2	257–499	317.3±26.9	11–23	17.2±1.3
					≥ 500g	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	≤ 250g	4	49–51	50.0±0.4	232–246	238.3±3.4	9–15	10.8±1.4
					251–499g	12	50–65	54.4±1.5	252–473	301.2±22.6	9–18	12.9±0.8
					≥ 500g	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	≤ 250g	3	49–51	50.3±0.7	238–246	243±2.5	8–9	8.3±0.3
					251–499g	3	48–50	48.7±0.7	251–260	255.3±2.6	6–12	8.7±1.8
					≥ 500g	2	60–64	62.0±2.0	509–528	518.5±9.5	8–11	9.5±1.5
	Waitemata Harbour	Sea	20	2	≤ 250g	2	45–47	46.0±1.0	223–237	230.0±7.0	6–7	6.5±0.5
					251–499g	14	48–63	51.3±1.2	251–489	299.6±21.5	6–19	11.1±1.3
					≥ 500g	2	59–60	59.5±0.5	513–578	545.5±32.5	6–13	9.5±3.5
	Rivers Other	Upper main stem (highland trib)	21	2	≤ 250g	2	50–52	51.0±1.0	233–247	240.0±7.0	10–11	10.5±0.5
					251–499g	8	50–61	55.9±1.8	253–487	346.4+36.6	11–20	13.9±1.2
					≥ 500g	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	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 Dams	Farm dams (Karaka)	22	1	≤ 250g	1	50	–	219	–	19	–
					251–499g	10	52–63	57.4±1.5	261–498	381.4±31.2	12–28	17.6±1.5
					≥ 500g	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	251–499g	3	60–63	61.3±0.9	454–496	473.0±12.3	5–12	8.0±2.1
					≥ 500g	2	63	63.0±0.0	565–598	581.5±16.5	9–13	11.0±2.0
		Estuary	24	1	251–499g	1	58		400		9	
					≥ 500g	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	≤ 250g	1	47		221		13	
					251–499g	2	51–61	56.0±5.0	262–466	364.0±102.0	12–14	13.0±1.0
					≥ 500g	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	251–499g	4	56–66	62.3±2.3	335–498	453.5±39.5	12–23	17.8±2.4
	Waikato River	Estuary	29	1	≤ 250g	20	45–50	47.7±0.3	200–250	226.5±3.9	9–16	12.6±0.5
					251–499g	4	48–51	50.0±0.7	260–330	282.5±16.0	10–14	11.3±0.9
					≥ 500g	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	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	≤ 250g	5	42–49	46.8±1.3	187–248	220.6±10.9	12–16	14.2±0.8
					251–499g	38	48–67	57.3±0.8	267–491	375.1±12.2	9–22	15.1±0.6
					≥ 500g	1	64		535		13	
		Lower main stem (lowland trib)	32	1	≥ 500g	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	≤ 250g	6	45–50	46.8±0.8	200–250	216.7±10.5	12–20	17.8±1.2
					≥ 500g	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	≤ 250g	6	50–52	50.8±0.3	225–237	232.3±1.8	10–17	13.7±0.9
					251–499g	9	50–61	53.8±1.4	256–479	312.7±31.0	8–18	12.8±0.9
					≥ 500g	4	60–78	66.8±3.9	504–1120	660.8±153.1	12–22	17.3±2.1
		Lake Whangape	35	1	≤ 250g	2	51–55	53.0±2.0	241–247	244.0±3.0	12–14	13.0±1.0
					251–499g	3	54–64	60.7±3.3	253–493	403.3±75.6	12–26	21.0±4.5
					≥ 500g	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	≤ 250g	1	49		240		4	
					251–499g	3	50–52	51.3±0.7	256–323	282.3±20.6	4–6	5.0±0.6
					≥ 500g	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	251–499g	2	51–53	52.0±1.0	274–284	279.0±5.0	6–7	6.5±0.5
					≥ 500g	1	68		562		5	

Table 4 – *continued*

Region	Location	Stratum definition	Group 1998	No. of Landings	Size	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)
East Cape–Hawkes Bay	Lowland lakes	Lake Rapongaere	38	1	≤ 250g	5	44–49	47.4±0.9	202–234	219.2±6.1	4–6	4.6±0.4
					251–499g	13	46–63	55.3±1.2	252–491	346.0±19.4	5–9	6.5±0.4
					≥ 500g	19	60–82	70.5±1.4	500–907	705.3±33.4	5–16	10.9±0.7
Taranaki	Wanganui River tributaries	Lower main stem (lowland meander)	40	1	≤ 250g	1	50		225		13	
		Upper main stem (highland trib)	42	1	≤ 250g	1	46		245		18	
					251–499g	5	46–57	50.6±2.4	251–474	344.8±50.2	23–33	27.4±2.1
					≥ 500g	3	56–95	69.3±12.8	506–1850	963.8±443.4	32–54	43.0±6.4
Manawatu	Manawatu ponds and dams	Farm dams (Marton)	43	1	251–499g	1	62		476		22	
					≥ 500g	1	64		516		21	
Marlborough	Wairau River	Lower main stem (mid catchment meander)	44	1	≤ 250g	21	41–51	48.9±0.5	115–248	213.8±6.5	9–20	15.8±0.5
					251–499g	1	50		259		15	
					≥ 500g	9	70–86	76.9±2.0	636–1268	915.8±70.7	17–35	24.0±2.1

Table 5: Mean age of longfinned eels in 3 weight ranges – ≤250g, 251–499g, and ≥500g, from 1997–1998 sampling. s.e., standard error; –, insufficient data. Group definition in Table 1

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

Table 5 – *continued*

Region	Location	Stratum definition	Group 1998	No of Landings	Size	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	≤ 250g	3	45–48	46.3±0.9	220–237	226.0±5.5	15–19	17.3±1.2
					251–499g	13	47–53	49.8±0.5	267–394	307.3±10.3	12–20	16.0±0.5
					≥ 500g	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	≤ 250g	6	44–45	44.7±0.2	232–247	238.7±2.7	19–20	19.3±0.2
					251–499g	6	46–57	53.0±1.6	284–483	444.3±32.1	18–24	20.5±1.0
					≥ 500g	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	≤ 250g	3	44–52	46.7±2.7	192–247	213.3±17.0	9–21	13.0±4.0
					251–499g	2	48–52	50.0±2.0	256–413	334.5±78.5	18–23	20.5±2.5
					≥ 500g	1	75		1078		39	
		Lake Tomarata	17	1	251–499g	2	48–51	49.5±1.5	251–282	266.5±15.5	12–14	13.0±1.0
	Northland Ponds and Dams	Farm dam (Mangawari)	18	1	≤ 250g	1	44	–	214	–	12	–
Auckland	Rivers Other	Upper main stem (highland)	21	2	≤ 250g	2	46	46.0±0.0	246–248	247.0±1.0	16–19	17.5±1.5
					251–499g	4	55–58	56.5±0.6	448–479	459.0±6.8	10–20	15.0±20.1
					≥ 500g	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	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)
Waikato Region and River basin	Waikato River	Estuary	29	1	≤ 250g	6	43–48	45.3±0.7	210–250	228.3±5.4	7–13	9.7±0.9
					251–499g	2	47–51	49.0±2.0	260–320	290.0±30.0	8	8.0±0.0
	Waikato River tributaries	Lower main stem (mid catchment meander)	30	2	≤ 250g	15	40–47	43.7±0.5	155–249	201.7±7.7	10–18	13.0±0.6
					251–499g	27	48–62	53.4±0.7	277–495	377.8±12.5	11–22	15.3±0.6
					≥ 500g	4	59–60	59.3±0.3	523–572	541.0±10.9	20–32	26.3±2.8
		Upper main stem (highland)	33	1	≤ 250g	3	41–45	43.3±1.2	200	200.0±0.0	8–14	10.7±1.8
					≥ 500g	1	61	–	600	–	14	–
	Waikato lowland lakes	Lake Whangape	35	1	251–499g	1	58	–	471	–	12	–
					≥ 500g	4	58–60	59.5±0.5	502–557	527.0±13.4	10–17	14.5±1.7
	Waikato hydro lakes	Lake Arapuni and Waipapa (combined)	37	1	≤ 250g	2	45–47	46.0±1.0	211–245	228.0±17.5	8–9	8.5±0.5
					251–499g	3	46–48	46.7±0.7	254–257	256.0±1.0	6–9	7.7±0.9
					≥ 500g	7	59–65	61.3±0.8	511–759	610.0±31.9	7–11	8.7±0.7
East Cape–Hawkes Bay	Lowland lakes	Lake Rapongaere	38	1	251–499g	1	48	–	280	–	12	–
Taranaki	Wanganui River tributaries	Lower main stem (lowland meander)	41	1	≤ 250g	1	47	–	250	–	21	–
					251–499g	1	56	–	460	–	26	–
					≥ 500g	1	56	–	500		34	–

Table 5 – *continued*

Region	Location	Stratum definition	Group 1998	No of Landings	Size	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	251–499g	3	47–60	54.7±3.9	262–490	410.7±74.4	16–34	22.0±6.0
					≥ 500g	1	59	–	513	–	21	–
Marlborough	Wairau River	Lower main stem (mid catchment meander)	44	1	≤ 250g	20	36–47	43.5±0.7	78–225	169.7±8.7	9–18	15.0±0.5
					251–499g	4	44–53	48.8±1.8	257–362	297.8±23.7	12–19	15.8±1.4
					≥ 500g	12	61–80	69.9±1.8	522–1285	863.0±67.7	11–25	19.5±1.1

Table 6: Shortfinned (SFE) and longfinned (LFE) eels where sex has been identified. M, mail; 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)±s.e.	Weight range (g)	Mean weight (g)±s.e.	Age range (y)	Mean age (y)±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± 1.0	496–565	530.5±34.5	5–9	7.0±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±1.5	490–491	490.5±0.5	16–23	19.5±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)±s.e.	Weight range (g)	Mean weight (g)±s.e.	Age range (y)	Mean age (y)±s.e.
Waikato Region	Waikato lowland lakes	Lake Whangape	35	LFE	M	5	58–60	59.2±0.5	471–557	515.8±15.3	10–17	14.0±1.4
			35	SFE	F	2	64–69	66.5±2.5	493–506	499.5±6.5	12–26	19.0±7.0
Waikato Region	Waikato ponds and dams	Pond	36	SFE	M	6	49–83*	58.5±5.5	240–1160	463.8±146.2	4–8	5.5±0.6
	Waikato hydro lakes	Lake Arapuni and Waipapa (combined)	37	LFE	M	2	59–65	62.0±3.0	537–755	646.0±109.0	7–11	9.0±2.0
			37	LFE	F	2	62–63	62.5±0.5	590–675	632.5±42.5	9–11	10.0±1.0
East Cape–Hawkes Bay	Lowland lakes	Lake Rapongaere	38	SFE	F	10	66–78	71.8±1.4	532–907	728.6±40.5	9–16	11.9±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±2.5	766–1268	972.2±91.3	17–29	23.8±2.1

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

Region	Location	Group 1998	N 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
	Maungaturoto estuary	2	1	0.0	117.0	14.6
	Wairoa River	3	1	0.0	131.0	5.9
	Wairoa River tributaries	4	1	2.0	690.0	10.0
		5	4	4.0	1066.0	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
	Northland lowland lakes	16	1	4.0	110.0	5.5
		17	1	10.8	411.5	2.7
	Northland ponds and dams	18	1	1.0	210.0	8.7

Table 7 – *continued*

Region	Location	Group 1998	N of samples	%LF by weight	Total landing 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
Hauraki–Coromandel	Firth of Thames and Hauraki Plains rivers	23	1	0	183.0	0.6
		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
Waikato	Raglan Harbour	28	1	0.0	9.9	1.0
	Waikato River	29	1	9.4	313.0	1.7
	Waikato River tributaries	30	2	75.8	1317.0	–
		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	N of samples	%LF by weight	Total landing weight (kg)	Mean weight/net/night (kg)
East Cape–Hawkes Bay	Lowland lakes	38	1	0.2	15042.5	7.7
Bay of Plenty	Tauranga Harbour	39	1	39.7	268.0	0.9
	Kaituna River	40	1	41.2	197.0	1.3
Taranaki	Wanganui River tributaries	41	1	65.2	416.0	4.5
		42	1	100.0	290.0	–
Manawatu	Manawatu ponds and dams	43	1	41.4	891.0	3.7
Marlborough	Wairau River	44	1	75.1	264.0	–

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

Stratum Code		Definition	N of landings	Mean weight landed (kg)			
				SFE	LFE	Mean total	%LFE
Minor tributary	1	upper main stem (highland trib)	18	15314	3095	18409	17
	2	lower main stem (lowland trib)	7	734	768	1502	51
River	3	upper main stem (at least partially forested)	1	99	4	103	4
	4	upper main stem (predominantly pasture)	10	1129	722	1851	39
	5	lower main stem (mid catchment meander)	18	3598	2670	6268	43
	6	lower main stem (lowland meander)	19	2866	1828	4694	39
	7	estuarine	8	2431	25	2456	1
Sea	8	sea other than harbour	4	4321	68	4389	2
	81	harbour	7	1088	115	1203	10
Lake	9	lake	18	6259	935	7194	13
Pond-dam	10	pond-dam	6	1026	479	1505	32
		Total	116				

Table 9: Number of landings, total and mean landing weights, and %longfin from North Island sampling 1995-98

Region	N of landings	Total landing weight (kg)		Mean landing weight (kg)		%LFE
		SFE	LFE	SFE	LFE	
Northland	31	5166	1830	167	70	26
Auckland	6	902	368	150	92	29
Coromandel	7	2142	62	306	62	3
Waikato	47	5580	4876	119	152	47
Hauraki	10	1437	225	144	28	14
Taranaki	2	146	560	146	280	79
Bay of Plenty	4	800	199	200	66	20
East Cape-Hawkes Bay	2	16214	12	8107	6	0
Manawatu	3	2025	1148	675	383	36
Wairarapa	2	979	1196	490	599	55
Marlborough (South Island)	2	3474	233	1737	117	6
Total	116					29

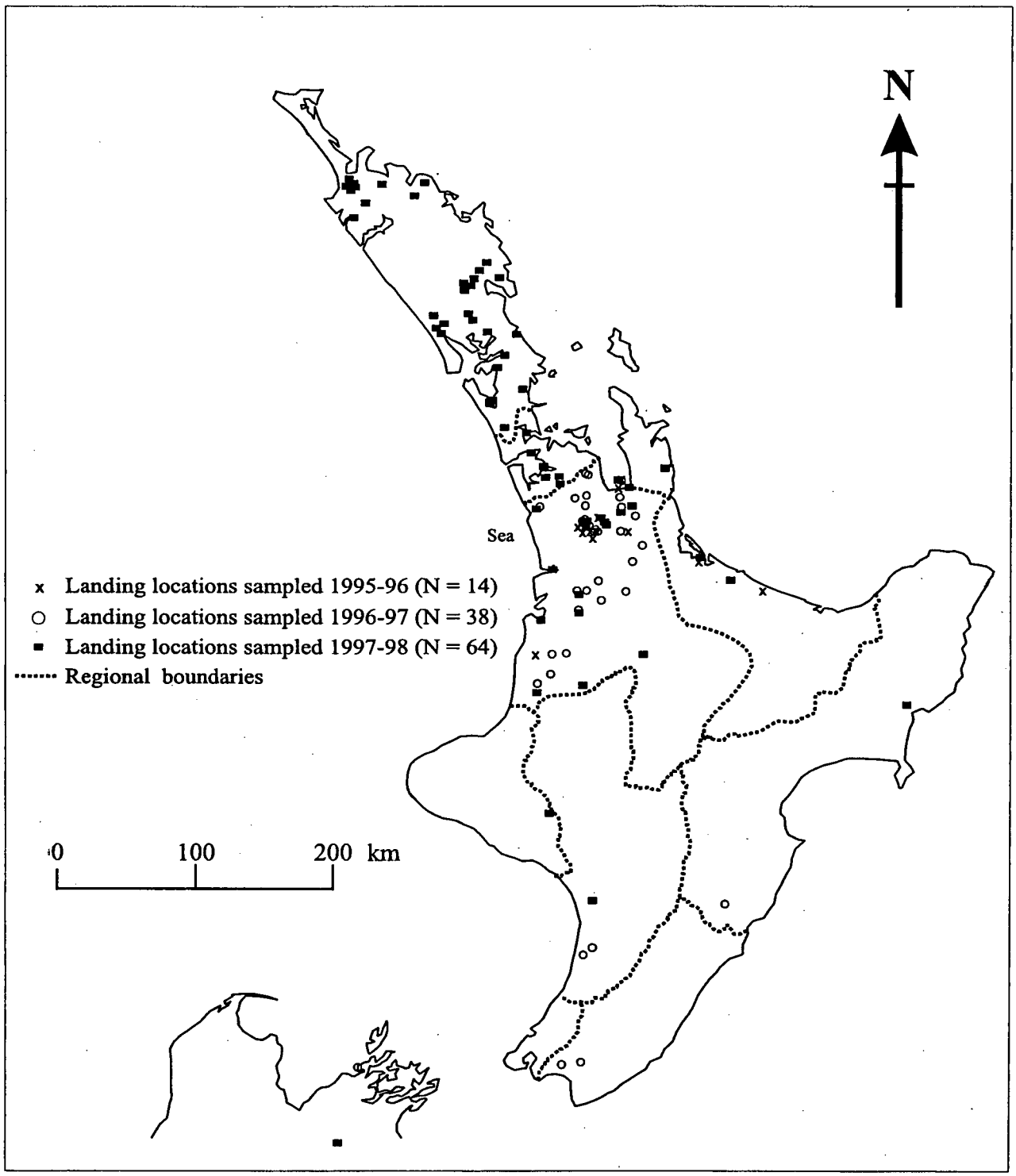


Figure 1: Locations of landings sampled in the North Island eel processors at Levin, Te Kauwhata, Whenuapai and depot at Kamo Kamo, between 1995 - 1998. Regional boundaries based on catchments.

Northland

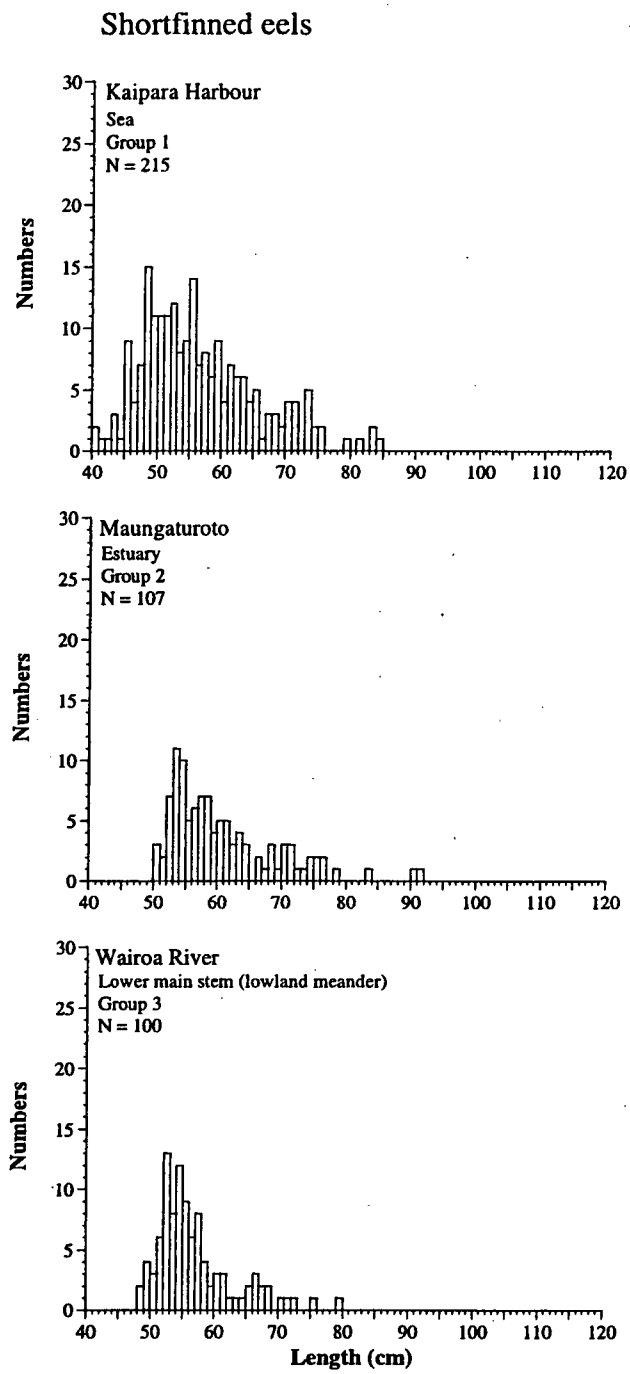


Figure 2: Length distribution of Northland shortfin eels; sea to lower river.

Northland

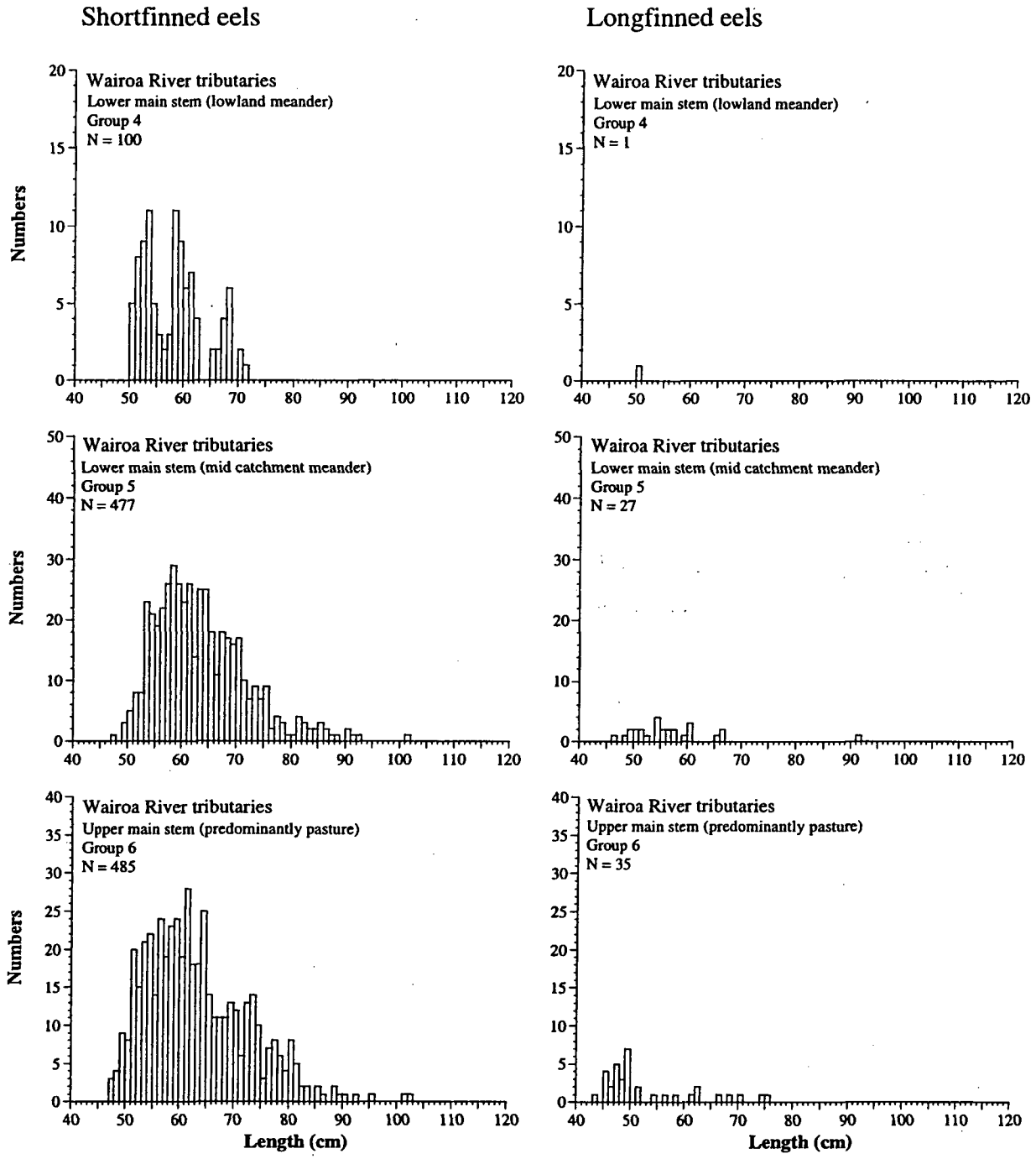


Figure 3: Length distribution of Northland shortfin and longfin eels; Wairoa river tributaries, lowland.

Northland

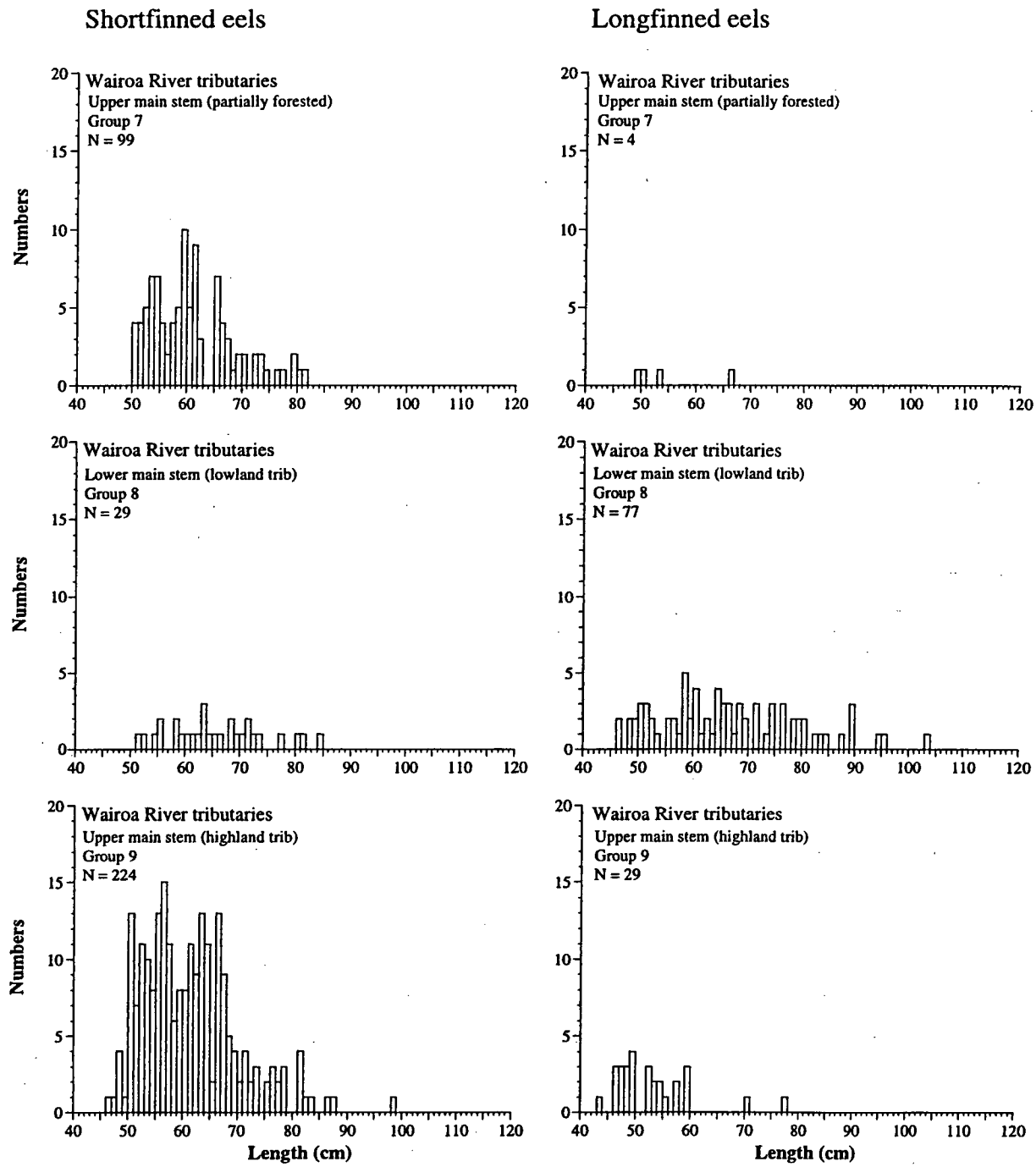


Figure 4: Length distribution of Northland shortfin and longfin eels; Wairoa river tributaries, upper reaches.

Northland

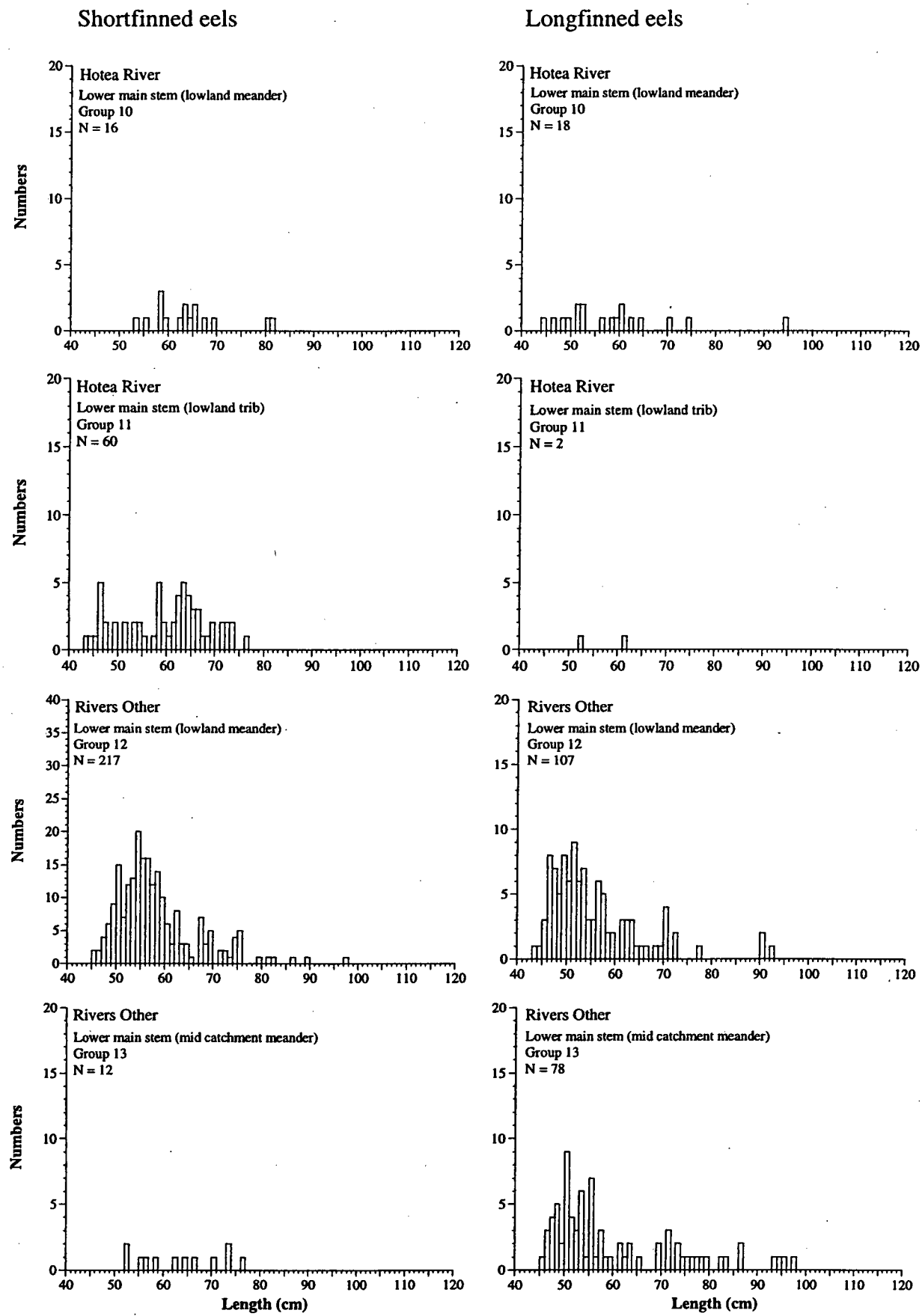


Figure 5: Length distribution of Northland shortfin and longfin eels; Hotea and other rivers, lowland to mid catchments.

Northland

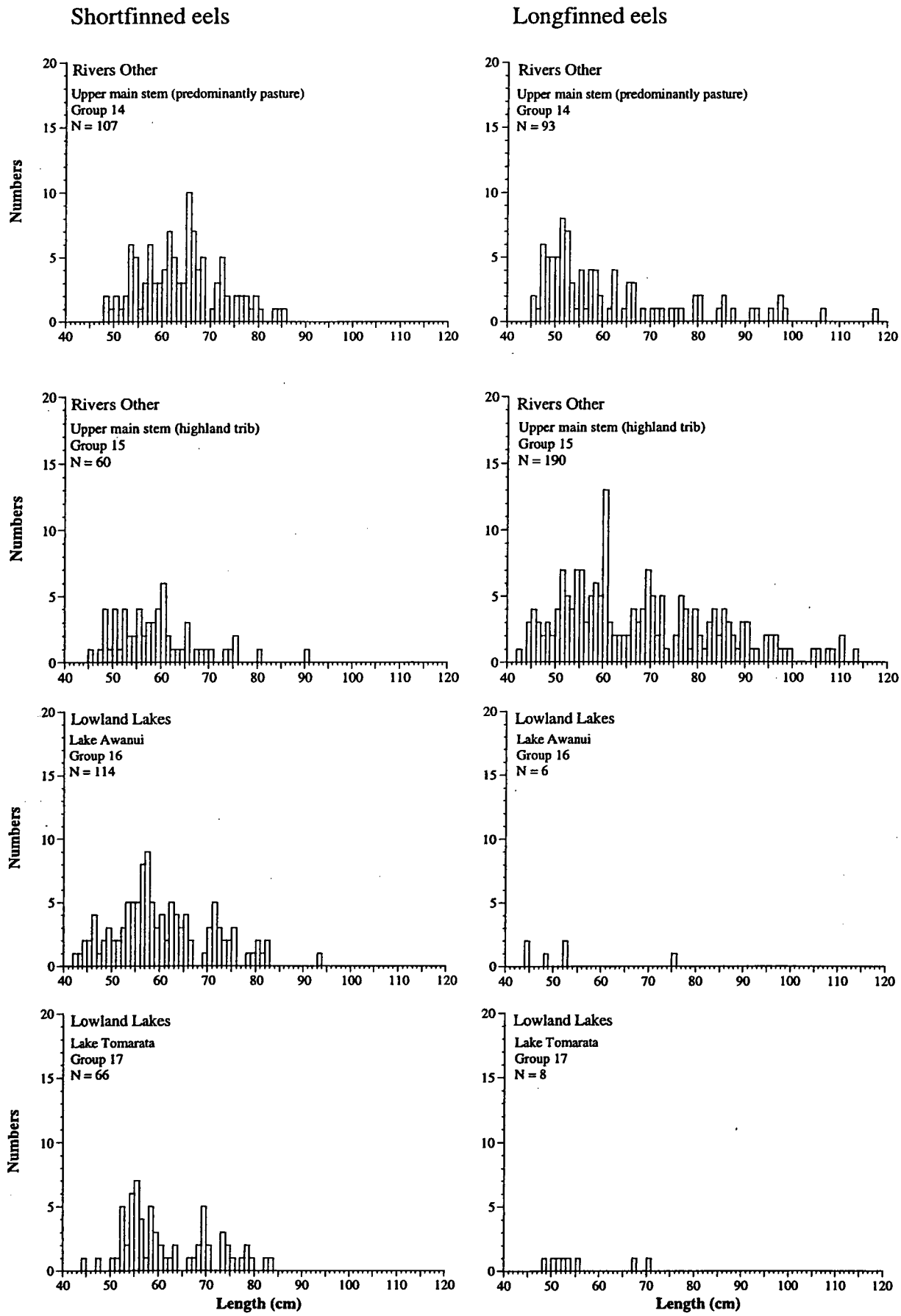


Figure 6: Length distribution of Northland shortfin and longfin eels; other rivers, upper catchments and lowland lakes.

Northland

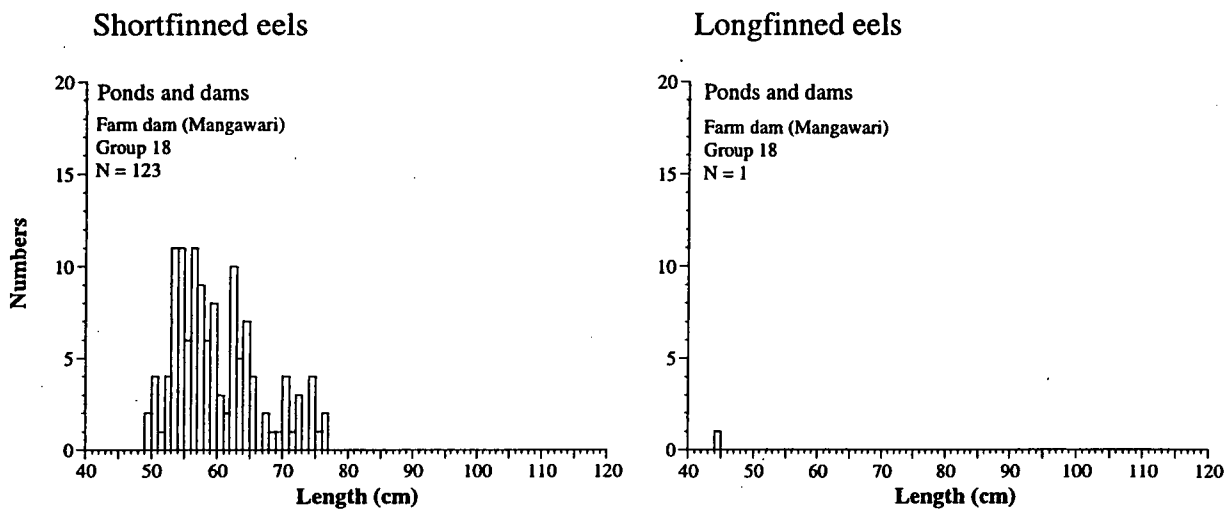


Figure 7: Length distribution of Northland shortfin and longfin eels; ponds and dams.

Auckland

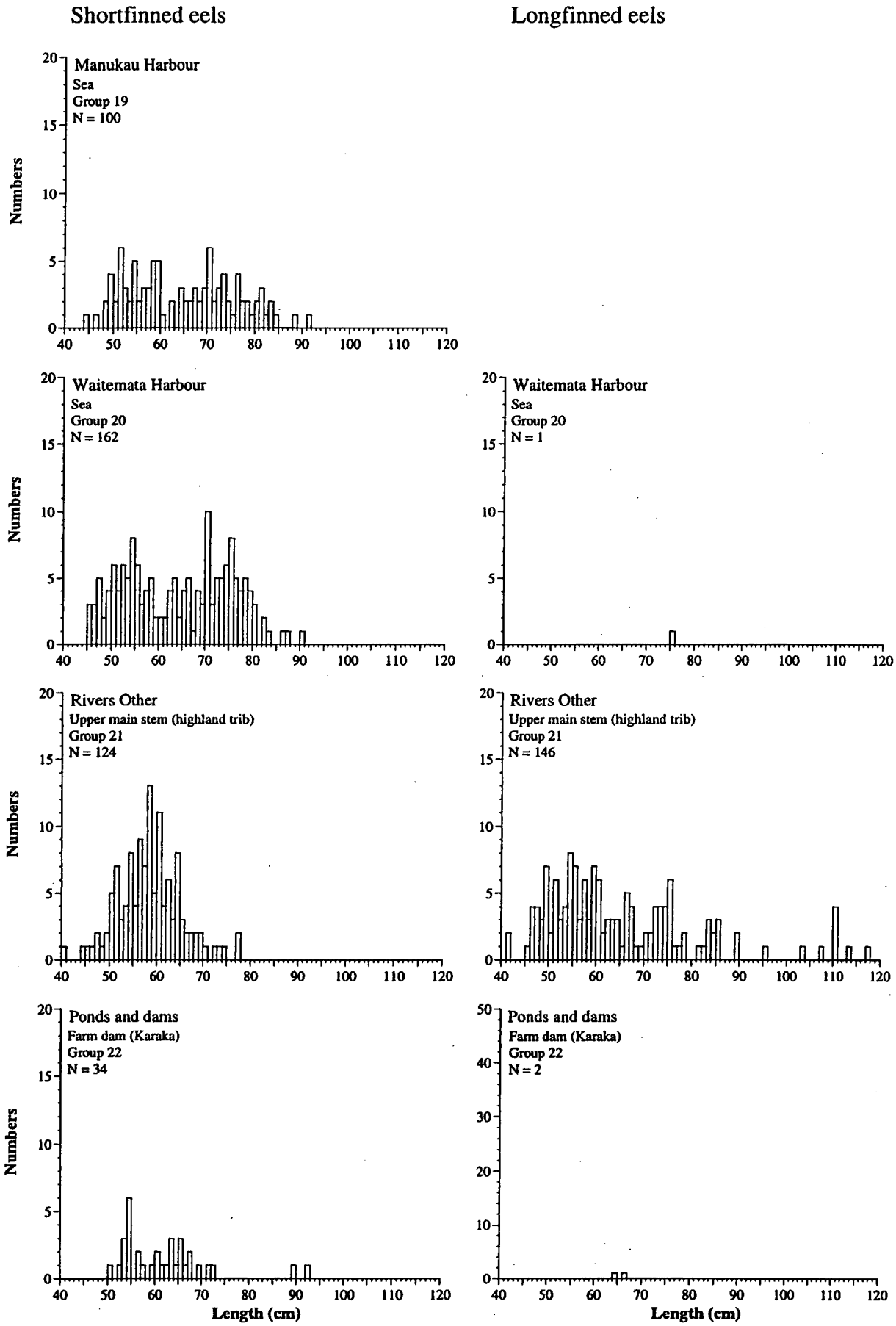


Figure 8: Length distribution of Auckland shortfin and longfin eels; sea to upper catchments, ponds and dams.

Hauraki - Coromandel

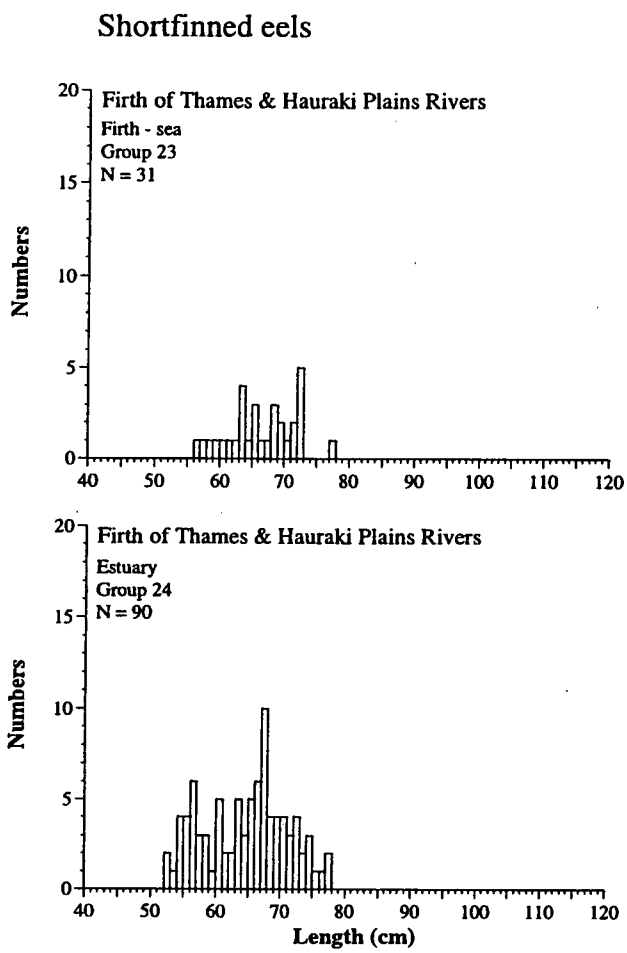


Figure 9: Length distribution of Hauraki-Coromandel shortfin and longfin eels; sea to river estuary.

Hauraki - Coromandel

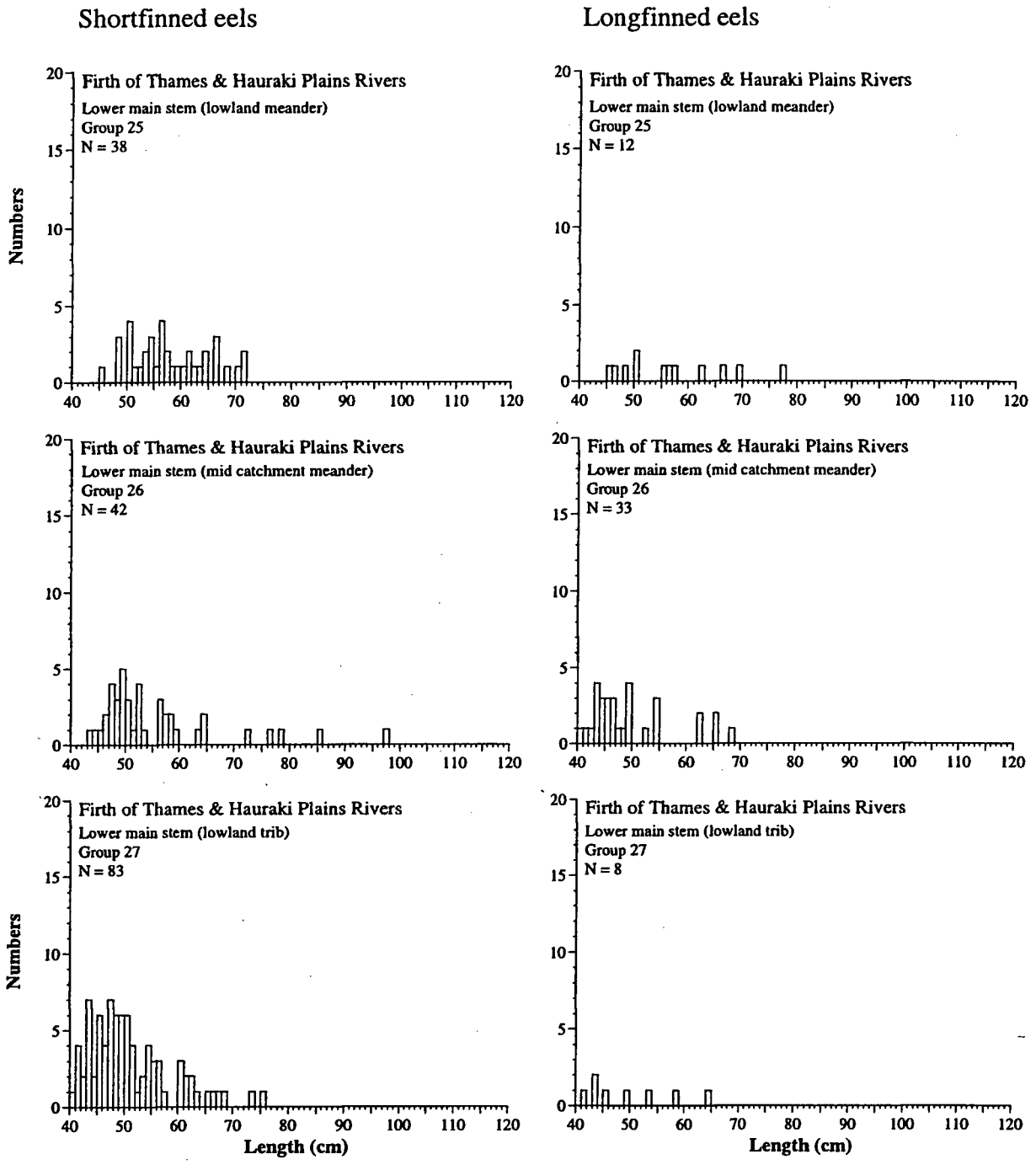


Figure 10: Length distribution of Hauraki-Coromandel shortfin and longfin eels; lowland to mid catchment rivers.

Waikato

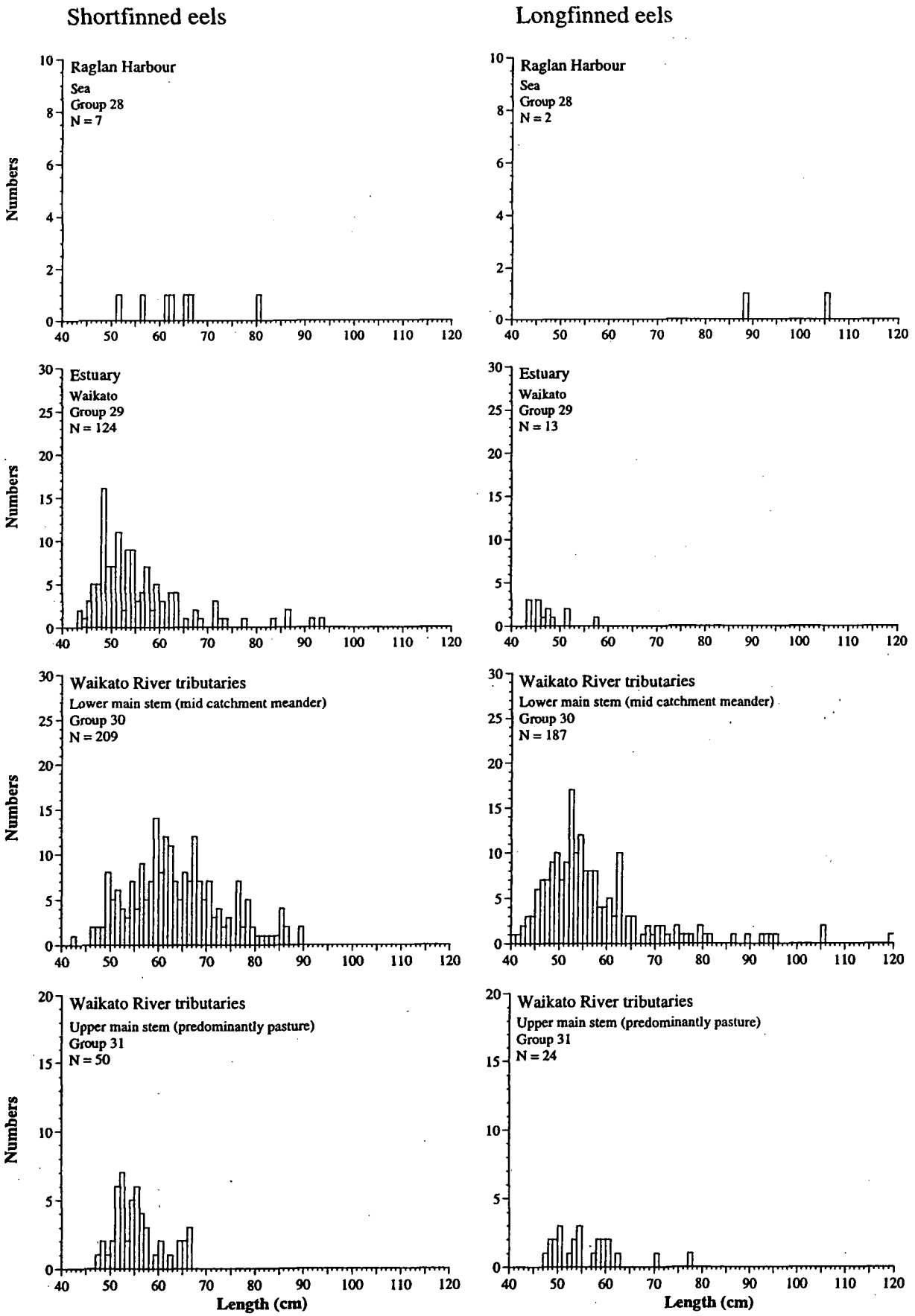


Figure 11: Length distribution of Waikato shortfin and longfin eels; sea to mid catchment Waikato river tributaries.

Waikato

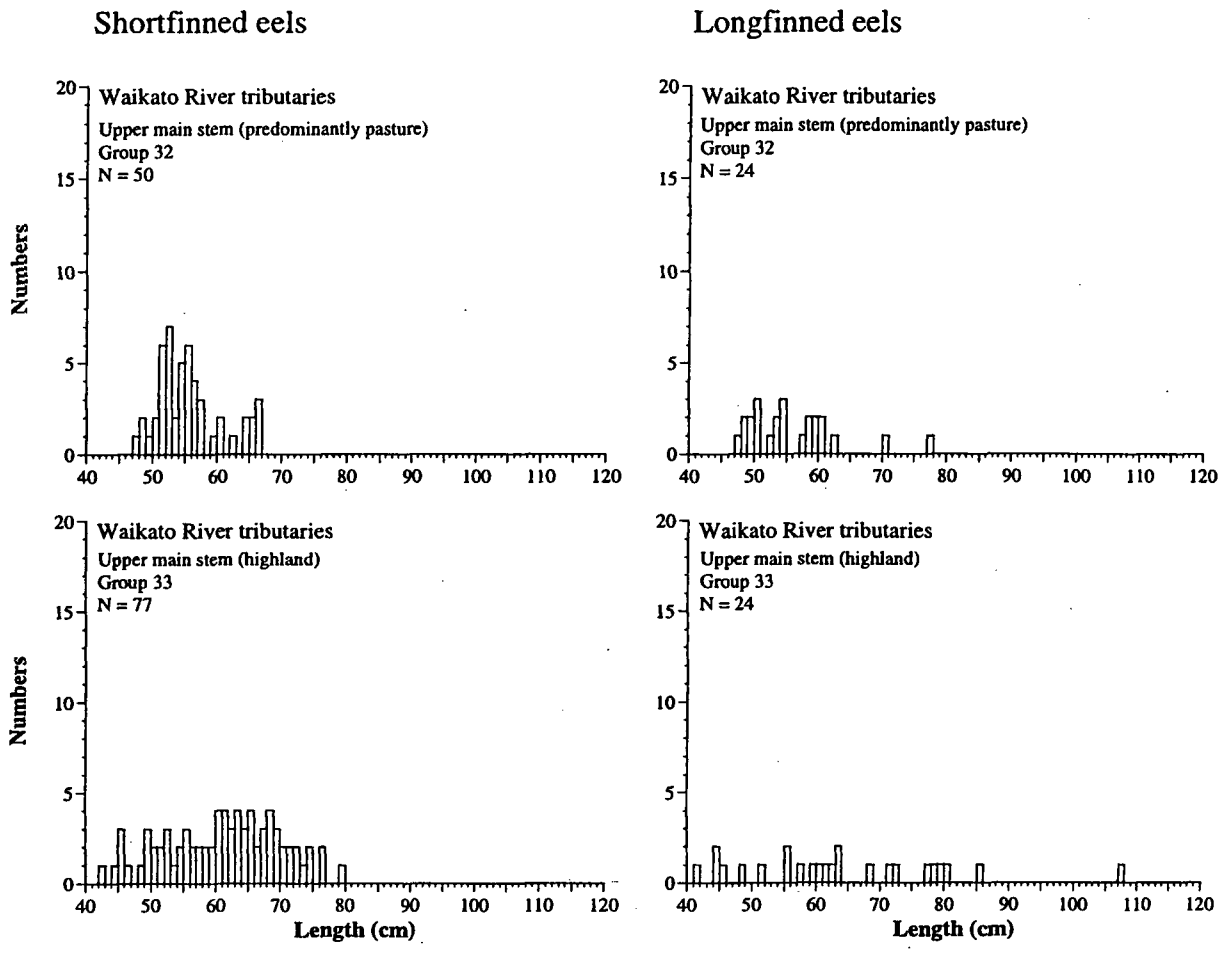


Figure 12: Length distribution of Waikato shortfin and longfin eels; upper catchment of Waikato river tributaries.

Waikato

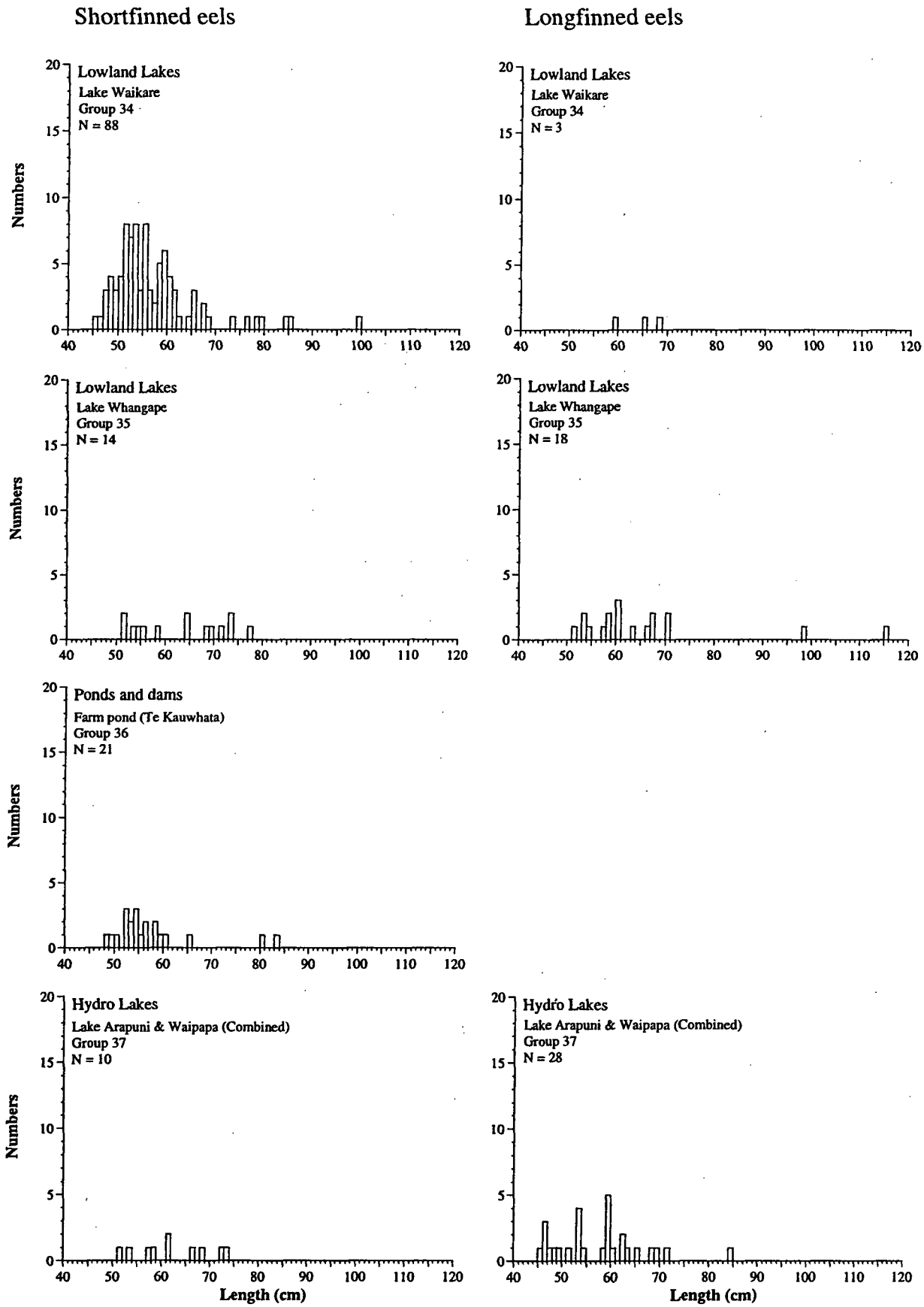


Figure 13: Length distribution of Waikato shortfin and longfin eels; lowland lakes, ponds and dams and Waikato river hydro lakes.

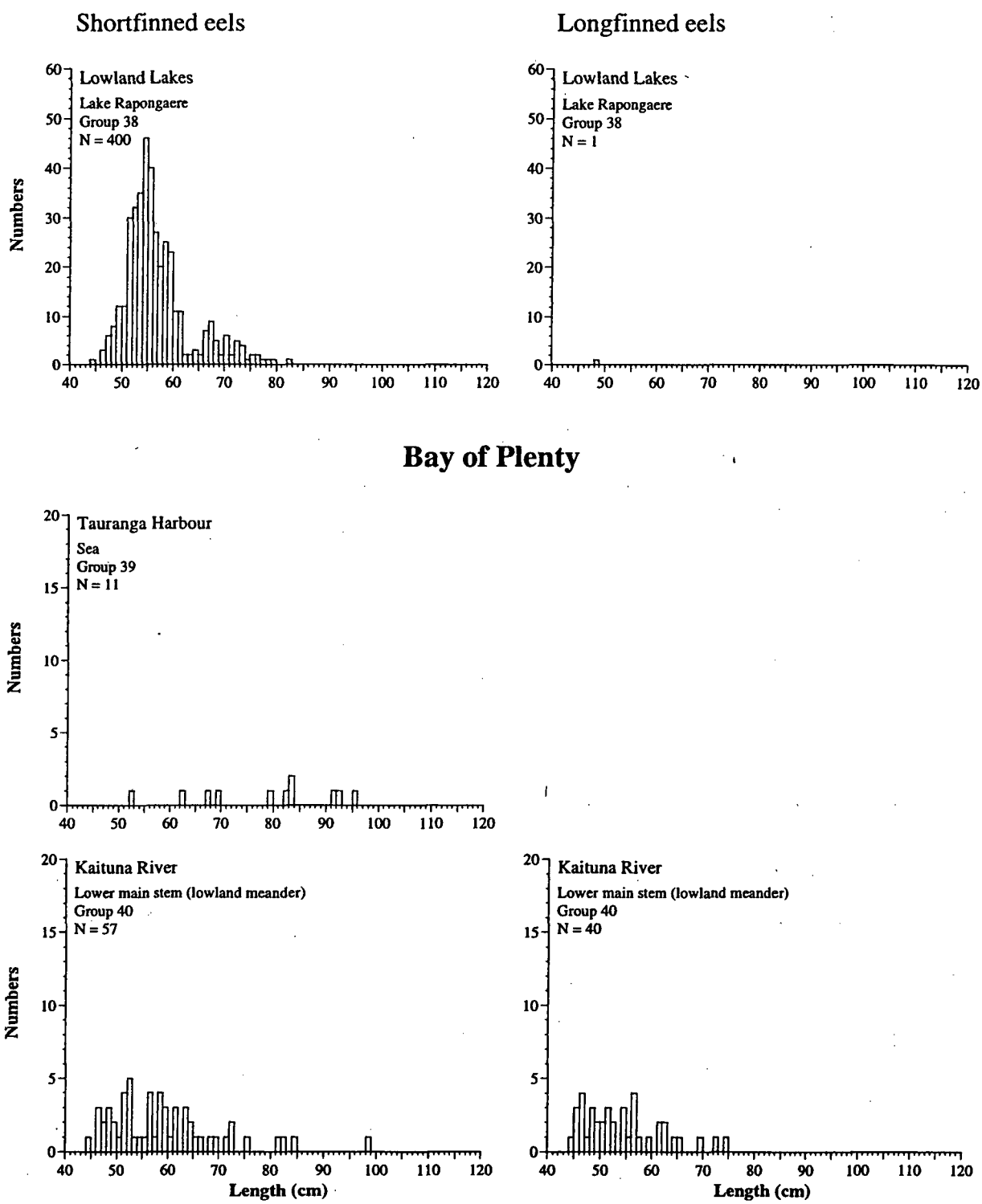
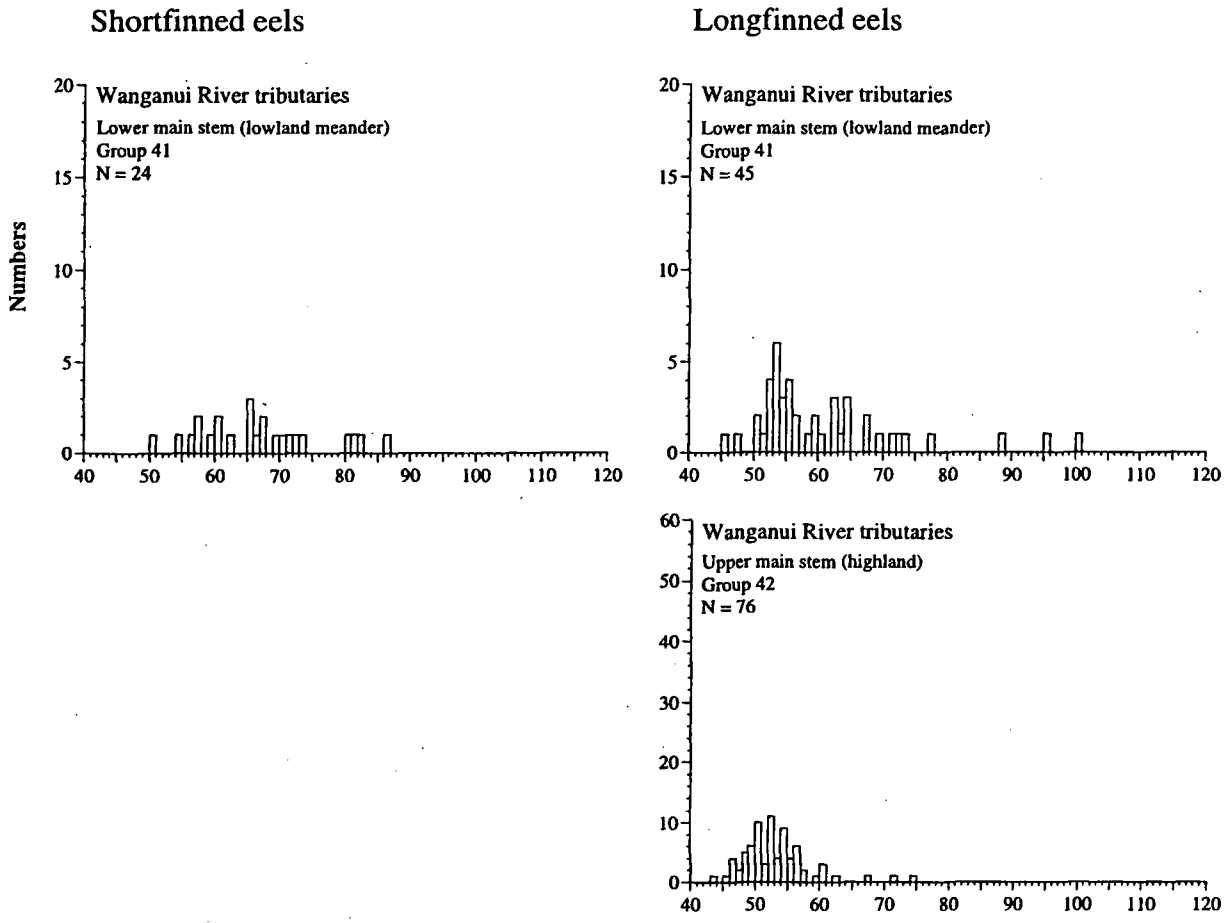


Figure 14: Length distribution of East Cape - Hawkes Bay and Bay of Plenty shortfin and longfin eels; lowland lakes, sea and lower river

Taranaki



Manawatu

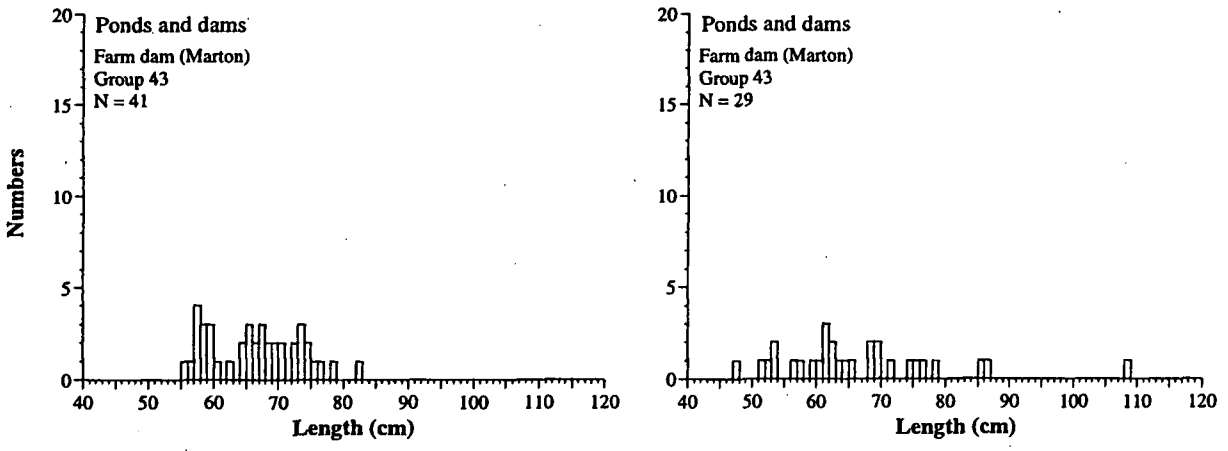


Figure 15: Length distribution of Taranaki and Manawatu shortfin and longfin eels; Wanganui river tributaries, lowland and ponds and dams.

Marlborough

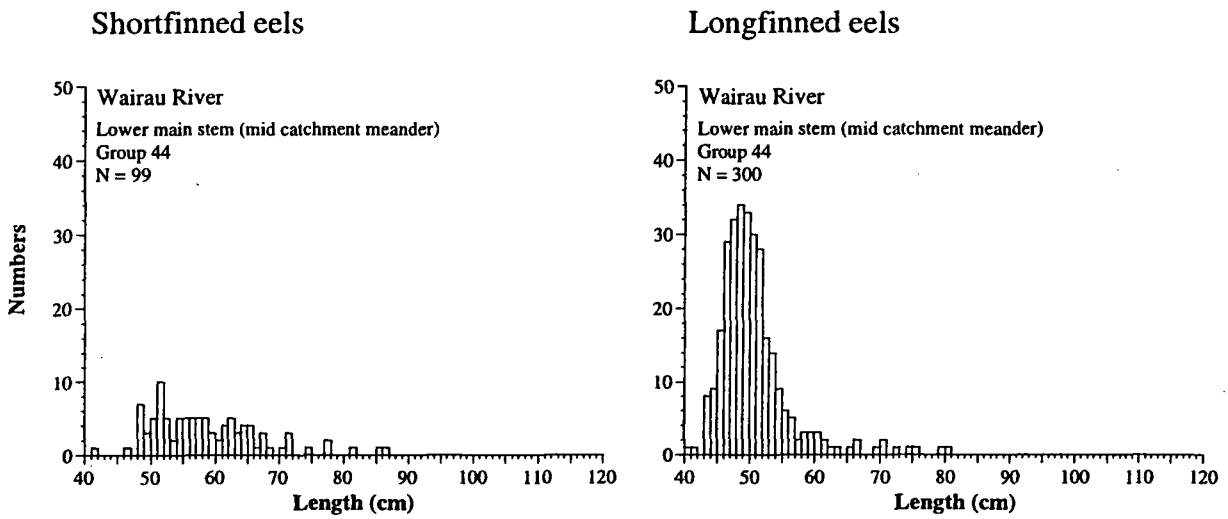


Figure 16: Length distribution of Marlborough shortfin and longfin eels; Wairau river lowland.

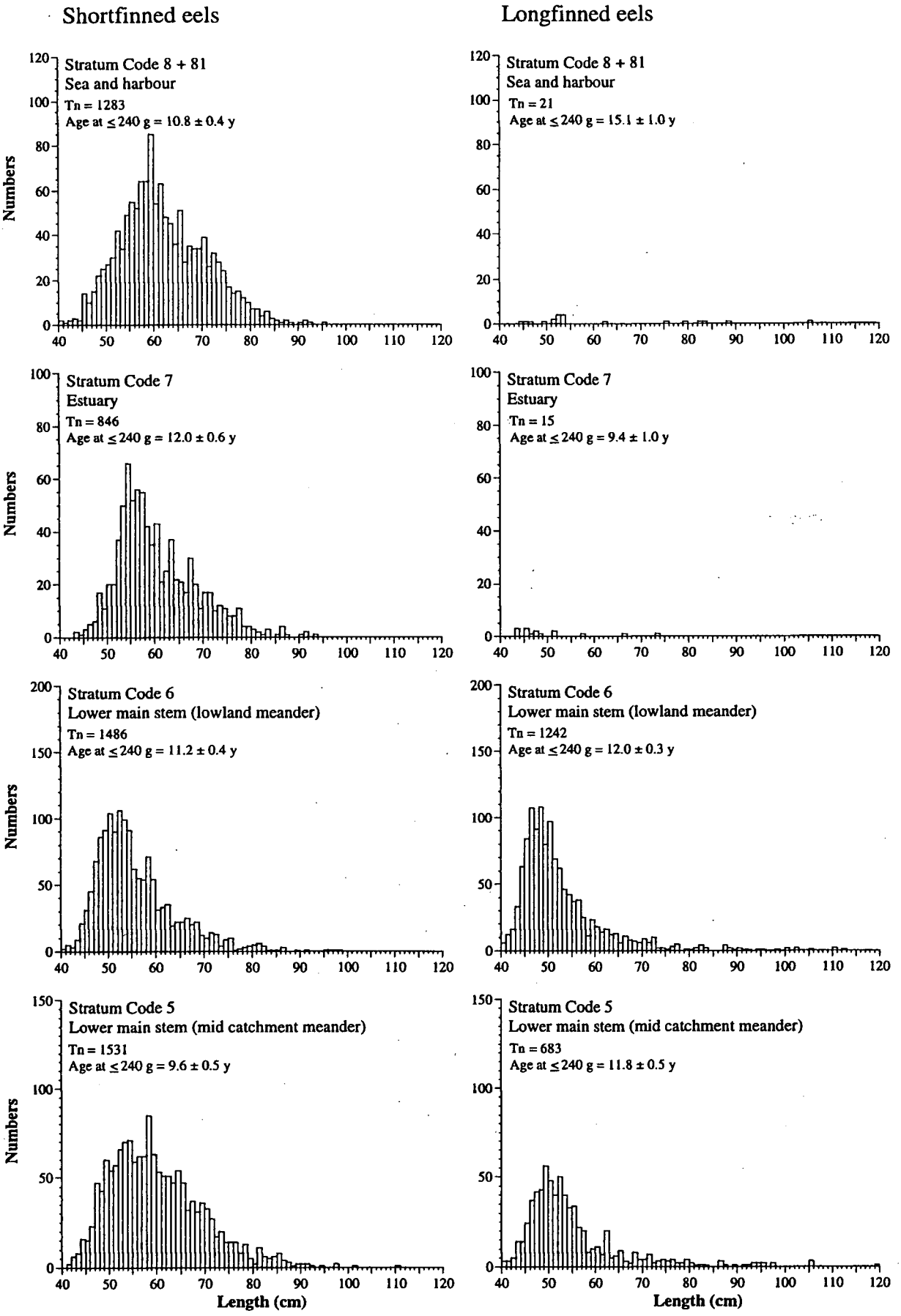


Figure 17: Length distributions and mean age at ≤ 240 g in years ± s.e. of all North Island eels sampled from landings during 1995-1998; from the sea to mid catchment. Tn, total number measured.

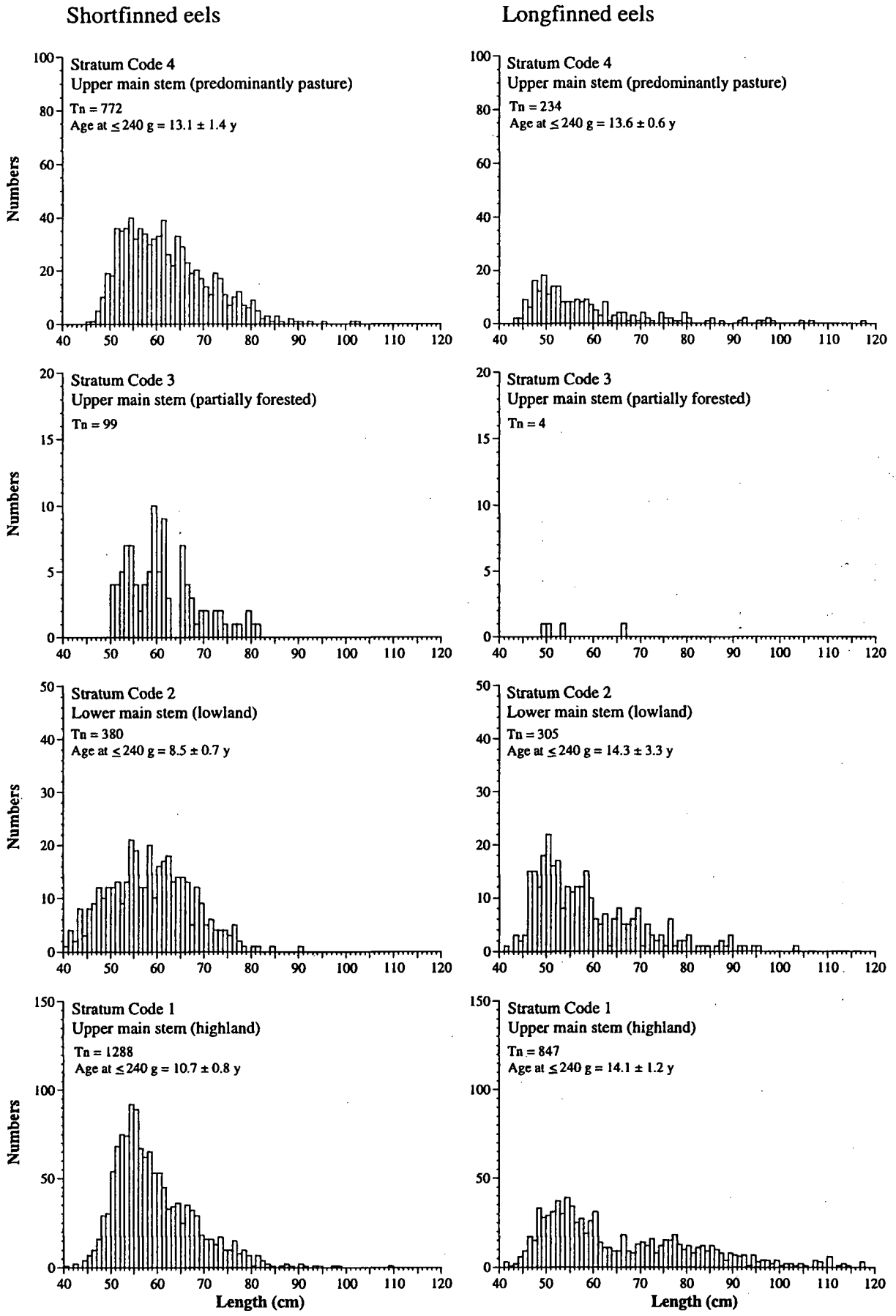


Figure 18: Length distributions and mean age at ≤ 240 g in years ± s.e. of all North Island eels sampled from landings during 1995-1998; upper main stem of rivers to upper main stem of minor tributaries. Tn, total number measured.

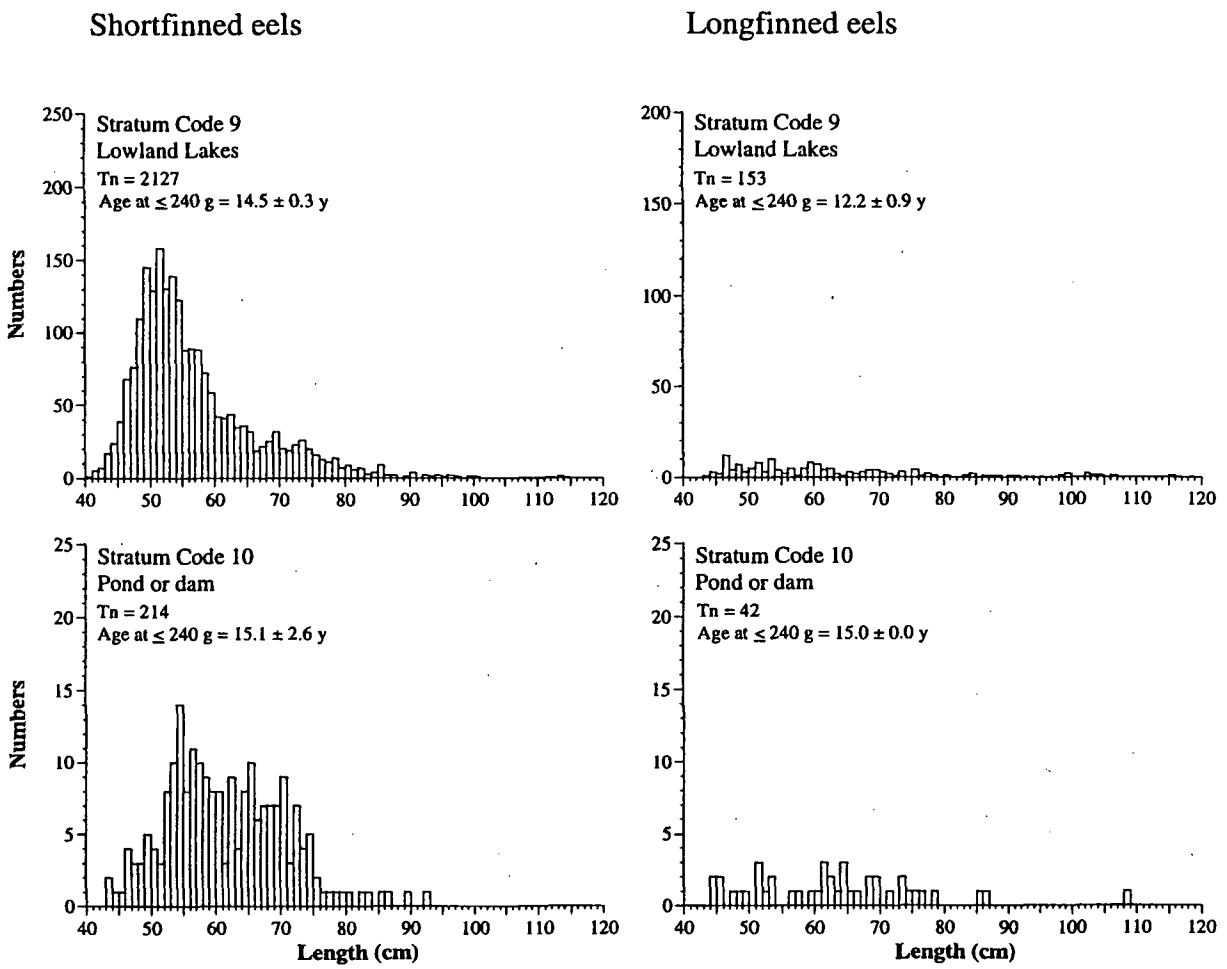


Figure 19: Length distributions and mean age at ≤ 240 g in years ± s.e. of all North Island eels sampled from landings during 1995-1998; lowland lakes and ponds or dams. Tn, total number measured.

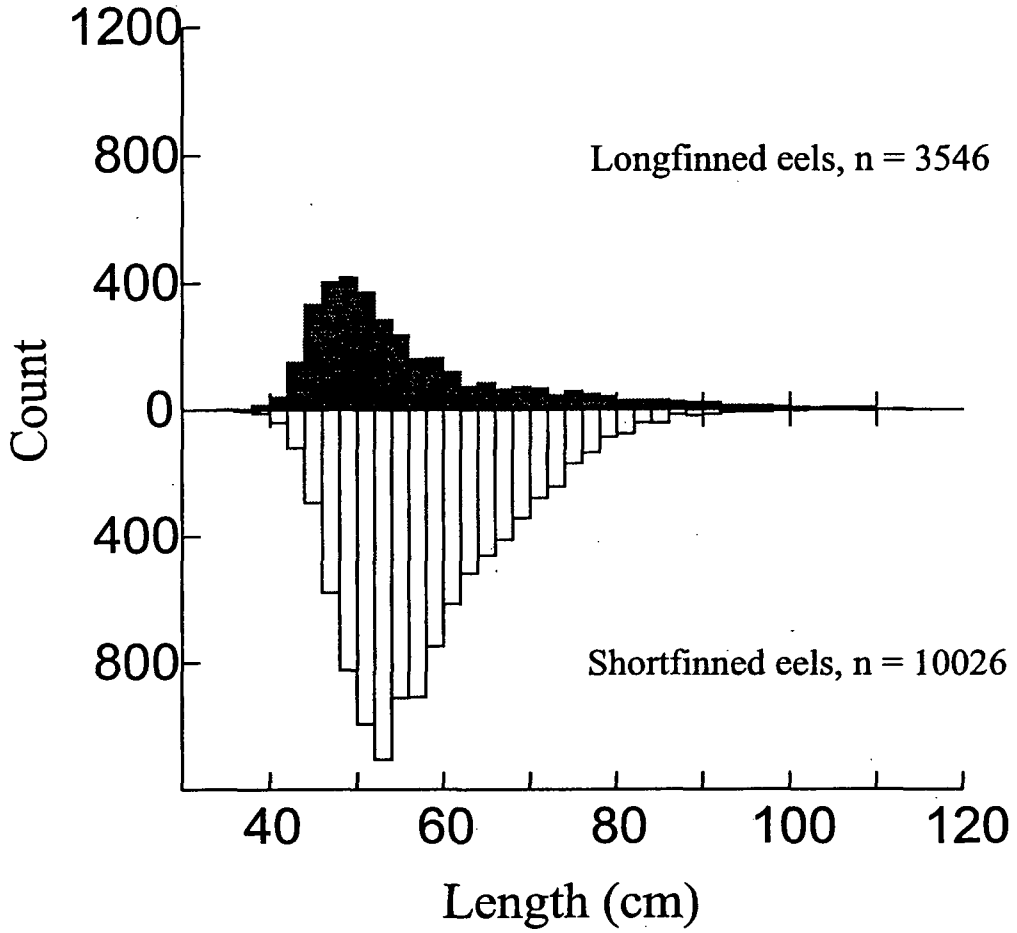


Figure 20: Length distributions of shortfinned and longfinned eels sampled from North Island landings 1995-1998 (excluding 2 landings from the South Island).