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EXECUTIVE SUMMARY

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The commercial eel monitoring programme began in 2003–04 with the aim of capturing processor recorded data on size grades, species composition, and catch location from individual landings throughout New Zealand. This report provides results from 2005–06 and 2006–07. In the North Island virtually all freshwater eel (longfin, *Anguilla dieffenbachii*; shortfin, *A. australis*) landings in the 2005–06 and 2006–07 fishing years were provided together with detailed location data. South Island data were provided for the first time in 2006–07 for ANG 15 only, with no details of catch location other than that all landings were from ANG 15 (Southland/Otago). The South Island processor's historical database summarising annual processed landings by size grades for each species from the mid 1970s was updated.

North Island

In 2005–06, data from 103 t (23.5%) of longfin and 335 t (76.6%) of shortfin from 1260 landings were provided by processors (88% of North Island total reported catch for 2005–06). Estimated eel numbers were 182 000 (21.4%) longfins and 668 000 (78.6%) shortfins. Mean weight estimates of individual eels were 0.501 kg for shortfin and 0.563 kg for longfin. The proportion of large shortfins (over 1000 g) by weight was 14–17%, and 5–7% by eel numbers. For longfin about 38% by weight were from the large size grades (over 1000 g or 1200 g) and 12–15% by eel number. Data are presented by three geographical levels of scale (4 QMAs, 12 ESAs, and 65 ESA subareas). Differences in size distributions of each species, and species composition by area, are described.

In 2006–07, data from 100 t (22.8%) of longfin and 339 t (77.2%) of shortfin from 1304 landings were provided by processors (99.6% of North Island total reported catch for 2006–07). Estimated eel numbers were 177 000 (20.3%) longfins and 697 000 (79.7%) shortfins. Mean weight estimates of individual eels were 0.486 kg for shortfin and 0.563 kg for longfin. The proportion of large shortfins (over 1000 g) by weight was about 13%, and 5% by eel numbers. For longfin about 40% by weight were from the large size grades (over 1000 g or 1200 g) and 14% by eel number. Data are presented by three geographical levels of scale (4 QMAs, 12 ESAs, and 65 ESA subareas). Differences in size distributions of each species, and species composition by area are described.

The data show a trend of progressively increasing size in both longfin and shortfin from 2001–02 to 2006–07 for the New Zealand Eel Processing Co. data, and in longfin for the Aotearoa Fisheries (AFL) data. There was no trend in the overall percent of the catch by species for either processor from 2001–02 to 2006–07 and the longfin average over this period was 20% and 30% for New Zealand Eels and AFL, respectively. The proportion of longfin in the catch is about 10 to 20% less today than in the mid 1970s to mid 1980s.

South Island

In 2006–07, data from 64 t (78.5%) of longfin and 17 t (21.5%) of shortfin from 300 landings were provided by Mossburn Enterprises (102% of ANG 15 total reported catch for 2006–07). Estimated eel numbers were 130 000 (80.3%) longfins and 32 000 (19.7%) shortfins. Mean weight estimates of individual eels were 0.549 kg for shortfin and 0.492 kg for longfin. The proportion of large shortfins (over 800 g) by weight was about 47%, and 22% by eel numbers. For longfin about 28% by weight were over 1000 g and 13% by eel number.

The Mossburn Enterprises historical data indicate that the average size of both longfin and shortfin in the South Island has progressively declined over the last 33 years, and is now based on eels in the smallest processed size grade (under 450 g). The inclusion of the most recent data from 2006–07, confirms that there has been little change since the 1990s, for either species. The proportion of longfin eels processed in the South Island declined from about 90% in the 1970s to about 60% in the early 1990s and it has since been stable (average for 2000s is 60%).

1. INTRODUCTION

Results of the commercial eel monitoring programme for the fishing years 2005–06 and 2006–07 on size grades, species composition, and catch location of landings from New Zealand eel processors are presented. In addition, the key South Island eel processor's historical records of species composition and size grade proportions are updated by including 2006–07 data to the time series which began in the mid 1970s.

1.1 The fishery

The commercial freshwater eel fishery in New Zealand developed in the late 1960s and landings consist of both the endemic longfin eel (Anguilla dieffenbachii), and the shortfin eel (A. australis) which is also found in southeast Australia. Landings from the north of the North Island can include the occasional Australian longfin eel (A. reinhardtii). Total New Zealand eel catches peaked in 1972 at about 2100 t (Figure 1) and from 1972 to 1999 catch fluctuated somewhat, but there was no clear trend with an annual average catch of about 1300 t. Since 1999, however, New Zealand catches have progressively declined with about 730 t landed in 2006-07 (Ministry of Fisheries 2008). Breakdown of the catch by island and species since 1984 indicates that the North Island contributes, on average, about 65% of the total New Zealand eel catch (Figure 1). In the North Island, shortfin has consistently been the dominant species representing, on average, about 66% of the catch. Catches of both longfin and shortfin have declined — longfin from 1990-91 and shortfin after 1995-96 (Figure 1). In the South Island since 1984 there has been little difference between longfin and shortfin catches, but over the last 10 years shortfin landings have slightly exceeded those of longfin. Both South Island shortfin and longfin catches have declined since about 1993–94, although the decline has been most marked for longfin, while shortfin catch has been remarkably consistent since 2000-01 (Figure 1). The trend of declining catches preceded the introduction of eels into the Quota Management System (QMS) in both the North and South Islands.

The South Island eel fishery was introduced into the Quota Management System (QMS) on 1 October 2000 and Total Allowable Commercial Catches (TACC) were set in six Quota Management Areas (QMA) (ANG 11 to ANG 16) for both species combined (Table 1, Figure 2). TACCs have been consistently undercaught in all South Island QMAs, with the exception of ANG 13 (Te Waihora), which was 100% caught in 2003–04, 2004–05, and 2005–06 (Ministry of Fisheries 2008). The combined South Island TACC (420 t) has been between 65 and 75% caught over the last six years. The North Island eel fishery was introduced into the QMS four years later on 1 Oct 2004 with four separate QMAs each for shortfin and longfin (SFE 20–23 and LFE 20–23). The total North Island TACC for both species was set at 650 t, and in the first three years the combined TACC was 66%, 76% 68% caught – the only individual area and species TACC close to being caught was SFE 22 in 2005–2006 (99% caught). The North Island TACC was reduced to 418 t on 1 October 2007.

1.2 Research

1.2.1 Programmes

Understanding of the sustainability of the eel fishery, until recently, was based mainly on interpretation of annual catch data, knowledge of the biology of the two species, and reports from processors and fishers on catch composition and catch rates. In recent years, data have been collected from commercial catch sampling programmes (Beentjes 1999, 2005, Beentjes & Chisnall 1997, 1998, Speed et al. 2001), monitoring recruitment of elvers and glass eels (Boubée et al. 2002, Jellyman et al. 2000), and the current programme of collating size-grade, species composition and catch location from commercial landings (Beentjes 2005, 2008). Studies have also provided a method of estimating longfin eel biomass in New Zealand rivers based on physical variables such as river gradient and flow (Graynoth & Niven 2004). Analyses to assess the New Zealand eel stocks include ongoing catch-per-

unit-effort (CPUE) analyses (Beentjes & Bull 2002, Beentjes & Dunn 2003a, 2003b, 2008), and most recently, modelling the longfin fishery in Southland (Dunn et al. in press). The sustainability of the fishery under current levels of harvest is unknown (Ministry of Fisheries 2008).

1.2.2 Research findings

The commercial eel catch sampling programme included landings from throughout New Zealand over three consecutive years between 1995–96 and 1997–98 (Beentjes 1999, Beentjes & Chisnall 1997, 1998), in 1999–2000 (Speed et al. 2001), and most recently in 2003–04 (Beentjes 2005). The results showed that size and sex composition of longfins have been significantly altered compared to shortfin. Longfin populations in the more heavily fished mainstem rivers, such as those in the lower South Island, had a strongly unimodal size structure with mean length about 50 cm, and were predominantly male. Eels sampled from tributaries and lightly fished areas, however, were considerably larger and tended to be predominantly female. Sampling also provided information on the age structure of the eel populations throughout the country, indicating a high degree of variability within and among catchments.

Catch effort data from throughout New Zealand for 1990–91 to 1998–99 showed a general decline in CPUE for longfin eels (Beentjes & Bull 2002), and subsequent analyses (up to 2002–03) reaffirmed these trends (Beentjes & Dunn 2003a, 2003b). The most recent analyses, comprising data up to 2005–06 for the South Island, however, indicate a general reversal of the declining trend in CPUE (Beentjes & Dunn 2008). North Island CPUE up to 2006–07 is being analysed (unpublished results).

The age structured stock assessment population model (using CASAL) for the Southland longfin eel fishery was the first attempt at using these and other available data to model this fishery (Dunn et al. in press). Two spatial model structures were investigated — single-area and two-area. The single-area models include only the fished part of the eel population and ignore eels in areas closed to fishing. The two-area models assume a constant proportion of recruitment to a closed area. Exploitation rate in 2005–06 was estimated at 30%. Current biomass in fished areas was estimated at about 25–38% of virgin biomass. Current spawning stock biomass (SSB) (both sexes) was estimated at about 21% of the pre-exploitation value in fished areas (single area model). When only female biomass was used as an index of spawning stock state, the current SSB was estimated at only 5% of pre-exploitation levels in a single-area model, and 20–25% in a two-area model. Deterministic model projections to 2106 suggested that at current catches, the SSB estimates from most models stayed at similar levels or declined slightly. Further work is proposed to extend this model to the entire New Zealand longfin fishery.

The most comprehensive data sets of eel processors' historic records of species composition and size grades for both North Island and South Island indicate a clear and progressive trend of declining size from the 1970s through to the 1990s for both eel species (Beentjes 2005, Beentjes & Chisnall 1997). There was also a general decline in the proportion of longfinned eels in the landed catches over time.

The size grade, species composition, and location data provided in the first two years (2003–04 and 2004–05) of the commercial eel monitoring programme have been only from the North Island. Data include landing weights, size distributions, and species composition by QMA, eel statistical area (ESA), and the finer scale eel statistical subarea (= general catchment level). Overall, about 73% of the landed weight of eels was shortfin. About 9 to 14% of the shortfin landed weight and more than one-third of longfin landed weight was contributed by eels in the largest size grades (over 1000 g). Based on size at maturity, eels in the largest longfin size grade are exclusively female.

1.3 Objectives

Overall objective

1. To monitor size and species composition of commercially processed eels.

Specific objective

1. To monitor size and species of eels by recording quantities in the different commercial size grades and link this to catch location.

The requirement of this project was to collect data for the 2005–06 and 2006–07 fishing years.

2. METHODS

2.1 Size, species composition, and catch location

2.1.1 North Island

Data were collected in 2005–06 and 2006–07 in the North Island from two processors, New Zealand Eel Processing Co. Limited (New Zealand Eel) (Te Kauwhata) and Aotearoa Fisheries Limited (AFL) (Whenuapai). Together, these companies process about 90% of North Island eel landings. In the factory the catch from each landing is sorted into species (shortfin and longfin) and visually graded by size before weighing, i.e., eels are sorted into weight grades by eye and a total weight of each species in each grade is recorded. The size grades are processor specific, and are usually determined by market demands, although they have varied little since 2001–02. New Zealand Eel grade and record weights of longfin at 200–500 g (changed to 300–500 g in July 2006), 500–1200 g, and over 1200 g, and weights of shortfin at 200–500 g, 500–1000 g, and over 1000 g; AFL grade and record weights of longfin and shortfin 220–500 g, 500–1000 g, and over 1000 g.

The species weight grade information for each landing, including catch location, is recorded on customised landing record forms by the processor. Catch location is recorded at the catchment level (or part thereof). This was achieved by subdividing the 12 North Island ESAs (Table 1, Figure 3) into 65 ESA subareas, broadly equivalent to catchments (Appendices 1 and 2). ESAs were divided into between 2 and 6 subareas except ESA 4, which has 17 subareas (Table 2). Maps with the subareas marked were provided to each processor. Landings with catch taken from more than one subarea were prorated across the respective areas (e.g., Area 9A, 60%; 9B, 30%; 9E, 10%), although this occurred infrequently. Data were provided to NIWA on a monthly basis for checking, collation, and entry onto a customised database.

For each fishing year (2005–06 and 2006–07) and species, catch from both processors combined were plotted by subarea, ESA, and Quota Management Area. Data were also expressed as species composition (proportion of each species). The QMAs for the North Island eel fishery are QMA 20 (ESAs 1 and 2), QMA 21 (ESAs 3–6), QMA 22 (ESAs 7 and 10–12), and QMA 23 (ESAs 8 and 9). Size grade data were analysed separately for each processor and species because of the different longfin size grades used by the two processors and also because these processors tend to take landings from different geographical areas.

Numbers of eels landed in each weight grade are not recorded, but were estimated as follows: length frequency data from the North Island catch sampling programme in 1995–96, 1996–97, and 1997–98 (Beentjes 1999, Beentjes & Chisnall 1997, 1998) were extracted from the *market* database for each species and scaled by landed weight using the NIWA catch-at-age program (Bull & Dunn 2002) (Figure 4). We assume that this is a reasonable representation of the overall size distribution of the North Island longfin and shortfin eel populations. The scaled length frequency data were then plotted as cumulative distributions and the weight grades converted to the equivalent length grades using the length weight relationship taken from the South Island catch sampling programme where length weight sampling was comprehensive (longfin a = 0.0013, b = 3.19; shortfin a = 0.0016, b = 3.1). The length corresponding to the

mid point (cumulative percent) of each length grade range was determined and then converted back to a weight (mid-point weight). The total landed weight in each size grade was then divided by the mid-point weight to provide an estimate of numbers of eels in each weight grade (Figure 5). Mid-point lengths and weights for size grades are shown in Table 3. The 4 kg limit which came into effect in the North Island in March 2007 (i.e., half way through the 2006–07 fishing year) was ignored for the purpose of this analysis.

In this report eel statistical areas (ESAs) are referred to by the numeric code (1-12) to be consistent with previous reports (see Table 1 for equivalent alpha codes).

2.1.2 South Island

Collection of size grade data in the South Island, as part of this programme, was carried out for the first time in 2006–07 by Mossburn Enterprises Limited (Kennington, Invercargill). However, this included landings only from ANG 15 (Otago–Southland, see Figure 2) and detailed catch location was not provided, as it was in the North Island. All catches in ANG 15 are landed into Mossburn Enterprises.

As in North Island factories, the catch from each landing was sorted into species (shortfin and longfin) and visually graded by size before weighing, i.e., eels are sorted into weight grades by eye and a total weight of each species in each grade is recorded. The size grades used by Mossburn Enterprises for longfin were 220–1000 g, 1000–1500 g, and 1500–4000 g. The upper limit of 4000 g in the largest longfin grade and represents the maximum legal size limit in the South Island. For shortfin the size grades were 220–800 g and over 800 g. These size grades tend to be based on the live export market.

The ANG 15 data were plotted as percent weight and percent numbers in each size grade for each species. Species composition was also plotted by weight and numbers. Numbers of eels were estimated from the North Island scaled length frequency data using the methods described above (not illustrated). Scaled length frequency data from ANG 15 collected during the South Island catch sampling programmes were not used in the estimate of numbers because landings were sampled predominantly from heavily fished main stems, and tended to contain smaller eels on average than had all landings or a random selection been sampled. The 4 kg limit for the South Island was taken into account for this analysis and the maximum size of eels was set at 108 cm which is approximately equivalent to 4000 g.

2.2 South Island historic size grades

Distinct from the commercial eel monitoring programme, summary data comprising the proportion of the total processed annual catch within specific size grades, and species composition, were provided by Mossburn Enterprises for 2006–07. These data were included and analysed with previous historical data from Mossburn that dates back to the mid 1970s (1974–75, 1977–78, 1978–79, and 1983–84 to 2005–06). Current analyses update those carried out in 1997 (Beentjes & Chisnall 1997), 2005 (Beentjes 2005), and 2007 (Beentjes 2008). The proportion of the catch in each size grade was first calculated for each species separately, and for each decade the mean proportion and standard errors in each size grade were determined. These data are pooled and presented by decade (1970s, 1980s, 1990s, and 2000s). These data were provided to NIWA as proportions of total weight of eels in each size grade, and contain no information on individual landings or catch location, but represent the bulk of landings from the South Island, with limited landings from Te Waihora.

The same size grades, recorded in imperial units (lbs), were used until 1995 for longfins and 1996 for shortfins after which there was amalgamation of some large grades, partly as a result of live export of large eels and market demands. For consistency, all data are converted to the size grades used since 1995 where some grades have been amalgamated into plus groups. For analysis and presentation, pounds were converted to metric units (g) and rounded.

3. RESULTS

3.1 Size, species composition, and catch location

3.1.1 North Island (2005–06 fishing year)

3.1.1.1 Landings and catch

Total landings, tonnages, sampling proportion, and species composition from North Island processors between 2003–04 and 2006–07 are shown in Table 4. Total North Island catch in 2005–06 included 103 t (23.5%) of longfin and 335 t (76.5%) of shortfin from 1260 landings. Comparison of reported landings (Ministry of Fisheries 2008) and those provided to NIWA indicates that 88% of landed catch was included in the analyses.

Total landings, estimated number of eels, and species composition from North Island processors between 2003–04 and 2006–07 are shown in Table 5. Total North Island eel numbers in 2005–06 included about 182 000 (21.4%) longfins and 668 000 (78.6%) shortfins from 1260 landings. Mean weight of individual eels in 2005–06 was estimated at 0.501 kg for shortfin and 0.563 kg for longfin (Table 6).

3.1.1.2 Catch location

The catch (t) of each species by subarea, ESA, and QMA is shown in Figures 6, 7, and 8 respectively. Catch was landed from a total of 56 of the 65 North Island subareas (86%), and 1 landing from unspecified locations. On a broadscale, 41% of the catch was landed from QMA 21, 25% from each of QMA 20 and QMA 22, with only 9% from QMA 23 (Figure 8). The major contributors, in order, were ESA 4 (Waikato), ESA 1 (Northland), ESA 3 (Hauraki), and ESA 7 (Hawke's Bay) (Figure 7) providing a combined 63% of the catch. At the fine scale the subareas that contributed relatively large proportions of the catch (over 20 t) included 1D (Dargaville), 3A–3C (Hauraki Plains, Coromandel Peninsula), 4J (Pirongia Forest Park), 4L (Lake Waikare/Port Waikato), 7E (Tukituki River), 10A (Manawatu River coast), and 11A (Lake Wairarapa) (Figure 6).

3.1.1.3 Species composition

Overall North Island species composition in 2005–06 was 23.5% longfin and 76.5% shortfin. The species composition by subarea, ESA, and QMA is shown in Figures 6, 7, and 8, respectively. At the QMA level, shortfin were dominant in all QMAs (QMA 20, 80%; QMA 21, 79%; QMA 22, 78; QMA 23, 59%) (Figure 8). Species composition expressed by ESA indicates that shortfin dominated catches in all areas except ESA 12, where longfin made up 63% of the catch, albeit the catches were small. In all other ESAs shortfin made up between 51% and 91% of the catch (Figure 7). At the subarea level, shortfin were dominant in 44 of 57 (77%) sub-areas and particularly in Northland, and Waikato subareas catchments that drain into the Waikato River (Figure 6). In contrast, the western draining sub-areas of the Waikato, Rangitikei/Wanganui, and particularly Taranaki tended to be dominated by longfin. Despite catches being dominated by longfin from these areas, catches were relatively small.

3.1.1.4 Size composition

New Zealand Eel Processing Co. Ltd

Shortfin – shortfin eels processed by New Zealand Eel in 2005–06 were sourced from 31 subareas, 9 ESAs, and all 4 QMAs (Figure 9). The overall proportions of shortfin in the three size grades were 56%, 30%, and 14% for the 220–500 g, 500–1000 g, and over 1000 g grades, respectively. The equivalent proportions by eel numbers were 74%, 21%, and 5% (Table 7). The shortfin size composition was reasonably consistent among QMAs, although the smallest eels overall were from QMA 20 and the largest from QMA 22. Size composition was also generally similar among ESAs, although overall the largest eels were from ESA 3 and the smallest from ESA 2 (Figure 9). There was more variation in size among the subareas, although the Waikato subareas generally yielded similar size proportions with a consistently high proportion of small eels in the landings.

Longfin – longfin eels processed by New Zealand Eel in 2005–06 were sourced from 30 subareas, 9 ESAs, and all 4 QMAs (Figure 10). The overall proportions of longfin in the three size grades were 45%, 17%, and 38% for the 220–500 g, 500–1200 g, and over 1200 g grades, respectively. The equivalent proportions by eel numbers were 74%, 14%, and 12% (Table 8). The longfin size composition by QMA shows that QMAs 22 and 23 had the highest proportion of larger eels, and QMA 20 and 21 the lowest. ESAs 1 to 5 had the highest proportion of small eels and ESAs 6 and 7 the largest eels. Eels in ESAs 8 and 9 were intermediate in size. There was a wide variation in size grade composition among the 30 subareas, but eels were generally smallest in subareas of ESA 4 that drain into the Waikato River, Northland and Hauraki. In contrast, longfins from subareas from ESAs 6 to 9 were the largest.

Aotearoa Fisheries Ltd

Shortfin – shortfin eels processed by AFL in 2005–06 were sourced from 44 subareas (2 of which are unknown), all 12 ESAs, and all 4 QMAs (Figure 11). The overall proportions of shortfin in the three size grades were 51%, 32%, and 17% for the 220–500 g, 500–1000 g, and over 1000 g grades, respectively. The equivalent proportions by eel numbers were 70%, 23%, and 7% (see Table 7). Shortfin eels were markedly smaller in QMA 21 than in the other QMAs, increasing in size in the order QMA 20, QMA 23, and QMA 22. Size composition was variable among ESAs although overall smallest eels were from ESAs 4 and 9 and largest from ESA 7 (Figure 11). There was considerably more variation in size among the subareas, although the Waikato subareas generally yielded high proportions of small eels, whereas those subareas of ESAs 7 and 8 had larger eels.

Longfin – longfin eels processed by AFL in 2005–06 were sourced from 43 subareas (2 unknown), all 12 ESAs, and all 4 QMAs (Figure 12). The overall proportions of longfin in the three size grades were 43%, 19%, and 38% for the 220–500 g, 500–1200 g, and over 1000 g grades, respectively. The equivalent proportions by eel numbers were 70%, 15%, and 15% (Table 8). The longfin size composition by QMA shows that QMAs 22 and 23 had the highest proportion of larger eels, and QMAs 20 and 21 the lowest. ESAs 2 to 5 had the highest proportion of small eels and ESA 8 the largest eels. There was a wide variation in size grade composition among the subareas, but eels were generally smallest in subareas of ESAs 2 and 3 and were the largest in subareas from ESAs 6 to 9.

3.1.2 North Island (2006–07 fishing year)

3.1.2.1 Landings and catch

Total landings, tonnages, sampling proportion, and species composition from North Island processors between 2003–04 and 2006–07 are shown in Table 4. Total North Island catch in 2006–07 included 100 t (22.8%) of longfin and 339 t (77.2%) of shortfin from 1304 landings. Comparison of reported landings (Ministry of Fisheries 2008) and those provided to NIWA indicates that 99.6% of landed catch were included in the analyses.

Total landings, estimated number of eels, and species composition from North Island processors between 2003–04 and 2006–07 are shown in Table 5. Total North Island eel numbers in 2005–06 included about 177 000 (20.3%) longfins and 697 000 (79.7%) shortfins from 1340 landings. Mean weight of individual eels in 2006–07 was estimated at 0.486 kg for shortfin and 0.563 kg for longfin (see Table 6).

3.1.2.2 Catch location

The catch (t) of each species by subarea, ESA and QMA is shown in Figures 13, 14, and 15 respectively. Catch was landed from a total of 53 of the 65 North Island subareas (81%), and 1 landing was from unspecified locations. On a broad-scale, QMAs 20, 21, and 22 contributed similar catches (30%, 33%, and 27%) whereas QMA 23 contributed only 10% of the catch (Figure 15). The major contributors, in order, were ESA 1 (Northland), ESA 4 (Waikato), and ESA 7 (Hawke's Bay)) providing a combined 51% of the catch (Figure 14. At the fine scale the subareas that contributed relatively large proportions of the catch (over 20 t) included 1D (Dargaville), 2C (Manukau Harbour), 4L (Lake Waikare/Port Waikato), 7E (Tukituki River), 10A (Manawatu River coast), and 11A (Lake Wairarapa) (Figure 13).

3.1.2.3 Species composition

Overall North Island species composition in 2006–07 was 23% longfin and 77% shortfin. The species composition by subarea, ESA, and QMA is shown in Figures 13, 14, and 15, respectively. At the QMA level, shortfin were dominant in all QMAs (QMA 20, 78%; QMA 21, 79%; QMA 22, 78%; QMA 23, 67%) (Figure 15). Species composition expressed by ESA indicates that shortfin dominated catches in all areas except ESA 9, where longfin made up 82% of the catch. In all other ESAs (excluding unknown) shortfin made up between 71% and 86% of the catch (Figure 14). At the subarea level, shortfin were dominant in 42 of 53 (77%) sub-areas, and particularly in Northland, Hauraki, and Waikato subarea catchments that drain into the Waikato River (Figure 13). In contrast, the western draining sub-areas of the Waikato, Whakatane River, Ohiwa Harbour, Taumaranui, Castle Point, Rangitikei/Wanganui, and particularly Taranaki tended to be dominated by longfin. Despite catches being dominated by longfin from these areas, catches were relatively small.

3.1.2.4 Size composition

New Zealand Eel Processing Co. Ltd

Shortfin – shortfin eels processed by New Zealand Eel in 2006–07 were sourced from 24 subareas, 8 ESAs, and all 4 QMAs (Figure 16). The overall proportions of shortfin in the three size grades were 59%, 28.5%, and 12.5% for the 220–500 g, 500–1000 g, and over 1000 g grades, respectively. The equivalent proportions by eel numbers were 76%, 20%, and 5% (see Table 7). The shortfin size composition was reasonably consistent among QMAs 20 to 22 but eels were markedly larger from QMA 23, particularly those of medium size. Size composition was generally similar among ESAs, although overall largest eels were from ESAs 3 and 8, and smallest from ESAs 1 and 6 (Figure 16). There was more variation in size among the subareas, with the smallest eels from subarea 1B and those subareas in ESA 4 that drain into the Waikato River near the mouth. The largest eels were from 4Q.

Longfin – longfin eels processed by New Zealand Eel Processing in 2006–07 were sourced from 24 subareas, 8 ESAs, and all 4 QMAs (Figure 17). The overall proportions of longfin in the three size grades were 40%, 19%, and 41% for the 220–500 g, 500–1200 g, and over 1200 g grades, respectively. The equivalent proportions by eel numbers were 70%, 16%, and 14% (Table 8). The longfin size composition by QMA shows that QMAs 23 and particularly 23 had the highest proportion of larger eels, and QMAs 20 and 21 the lowest. There was relatively little catch from ESAs 2, 5, 6, and

8 and hence the size distributions are not representative of these areas. The other ESAs had similar sized eels. There was a wide variation in size grade composition among the 24 subareas, but eels were generally smallest in subareas of ESA 4 that drain into the Waikato River, Northland, and Hauraki. In contrast, longfins from subareas from ESAs 7 were the largest.

Aotearoa Fisheries Ltd

Shortfin – shortfin eels processed by AFL in 2006–07 were sourced from 47 subareas (1 of which is unknown), 11 ESAs, and all 4 QMAs (Figure 18). The overall proportions of shortfin in the three size grades were 56%, 31%, and 13% for the 220–500 g, 500–1000 g, and over 1000 g grades, respectively. The equivalent proportions by eel numbers were 73%, 22%, and 5% (Table 7). Shortfin eels were markedly smaller in QMA 21 than in the other QMAs, and of similar size in other QMAs. Size composition was variable among ESAs although overall the smallest eels were from ESAs 4 and the largest from ESA 7 (Figure 18). There was considerably more variation in size among the subareas, although the Waikato subareas generally yielded high proportions of small eels, whereas those subareas of ESAs 7 to 9 had larger eels.

Longfin – longfin eels processed by AFL in 2006–07 were sourced from 46 subareas (1 of which unknown), 11 ESAs, and all 4 QMAs (Figure 19). The overall proportions of longfin in the three size grades were 46%, 15%, and 39% for the 220–500 g, 500–1200 g, and over 1000 g grades, respectively. The equivalent proportions by eel numbers were 73%, 12%, and 15% (see Table 8). The longfin size composition was similar among QMAs, although the largest eels were from QMA 22 and the smallest from QMA 21. ESAs 4 to 6 had the highest proportion of small eels and were generally similar in size in other ESAs. There was a wide variation in size grade composition among the subareas.

3.1.3 South Island (2006–07 fishing year)

3.1.3.1 Landings, catch, species and size composition

Total landings, tonnages, sampling proportion, and species composition from ANG 15 (Mossburn Enterprises) in 2006–07 are shown in Table 4. The was no breakdown of catch by ESA subarea. Total catch included 64 t (78.5%) of longfin and 17 t (21.5%) of shortfin from 300 landings. Comparison of reported landings (Ministry of Fisheries 2008) and those provided to NIWA indicates that 102% of landed catch were included in the analyses. The value of 102% indicates that landings reported to MFish were 2% less than those received by NIWA — we have no explanation for this.

Total landings, estimated number of eels, and species composition from ANG 15 in 2006–07 are shown in Table 5. Total eel numbers included about 130 000 (80.3%) longfins and 32 000 (19.7%) shortfins from 300 landings. Mean weight of individual eels was estimated at 0.549 kg for shortfin and 0.492 kg for longfin (see Table 6).

The overall proportions of shortfins in the two size grades were 53% in the 220–800 g and 47%, in the over 800 g grade (Table 7, Figure 20). The equivalent proportions by shortfin eel numbers were 78% and 22%. The overall proportions of longfin in the three size grades were 72%, 18.5%, and 9.5% for the 220–1000 g, 1000–1500 g, and 1500–4000 g grades (Table 8, Figure 20). The equivalent proportions by longfin eel numbers were 87%, 11%, and 2.5%.

3.1.4 Mossburn Enterprises historical data (1974–75 to 2006–07)

3.1.4.1 Longfins

The Mossburn Enterprises historical size grade data show a clear and progressive trend of declining size from the 1970s through to the 1990s (Figure 21). In the 1970s the predominant size grade was 900–1800 g, but changed to the smallest size grade (under 450 g) in the 1980s and has remained so through the 1990s and into the 2000s (15% in 1970s, 44% in 1980s, 52% in 1990s, and 53% in 2000s). The increase in the proportion of the smallest size grade in the 1980s and 1990s was generally accompanied by a progressive decrease in proportions of the larger grades and most of the reduction in size of eels processed took place in the 1970s. The size grade data from the 2000s (up until 2006–07) indicates that there has been little change relative to the 1990s in the smaller grades. The over 2 kg size grade appears to be largely unchanged over time.

3.1.4.2 Shortfins

Trends in size grades of shortfin eels are similar to those for longfin eels with a clear and progressive decline in size from the 1970s through to the 1990s (Figure 21). Unlike longfins, however, the proportion of the smallest size grade processed (under 500 g) increased most sharply in the 1990s (1970s 13%, 1980s 23%, 1990s 60%, and 2000s 59%). This may be due in part, to the inclusion of Te Waihora eels from 1992–93 onward, although since about 2000, very little catch was taken from Te Waihora (under 10 t per year). Te Waihora is a shortfin fishery that has dispensation to target male migrating eels which would otherwise be smaller than the minimum legal size of 220 g; average weights of shortfin migratory males is about 125 g (40 cm) (Beentjes & Chisnall 1998, Jellyman et al. 1995). Irrespective of this, for the next two largest size grades, (500–900 g, 900–1360 g), the greatest differences are between the 1980s and the 1990s. There appears to be little change in the proportions of all but the largest size grade (over 1360 g) between the 1990s and 2000s.

3.1.4.3 Species composition

The annual proportions of longfin and shortfin eels processed at Mossburn Enterprises are shown in Figure 21. In the 1970s and early 1980s the species composition was about 90% longfin, but from the late 1980s to the early 1990s this declined gradually to about 60%. The inclusion of eels from Te Waihora in 1991–93 probably contributed to the increased proportion of shortfin eels processed at this time. In recent years there are indications that the proportion of longfin in landed catches may be increasing, with the 2006–07 value of 68% longfin.

4. **DISCUSSION**

4.1 Monitoring programme

Data are presented from the second two years (2005–06 and 2006–07) of the commercial eel fishery monitoring programme that collects processor data on size grades, species composition, and catch location from New Zealand landings. Although this provides less information on size and sex distribution from individual landings than previous catch sampling programmes (Beentjes 1999, 2005, Beentjes & Chisnall 1997, 1998, Chisnall & Kemp 2000), it has the distinct advantage that it captures data from nearly all North Island eel landings and all South Island ANG 15 landings, rather than a select few, thus providing a more accurate representation of the overall stock structure. Because virtually the entire annual catch is sampled (North Island 99.6% in 2006–07, South Island ANG15, 102%), it provides an accurate estimate of the proportion of large eels in the total catches of the North Island and Southland/Otago — for longfins this is, in effect, an index of potential spawning females

since males migrate at a mean length of about 62 cm (Todd 1980) (equivalent to about 680 g), and so eels over 1000 g are almost certainly females. Finally, because the location of the North Island catch is recorded at the time of landing, these variables can be related to three geographic area levels, i.e., QMA, ESA, and catchment based subarea. The shortcomings of this monitoring approach are that size grade data are coarse with only two to three size grades used, grades differ among the processors and/or species, and grades could change depending on market demands or regulation changes affecting size limits (e.g., 4 kg maximum size limit). The data also offer limited information on the sex structure of the populations, except for assumptions of sex inferred from size.

In this report a first attempt was made to estimate numbers of eels in the size grades by using previous catch sampling length frequency data to estimate mean size in each grade. Estimates of eel numbers are particularly important for the largest size grades where, until March 2007, there was no upper limit on the North Island size grade (e.g., over 1000 g) and the catch could contain few very large eels, or many smaller eels. This analysis also resulted in an overall estimate of the mean size of eels of each species. To keep these estimates of numbers accurate, ideally we would need to update the catch sampling length frequency.

4.2 North Island

4.2.1 Catches and location

In the North Island, data have been collected from all four years (2003–04 to 2006–07) (Appendix 3) of the monitoring programme and accurate information provided on location of individual landings. The 437 t of eels included in our analyses for 2005–06 and 439 t in 2006–07 represent 88% and 99.6%, respectively, of the landed catch for the North Island (Ministry of Fisheries 2008) (see Table 4). The missing 12% in 2005–06 may have been landed by smaller processors that we did not sample, or we did not receive all the data from the processors. Data in 2006–07 were provided electronically from both processors and this has probably improved the accuracy. Regardless, the sampling proportion in 2006–07 suggests that we are now capturing virtually all landed North Island catch.

The relative catches by ESA are similar to long-term averages (1990–91 to 1998–99) (Beentjes & Bull 2002) with ESAs 1 and 4 remaining the largest contributors. However, other ESAs now contribute a greater proportion of the catch, particularly ESA 7 (see Figures 7 and 14). The number of landings sourced from each ESA and QMA was generally proportional to the catch (see Figures 7 and 14). The number of landings, however, is only a proxy of effort since it reveals nothing about the number of nets used for a given landing. Further, landing weights tend to increase with distance from the factory and are more likely to include catch from multiple days fishing, collected and transported to the factory by tanker-truck.

The expression of catch by subarea shows that within a given ESA there was a large variation in the contribution of the various catchments in catch and species composition, and this also varied between years (see Figures 6 and 7, 13 and 14). The variability is partly a reflection of the productivity of specific areas and also the amount and location of effort applied to each area. Only data from subareas with consistently large numbers of landings are likely to be representative of the eel fishery in the short-term. However, as the time series lengthens, patterns in size and species distribution will emerge, even for those subareas that yield few landings. Subsequent reporting, that will include the 2007–08 and 2008–09 fishing years, will describe trends in more detail for key areas over six years.

4.2.2 Species composition

The species composition of the catches in 2005–06 and 2006–07 were 76% and 77% shortfin (see Table 4) which is similar to the values in 2003–04 and 2004–05 (75% and 69%). This is also in line

with the proportion of shortfin between 1991and 2003 (68%, estimated catch from CELRs and ECERs) (Beentjes & Dunn 2003b). The important longfin areas tend to be in ESAs 8 and 9 (Taranaki and Rangitikei/Whanganui), and those westward draining catchments of the ESA 4 from Kawhia Harbour to Mokau River. Catch and species composition by subarea for the previous years (2003–04 and 2004–05) are summarised in Appendix 3. The occasional specimen of the Australian longfin species, *Anguilla reinhardtii*, is landed to both New Zealand Eel and AFL, but in negligible numbers — these are recorded as shortfin.

4.2.3 Size composition

The proportions of eels in the equivalent size grades of New Zealand Eel and AFL were generally similar for both species despite that the longfin maximum grade of New Zealand Eel was 200 g above that of AFL (see Tables 7 and 8). We might expect this to change slightly in future years as New Zealand Eel changed their smallest grade from 220–500 g to 300–500 g in July 2006, to reduce catch of very small eels. It is difficult to generalise about size distribution by geographic area, but areas with the smallest longfins and shortfins tended to be those catchments (subareas) of Northland, Hauraki, and those that drain into the Waikato River. Large eels of both species were often in ESAs 7 or in southern North Island catchments. Subsequent reporting, that will include the 2007–08 and 2008–09 fishing years, will describe temporal trends in size for key areas over six years.

A major concern regarding the sustainability of the longfin eel fishery relates to spawning escapement and the decline in numbers of large females from mainstem rivers. On average, from 2003–04 to 2006–07, more than one-third (36–38%) of longfins landed (by weight) were over 1000 g or 1200 g, and more than half (53–55%) were over 500 g. Because longfins above about 700 g are predominantly, if not exclusively, females, it follows that less than about one-half, and more than onethird of all longfins caught in 2005–06 and 2006–07 were female, with the remainder being either male or female. However, if we use the estimates of eel numbers, then less than about one-quarter (26– 27%) and more than 12–13% of longfins were female with the remainder being either male or female. This demonstrates the value of estimating eel numbers (see Tables 7 and 8).

4.2.4 Comparison among years

To examine general trends in size and species composition throughout the North Island, size grade data (proportions by weight and by eel numbers) for 2001–02 and 2002–02, previously provided in summary form by AFL and New Zealand Eel (see Beentjes 2005), are plotted with data from the eel monitoring time series, 2003–04 to 2006–07 (see Tables 7 and 8). New Zealand Eel landings suggest a trend of increasing size of both shortfin and longfin over this six year period (Figures 22 and 23). There was no trend, however, in New Zealand Eel species composition which averaged 80% shortfin by weight and 82% by number (Figure 24). Surprisingly, there was no similar trend for the AFL shortfin data, although overall AFL shortfin have been consistently larger than those from New Zealand Eel (Figure 25). There is some suggestion, however, of a slight trend of increasing longfin size in the AFL data. There was no trend in the AFL species composition which averaged 70% shortfin by weight and 71% by number.

The trend of increasing size of eels (both species for New Zealand Eel and possibly longfin for AFL) landed is in contrast to the increased market demand for small eels, whereas there has been no change in the market demand for large eels since 2000 (John Jameson, AFL, pers. comm.). The increase in size may, in part, reflect a decline in catch and effort following introduction of North Island eels into the QMS in October 2004. There may be some changes in size proportions resulting from the introduction of the 4 kg maximum size limit for the North Island in March 2007, however, these are likely to be minor since only 1.5% of longfin eels caught in the North Island were over 4 kg (data from 1996–98 catch sampling; see Figures 4 and 5). The 4 kg limit will have no impact on shortfin eels which migrate before reaching 4 kg.

Historically North Island eels were larger than the current time series indicates and the dominant size grade was between about 450 g and 900 g for both species (Beentjes 2005). Similarly the proportion of longfin in the catch is 10 to 20% less today than historical catches taken during the development period (1970s) of the eel fishery in the North Island (Beentjes 2005).

4.3 South Island

The South Island commercial eel monitoring programme began only in 2006–07 and does not separate catches at the level of ESA or subarea, but provides accurate data at the broad level of a single QMA (ANG 15, Otago/Southland). It is not possible to compare shortfin size between the North Island and ANG 15 because size grades differ. However, the proportion of large longfins (over 1000 g) in ANG 15 was about 11% less than in the North Island in 2006–07. Numbers were similar, however, because South Island longfins are slightly smaller than those from the North Island, and the 4 kg limit was taken into account in the South Island estimates. Species composition is markedly different between these regions, with about 75% of the catch being shortfin is the North Island and 20% in ANG 15.

The 33 year time series of eel species/size grades processed by Mossburn Enterprises that began in the 1970s is a valuable database. There have been some changes to the grading categories in recent years but this has not detracted from the utility of the data overall. Mossburn Enterprises is now the only eel processor in the South Island taking eels from outside Te Waihora, and hence these data reflect the population structure of commercial eels in the South Island, and particularly Otago/Southland. Analysis of this time series shows that the average size of both shortfin and longfin eels processed in the South Island progressively declined over time and is now largely based on eels in the smallest processed size grade (under 450 g) (see Figure 16). The inclusion of data from 2005–06 to 2006–07, suggest that there has been little change since the 1990s for longfin, but for shortfin there appears to be a decline in the proportions of the largest eels (see Figure 21).

Following the introduction of South Island eels into the QMS on 1 October 2000, the number of fishers declined by about 6-fold (Victor Thompson, Mossburn enterprises, pers comm.). There are substantial quota holdings that are not being fished despite a number of core fishers catching 100% of their own quota. This reduction in fishing effort, unfished quota, and poor market demand for eels has resulted in the TACC being consistently undercaught (between 65% and 76% caught). Given the reduction in both effort and catch, we might expect to have observed a general increase in the size of eels landed in the 2000s, but this is not apparent from the time series data. One explanation for the status quo is that the remaining eel fishers continue to fish the main Otago/Southland river fisheries and have not extended their effort into the smaller streams and less accessible areas that are now seldom fished (Victor Thompson, pers. comm.). As markets improve, effort will also increase and we could expect to see larger eels landed from these areas. The most recent catch per unit effort analysis (CPUE) for the South Island indicates that longfin and shortfin CPUE is trending upward, possibly signalling an increase in abundance and/or size (Beentjes & Dunn 2008). If size is increasing, the current monitoring programme that began in 2006–07 should reflect this.

There was a gradual decline in the proportion of longfins processed by Mossburn Enterprises from the 1970s to the early 1990s, but since 1992–93 the proportion of longfin in the catch has been relatively stable at about 60% (see Figure 21).

Although data on size of eels processed before the 1970s is lacking, studies before commercial fishing began indicate that longfin populations in Southland were dominated by large females. For instance, the average weight from more than 11 000 eels caught in tributaries of the Oreti River in 1939 was about 1400 g (Cairns 1942), which equates to a length of about 83 cm. Further, longfins from three inland Southland rivers (Waiau tributaries) sampled between 1947 and 1949 (Burnet 1952) were mainly between about 60 and 90 cm, with many eels over 100 cm in length. This contrasts markedly

with the size of longfins that are currently processed in the South Island, and provides strong evidence of a major change in the population size structure in the main stems as a result of commercial fishing.

4.4 General remarks

The long-term success of this programme is totally dependent on the eel processors providing timely and accurate data. The collection of size grade data and species composition by location (QMA, ESA, subarea) serves to highlight how eel populations can vary between and within geographic areas of different scale. The benefit of collecting landing data on a finer scale is that, given sufficient landings, the relative catch contributions, species composition, and size ranges of eels from discrete catchments can be quantified. The value of the monitoring programme is enhanced with the length of the time series, and the next report will include six years of data from the North Island (2003–04 to 2008–09), sufficient to look at temporal and spatial changes for key areas. This information could be potentially useful to fisheries managers who may wish to manage fisheries within each QMA using different strategies, such as closed areas, size limits, species or catch restrictions etc.

4.5 Conclusions

North Island

- 1. Data are presented from the second two years (2005–06 and 2006–07) of a monitoring programme that collected size grade, species composition, and catch location data from two North Island commercial eel processors.
- 2. The analyses for 2005–06 and 2006–07 included 88% (437 t) and 99.6% (438 t) respectively, of the North Island landed catch.
- 3. The analyses for 2005–06 and 2006–07 included an estimated 850 000, and 875 000 eels, respectively.
- 4. Overall, 76% in 2005–06 and 77% in 2006–07 of the total landed catch of eels by weight in the North Island was shortfin. Correspondingly, 79% and 80% by eel numbers.
- 5. There was a large variation in the landed catch from the 65 North Island catchment-based subareas, and this also varied between years.
- 6. Catch location for each landing has enabled species composition and size to be related to North Island geographic areas of progressively finer resolution, i.e., QMA, ESA, and catchment based subarea.
- 7. About 38–40% of North Island longfin landed weight in 2005–06 and 2006–07 was made up of eels in the largest size grades (individual weights over 1000 g or 1200 g), and by virtue of size were females. Correspondingly, 12–15% by eel numbers.
- 8. There was an indication of increasing size of shortfin and particularly longfin since 2001–02.

South Island

- 1. Provision of data for the South Island eel monitoring programme began only in 2006–07 and does not separate catches at the level of ESA or subarea, but provides accurate data at the broad level of a single QMA (ANG 15, Otago/Southland).
- 2. The analyses included 102% (81 t) of the ANG 15 landed catch, of which 21.5% was shortfin. Correspondingly, the catch included an estimated 161 000 eels of which 20% were shortfin.
- 3. The proportion of large longfins (over 1000 g) in ANG 15 by weight was 28%, which is about 11% less than in the North Island in 2006–07.
- 4. The Mossburn Enterprises historical database that summarises annual processed landings by size grades for each species from the mid 1970s was updated with 2005–06 and 2006–07 catch. The conclusions are:
 - The average size of both shortfin and longfin eels processed in the South Island has progressively declined over the last 33 years and is now largely based on eels in the smallest

processed size grade (under 450 g), and there has been little change since the 1990s for either species.

• There was a gradual decline in the proportion of longfins processed in the South Island from the 1970s to the early 1990s, but since 1992–93 the proportion of longfin in the catch has been relatively stable at about 60%.

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Table 1: Quota Management Areas (QMAs) for longfin (LFE) and shortfin (SFE) eels and both species combined (ANG), and eel statistical areas (ESA alpha codes replaced numeric codes on 1 October 2001).

		QMA	ESA (alpha)		ESA (numeric)
			(after 1 Oct		(before 1 Oct
Area	LFE	SFE	2001)		2001)
Northland	LFE 20	SFE 20	AA		1
Auckland	LFE 20	SFE 20	AB		2
Hauraki	LFE 21	SFE 21	AC		3
Waikato	LFE 21	SFE 21	AD		4
Bay of Plenty	LFE 21	SFE 21	AE		5
Poverty Bay	LFE 21	SFE 21	AF		6
Hawke's Bay	LFE 22	SFE 22	AG		7
Rangitikei-Wanganui	LFE 23	SFE 23	AH		8
Taranaki	LFE 23	SFE 23	AJ		9
Manawatu	LFE 22	SFE 22	AK		10
Wairarapa	LFE 22	SFE 22	AL		11
Wellington	LFE 22	SFE 22	AM		12
Nelson	ANG 11	ANG 11	AN		13
Marlborough	ANG 11	ANG 11	AP	}	14
South Marlborough	ANG 12	ANG 12	AQ	}	14
Westland	ANG 16	ANG 16	AX	-	15
North Canterbury	ANG 12	ANG 12	AR		16
South Canterbury	ANG 14	ANG 14	AT		17
Waitaki	ANG 14	ANG 14	AU		18
Otago	ANG 15	ANG 15	AV		19
Southland	ANG 15	ANG 15	AW		20
Te Waihora (outside Migration Area)	ANG 13	ANG 13	AS1	}	21
Te Waihora Migration Area	ANG 13	ANG 13	AS2	}	21
Chatham Islands	LFE 17	SFE 17	AZ	-	22
Stewart Island	ANG 15	ANG 15	AY		23

Table 2: Catchment subareas, eel statistical areas (ESA alpha and numeric codes), and Quota Management Areas (QMA) for the North Island eel fishery. Eel statistical area alpha codes replaced the numeric codes in October 2001.

	Subarea	Eel sta	tistical area	
Code	Count	Numeric	Alpha	QMA
1A-1E	5	1	AA	20
2A-2C	3	2	AB	20
3A-3C	3	3	AC	21
4A-4Q	17	4	AD	21
5A-5D	4	5	AE	21
6A-6G	7	6	AF	21
7A–7F	6	7	AG	22
8A-8F	6	8	AH	23
9A–9F	6	9	AJ	23
10A-10C	3	10	AK	22
11A-11C	3	11	AL	22
12A-12B	2	12	AM	22
Total	65	12	12	4

Table 3: Weight grades and equivalent length grades with mid-point length and weight derived from the cumulative length frequency distribution. Mid point weight was used to estimate total numbers of eels in each size grade.

		Grade		Mid-point
	Weight (g)	Length (cm)	Length (cm)	Weight (g)
North Island SFE	220-500	46-60	54	375
	500-1000	60-75	66	699
	>1000	75–100	80	1270
North Island LFE	220-500	43–56	50	345
	500-1000	56-70	62	685
	>1000	70–125	78	1425
	>1200	74–125	83	1738
South Island LFE	220-1000	43-70	52	391
	1000–1500 g	70–79	75	1258
	1500–4000g	79–108	88	2095
South Island SFE	220-800	46–70	55	397
	> 800	70-100	73.5	976

Table 4: Summary of landings and species landed weights from North Island and South Island processors from 2003–04 to 2006–07 fishing years. % samp., percent of landed weight included in analysis, relative to the total reported landings.

North Island

nbined	%	SFE	74.0	68.9	76.5	77.2	74.3
essors con	%	samp.	89.1	90.6	88.0	9.66	
All proc	ight (kg)	LFE	105 281	$120\ 240$	102 651	99 788	427 960
	We	SFE	299 386	265 883	334 578	338 770	1 238 617
	No.	Lndg	1415	1139	1260	1304	5118
Fisheries	eight (kg)	LFE	55 396	77 889	63 997	70 216	267 498
Aotearoa	We	SFE	129 367	140 903	173 853	185 868	629 991
	No.	Lndg	729	590	697	772	2788
aland Eel	eight (kg)	LFE	28 007	42 351	38 654	29 572	138 584
New Ze	We	SFE	151 947	$124\ 980$	160 725	152 902	590 554
	No.	Lndg	511	549	563	532	2155
anderdrift	eight (kg)	LFE	21 878	Ι	Ι	I	21 878
V	W	SFE	18 072	I	Ι	I	18 072
	No.	Lndg	175	Ι	Ι	I	175
		Year	2003-04	2004-05	2005-06	2006-07	Totals

South Island (ANG 15/Otago and Southland only)

•				Mossburn E	unterprises
	No.	M	'eight (kg)		
Year	Lndg	SFE	LFE	% samp.	% SFE
2003-04	I	I	I	I	
2004-05	Ι	Ι	Ι	I	
2005-06	Ι	I	Ι	I	
2006–07	300	17 520	63 941	102	21.5
Totals	300	17 520	63 941	102	21.5

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Table 5: Summary of landings and species estimated landed numbers of ϵ	

North Island

cessors combined	umber %	LFE SFE	3 031 75.3	9 357 71.0	32 252 78.6	77 285 79.7	31 925 76.3
All proc	N	SFE	618 027 20	535 824 21	667 803 18	697 301 17	2 518 955 78
	No.	Lndg	1415	1139	1260	1304	5118
Fisheries	Number	LFE	110 351	$144\ 039$	113 955	127 858	496 204
Aotearoa		SFE	255 279	280 246	340 270	379 383	1 255 178
	No.	Lndg	729	590	697	772	2788
aland Eel	Number	LFE	51 935	75 317	68 297	49 427	244 976
New Ze		SFE	323 832	255 578	327 533	317 918	1 224 861
	No.	Lndg	511	549	563	532	2155
anderdrift	Number	LFE	40 745	Ι	Ι	I	40 745
V		SFE	38 916	I	I	I	38 916
	No.	Lndg	175	I	Ι	I	175
I		Year	2003-04	2004-05	2005-06	2006-07	Totals

South Island (ANG 15/Otago and Southland only) Mossburn Enterprises

	No.		Number	
Year	Lndg	SFE	LFE	% SFE
2003-04	I	I	I	Ι
2004-05	I	I	I	Ι
2005-06	I	I	I	Ι
2006-07	300	31 904	130 058	19.7
Totals	300	31 904	130 058	19.7

Table 6: Summary of landings and species estimated mean size of eels from North Island and South Island processors from 2003–04 to 2006–07 fishing years.

North Island

ombined	size (kg)	LFE	0.519	0.548	0.563	0.563	0.547
processors c	Mean	SFE	0.484	0.496	0.501	0.486	0.492
All	No.	Lndg	1415	1139	1260	1304	5118
Fisheries	size (kg)	LFE	0.502	0.541	0.562	0.549	0.539
Aotearoa I	Mean	SFE	0.507	0.503	0.511	0.490	0.502
	No.	Lndg	729	590	697	772	2788
lland Eel	size (kg)	LFE	0.539	0.562	0.566	0.598	0.566
New Zea	Mean	SFE	0.469	0.489	0.491	0.481	0.482
	No.	Lndg	511	549	563	532	2155
nderdrift	size (kg)	LFE	0.537	Ι	I	Ι	0.537
Va	Mean	SFE	0.464	Ι	Ι	I	0.464
	No.	Lndg	175	Ι	Ι	I	175
·		Year	2003-04	2004-05	2005-06	2006–07	Totals

South Island (ANG 15/Otago and Southland only)

		Mossburn E	nterprises
	No.	Mean	size (kg)
Year	Lndg	SFE	LFE
2003–04	I	Ι	Ι
2004-05	Ι	Ι	Ι
2005-06	Ι	Ι	Ι
2006–07	300	0.549	0.492
Totals	175	0.549	0.492

Table 7: Percent of landed shortfin catch and percent numbers of shortfin in each size grade by fishing year, for individual processors. Data from 2001–02 and 2002–03 pre date the time series and were provided by AFL and New Zealand Eel.

Aotearoa Fisheries

_]	Percent of landed s	shortfin catch	Perce	ent of landed shor	tfin numbers
_			size grade			size grade
Fishing year	220–500 g	500–1000 g	>1000 g	220–500 g	500–1000 g	>1000 g
2001-02	50.6	32.2	17.2	69.3	23.7	7.0
2002-03	50.2	34.5	15.2	68.6	25.3	6.1
2003-04	51.4	34.2	14.4	69.5	24.8	5.8
2004-05	52.3	33.9	13.7	70.2	24.4	5.4
2005-06	51.4	31.8	16.8	70.0	23.3	6.8
2006-07	56.1	31.1	12.8	73.3	21.8	5.0

New Zealand Eel

_]	Percent of landed s	hortfin catch	fin catch Percent of landed she		
_			size grade			size grade
Fishing year	220–500 g	500–1000 g	>1000 g	220–500 g	500–1000 g	>1000 g
2001_02	63.2	30.3	6.4	ר דד	20.0	23
2001-02	58.8	32.8	8.4	74.5	20.0	3.2
2003–04	61.9	29.1	9.4	77.0	19.5	3.5
2004-05	56.9	29.3	13.8	74.2	20.5	5.3
2005-06	56.3	29.9	13.8	73.7	21.0	5.3
2006-07	59.0	28.5	12.5	75.6	19.6	4.7

Vanderdrift

	Percent of landed		I	Percent of landed
	shortfin catch			shortfin numbers
	Size grade			Size grade
Fishing year	220–1000 g	>1000	220–1000 g	>1000
2003–04	85.7	14.3	94.8	5.2

Mossburn Enterprises

	Perce sł	Percent of landed shortfin catch		ent of landed fin numbers
-		Size grade		Size grade
Fishing year	220–800 g	>800	220–800 g	>800
2006–07	53.3	46.7	77.6	22.4

Table 8: Percent of landed longfin catch and percent numbers of longfins in each size grade by fishing year for individual processors. Data from 2001–02 and 2002–03 pre-date the time series and were provided by AFL and New Zealand Eel.

Aotearoa Fisheries

_	Percent of landed longfin catch		Perc	ent of landed lon	gfin numbers	
_			size grade			size grade
Fishing year	220–500 g	500–1000 g	>1000 g	220–500 g	500–1000 g	>1000 g
2001-02	47.6	19.3	33.1	72.9	14.9	12.3
2002-03	49.7	17.4	32.9	74.8	13.2	12.0
2003-04	53.5	16.3	30.2	77.5	11.9	10.6
2004-05	46.3	18.4	35.2	72.2	14.5	13.3
2005-06	43.1	18.9	38.1	69.7	15.4	14.9
2006-07	46.4	14.6	39.0	73.4	11.6	14.9

New Zealand Eel

	Percent of landed longfin catch			Perc	ent of landed long	gfin numbers
_			size grade			size grade
Fishing year	220–500 g	500–1200 g	>1200 g	220–500 g	500–1200 g	>1200 g
2001 02	54.0	10.1	267	70 7	12.6	
2001–02	54.2	19.1	26.7	/8./	13.6	1.1
2002–03	51.5	20.1	28.4	76.9	14.7	8.4
2003-04	49.4	15.4	35.2	77.3	11.8	10.9
2004–05	46.0	16.0	38.1	74.9	12.8	12.3
2005-06	45.0	17.2	37.8	73.9	13.8	12.3
2006–07	40.2	19.1	40.7	69.7	16.3	14.0

Vanderdrift

	Percent of landed		I	Percent of landed
-	Size grade			Size grade
Fishing year	<1000 g	>1000	<1000 g	>1000
2003–04	63.1	36.9	86.6	13.4

Mossburn Enterprises

	Percent of landed longfin catch			Pe	rcent of landed lo	ongfin numbers
_			size grade			size grade
Fishing year	<1000 g	1000–1500 g	1500–4000 g	<1000 g	1000–1500 g	1500–4000 g
2006–07	72.0	18.5	9.5	86.6	10.9	2.5



Figure 1: New Zealand eel catch from 1965 to 2006–07 (top). North Island (centre) and South Island (bottom) catch by species from 1984 to 2006–07. Species catch estimated from catch effort data species proportions (FSU, CELR, ECER) for all years except North Island 2004–05 to 2006–07 which was taken from actual landings (Ministry of Fisheries 2008; Table 5). TACCs are also shown.



Figure 2. Quota Management Areas for the New Zealand eel fishery (see Table 1 for breakdown by eel statistical areas). Shortfin stocks are denoted by the prefix SFE, and longfin by LFE. ANG comprises both shortfin and longfin combined.



Figure 3: Eel statistical areas (ESAs). (see Table 1 for numeric codes).





Figure 4: Scaled length frequency distributions for North Island longfin and shortfin eels from catch sampling programmes in 1996, 1997, and 1998. Includes all sampled landings. Longfin, $N = 15\,330$; shortfin, $N = 79\,535$ (scaled numbers).





Figure 5: Cumulative length frequency distribution of North Island longfin and shortfin eels (data from Figure 4) with weight grades shown as equivalent length grades (solid vertical lines). Dashed vertical lines represent cumulative mid-point length of each length /weight grade (see Table 3).





Figure 7: Catch of shortfin (SFE), longfin (LFE), and landings in 2005–06, grouped by eel statistical area. Data are from North Island processors' records.



Figure 8: Catch of shortfin (SFE), longfin (LFE), and landings in 2005–06 grouped by Quota Management Area. Data are from North Island processors' records.



Figure 9: Proportion of longfin (SFE) catch in three size grades, by area, processed by New Zealand Eel in 2005–06.



Figure 10: Proportion of longfin (LFE) catch in three size grades, by area, processed by New Zealand Eel in 2005–06.



Figure 11: Proportion of shortfin (SFE) catch in three size grades, by area, processed by AFL in 2005–06.



Figure 12: Proportion of longfin (LFE) catch in three size grades, by area, processed by AFL in 2005–06.







Figure 14: Catch of shortfin (SFE), longfin (LFE), and landings in 2006–07, grouped by statistical area. Data are from North Island processors' records.



Figure 15: Catch of shortfin (SFE), longfin (LFE), and landings in 2006–07 grouped by Quota Management Area. Data are from North Island processors' records.



Figure 16: Proportion of longfin (SFE) catch in three size grades, by area, processed by New Zealand Eel in 2006–07.



Figure 17: Proportion of longfin (LFE) catch in three size grades, by area, processed by New Zealand Eel in 2006–07.







Figure 18: Proportion of longfin (SFE) catch in three size grades, by area, processed by AFL 2006–07.



Figure 19: Proportion of longfin (LFE) catch in three size grades, by area, processed by AFL in 2006–07.



Figure 20: Proportion of shortfin (SFE) and longfin (LFE) catch and estimated numbers of eels in various weight grades from ANG 15, processed by Mossburn Enterprises in 2006–07. The species composition by weight and numbers of eels is also shown (bottom).



Figure 21: Size grades of longfin and shortfin eels processed at Mossburn Enterprises Ltd (Invercargill) in the 1970s 1980s, 1990s, and 2000s. 1970s years: 1974–75, 1977–78 and 1978–79; 1980s years: 1983–84 to 1988–89; 1990s years: 1989–90 to 1998–99: 2000s years: 1999–2000 to 2006–07. Error bars represent standard errors. Species proportion is also shown.



Figure 22: Proportion of shortfin eel catch and eel numbers in three size grades processed at New Zealand Eel from 2001–02 to 2006–07.



Figure 23: Proportion of longfin eel catch and eel numbers in three size grades processed at New Zealand Eel from 2001–02 to 2006–07.



Figure 24: Proportion of longfin and shortfin by catch and numbers processed at New Zealand Eel from 2001–02 to 2006–07.



Figure 25: Proportion of shortfin eel catch and eel numbers in three size grades processed at AFL from 2001–02 to 2006–07.



Figure 26: Proportion of shortfin eel catch and eel numbers in three size grades processed at AFL from 2001–02 to 2006–07.



Figure 27: Proportion of longfin and shortfin by catch and numbers processed at AFL from 2001–02 to 2006–07.

Appendix 1: Eel statistical area (ESA) and subarea boundaries for reporting species and size grade of commercial landings. Reproduced by permission of Land Information New Zealand. Red borders indicate ESAs and black borders ESA subareas.

















Appendix 2: The 65 North Island subarea codes with general locations. The number of the alphanumeric subarea code refers to the eel statistical area within which the subarea is located.

Subarea	
code	Location
1A	Kaitaia
1B	Hokianga Harbour
10	Bay of Islands
10 1D	Dargaville
1D 1E	Broom Boy
1L 2A	Warkworth
2A 2D	
2B	
20	Manukau Harbour
3A	Hauraki Plains west
3B	Hauraki Plains east
3C	Coromandel Peninsula
4A	Lake Taupo
4B	Lake Ohakuri
4C	Lake Atiamuri
4D	Lake Whakamaru
4E	Lake Maraetai
4F	Lake Waipapa
4G	Lake Arapuni
4H	Lake Karapiro
4I	Hamilton
41	Pirongia Forest Park
4K	Lake Whangape
4I	Lake Waikare/Port Waikato
чL 4М	Paglan Harbour
41VI 4NI	Kagian Harbour
4IN 40	Nawilia Harbour
40 4D	Marakopa River
4P	Awakino River
4Q	Mokau River
5A	Tauranga
5B	Rotorua Lakes
5C	Rangitaiki River
5D	Whakatane River
6A	Ohiwa Harbour
6B	Motu River
6C	Cape Runaway
6D	Waiapu River
6E	Tolaga Bay
6F	Gisborne
6G	Waipaoa River
7A	Mahia Peninsula
7B	Lake Waikaremoana
7C	Mohaka River
7D	Napier
7E	Tukituki River
7F	Waimarama/Porangahau
γ 1 8 Δ	Taumarunui
8R	Whanganui Divor inland
0D	Whongony: Divor as at
0U	whanganul Kiver coast
8D	wnangaenu River

8E	Turakina River
8F	Rangitikei River
9A	North Taranaki Bight
9B	Waitara River
9C	Mount Taranaki coast
9D	Patea River inland
9E	Patea River coast
9F	Waitotara River
10A	Manawatu River coast
10B	Manawatu River Inland
10C	Akitio River
11A	Lake Wairarapa
11 B	Wairarapa coast
11C	Castle point
12A	Otaki
12B	Wellington

Appendix 3: Summary of catch by eel statistical area subarea, species and fishing year (2003–04 to 2006–07). Data from North Island eel processors.

2003–04				
		Weight (kg)	Perc	cent species
Sub-area	LFE	SFE	LFE	SFE
1A	2624	27 570	8.7	91.3
1 B	3912	7871	33.2	66.8
1C	4309	7725	35.8	64.2
1D	9909	28 881	25.5	74.5
1E	1599	5821	21.5	78.5
2A	3634	13 734	20.9	79.1
2B	2341	4421	34.6	65.4
2C	4239	12 931	24.7	75.3
3A	2764	19 550	12.4	87.6
3B	1313	11 820	10.0	90.0
3C	318	994	24.2	75.8
4B	193	334	36.6	63.4
4C	214	572	27.2	72.8
4D	156	378	29.2	70.8
4F	117	347	25.2	74.8
4H	422	5788	6.8	93.2
4I	2118	5282	28.6	71.4
4J	12 334	19 954	38.2	61.8
4K	5083	18 295	21.7	78.3
4L	8390	39 406	17.6	82.4
4M	2149	1569	57.8	42.2
4N	350	192	64.6	35.4
40	651	18	97.3	2.7
4P	373	87	81.1	18.9
40	1349	256	84.0	16.0
5A	1227	3003	29.0	71.0
5B	1383	2393	36.6	63.4
5C	2600	3559	42.2	57.8
5D	1317	4059	24.5	75.5
6A	452	96	82.5	17.5
6F	0	9146	0.0	100.0
6G	52	9299	0.6	99.4
7A	465	737	38.7	61.3
7B	205	0	100.0	0.0
7C	277	0	100.0	0.0
7D	1072	5623	16.0	84.0
7E	60	3044	1.9	98.1
7F	3269	8635	27.5	72.5
8A	728	0	100.0	0.0
8B	2064	3360	38.0	62.0
8C	2537	1984	56.1	43.9
8F	1242	362	77.4	22.6
9?	369	444	45.4	54.6
9A	1128	86	92.9	7.1
9B	1846	391	82.5	17.5
9C	3321	588	85.0	15.0

9D	4698	1504	75.7	24.3
Appendix 3	– continued			

2003-04

				Percent
		Weight (kg)		species
Sub-area	LFE	SFE	LFE	SFE
9E	783	696	52.9	47.1
9F	997	467	68.1	31.9
10A	2091	4013	34.3	65.7
12A	91	1902	4.6	95.4
unknown	147	200	42.4	57.6
Totals	105 281	299 386	26.0	74.0

200 00				Percent
		Weight (kg)		species
Sub-area	LFE	SFE	LFE	SFE
1A	353	2670	11.7	88.3
1 B	6677	18 338	26.7	73.3
1C	3973	5228	43.2	56.8
1D	7063	23 509	23.1	76.9
1E	1100	4581	19.4	80.6
2A	666	5091	11.6	88.4
2B	1024	2456	29.4	70.6
2C	4124	8648	32.3	67.7
3A	4326	22 496	16.1	83.9
3B	778	12 041	6.1	93.9
3C	3915	5934	39.8	60.2
4B	1168	4472	20.7	79.3
4C	1000	1622	38.1	61.9
4G	88	152	36.7	63.3
4H	385	3791	9.2	90.8
4I	1047	3791	21.6	78.4
4J	13 965	14 884	48.4	51.6
4K	1339	5211	20.4	79.6
4L	8179	27 640	22.8	77.2
4M	869	3469	20.0	80.0
4N	1769	181	90.7	9.3
4Q	3352	1771	65.4	34.6
5A	664	1588	29.5	70.5
5B	1407	1306	51.9	48.1
5C	2784	6429	30.2	69.8
5D	1959	1784	52.3	47.7
6B	94	628	13.0	87.0
6F	309	176	63.7	36.3
6G	2853	1443	66.4	33.6
7A	19	259	6.8	93.2
7B	798	405	66.3	33.7
7D	1396	12 596	10.0	90.0
7E	5002	10 348	32.6	67.4
7F	1797	3992	31.0	69.0
8B	1124	2178	34.0	66.0

Appendix 3 – continued

2004/05

		Weight (kg)		Percent species
8C	3264	4319	43.0	57.0
8D	4260	2722	61.0	39.0
8E	2111	2016	51.2	48.8
8F	802	2015	28.5	71.5
9A	423	14	96.8	3.2
9C	2364	535	81.5	18.5
9D	7264	1634	81.6	18.4
9E	736	61	92.3	7.7
9F	118	11	91.5	8.5
10A	3507	9856	26.2	73.8
10B	2315	6217	27.1	72.9
11A	5417	14 239	27.6	72.4
11B	295	658	31.0	69.0
12A	0	480	0.0	100.0
Totals	120 240	265 883	31.1	68.9

				Percent
		Weight (kg)		species
Sub-area	LFE	SFE	LFE	SFE
1A	1031	3585	22.3	77.7
1B	634	13 921	4.4	95.6
1C	710	864	45.1	54.9
1D	11 449	38 684	22.8	77.2
1E	23	1308	1.7	98.3
2A	1441	5109	22.0	78.0
2B	2273	5635	28.7	71.3
2C	3838	15 047	20.3	79.7
3A	4722	23 498	16.7	83.3
3B	4502	22 168	16.9	83.1
3C	256	995	20.5	79.5
4?	330	284	53.7	46.3
4B	38	835	4.4	95.6
4C	167	1266	11.7	88.3
4D	395	2095	15.9	84.1
4G	535	2308	18.8	81.2
4H	86	2469	3.4	96.6
4I	277	1776	13.5	86.5
4J	9222	12 700	42.1	57.9
4K	1473	7301	16.8	83.2
4L	8926	38 591	18.8	81.2
4M	247	389	38.8	61.2
4N	1069	259	80.5	19.5
40	277	36	88.5	11.5
4P	444	26	94.5	5.5
4Q	358	10	97.3	2.7

Appendix 3 – continued

2005/06

2000/00				Percent
~ · _		Weight (kg)		species
Sub-area	LFE	SFE	LFE	SFE
5A	297	1360	17.9	82.1
5B	865	2758	23.9	76.1
5C	1107	5658	16.4	83.6
6E	330	584	36.1	63.9
6F	0	5200	0.0	100.0
6G	552	3198	14.7	85.3
7A	33	2115	1.5	98.5
7B	552	4678	10.6	89.4
7C	391	1214	24.4	75.6
7D	1634	11 174	12.8	87.2
7E	5981	24 355	19.7	80.3
7F	470	118	79.9	20.1
7L	43	1307	3.2	96.8
8A	214	96	69.0	31.0
8B	1960	2899	40.3	59.7
8C	491	98	83.4	16.6
8D	1930	3747	34.0	66.0
8E	2820	3072	47.9	52.1
8F	3896	9970	28.1	71.9
9A	1007	345	74.5	25.5
9B	1445	316	82.1	17.9
9D	5073	1522	76.9	23.1
9E	375	184	67.1	32.9
9F	1651	7657	17.7	82.3
10A	3715	17 082	17.9	82.1
10B	1705	5930	22.3	77.7
10C	521	1142	31.3	68.7
11A	8171	13 588	37.6	62.4
12A	419	172	70.9	29.1
12D	0	71	0.0	100.0
unknown	280	1809	13.4	86.6
Totals	102 651	334 578	23.5	76.5

		Weight (kg)		Percent species
Sub-area	LFE	SFE	LFE	SFE
1A	1306	7516	14.8	85.2
1B	171	18 555	0.9	99.1
1C	1270	2302	35.6	64.4
1D	13 002	40 734	24.2	75.8
1E	1811	3036	37.4	62.6
2A	3037	9319	24.6	75.4
2B	675	3711	15.4	84.6
2C	6991	17 125	29.0	71.0
3A	1779	17 394	9.3	90.7

Appendix 3 – continued

				Percent
		Weight (kg)		species
Sub-area	LFE	SFE	LFE	SFE
3B	3083	11 134	21.7	78.3
3C	50	684	6.8	93.2
4B	1138	7042	13.9	86.1
4C	187	894	17.3	82.7
4D	312	940	24.9	75.1
4E	49	877	5.3	94.7
4F	57	345	14.2	85.8
4G	802	4167	16.1	83.9
4H	1025	7380	12.2	87.8
4I	677	1387	32.8	67.2
4J	5333	6607	44.7	55.3
4K	1715	6434	21.0	79.0
4L	4543	24 619	15.6	84.4
4M	39	314	11.0	89.0
4N	431	72	85.7	14.3
4Q	2866	1613	64.0	36.0
5A	489	1145	29.9	70.1
5B	852	2542	25.1	74.9
5C	1160	6211	15.7	84.3
5D	899	647	58.2	41.8
6A	400	156	71.9	28.1
6B	347	495	41.2	58.8
6G	1731	10 899	13.7	86.3
7A	189	1213	13.5	86.5
7C	105	954	9.9	90.1
7D	2557	9086	22.0	78.0
7E	9496	30 176	23.9	76.1
7F	67	824	7.5	92.5
8A	243	4	98.4	1.6
8B	2263	3775	37.5	62.5
8D	1342	3279	29.0	71.0
8E	1296	6382	16.9	83.1
8F	1848	15 446	10.7	89.3
9A	2328	962	70.8	29.2
9C	799	34	95.9	4.1
9D	2587	501	83.8	16.2
9E	1097	32	97.2	2.8
9F	1330	193	87.3	12.7
10A	3723	26 252	12.4	87.6
10B	1843	3076	37.5	62.5
10C	435	594	42.3	57.7
11A	7459	19 274	27.9	72.1
11C	457	282	61.8	38.2
unknown	97	135	41.8	58.2
Totals	99 788	338 770	22.8	77.2