



Monitoring commercial eel fisheries: 2003–04 to 2014–15

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EXECUTIVE SUMMARY

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The commercial freshwater eel (longfin, *Anguilla dieffenbachii*; shortfin, *A. australis*) monitoring programme began in the North Island in 2003–04, capturing processor data on size grades, species composition, and catch location from individual landings. In the South Island data were provided initially in 2006–07 for the Quota Management area (QMA) ANG 15 only (Southland/Otago), with no details of catch location other than that all landings were from ANG 15. Provision of complete data, similar to the North Island, has been collected for the South Island since the 2010–11 fishing year. This report provides results from the 2012–13, 2013–14 and 2014–15 fishing years, and also examines trends in the 12 years of landing data from the North Island, 9 years of landing data from ANG 15, and 5 years of landing data from the South Island.

North Island shortfin

Shortfin in the North Island were caught from nearly all subareas (63 of the possible 65) over the 12 years (2003–04 to 2014–15), but the catch is highly aggregated with nearly one-third of the catch originating from just three subareas, AA4 (Dargaville), AD12 (Lake Waikare, Port Waikato), and AC1 (Hauraki plains west). The Dargaville subarea (AA4) drains into the northern arm of the Kaipara Harbour and includes rivers such as the Wairoa, Wairua, Manganui, Awakino, and Mangakahia rivers. The AA4 subarea contributed 431 t or 12% of the total North Island shortfin catch over the 12 years and is the most productive subarea in the North Island. This is followed by the AD12 subarea that includes the lower Waikato River and tributaries such as Lakes Waikare and the Whangamarino River, and the western Hauraki plains which include the Piako River and tributaries (AC1). The bulk of the remaining subareas in the North Island have individually contributed less than 1% of the annual shortfin catch. Total North Island shortfin annual catch over the 12 years shows no consistent trend in annual catch weight or in the distribution of these catches in the three size grades used. It is likely that some of the minor fluctuations from year to year have been influenced by one or more factors such as port price, TACC reductions, market fluctuations, quota availability, and escape tube increases. The number of subareas for which shortfin catch was landed has declined from 49 subareas per year, on average for the first six years, to 43 subareas per year on average for the last six years, indicating a contraction in the spatial distribution of fishing effort over time. This is consistent with a decline in both the number of permits fished and the fishing events over time. Despite the contraction in the spatial distribution of fishing effort over time, the catch of shortfin in the key subareas over the 12 years shows no apparent trends.

North Island longfin

Longfin in the North Island were caught from nearly all subareas (63 of the possible 65) over the 12 years, but the catch is aggregated with more than one-third of the catch originating from just four subareas, AA4 (Dargaville), AD10 (Waipa River), AD12 (Lake Waikare, Port Waikato), and AL1 (Lake Wairarapa), two of which are also the most important subareas for shortfin (i.e., AA4, AD12). The most important subarea (AA4, Dargaville) contributed 101 t or 12% of North Island longfin catch over the 12 years and is the most productive catchment in the North Island for longfin, as well as shortfin. This is followed by the Waipa River (AD10) and its many tributaries, the lower Waikato River and tributaries (AD12), and Lake Wairarapa (AL1), a subarea that includes all streams that drain the central North Island from Palmerston North to the coast at Palliser Bay, including the frequently fished Ruamahanga River. The bulk of the remaining subareas in the North Island individually contributed less than 2% of the annual longfin catch. Total North Island longfin annual catch over the 12 years has fluctuated more than shortfin and is characterised by particularly low catches in 2008–09 to 2010–11 and 2014–15 seasons, with an overall trend of declining catch. Factors that may have influenced annual longfin catches, overall and within size grades include port price, the 58% TACC reductions for North Island longfin stocks implemented in the 2007–08 fishing year, limited market for medium sized longfins, access to quota from 2008–09 to 2010–11, and the loss of European and Asian markets in recent years.

The longfin fishery is more prone to market demand fluctuations than shortfin because it is a less desirable species of eel. The number of subareas from which longfin catch was landed has also declined from 49 subareas per year, on average for the first six years, to 43 subareas per year on average for the last six years indicating a contraction in the spatial distribution of fishing effort over time and is consistent with a decline in number of permits fished and fishing events. Despite the contraction in the spatial distribution of fishing effort over time the catch of longfin has been stable in the key subareas over the 12 years with no apparent trends.

South Island shortfin

Shortfin in the South Island were caught from most subareas (49 of the possible 58) over the five years (2010–11 to 2013–14), but the catch is highly aggregated with nearly three-quarters of the catch originating from Te Waihora (AS1 and AS2), and Lake Brunner (AX4). Te Waihora contributed 565 t or 66% of South Island shortfin catch over the five years and is by far the most productive area in the South Island for shortfin. The bulk (92%) of the subareas in the South Island have individually contributed, less than 2% of the annual shortfin catch highlighting the concentrated fishing effort in the South Island and importance of these three subareas to the commercial shortfin fishery. The commercial shortfin catch in ANG 15 over the nine years (2006–07 to 2014–15), shows no consistent trend in annual catch weight. Similarly, for the South Island, there is no trend in shortfin catch or size grades over the five year time series. There is currently no information on factors influencing the catch or on port prices for the South Island. South Island catches by subareas are generally similar each year, except that AS1 and AS2 catches tend to display opposite trends, i.e., large catches from the lake relate to small catches from the migration area and vice versa. This is because the Te Waihora quota (ANG 13) can be filled from either the lake (AS1) or the migration area (AS2).

South Island longfin

Longfin in the South Island were caught from most subareas (53 of the possible 58) over the five years, and although less aggregated than shortfin, nearly half of the catch originated from just seven subareas: AW11 (Mataura River coast), AW9 (Oreti River coast), AW3 (Oreti River inland down to Bog Burn), AV10 (Clutha River coast), AP2 (Wairau River), AU5 (Waitaki River), and AX2 (Buller River). Two southland subareas alone (AW11 and AW9) contributed 127 t or 20% of South Island longfin catch over the five years and Southland is by far the most productive area in the South Island for longfin. The bulk (75%) of the subareas in the South Island, however, individually have contributed less than 2% of the annual longfin catch. The commercial longfin catch in ANG 15 over the nine year period from 2006–07 to 2014–15 is variable but shows no consistent trend in annual catch weight or size grades. Similarly, for the South Island, there is no trend in longfin catch or size grades over the five years. There is currently no information on factors influencing the longfin catch or on port prices for the South Island. Although there are only five years in the South Island time series, catch of longfin has been stable in the key subareas, but more variable for the subareas with smaller catches.

1. INTRODUCTION

The commercial eel monitoring programme began in 2003–04 in the North Island with the collation of processor data on all freshwater eel (longfin, *Anguilla dieffenbachii*; shortfin, *A. australis*) size grades, species composition, and fine scale catch location from individual eel landings (Appendix 1). In the South Island, data were provided for the first time in 2006–07 for Quota Management Area (QMA) ANG 15 only, but no details were provided on catch location other than that all landings were from ANG 15 (Southland/Otago). Full reporting of South Island landings began in 2010–11. In this report, details of catch for the fishing years 2012–13, 2013–14 and 2014–15 are presented, as well as trends in 12 years of landing data from the North Island, 9 years of landings data from ANG 15, and 5 years of landing data from South Island.

1.1 The commercial fishery

The commercial freshwater eel fishery in New Zealand began in the mid-1960s. Landings consist of both the endemic longfin eel (*A. dieffenbachii*), and the shortfin eel (*A. australis*) which is also found in southeast Australia. Landings from the top of the North Island can include the occasional Australian longfin eel (*A. reinhardtii*) (Jellyman et al. 1996). Total New Zealand eel catches peaked in 1972 at about 2100 t (Figure 1) and from 1972 to 1999 the catch fluctuated somewhat, but there was no clear trend with an annual average catch of about 1300 t. Over the next 10 years, catches progressively declined to a low of about 520 t in 2008–09, but over the last five years catches have generally increased or been stable with a catch of 547 t in 2014–15.

The North Island has contributed about 60% (range 52 to 72%), on average, of the total New Zealand eel catch since 1984 (Figure 1). In the North Island, shortfin has consistently been the dominant species, representing, on average, about 71% of the catch, although this proportion has been increasing and over the last 10 years the average proportion was 82% shortfin. North Island shortfin catch steadily declined after 1995–96 to a low of 258 t in 2008–09, after which it has been increasing or stable with a catch of 278 t recorded in 2014–15 (Figure 1). Similarly, North Island longfin catch peaked at 480 t in 1990–91 and then over the next 19 years declined steadily, stabilising at about 40 to 60 t over the last seven years (Figure 1).

In the South Island, historically there was little difference between the reported longfin and shortfin catches, but in the last 10 years shortfin landings have exceeded those of longfin and have comprised on average about 60% (53 to 76%) of the South Island landed catch. South Island catches of both species gradually declined since the mid-1990s, but stabilised with the introduction of the Quota Management System (QMS) in the 2000–01 fishing year, although longfin landings have fluctuated more than three fold over the last 10 years.

The onset of the shortfin and longfin declines in catches preceded the introduction of eels into the QMS in both the North and South Islands. These declines may, in part, have been the result of effort restrictions imposed on the fishery in the early 1990s. In the South Island, the decline may also be related to the voluntary incremental increase in the fyke net escape tube openings from 25 to 26 mm in 1990–91, to 27 mm in 1993–94, to 28.5 mm in 1994–95, and finally to 31 mm in 1997–98 (Vic Thompson, Mossburn Enterprises, Pers. Comm.). In recent years access to quota for longfin has also been limited and market demands for longfin have also been poor.

The South Island eel fishery was introduced into the QMS on 1 October 2000 and Total Allowable Commercial Catches (TACCs) were set in six QMAs (ANG 11 to ANG 16) for both species combined (Table 1, Figure 2). TACCs have been consistently under-caught in all South Island QMAs, with the exception of ANG 13 (Te Waihora) in 2005–05 and 2006–07 years (Ministry for Primary Industries 2016). On average the South Island TACC is about 66% caught (range 51 to 85%) with the highest proportion of the TACC caught in 2012–13.

The North Island eel fishery was introduced into the QMS on 1 Oct 2004 with four separate QMAs allocated to each species (SFE 20–23 and LFE 20–23) (Table 1, Figure 2). The initial shortfin TACC of 457 t was reduced by 26% to 337 t in 2007–08 and overall has been 83% caught (range 65 to 100 %) over the 11 year period. The initial longfin TACC was also reduced in 2007–08 from 193 t to 81 t, a 58% reduction. The North Island longfin TACC has been on average 67% caught (range 44 to 95%) with the lowest catch and proportion of the TACC caught in the last fishing year (Ministry for Primary Industries 2016) (Figure 1). The under catch of the TACCs, especially longfin, is likely to be due to a number of factors including factory closures, retirement of long term fishers, market demands for various sizes, availability of ACE (annual catch entitlement).

1.2 Stock assessment Information

Until the mid-1990s, knowledge of the sustainability of the eel fishery was based mainly on the interpretation of annual commercial catch data recorded on fisher and processor reporting forms (i.e. catch effort landing returns, CELR; eel catch effort returns, ECER; eel catch landing returns, ECLR; and monthly harvest returns, MHR), and knowledge of the biology of the two species. In more recent years, our understanding has been enhanced by sampling of commercial landings (Beentjes & Chisnall 1997, 1998, Beentjes 1999, Speed et al. 2001, Beentjes 2005), monitoring recruitment of elvers and glass eels (Jellyman et al. 2000, Boubée et al. 2002, Martin et al. 2009, Martin & Bowman 2016), and the ongoing collection of size-grade data, species composition and catch location from commercial landings (i.e., the subject of this report) (Beentjes 2005, 2008a, 2008b, 2011, 2013). GIS studies have also included attempts to estimate longfin eel biomass in New Zealand rivers based on physical variables such as river gradient and flow (Graynoth & Niven 2004) and more recently mapping of longfin commercial fishing effort throughout New Zealand and the proportion of habitat that is fished (Beentjes et al. 2016). Analyses to assess New Zealand eel stocks include routine catch-per-unit-effort (CPUE) analyses (Beentjes & Bull 2002, Beentjes & Dunn 2003a, 2003b, 2008, 2010, 2013a, 2014a, 2014b, 2015), and stock assessment modelling for the longfin fishery in Southland and subsequently New Zealand wide (Dunn et al. 2009, Fu et al. 2012). The Ministry for Primary Industries (MPI) rejected the stock assessment models because of the underlying assumptions on estimates of longfin commercial catches and recruitment from individual eel statistical areas. More recently a study investigating the feasibility of eel stock assessment methods concluded that a conventional stock assessment for eels is unlikely to be successful and recommended that any future modelling will need to use a GIS based approach (Hoyle 2016). Analysis of trends in abundance of longfin and shortfin eels from records in the New Zealand Freshwater Fish Database has also been shown to be a useful tool for interpreting trends in relative abundance of eels (Crow & Dunn 2014).

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 of eels in the different commercial size grades and link this to catch location in 2012–13, 2013–14 and 2014–15.

2. METHODS

2.1 North Island

Sampling

The database and analyses were updated with North Island landings from 2012–13, 2013–14 and 2014–15 from two processors: New Zealand Eel Processing Company Limited (NZ Eel) based in Te Kauwhata, and Levin Eel Trading Company Limited (AFL-LET)¹. Together, these two companies process virtually all 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 and hence have changed slightly over time (Table 2).

Catch location is recorded at the sub catchment level, e.g., the Waikato River catchment has twelve subareas, several of which are the hydro lakes. Each of the 12 North Island Eel Statistical Areas (ESA) were subdivided in this way resulting in 65 North Island ESA subareas (Table 1, Figures 3 and 4). ESAs have between one and seven subareas except ESA AD, which has 17 subareas (Table 3). To ensure landings were correctly assigned to an ESA, maps showing the marked subareas were provided to each processor. Data were provided to NIWA on a monthly basis for checking, collation, and entry onto a customised database.

For each fishing year (2012–13, 2013–14 and 2014–15) the catch of longfin and shortfin, from both processors combined, was plotted by subarea and ESA. To allow for the slightly different size grades used by North Island processors, data from the various size grades were combined and assigned into one of three categories; small, medium, or large (Table 2). This is necessary to develop a continuous time series comparison and to avoid creating multiple fragmented series of data whenever minor changes to the size grades are made by the processors.

The catch of each species in these data provided to NIWA by processors, was compared against landed catches recorded by MPI in the plenary document (Ministry for Primary Industries 2016) to determine the proportion included in the analyses.

Analyses

Numbers of eels landed in each weight grade are not recorded, but were estimated as follows:

1. As part of previous analyses (Beentjes 2011) length frequency data for each eel species collected during the North Island catch sampling programme undertaken in 1995–96, 1996–97, and 1997–98 (Beentjes & Chisnall 1997, 1998, Beentjes 1999) were extracted from the MPI *market* database and scaled to landed weight using the catch-at-age program (Bull & Dunn 2002) (Figure 5). These represent the overall recruited size distribution of the North Island longfin and shortfin eel populations for the mid-1990s.
2. 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 (Table 4, Figure 5). In order to simplify the estimation of eel numbers, it was assumed that the North Island shortfin and longfin weight grades were 300–500 g, 500–1000 g, and 1000–4000 g, despite some minor variation over time (see Table 2).
3. 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) (Table 4). The total landed weight

¹ In 2008–09 the AFL owned Whenuapai factory closed and the operation was moved to Levin where catches were processed by Levin Eel Trading Ltd. For the purposes of reporting we refer to these data in this report as AFL-LET.

in each size grade was then divided by the mid-point weight to provide an estimate of the numbers of eels in each weight grade.

These midpoints are the same as those used in Beentjes (2013), but differ slightly from those used by Beentjes (2011) when the exact grades for each processor and year were used. A 4 kg maximum limit was also used in the 2013 and current analyses, even though this did not come into effect in the North Island until March 2007.

The total catch by species, and catch in each size grade by species are tabulated and plotted by year for the North Island (2003–04 to 2014–15). In addition, catch data are plotted by location (subarea and ESA) for the three most recent years (2012–13 to 2014–15). To further examine both temporal trends in catch, and spatial distribution of catch and fishing effort over the 12 year time series, catch by subarea and year are presented as bubble plots.

In this report North Island Eel Statistical Areas (ESAs) are referred to by their correct alpha codes, (see Table 1 for equivalent numeric codes). Similarly subareas are also referred to by their alpha codes consistent with the ESA alpha codes. Previous reports used subarea codes based on the historic numeric ESA codes, i.e., subarea 1A was within ESA 1, but was changed to AA1 in ESA AA.

2.2 South Island

For the South Island, analyses are updated with landings from (2012–13, 2013–14 and 2014–15) (Appendix 1). Collection of species size grade data in the South Island began in 2006–07 by Mossburn Enterprises Limited (Invercargill), but these data included landings only from ANG 15 (Otago–Southland, see Figure 2), and unlike the North Island, detailed catch location for subarea or ESA were not provided. Catch location data for the entire South Island began in 2010–11. Three eel processors receive eel catch from the South Island: Mossburn Enterprises (Invercargill), Independent Fisheries (Christchurch), and Levin Eel Trading Ltd (Levin). Hence there are now two time series for the South Island, ANG 15 from 2006–07 to 2014–15 (nine years without subarea location), and all South Island from 2010–11 to 2014–15 (five years), which has complete catch location data.

Sampling

As for the North Island, processors of South Island eels sort the catch from each landing into species (shortfin and longfin) and then visually grade it by size before weighing. Catch location is also recorded. The size grades used by the three South Island processors are shown in Table 5. Although up to three size grades have been used by processors, the data were assigned to two generic size grades (small and large) for each species because of the difficulty in combining North and South Island size grades in any meaningful way (Table 5).

Numbers of eels were estimated from the North Island scaled length frequency data using the methods described above. Scaled length frequency data from the South Island catch sampling programmes were not used in the estimate of numbers because sampled landings were targeted from predominantly heavily fished mainstem rivers, and tended to contain smaller eels on average than that of all landings. In addition, eels landed from AS2 (Te Waihora, shortfin male migration area), exclusively by Independent Fisheries in the South Island, are smaller than the estimated midpoint weight for the small grade category (see Table 4). Numbers of small South Island shortfin are therefore underestimated.

The total catch by species, and catch in each size grade by species are tabulated and plotted by year for ANG 15 (2006–07 to 2014–15) and the South Island (2010–11 to 2014–15). In addition, South Island data are plotted by location (subarea and ESA) for the three most recent years (2012–13 to 2014–15). To further examine both temporal trends in catch, and spatial distribution of catch and fishing effort over the five year time series, catch by subarea and year are presented as bubble plots.

2.3 Markets and port prices

Commercial eel processors were contacted and asked for information relating to markets for both species and size grades. Data were also requested on port prices paid to fishers for each species and size grade by fishing year. Where port price changed during the fishing year, the mean port price was used, weighted by the proportion of the year it was in effect. The port price is presented as an index standardised to the first year in the time series. In addition, the relative port price among size grades is plotted against catch by size grade to investigate the relationship between the price paid and the catch within each of the three grades.

3. RESULTS

3.1 North Island

3.1.1 North Island landings and catch

A summary of landings, species tonnages, sampling proportions, and species composition from North Island processors between 2003–04 and 2014–15 is shown in Table 6, and the catch by species plotted in Figure 6. Catches of shortfin have remained reasonably stable at around 300 t over the twelve years. Longfin catch was between 100 and 120 t at the start of the monitored period, but has generally declined since 2006–07 with the lowest catch of 34 t taken in 2014–15. The proportion of shortfin overall is 80% and the continued decline in longfin and stabilisation of shortfin has caused the shortfin component of the catch to rise in recent years. Comparison of catches reported to MPI from ECERs and/or MHRs (Ministry for Primary Industries 2016), and those provided to NIWA in this programme show a close match from 2006–07 onward. The values of 110% in 2010–11 and 95% in 2013–14 are anomalous (Table 6).

Estimated numbers of eels, and species composition from North Island landings between 2003–04 and 2014–15 are shown in Table 7. The estimated commercial landings of shortfin for each season has varied from about 500 000 to 700 000 eels and from about 50 000 to 200 000 eels for longfin. The proportions of shortfin in the total eel landings are slightly higher when estimated by number than by weight because longfins have a larger mean weight than shortfins (compare Tables 6 and 7). The mean weight for shortfin has been stable at about 500 g throughout the monitoring period, but longfin mean weight varies according to the proportion of the catch in the various size grades (Table 7).

Individual landing weights (both species combined) were mostly between 50 and 400 kg with the most common weight about 100 to 150 kg and the largest over 2000 kg (Figure 7). The largest landings are likely to be from multiple days fishing that were combined and trucked to the factory as a single landing.

3.1.2 2012–13 fishing year (North Island)

North Island catch location (subarea)

The catches of each species by subarea for 2012–13 are shown in Figure 8. Shortfin were landed from 42 of the 65 North Island subareas (65%), but about half (47%) of the catch was from just five subareas, i.e., in decreasing order of catch: AA4 (Dargaville), AC1 (Hauraki Plains west), AC2 (Hauraki Plains east), AD12 (Lake Waikare/Port Waikato), and AK1 (Manawatu River coast) (Figures 8 and 9). Longfin were landed from 41 of the 65 North Island subareas (63%), but about half (49%) of the catch was from just six subareas, i.e., in decreasing order of catch: AA4 (Dargaville), AD12 (Lake Waikare/Port Waikato), AL1 (Lake Wairarapa), AK1 (Manawatu River coast), AC2 (Hauraki Plains east), and AC1 (Hauraki Plains west) (Figure 8 and 10).

North Island catch location (ESA)

The catches of each species by ESA for 2012–13 are shown in Figure 11. Shortfin was landed from all twelve ESAs (Figures 11 and 12). The major contributors by statistical area, in descending catch order, were AC (Hauraki), AD (Waikato), AA (Northland), AG (Hawkes's Bay), and AK (Manawatu) which together accounted about three-quarters (77.8%) of the shortfin catch. Longfin was landed from all ESAs except AF, and in AM catch was negligible (Figures 11 and 13). The major contributors by statistical area, in descending catch order, were AD (Waikato), AA (Northland), AK (Manawatu), AC (Hauraki), and AB (Auckland) which together accounted for three quarters (75%) of the longfin catch.

North Island species composition

The overall species composition of the North Island catch in 2012–13 was 81.1% shortfin (Table 6, Figure 8). Shortfin was also the dominant species in all but three subareas (AJ2, AJ3, and AE4), although catches in these subareas were relatively small. Shortfin was the dominant species in all ESAs in 2012–13 (Figure 11).

North Island size composition

The overall proportions by weight of shortfin in the three size grades for 2012–13 were 49%, 38%, and 13% for small, medium, and large, respectively (Table 8). The equivalent proportions by shortfin numbers were 65%, 29%, and 6%, respectively (Table 8). The three size grades were present in all subareas and ESAs where shortfin was landed (Figures 9 and 12).

The overall proportions by weight of longfin in the three size grades were 39%, 21%, and 40% for the small, medium, and large, respectively (Table 9). The equivalent proportions by longfin numbers were 64%, 18%, and 17%, respectively (Table 9). The three size grades were present in all subareas and ESAs where longfin was landed (Figures 10 and 13).

3.1.3 2013–14 fishing year (North Island)

North Island catch location (subarea)

The catches of each species by subarea for 2013–14 are shown in Figure 8. Shortfin were landed from 45 of the 65 North Island subareas (69%), but about half (47%) of the catch was from just five subareas, i.e., in decreasing order of catch: AA4 (Dargaville), AC2 (Hauraki Plains east), AC1 (Hauraki Plains west), AG5 (Tukituki River), AD12 (Lake Waikare/Port Waikato), and AK1 (Manawatu River coast) (Figures 8 and 9). Longfin were landed from 44 of the 65 North Island subareas (68%), but about half (50%) of the catch was from just seven subareas, i.e., in decreasing order of catch: AA4 (Dargaville), AD10 (Waipa River), AD12 (Lake Waikare/Port Waikato), AL1 (Lake Wairarapa), AK2 (Manawatu River inland), AK1 (Manawatu River coast), and AD11 (Lakes Whangape, Waahi and Rotongaro) (Figure 8 and 10).

North Island catch location (ESA)

The catches of each species by ESA for 2013–14 are shown in Figure 11. Shortfin was landed from all ESAs except AM (Figures 11 and 12). The major contributors by statistical area, in descending catch order, were AC (Hauraki), AD (Waikato), AA (Northland), and AG (Hawkes's Bay) which together accounted about three-quarters (72%) of the shortfin catch. Longfin was landed from all ESAs except AM (Figures 11 and 13). The major contributors by statistical area, in descending catch order, were AD (Waikato), AA (Northland), AK (Manawatu), AC (Hauraki), and AB (Auckland), which together accounted for three quarters (72%) of the longfin catch.

North Island species composition

The overall species composition of the North Island catch in 2013–14 was 82.8% shortfin (Table 6, Figure 8). Shortfin was also the dominant species in all but two subareas (AD16 and AJ1), although catches in these subareas were relatively small. Shortfin was the dominant species in all ESAs in 2013–14 (Figure 11).

North Island size composition

The overall proportions by weight of shortfin in the three size grades for 2013–14 were 47%, 40%, and 12% for small, medium, and large, respectively (Table 8). The equivalent proportions by shortfin numbers were 63%, 31%, and 5%, respectively (Table 8). The three size grades were present in all subareas and ESAs where shortfin was landed (Figures 9 and 12).

The overall proportions by weight of longfin in the three size grades were 39%, 21%, and 40% for the small, medium, and large, respectively (Table 9). The equivalent proportions by longfin numbers were 64%, 18%, and 17%, respectively (Table 9). The three size grades were present in all subareas and ESAs where longfin was landed except AH4 where only 9 kg were landed (Figures 10 and 13).

3.1.4 2014–15 fishing year (North Island)

North Island catch location (subarea)

The catches of each species by subarea for 2014–15 are shown in Figure 8. Shortfin were landed from 44 of the 65 North Island subareas (68%), but about half (53%) of the catch was from just six subareas, i.e., in decreasing order of catch: AC2 (Hauraki Plains east), AA4 (Dargaville), AD12 (Lake Waikare/Port Waikato), AC1 (Hauraki Plains west), AD11 (Lakes Whangape, Waahi and Rotongaro), and AG4 (Napier) (Figures 8 and 9). Longfin were landed from 44 of the 65 North Island subareas (68%), but about half (50%) of the catch was from just seven subareas, i.e., in decreasing order of catch: AA4 (Dargaville), AD10 (Waipa River), AD12 (Lake Waikare/Port Waikato), AL1 (Lake Wairarapa), AK2 (Manawatu River inland), AK1 (Manawatu River coast), and AD11 (Lakes Whangape, Waahi and Rotongaro) (Figure 8 and 10).

North Island catch location (ESA)

The catches of each species by ESA for 2014–15 are shown in Figure 11. Shortfin was landed from all ESAs except AM (Figures 11 and 12). The major contributors by statistical area, in descending catch order, were AD (Waikato), AC (Hauraki), AA (Northland), and AG (Hawkes's Bay) which together accounted for about three-quarters (72%) of the shortfin catch. Longfin was landed from all ESAs except AM (Figures 11 and 13). The major contributors by statistical area, in descending catch order, were AD (Waikato), AA (Northland), AG (Hawkes's Bay), AK (Manawatu), and AB (Auckland) which together accounted for about three quarters (72%) of the longfin catch.

North Island species composition

The overall species composition of the North Island catch in 2014–15 was 88.4% shortfin (Table 6, Figure 8). Shortfin was also the dominant species in all but three subareas (AF1, AJ2 and AJ3), although catches in these subareas were relatively small. Shortfin was the dominant species in all ESAs in 2014–15 (Figure 11).

North Island size composition

The overall proportions by weight of shortfin in the three size grades were 44%, 42%, and 14% for small, medium, and large, respectively (Table 8). The equivalent proportions by shortfin numbers were 60%, 34%, and 6%, respectively (Table 8). The three size grades were present in all subareas and ESAs where shortfin was landed (Figures 9 and 12).

The overall proportions by weight of longfin in the three size grades 2014–15 were 42%, 23%, and 34% for the small, medium, and large, respectively (Table 9). The equivalent proportions by longfin numbers were 66%, 20%, and 14%, respectively (Table 9). The three size grades were present in all subareas and ESAs where longfin was landed (Figures 10 and 13).

3.1.5 Time series trends in the North Island

3.1.5.1 Shortfin

Shortfin temporal trends in catch and size of eels

The North Island commercial shortfin catch over the twelve year period from 2003–04 to 2014–15 shows no consistent trend in annual catch weight or in the distribution of these catches in the three size grades used (Figure 14). Despite the generally stable temporal pattern in North Island shortfin catch there are a number of factors that may have influenced annual shortfin catches, overall and within size ranges. Some of these factors are annotated on Figure 14 and include, in chronological order:

1. 1 October 2004: North Island shortfin introduced into the Quota Management System.
2. 1 October 2007: TACC reductions of 26% for North Island shortfin stocks.
3. September 2011: access to Taiwan market lost.
4. 1 October 2013: fyke net escape tube size increase from 25 mm to 31 mm (legislated).
5. 2012–13: strong demand from Russian markets.
6. 2013–14 and 2014–15: weak demand from Russian markets due to conflicts in Ukraine and weak Chinese market demand due to increase supply of glass eels from Europe. Longfin more affected than shortfin because the latter is the preferred species.
7. 2014–15: 35 mm escape tubes used voluntarily by some fishers to reduce catch of small eels, mainly in the south of North Island.
8. 2015–16: European and Russian frozen eel demand low but improving.

Despite the various factors listed above and shown in Figure 14, there does not appear to be any clear driver of shortfin total catch and catch by size grades.

Impact of port price and effort on shortfin catch

Market demand often drives the port price of eels paid to fishers and also the effort applied to the fishery. Shortfin eel port price can differ for the three size grades (small, medium, and large) among and within fishing years. Shortfin port price indices by size grade for both North Island eel processors are shown in Figure 15. Within each size grade the catch and the port price index are not always correlated over time, but there are indications that it is often the main driver of catch. For example the lowest catch of small and large shortfin corresponds to the lowest port price for AFL-LET (Figure 15). The catch of medium sized shortfin appears to be most sensitive to port price as both have increased since 2010 for both processors.

The relative port price among size grades does not appear to have had a large impact on the catch of small, medium, or large shortfin for either processors, i.e., fluctuations among port prices by size grade are not generally correlated with catch for a particular grade (Figure 16). For AFL-LET, the only apparent effect was a reduction in the catch of small shortfin eels commensurate with a fall in the relative port price within this size grade in 2014–15. Similarly, NZeel catch of medium sized eels increased relative to the higher port price for medium than small eels from 2011–12 onward, although catch of small eels was unaffected.

The total eel catch, and especially longfin, shows good correlation to both the numbers of permits that have been fished and the number of fishing events in a year (Figure 17).

Spatial trends in shortfin catch

Spatial and temporal trends in the North Island catch of shortfin by subarea from 2003–04 to 2014–15 are shown in Figure 18. Shortfin was landed from 63 of the possible 65 subareas (no landings from AF3 (Cape Runaway) and AF4 (Waiapu River)). Of these 63 subareas, AA4 (Dargaville), AD12 (Lake Waikare, Port Waikato) and AC1 (Hauraki plains west) are consistently the main contributors to the North Island shortfin annual landings making up almost one-third (30%) of the catch over the twelve years (Figure 18). For other subareas, catches are more variable among years, but the most important subareas, in descending order of catch, include: 3A (Hauraki Plains east), AK1 (Manawatu River coast),

AG4 (Napier), and AB3 (Manukau Harbour). Together these seven subareas have contributed over half (51.5%) of the shortfin catch from 2003–04 to 2014–15. The pattern of catches by subareas is generally similar over the twelve years.

3.1.5.2 Longfin

Longfin temporal trends in catch and size

North Island commercial longfin catches over the twelve year period from 2003–04 to 2014–15 have fluctuated more than three-fold and are characterised by low catches in 2008–09 to 2010–11 and 2014–15 (Figure 19). The medium longfin size grade is poorly represented in these first three years of low catches. There are a number of factors that may have influenced annual longfin catches, overall and within size ranges. Some of these factors are annotated on Figure 19 and include, in chronological order:

1. 1 October 2004: North Island longfin introduced into the Quota Management System.
2. 1 October 2007: TACC reductions of 58% for North Island longfin stocks.
3. 1 April 2007: 4 kg maximum size limit introduced for longfin in the North Island.
4. 2008–09 to 2010–11: limited market for longfin eels in the medium size grade (500–1000 g) and fishers actively discouraged from landing eels in this grade (both AFL-Levin and NZ Eel).
5. 2010–11: Aotearoa Fisheries Ltd (AFL) did not lease longfin quota to North Island fishers which resulted in most fishers having insufficient quota to cover their catch. As a result some fishers sorted their catch at or near the capture point and released longfin.
6. 2011–12: access to AFL longfin quota restored to North Island fishers.
7. 2011–12: all size grades of both species in high demand and there were no restrictions imposed on fishers not to land medium sized longfin.
8. September 2011: access to Taiwan market lost. Predominantly longfin market
9. 2012–13: strong demand from Russian market
10. 1 October 2013: fyke net escape tube size increase from 25 mm to 31 mm (legislated).
11. 2013–14 and 2014–15: weak demand from Russian markets (see shortfin factors). Longfin more affected than shortfin because the latter is the preferred species.
12. 2014–15: 35 mm escape tubes used voluntarily by some fishers to reduce catch of small eels, mainly in the south of North Island.
13. 2015–16 fishing year: European and Russian frozen eel demand low but improving
14. 2015–16: Smaller grade LFE is not wanted by AFL-LET and fishers are being advised not to land longfin in this size.

The reduced catches after 2006–07 are to some extent driven by the 58% TACC reduction in 2007–08, followed by a fall in demand for medium size longfin eels during the three low catch years, which explains the low proportions of medium sized eels in the catch from 2008–09 to 2010–11 (Figure 19). AFL quota was not leased to fishers in 2010–11 resulting in further reductions to landed catch. The increase in total longfin catch and of the medium size grade in 2011–12, reflects both an improved market for this grade, and restoration of AFL quota for lease. Although markets into Taiwan and Russia were poor from 2011–12 to 2014–15, only the 2014–15 catch appears to have been affected. The 2014–15 fishing year may also have been impacted by the 35 mm escape tube incorporated into fyke nets by some fishers in the lower North Island, although the proportion of small longfin eels does not appear to have been affected (Figure 19).

Impact of port price and effort on longfin catch

Longfin eel port price can differ for the three size grades (small, medium, and large) among and within fishing years. Longfin port price indices by size grade for both North Island eel processors are shown in Figure 20. Within each size grade the longfin catch and the port price shows very little correlation for AFL-LET landings, however, there are no port price data before 2009–10 when catches show the steepest decline. For NZEel there are indications of correlations between catch of medium and large size longfin eels and port price (Figure 20).

The relative port price among size grades does not appear to have had a large impact on the catch of small, medium, or large longfin for either processor, i.e., fluctuations among port prices by size grade are not generally correlated with catch for a particular grade (Figure 21). For AFL-LET, the only apparent effect was a broad correlation between port price and catch of large longfin eels, but for NZeel there was no clear correlation.

The total eel catch, and especially longfin, shows good correlation to both the numbers of permits that have been fished and the number of fishing events in a year (see Figure 17).

Longfin spatial trends in catch

Spatial and temporal trends in the North Island catch of longfin by subarea from 2003–04 to 2014–15 are shown in Figure 22. Longfin have been landed from 63 of the possible 65 subareas (no landings from AF3 (Cape Runaway) and AF4 (Waiapu River)). Of these 63 subareas, AA4 (Dargaville), AD10 (Waipa River), AD12 (Lake Waikare, Port Waikato), and AL1 (Lake Wairarapa), are consistently the main contributors to the North Island longfin annual landings, making up over one-third (34.6%) of the catch (Figure 22). For other subareas, catches are more variable among years, but the most important subareas, in order of contribution are: AK1 (Manawatu River coast), AB3 (Manukau Harbour), AG5 (Tukituki River), and 3A (Hauraki Plains west). Together these eight subareas have contributed half (50.1%) of the longfin catch from 2003–04 to 2014–15 (Figure 22). The catches for the four main subareas (AA4, AD10, AD12, and AF4) vary among years but there is no clear pattern of declining or increasing catch. In three of these subareas, however, the 2014–15 year is the lowest of the twelve years. For the minor subareas there is more variation among years as catch is not always landed from these subareas every year. The number of subareas for which longfin catch was landed has declined from 49 subareas per year, on average for the first six years, to 43 subareas per year on average for the last six years, indicating a contraction of effort over time

3.2 South Island

3.2.1 Landings and catch

ANG 15

A summary of landings, species tonnages, sampling proportions, and species composition from eel processors between 2006–07 and 2014–15 for ANG 15 are shown in Table 6, and the species catch plotted in Figure 23. Catches of shortfin have ranged from about 13 t to 28 t with no consistent trend. Longfin catch was between 35 t and 91 t, with low catches in 2008–09 and 2009–10. The proportion of shortfin in the total eel catch over this six year period is 23%, but has varied annually between 16% and 42%. Comparison of catches reported to MPI from ECERs and/or MHRs (Ministry for Primary Industries 2016) and those provided to NIWA in this programme show a close match for most years (Table 6), suggesting that the data used in the present report is an accurate reflection of the commercial catches.

The annual commercial catch from ANG 15 is estimated to have varied between 23 000 and 44 000 shortfin and 52 000 to 173 000 longfin over the nine years. The proportions of shortfin in the estimated total number of eels are similar to that derived from actual catch weights (compare Table 6 and 7). The mean size for shortfin has been stable at just over 600 g, and for longfins it has been more variable ranging from 520 to 740 g, averaging about 570 g (Table 7).

All South Island

A summary of landings, tonnages by species, proportion of landings examined, and species composition from 2010–11 to 2014–15 for all South Island catches are shown in Table 6. Catch by species from the same records are plotted in Figure 24. Catches of shortfin have ranged from about 144 t to 193 t with no consistent trend. Longfin catch was between 76 t and 160 t, with the lowest catch in 2014–15. The proportion of shortfin overall is 58%, ranging from 47% to 67% over the five years. Comparison of catches reported to MPI from ECERs and/or MHRs (Ministry for Primary Industries 2016) and those

provided to NIWA in the programme show a close match for both all years, except 2012–13 when only 86% of the reported catch is accounted for in the collected data (Table 6).

Estimated numbers of eels, and species composition from all South Island landings from 2010–11 to 2014–15 are shown in Table 7. The annual commercial catch has ranged from 253 000 to 356 000 shortfin and 140 000 to 292 000 longfin over the five years. The proportions of shortfin in the estimated total number of eels are similar to that derived from actual catch weights (compare Table 6 and 7). The mean size for shortfin is about 570 g and 590 g for longfin, although it is more for the latter (Table 7).

Individual landing weight (both species combined) was most commonly between 50 and 300 kg with largest landings over 2400 kg (Figure 25). Largest landings are likely to be from extended fishing periods with the combined catch trucked to the processors.

3.2.2 ANG 15 catch by fishing year

2012–13

The overall proportions by weight of shortfin in the two size grades were 58% and 42% for the small and large, respectively, in 2012–13 (Table 8). The equivalent proportions by estimated eel numbers were 79% and 21%, respectively (Table 8).

The overall proportions by weight of longfin in the two size grades were 77% and 23% for the small and large, respectively (Table 9). The equivalent proportions by estimated eel numbers were 92% and 8%, respectively (Table 9).

2013–14

The overall proportions by weight of shortfin in the two size grades were 74% and 26% for the small and large, respectively, in 2013–14 (Table 8). The equivalent proportions by estimated eel numbers were 89% and 11%, respectively (Table 8).

The overall proportions by weight of longfin in the two size grades were 75% and 25% for the small and large, respectively (Table 9). The equivalent proportions by estimated eel numbers were 91% and 9%, respectively (Table 9).

2014–15

The overall proportions by weight of shortfin in the two size grades were 61% and 39% for the small and large, respectively, in 2014–15 (Table 8). The equivalent proportions by estimated eel numbers were 81% and 19%, respectively (Table 8).

The overall proportions by weight of longfin in the two size grades were 78% and 22% for the small and large, respectively (Table 9). The equivalent proportions by estimated eel numbers were 92% and 8%, respectively (Table 9).

3.2.3 2012–13 fishing year (South Island)

South Island catch location (subarea)

The catches of each species by subarea for 2012–13 are shown in Figure 26. Shortfin were landed from 39 of the 58 South Island subareas (67%), but about two thirds (67%) of the catch was from just four subareas, i.e., in decreasing order of catch: AS1 (Te Waihora, excluding migration area), AS2 (Te Waihora migration area), AX4 (Lake Brunner), and AR3 (Waimakariri River) (Figures 26 and 27). Longfin were landed from 40 of the 58 South Island subareas (69%), but about half (50%) of the catch was from just seven subareas, i.e., in decreasing order of catch: AW11 (Mataura River coast), AW9 (Oreti River coast), AV10 (Clutha River coast), AU5 (Waitaki River), AW3 (Oreti River inland down to Bog Burn), AP2 (Wairau River), and AX2 (Buller River) (Figures 26 and 28).

South Island catch location (ESA)

The catches of each species by ESA for 2012–13 are shown in Figure 29. Shortfin was landed from all eleven South Island ESAs (Figures 29 and 30), but more than three quarters (77%) of the South Island shortfin catch was from just four ESAs, in decreasing order of catch: AS1 (Te Waihora, excluding migration area), AS2 (Te Waihora migration area), AX (Westland), and AR (North Canterbury) (Figures 27 and 28). Longfin was landed from all ESAs except Te Waihora (AS1 and AS2) (Figures 29 and 31). The major contributors by statistical area, in decreasing catch order, were AW (Southland), AV (Otago), and AX (Westland), which together accounted for more than three quarters (76%) of the longfin catch.

South Island species composition

The overall species composition of the South Island catch in 2012–13 was 47.4% shortfin (Table 6, Figure 26). Shortfin was the dominant species in 14 of the 43 subareas where eels were caught, with only shortfin landed from AS1 and AS2. Shortfin was the dominant species in ESAs AN, AQ, AR, AS1 and AS2 in 2012–13 (Figure 29).

South Island size composition

The overall proportions by weight of shortfin in the two size grades in 2012–13 were 62% and 37% for small and large, respectively (Table 8). The equivalent proportions by eel numbers were 82% and 18%, respectively (Table 8). The two size grades were present in all subareas and ESAs where shortfin was landed except AS2 (Te Waihora migration area), where only small shortfin eels were landed (Figures 27 and 30).

The overall proportions by weight of longfin in the two size grades were 73% and 27% for the small and large, respectively (Table 9). The equivalent proportions by eel numbers were 90% and 10% respectively (Table 9). The two size grades were present in all subareas and ESAs where longfin was landed (Figures 28 and 31).

3.2.4 2013–14 fishing year (South Island)

South Island catch location (subarea)

The catches of each species by subarea for 2013–14 are shown in Figure 26. Shortfin were landed from 39 of the 58 South Island subareas (67%), but more than three quarters (76%) of the catch was from just three subareas, i.e., in decreasing order of catch: AS1 (Te Waihora, excluding migration area), AS2 (Te Waihora migration area), and AX4 (Lake Brunner) (Figures 26 and 27). Longfin were landed from 40 of the 58 South Island subareas (69%), but nearly half (49%) of the catch was from just seven subareas, i.e., in decreasing order of catch: AW11 (Mataura River coast), AW9 (Oreti River coast), AV10 (Clutha River coast), AX2 (Buller River), AW3 (Oreti River inland down to Bog Burn), AX? (Westland unidentified subarea), and AV11 (Pomahaka River) (Figure 26 and 28).

South Island catch location (ESA)

The catches of each species by ESA for 2013–14 are shown in Figure 29. Shortfin was landed from all eleven South Island ESAs (Figures 29 and 30), but more than three quarters (80%) of the South Island shortfin catch was from just three ESAs, in decreasing order of catch: AS1 (Te Waihora, excluding migration area), AX (Westland), and AR (North Canterbury) (Figures 29 and 30). Longfin was landed from all ESAs except AS2 (Te Waihora migration area) (Figures 29 and 31). The major contributors by statistical area, in decreasing catch order, were AW (Southland), AX (Westland), and AV (Otago), which together accounted for more than three quarters (80%) of the longfin catch.

South Island species composition

The overall species composition of the South Island catch in 2013–14 was 58.1% shortfin (Table 6). Shortfin was the dominant species in 13 of the 42 subareas where eels were caught, with only shortfin landed from AR1 and AS2 (Figure 26). Shortfin was the dominant species in ESAs AQ, AR, AS1 and AS2 in 2013–14 (Figure 29).

South Island size composition

The overall proportions by weight of shortfin in the two size grades in 2013–14 were 56% and 44% for small and large, respectively (Table 8). The equivalent proportions by eel numbers were 78% and 22%, respectively (Table 8). The two size grades were present in all subareas and ESAs where shortfin was landed except AS2 (Te Waihora migration area), where only small shortfin eels were landed (Figures 27 and 30).

The overall proportions by weight of longfin in the two size grades were 73% and 27% for the small and large, respectively (Table 9). The equivalent proportions by eel numbers were 90% and 10% respectively (Table 9). The two size grades were present in all subareas and ESAs where longfin was landed (Figures 28 and 31).

3.2.5 2014–15 fishing year (South Island)

South Island catch location (subarea)

The catches of each species by subarea for 2014–15 are shown in Figure 26. Shortfin were landed from 31 of the 58 South Island subareas (53%), but nearly three quarters (74%) of the catch was from AS1 (Te Waihora, excluding migration area) (Figures 26 and 27). Longfin were landed from 34 of the 58 South Island subareas (59%), but just over half (51%) of the catch was from just four subareas, i.e., in decreasing order of catch: AW9 (Oreti River coast), AW11 (Mataura River coast), AX3 (Grey and Arnold Rivers), and AW3 (Oreti River inland down to Bog Burn) (Figures 26 and 28).

South Island catch location (ESA)

The catches of each species by ESA for 2014–15 are shown in Figure 29. Shortfin was landed from all eleven South Island ESAs, except AS2 (Te Waihora migration area) (Figures 29 and 30), but nearly three quarters (74%) of the South Island shortfin catch was from AS1 (Te Waihora, excluding migration area) (Figures 29 and 30). Longfin was landed from all ESAs except AS1 and AS2 (Te Waihora) (Figures 29 and 31). The major contributors by statistical area, in decreasing catch order, were AW (Southland), AX (Westland), and AV (Otago), which together accounted for more than three quarters (87%) of the longfin catch.

South Island species composition

The overall species composition of the South Island catch in 2014–15 was 67.3% shortfin (Table 6). Shortfin was the dominant species in 14 of the 36 subareas where eels were caught. Shortfin were the only eel species landed from AS1 and AU4 (Figure 26), but were absent in landings from AV2, AV8, AW2, AW3, and AX9. Shortfin was the dominant species in ESAs AN, AQ, AR, AS1, and AT in 2014–15 (Figure 29).

South Island size composition

The overall proportions by weight of shortfin in the two size grades in 2014–15 were 62% and 38% for small and large, respectively (Table 8). The equivalent proportions by eel numbers were 82% and 18%, respectively (Table 8). The two size grades were present in all subareas except AU4 where there were no small eels, and all ESAs where shortfin was landed (Figures 27 and 30).

The overall proportions by weight of longfin in the two size grades were 76% and 24% for the small and large, respectively (Table 9). The equivalent proportions by eel numbers were 91% and 9% respectively (Table 9). The two size grades were present in all subareas and ESAs where longfin was landed (Figures 28 and 31).

3.2.6 Time series trends in the South Island

3.2.6.1 Temporal trends in catch and size of eels

The ANG 15 commercial shortfin catch over the nine year period from 2006–07 to 2014–15 show that the catch has varied nearly two-fold among years while the proportion of large shortfin has varied more than four-fold (Figure 32). The South Island commercial shortfin catch over the five year period from 2010–11 to 2014–15 shows no consistent trend in annual catch weight or the proportion in the two size grades, although the time series is relatively short (Figure 33).

The ANG 15 commercial longfin catch over the nine year period from 2006–07 to 2014–15 show that the catch has varied nearly three-fold among years while the proportion of large longfin has varied more than four-fold (Figure 34). The South Island commercial longfin catch over the five year period from 2010–11 to 2014–15 shows no consistent trend in annual catch weight or the proportion in the two size grades, although the last year has the smallest catch and smallest proportion of large longfin (Figure 35).

At the time of writing, there were no available data on shortfin or longfin port price by size grade for the South Island, or information on market demand. South Island is less affected by longfin market demands as the condition of longfin is better in the South Island than the North Island and there are different markets for South Island longfins (Pers. Comm. Vic Thompson - Mossburn Enterprises). The catch of shortfin relative to longfin can vary more in the South Island as both eel species are managed under a single eel catch quota for each QMA (ANG 13 to ANG 16) and hence the annual catch could conceivably be made up of a single species. The proportion of the South Island catch that is shortfin or longfin in a year can depend on market demand, but also on environmental conditions with shortfin targeted more often when rivers are high and longfin during dry conditions. Factors that may have affected North Island eel catch such as introduction to the QMS, introduction of a 4 kg longfin maximum legal size, and increases to escape tubes, all predate the time series for ANG 15 and the South Island.

3.2.6.2 Spatial trends in catch

Shortfin

Spatial and temporal trends in the South Island catch of shortfin by subarea from 2010–11 to 2014–15 are shown in Figure 36. Shortfin was landed from 49 of the possible 58 subareas. Of these 49 subareas, AS1 (Te Waihora excluding migration area), AS2 (Te Waihora migration area), and AX4 (Lake Brunner) are consistently the main contributors to the South Island shortfin annual landings making up almost three-quarters (73%) of the catch over the five years (Figure 36). For other subareas, catches are more variable among years, and only AR3 (Waimakariri River), and AV9 (Lake Waihora and Waipori) have contributed more than 2% of the shortfin catch over the five years. The pattern of catches by subareas is generally similar over the five years, however, AS1 and AS2 catches tend to display opposite trends, i.e., large catches from the lake result in small catches from the migration area and vice versa.

Longfin

Spatial and temporal trends in the South Island catch of longfin by subarea from 2010–11 to 2014–15 are shown in Figure 37. Longfin was landed from 53 of the possible 58 subareas. Of these 53 subareas, AW11 (Mataura River coast), AW9 (Oreti River coast), AW3 (Oreti River inland down to Bog Burn), AV10 (Clutha River coast), AP2 (Wairau River), AU5 (Waitaki River), and AX2 (Buller River) are consistently the main contributors to the South Island longfin annual landings making up almost half (49%) of the catch over the five years (Figure 37). For other subareas, catches are more variable among years, and only AV11 (Pomahaka River), AX3 (Grey River Arnold River), and AW10 (Mataura River from Riversdale to Gore) have contributed more than 3% of the longfin catch over the five years. The pattern of catches by subareas is generally similar over the five years, but more variable for the smaller contributors of catch.

4. DISCUSSION

4.1 General comments on the eel monitoring programme

Eel catch data are analysed and presented in detail for fishing years 2012–13 to 2014–15 of the commercial eel fishery monitoring programme. The North Island has had full participation since the inception of the monitoring programme in 2003–04, whereas the South Island processors have provided limited data from ANG 15 (Otago and Southland) since 2006–07, and complete data for the entire South Island from 2010–11. Data presented include processed size grades, species composition, and catch location from individual commercial eel landings.

4.2 Efficacy of the data collected

Because the location of the catch is recorded at the time of landing, species catch and size can be examined at three geographic spatial scales, i.e., QMA, ESA, and most importantly, the catchment based subarea. The latter two spatial area data are unique to this programme, although catch is estimated (not weighed) by species and recorded by ESA as part of the mandatory reporting by individual commercial fishers using ECERs. With 12 years in the North Island time series, the data can now be used to more effectively monitor temporal and spatial trends in catch and size of each species.

Although these records provide less information on size and sex distribution from individual landings than the historical catch sampling programmes (Beentjes & Chisnall 1997, 1998, Beentjes 1999, Chisnall & Kemp 2000, Beentjes 2005), they have the distinct advantage of capturing data from nearly all North and South Island eel landings, providing a more accurate and unbiased representation of the spatial stock structure.

Because virtually the entire annual catch is sampled (see Table 6), an accurate estimate of the proportion of large eels landed by the commercial eel fishery is obtained. For longfin eels, this provides an index of potential spawning females less than 4 kg in the population from the commercially fished habitat. Longfin eels over 1000 g or about 70 cm (i.e., large size grade) are almost certainly females as males migrate at a mean length of about 62 cm, equivalent to about 680 g (Todd 1980). Longfin females mature and migrate from about 90 cm or 2 kg depending on condition (see review in Fu et al. 2012). The maximum longfin size limit for commercial harvest is 4 kg (about 108 cm), and hence where commercial fishing takes place, the maturing and potentially migrating females, between 2 and 4 kg, are vulnerable to capture. Common practice, however, is for commercial fishers to voluntarily release eels that display morphological signs of migration, even if they are below 4 kg. Commercial fishers also tend to avoid waterways when mature longfins are migrating downstream. The full extent of the over 4 kg longfin eel releases is unknown, but voluntary recording of these data by South Island eel fishers showed that over 1400 longfins over 4 kg were caught and released in 2013–14 (Bill Chisolm, pers. comm.), some of which were as large as 16 kg. This equates conservatively to about six tonnes of longfin eels which would correspond to about 12% of the 2013–14 South Island longfin landed catch by weight. Some of these over 4 kg eels, however, are likely to have been recaptures.

4.3 Limitations of the data

The shortcomings of the commercial eel monitoring programme are: 1) size grade data are coarse with only two to three size grades recorded; 2) grades may differ among the processors and/or species; 3) grades have changed in response to market demands or regulation changes affecting size limits (e.g., 4 kg maximum size limit, escape tube size); 4) the data offer limited information on the sex structure of the populations, except where the sex of eels may be assumed from size, i.e., all shortfin caught outside of Te Waihora migration area (AS2), and all longfin in the large size grade are female; and 5) data are provided voluntarily by processors with no guarantee of long-term participation.

4.4 Estimating eel numbers

Numbers of eels in the size grades are not provided by the processors in the monitoring programme, but instead were estimated, allowing the overall mean size of each species each year to be calculated. 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 large size grade (e.g., over 1000 g) and the catch could contain a few very large eels, or many smaller eels. The estimated eel numbers that are presented in this report are based on a number of assumptions about the population length frequency distribution, and involve the amalgamation of different processor size grades. More accurate estimates of numbers, would require collection of detailed length and weight records at regular intervals.

4.5 Dealing with different size grades

In the present report and the previous commercial eel monitoring report (Beentjes 2013) the size grade catch data by island were combined for all processors (i.e., those processing North Island caught eels, or those processing South Island caught eels) despite some minor differences in the grades used. In the South Island there are currently three processors (Mossburn, AFL-LET, and Independent Fisheries) and because of the difference in size grades used between Mossburn and AFL-LET it was necessary to amalgamate shortfin and longfin, each into two size grades, not three as for the North Island. The rationale for using generic size grades is that size grades will inevitably change over time, grading is done by eye, and our goal is to provide an overall picture of the size of eels that are commercially landed. Hence, minor changes to the ranges of a size grade are not likely to mask any gross changes in size that might be occurring. This has simplified the analyses and the outputs allowing a continuous time series to be constructed for each island. As a consequence, this makes comparison between the South and North Islands difficult for shortfin, because the cut-off of large shortfin is 800 g for most South Island processed shortfin eels, and 1000 g for the North Island shortfin. Further the small shortfin grade in the South Island also includes eels less than 300 g caught from Te Waihora Migration area, so would be biased in some years depending on the extent of the catch from this part of the lake. Because of this, comparison of catch by size grades for either species between North and South Islands is not valid, perhaps with the exception of large longfin over 1000 g.

4.6 Captured data

The eel catches included in our analyses do not always match the reported landed catch for the North Island as documented by MPI (Ministry for Primary Industries 2016) (see Table 6). It is not clear which dataset is more accurate since MPI catches from Eel Catch Landing Returns (ECLRs) often differ from those reported from Monthly Harvest Returns (MHR). Despite the possibility that there are missing catch data in some years, this is unlikely to bias the patterns or trends shown by the captured data.

4.7 North Island

In the North Island, data on eel catch weight, size, and capture location by species from commercial landings have now been collected continuously for 12 years (2003–04 to 2014–15).

4.7.1 Shortfin

Although shortfin in the North Island were caught from nearly all subareas (63 of the possible 65) over the twelve years, the catch is highly aggregated with nearly one-third of the catch originating from just three subareas, AA4 (Dargaville), AD12 (Lake Waikare, Port Waikato), and AC1 (Hauraki plains west) (see Figure 18 and Figure 38). The Dargaville subarea (AA4) drains into the northern arm of the Kaipara Harbour and includes rivers such as the Wairoa, Wairua, Manganui, Awakino, and Mangakahia rivers,

all of which are commercially fished (Beentjes et al. 2016). This subarea alone has contributed 431 t or 12% of North Island shortfin catch over the twelve years and is the most productive catchment in the North Island (Figure 38). This is followed by the lower Waikato River and tributaries including Lake Waikare and the Whangamarino River (AD12), and the western Hauraki plains which include the Piako River and tributaries (AC1) (Figures 18 and 38). The bulk of the subareas in the North Island, however, have contributed individually, less than 1% of the annual shortfin catch.

The North Island commercial shortfin catch over the twelve year period from 2003–04 to 2014–15 shows no consistent trend in annual catch weight or in the distribution of these catches in the three size grades used. It is likely that some of the fluctuations from year to year have been influenced by one or more factors such as TACC reductions, market fluctuations, quota availability, and escape tube increases (see Figure 14). Market demand determines the port price that processors pay to fishers. While the correlation between catch and price paid within each size grade was not always strong, the catch of medium sized shortfin appears to be most sensitive to port price as both have increased since 2010 for both North Island processors (see Figure 15). Relative port price, however, had little impact on the magnitude of catch within each of the size grades. For example, an increase in port price of one grade, relative to that of the other grades, did not necessarily result in more shortfin catch within that grade, and vice versa (see Figure 16). Low port prices overall, can dictate the effort a fisher is prepared to expend to catch eels. During a recent survey looking at where commercial eel fishers have caught longfin (Beentjes et al. 2016), many fishers commented that they do not bother fishing for longfin or specific grades when the port price is low. Although more relevant to longfin, the total shortfin eel catch shows good correlation to both the numbers of permits that have been fished and the number of fishing events in a year (see Figure 17).

The number of subareas from which shortfin catch was landed has declined from 49 subareas per year, on average for the first six years, to 43 subareas per year on average for the last six years, indicating a contraction of effort over time (see Figure 18). This is borne out by the finding that both the number of permits fished and the fishing events have declined over time (see Figure 17). Despite the reduction in effort over time the catch of shortfin has been spatially stable in the key subareas over the twelve years, with no apparent trends.

4.7.2 Longfin

Longfin in the North Island were caught from nearly all subareas (63 of the possible 65) over the twelve years, although the catch is aggregated with more than one-third of the catch originating from just four subareas, AA4 (Dargaville), AD10 (Waipa River), AD12 (Lake Waikare, Port Waikato), and AL1 (Lake Wairarapa) (see Figure 22 and Figure 39), two of which are also the most important subareas for shortfin (i.e., AA4, AD12). The most important subarea (AA4, Dargaville) alone has contributed 101 t or 12% of North Island longfin catch over the twelve years and is the most productive catchment in the North Island for longfin (Figure 39). This is followed by the Waipa River (AD10) and its many tributaries, which flows into the Waikato River at Ngaruawahia; the lower Waikato river and tributaries (AD12); and Lake Wairarapa (AL1), a subarea that includes all streams that drain the central north Island from Palmerston North to the coast at Palliser Bay, including the frequently fished Ruamahanga River. The bulk of the subareas in the North Island, however, have contributed individually less than 2% of the annual longfin catch (see Figure 22 and Figure 39).

North Island commercial longfin catches over the twelve year period from 2003–04 to 2014–15 have fluctuated more than shortfin and are characterised by particularly low catches in 2008–09 to 2010–11 and 2015 with an overall trend of declining catch over the twelve years (see Figure 19). Further, the proportion of medium size longfin is also poorly represented in the first three years of low catches. There are a number of factors that may have influenced annual longfin catches, overall and within size ranges. Key drivers include the 58% TACC reductions for North Island longfin stocks for the 2007–08 fishing year, limited market for medium sized longfins and access to ACE in 2008–09 to 2010–11, and

the loss of European and Asian markets for longfin in recent years. The longfin fishery is more prone to market demand fluctuations than shortfin because it is a less desirable species of eel.

As for shortfin, the correlation between catch and port price paid within each size grade was not always strong, but there are indications of a correlation between catch of medium and large size longfin eels, and port price for one processor (see Figure 20). Relative port price, however, had little impact on the magnitude of longfin catch within each of the size grades. For example, an increase in port price of one grade, relative to that of the other grades, did not necessarily result in more longfin catch within that grade, and vice versa (see Figure 21). In contrast, the total longfin catch shows good correlation with both the numbers of permits that have been fished and the number of fishing events in a year (see Figure 17). So for longfin much of the fluctuation in catch are driven by the effort expended by commercial fishers and this may or may not be related to port price. In the 2015–16 fishing year one processor has instructed fishers not to land small shortfin (300–500 g), so we could expect to see a decline in the proportion of the small size grade in this year.

As discussed for shortfin, the number of subareas for which longfin catch was landed has also declined from 49 subareas per year, on average for the first six years, to 43 subareas per year on average for the last six years, indicating a contraction of effort over time (see Figures 22 and 17). Despite the reduction in effort over time the catch of longfin has been spatially stable in the key subareas over the twelve years with no apparent trends.

4.7.3 Large longfin eels

A major concern for the sustainability of the longfin eel fishery relates to spawning escapement and the reduction in numbers of large females in main stem rivers compared to historical levels, resulting from commercial fishing (Dunn et al. 2009, Fu et al. 2012). In 2011–12, when there were no restrictions on quota or marketable sizes in the North Island, about half of the longfin catch (by weight) comprised eels over 1000 g and less than 4000 g. Because longfins above about 700 g are predominantly, if not exclusively female, more than half the longfin catch caught in 2011–12 was female, with the remainder being either male or female (see Table 9). Using estimates of eel numbers rather than catch weight, about one-quarter (24%) of longfins were female and the remainder were either male or female (see Table 9). The proportion of eels within any size grade in the catch, as discussed, will be related to market demands, regulation changes, and fishing practices. The proportion of large longfin is likely to be higher than the values presented (see Table 9) because fishers frequently release eels in spawning condition that are of legal size. Overall, however, the North Island fishery continues to land large longfin eels with no apparent trend. Indeed, anecdotal reports by fishers suggest that capture of large longfin eels over 4 kg is becoming increasingly common and causing problems with fishing operations. Further, the presence of large longfin eels in a stretch of water often results in poor catches of smaller eels.

4.8 South Island

4.8.1 General comments

The South Island commercial eel monitoring programme began in 2006–07 with the provision of species catch and size grade data for ANG 15 (Otago and Southland), with no breakdown by subarea or eel statistical area. The nine year ANG 15 time series is presented as it provides information on size and species catch from Otago and Southland that precedes the all South Island time series by four years, but will assume less importance as more years are added to the South Island time series. Complete data on eel catch weight, size, and capture location by species from all South Island commercial landings have now been collected continuously for five years (2010–11 to 2014–15).

4.8.2 Shortfin

Although shortfin in the South Island were caught from most subareas (49 of the possible 58) over the five years, the catch is highly aggregated with nearly three-quarters of the catch originating from Te Waihora (AS1 and AS2), and Lake Brunner (AX4) which drains into the Grey River via the Arnold River (see Figure 36 and Figure 40). Te Waihora alone has contributed 565 t or 66% of South Island shortfin catch over the five years and is by far the most productive area in the South Island for shortfin (Figure 40). The bulk (92%) of the subareas in the South Island, however, have contributed individually, less than 2% of the annual shortfin catch. This highlights the concentrated nature of the shortfin eel stocks in the South Island and importance of these three subareas to the commercial shortfin fishery.

The commercial shortfin catch in ANG 15 over the nine year period from 2006–07 to 2014–15, shows no consistent trend in annual catch weight although the proportions of large eels are the lowest of the time series in the last two years. Similarly, for the South Island, there is no trend in shortfin catch or size grades over the five year time series. Unlike the north Island, there is currently no information on factors influencing the catch or on port prices for the South Island. Next analyses will include three more years' data and at that time the relationship between effort and catch will be explored, as well as impacts of port price and market forces.

Although there are only five years in the South Island time series, the pattern of catches by subareas is generally similar each year, except that AS1 and AS2 catches tend to display opposite trends, i.e., large catches from the lake relate to small catches from the migration area and vice versa. This is because the Te Waihora quota (ANG13) can be filled from either the lake (AS1) or the migration area (AS2). Fishing in the migration area is only permitted in February–March and fishers tend to fish this first (Te Waihora fishing year begins on 1 February) with any remaining unused quota taken from the lake. In 2014–15 there were no catches from AS2, and hence the entire quota was taken from AS1 (see Figure 36). The proportion of the shortfin catch that is from the migration area each year can depend on timing of the shortfin male migration, and associated lake openings to allow the migrants to reach the ocean over the gravel bar at the mouth of the lake, which may not always fall within February–March each year.

4.8.3 Longfin

Longfin in the South Island were caught from most subareas (53 of the possible 58) over the five years, and although less aggregated than shortfin, nearly half of the catch originated from just seven subareas: AW11 (Mataura River coast), AW9 (Oreti River coast), AW3 (Oreti River inland down to Bog Burn), AV10 (Clutha River coast), AP2 (Wairau River), AU5 (Waitaki River), and AX2 (Buller River) (see Figure 37 and Figure 41). The two southland subareas alone (AW11 and AW9) have contributed 127 t or 20% of South Island longfin catch over the five years and Southland is by far the most productive area in the South Island for longfin (Figure 41). The bulk (75%) of the subareas in the South Island, however, have contributed individually, less than 2% of the annual longfin catch.

The commercial longfin catch in ANG 15 over the nine year period from 2006–07 to 2014–15, is variable but shows no consistent trend in annual catch weight or weight grades (see Figure 34). Similarly, for the South Island, there is no trend in longfin catch or size grades over the five year time series, although the lowest catch was taken in the last year (see Figure 35). There is currently no information on factors influencing the longfin catch or on port prices for the South Island. Next analyses will include three more years' data and at that time the relationship between effort and catch will be explored, as well as impacts of port price and market forces.

Although there are only five years in the South Island time series, catch of longfin has been spatially stable in the key subareas, but more variable for the smaller contributors of catch.

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6. REFERENCES

- Beentjes, M.P. (1999). Size, age, and species composition of South Island commercial eel catches from market sampling (1997–98). *NIWA Technical Report 51*. 51 p.
- Beentjes, M.P. (2005). Monitoring commercial eel fisheries in 2003–04. *New Zealand Fisheries Assessment Report 2005/39*. 57 p.
- Beentjes, M.P. (2008a). Monitoring commercial eel fisheries in 2003–04 and 2004–05. *New Zealand Fisheries Assessment Report 2008/19*. 43 p.
- Beentjes, M.P. (2008b). Monitoring commercial eel fisheries in 2005–06 and 2006–07. *New Zealand Fisheries Assessment Report 2008/64*. 67 p.
- Beentjes, M.P. (2011). Monitoring commercial eel fisheries in 2007–08 and 2008–09. *New Zealand Fisheries Assessment Report 2011/50*. 82 p.
- Beentjes, M.P. (2013). Monitoring commercial eel fisheries: 2009–10 to 2011–12. *New Zealand Fisheries Assessment Report 2013/47*. 76 p.
- Beentjes, M.P.; Bull, B. (2002). CPUE analyses of the commercial freshwater eel fishery. *New Zealand Fisheries Assessment Report 2002/18*. 55 p.
- Beentjes, M.P.; Chisnall, B.L. (1997). Trends in size and species composition and distribution of commercial eel catches. *New Zealand Fisheries Data Report 89*. 71 p.
- Beentjes, M.P.; Chisnall, B.L. (1998). Size, age, and species composition of commercial eel catches from market sampling (1996–97). *NIWA Technical Report 29*. 124 p.
- Beentjes, M.P.; Dunn, A. (2003a). CPUE analysis of the commercial freshwater eel fishery in selected areas, 1990–91 to 2000–01. *New Zealand Fisheries Assessment Report 2003/54*. 47 p.
- Beentjes, M.P.; Dunn, A. (2003b). Species composition and CPUE analysis for North Island commercial eel fishery stocks for the period 1990–91 to 2002–03. Final Research Report for Ministry of Fisheries Research Project MOF200301A. 53 p. (Unpublished report held by Ministry for Primary Industries, Wellington.)
- Beentjes, M.P.; Dunn, A. (2008). Catch per unit effort (CPUE) analyses of the South Island commercial freshwater eel fishery, 1990–91 to 2005–06. *New Zealand Fisheries Assessment Report 2008/51*. 109 p.
- Beentjes, M.P.; Dunn, A. (2010). CPUE analyses of the North Island commercial freshwater eel fishery, 1990–91 to 2006–07. *New Zealand Fisheries Assessment Report 2010/5*. 100 p.
- Beentjes, M.P.; Dunn, A. (2013a). Catch per unit effort (CPUE) analyses and characterisation of the South Island commercial freshwater eel fishery, 1990–91 to 2009–10. *New Zealand Fisheries Assessment Report 2013/11*. 211 p.
- Beentjes, M.P.; Dunn, A. (2014a). Catch per unit effort (CPUE) analyses and characterisation of Te Waihora commercial freshwater eel fishery, 1990–91 to 2011–12. *New Zealand Fisheries Assessment Report 2014/17*. 46 p.
- Beentjes, M.P.; Dunn, A. (2014b). Catch per unit effort (CPUE) analyses and characterisation of the South Island commercial freshwater eel fishery, 1990–91 to 2012–13. Research Progress Report for MPI project 201301. 10 pp. (Unpublished report held by Ministry for Primary Industries, Wellington.)
- Beentjes, M.P.; Dunn, A. (2015). Catch per unit effort (CPUE) analyses and characterisation of the South Island commercial freshwater eel fishery, 1990–91 to 2012–13. *New Zealand Fisheries Assessment Report 2015/30*. 177 p.

- Beentjes, M.P.; Dunn, A. (2013b). Catch per unit effort (CPUE) analyses and characterisation of the North Island commercial freshwater eel fishery, 1990–91 to 2011–12. *New Zealand Fisheries Assessment Report 2013/62*. 292 p.
- Beentjes, M.P.; Sykes, J.; Crow, S.K. (2016). GIS mapping of the longfin eel commercial fishery throughout New Zealand, and estimates of longfin habitat and proportion fished. *New Zealand Fisheries Assessment Report 2016/32*. 53 p.
- Boubée, J.; Williams, E.; Beentjes, M.P.; Bowman, E. (2002). Recruitment of longfinned eels, 2001–02. Final Research Report for Ministry of Fisheries Research Project EEL2000/01. 52 p. (Unpublished report held by Ministry of Fisheries, Wellington.)
- Bull, B.; Dunn, A. (2002). Catch-at-age: User Manual v1.06.2002/09/12. NIWA Internal Report 114. 23 p. (Unpublished report held in NIWA Library, Wellington.)
- Chisnall, B.L.; Kemp, C. (2000). Size, age, and species composition of commercial eel catches from market sampling in the North Island. *NIWA Technical Report 87*. 67 p.
- Crow, S.; Dunn, A. (2014). Analysis of trends in abundance of longfin and shortfin eels from records in the New Zealand Freshwater Fish Database. Ministry for Primary Industries Eel Working Group Document EELWG-2014-18. (Unpublished report held by Ministry for Primary Industries, Wellington.)
- Dunn, A.; Beentjes, M.P.; Graynoth, E. (2009). Preliminary investigations into the feasibility of assessment models for New Zealand longfin eels (*Anguilla dieffenbachii*). *New Zealand Fisheries Assessment Report 2009/30*. 42 p.
- Fu, D.; Beentjes, M.P.; Dunn, A. (2012). Further investigations into the feasibility of assessment models for New Zealand longfin eels (*Anguilla dieffenbachii*). Final Research Report for Ministry of Fisheries Project EEL200702. 77 p. (Unpublished report held by Ministry for Primary Industries, Wellington.)
- Graynoth, E.; Niven, K. (2004). Habitat for female longfinned eels in the West Coast and Southland, New Zealand. *Science for Conservation 238*. 33 p.
- Hoyle, S.D. (2016). Feasibility of longfin eel stock assessment. *New Zealand Fisheries Assessment Report 2016/29*. 27 p.
- Jellyman, D.J.; Chisnall, B.L.; Dijkstra, L.H.; Boubée, J.A.T. (1996). First record of the Australian longfinned eel, *Anguilla reinhardtii*, in New Zealand. *Marine and Freshwater Research 47*: 1037–1040.
- Jellyman, D.J.; Graynoth, E.; Francis, R.I.C.C.; Chisnall, B.L.; Beentjes, M.P. (2000). A review of evidence for a decline in the abundance of longfinned eels (*Anguilla dieffenbachii*) in New Zealand. Final Research Report for Ministry of Fisheries Research Project EEL9802. 76 p. (Unpublished report held by Ministry for Primary Industries, Wellington.)
- Martin, M.L.; Bowman, E. (2016). Recruitment of freshwater eels 1995–2015. *New Zealand Fisheries Assessment Report 2016/46*. 102 p.
- Martin, M.L.; Stevenson, C.; Boubée, J.A.T.; Bowman, E.J. (2009). Freshwater elver recruitment trends 1995–2009. *New Zealand Fisheries Assessment Report 2009/58*. 43 p.
- Ministry for Primary Industries (2016). Fisheries Assessment Plenary, May 2016: stock assessments and stock status. Compiled by the Fisheries Science Group, Ministry for Primary Industries, Wellington, New Zealand. 1556 p.
- Speed, S.R.; Browne, G.N.; Boyd, R.O. (2001). Assessment and monitoring of commercial eel fisheries. Final Research Report for Ministry of Fisheries Research Project EEL9801. 178 p. (Unpublished report held by Ministry for Primary Industries, Wellington.)
- Todd, P.R. (1980). Size and age of migrating New Zealand freshwater eels (*Anguilla* spp.). *New Zealand Journal of Marine and Freshwater Research 14*: 283–293.

Table 1: Quota Management Areas (QMA) for longfin (LFE) and shortfin (SFE) eels, and both species combined (ANG) in the South Island, and Eel Statistical Areas (ESA).

Area	QMA		ESA (alpha) (after 1 Oct 2001)	ESA (numeric) (before 1 Oct 2001)
	LFE	SFE		
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: Summary of chronology of weight grades used by the two main North Island eel processors. NZ Eel, New Zealand Eel Processors; AFL-Levin, Aotearoa Fisheries and Levin Eel Trading.

Year	Processor	Species	Size grade (g)		
			Small	Medium	Large
2003–04	NZ Eel	LFE	220–500	500–1200	over 1200
2006–07			300–500	500–1200	over 1200
2008–09			300–500	500–1000	over 1000
2003–04	NZ Eel	SFE	220–500	500–1000	over 1000
2009–10			300–500	500–1000	over 1000
2003–04	AFL-Levin	LFE	220–500	500–1000	over 1000
2009–10			300–500	500–1000	over 1000
2003–04	AFL-Levin	SFE	220–500	500–1000	over 1000
2008–09			220–650	650–1000	over 1000
2009–10			300–650	650–1000	over 1000
2012–13			300–600	600–1000	over 1000
2014–15			300–500	500–1000	over 1000

Table 3: Subareas, Eel Statistical Areas (ESA alpha and numeric codes), and Quota Management Areas (QMA). Eel Statistical Area alpha codes replaced numeric codes on 1 October 2001.

Island	Subarea		Eel Statistical Area		QMA
	Code	Number	Numeric	Alpha	
North	AA1-AA5	5	1	AA	20
	AB1-AB3	3	2	AB	20
	AC1-AC3	3	3	AC	21
	AD1-AD17	17	4	AD	21
	AE1-AE4	4	5	AE	21
	AF1-AF7	7	6	AF	21
	AG1-AG6	6	7	AG	22
	AH1-AH6	6	8	AH	23
	AJ1-AJ6	6	9	AJ	23
	AK1-AK4	4	10	AK	22
	AL1-AL3	3	11	AL	22
	AM2	1	12	AM	22
	Sub total	65	12	12	4
South	AN1-AN3	3	13	AN	ANG11
	AP1-AP2	2	14	AP	ANG11
	AQ1-AQ2	2	14	AQ	ANG12
	AR1-AR5	5	16	AR	ANG12
	AS1	1	21	AS1	ANG13
	AS2	1	21	AS2	ANG13
	AS1A	1	21	AS1	ANG13
	AT1-AT4	4	17	AT	ANG14
	AU1-AU5	5	18	AU	ANG14
	AV1-AV12	12	19	AV	ANG15
	AW1-AW12	12	20	AW	ANG15
	AX1-AX10	10	15	AX	ANG16
	Sub total	58	9	11	6
	Total	123	21	23	10

Table 4: Size grades and equivalent length ranges, 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. See methods for weight grades that correspond to small, medium, and large categories. 100 cm was close to the maximum size of shortfin, and 125 close to the maximum size of longfin recorded in the catch sampling data. ** eels landed from AS2 (Te Waihora migration area) are smaller than this grade.

	Grade	Weight range (g)	Size grade	Length (cm)	Mid-point
			Length range (cm)		Weight (g)
North Island SFE	Small	300–500	50–59	54	375
	Medium	500–1000	59–75	64.5	651
	Large	over 1000	75–100	78.5	1197
North Island LFE	Small	300–500 g	48–59	52	391
	Medium	500–1000 g	59–70	63	721
	Large	over 1000 g	70–108	79	1484
South Island SFE	Small		**50–77	56.5	432
	Large		75–100	78.8	1197
South Island LFE	Small		48–70	54	441
	Medium		70–108	79	1484

Table 5: Summary of chronology of weight grades used in the South Island. Mossburn, Mossburn Enterprises; AFL-Levin, Aotearoa Fisheries and Levin Eel Trading; Independent, Independent Fisheries.

Year	Processor	Species	Size grade (g)	
			Small	Large
2006–07	Mossburn	LFE	300–1000	1000–1500 and over 1500
2010–11	AFL-Levin	LFE	300–500 and 500–1000	over 1000
2006–07	Mossburn	SFE	300–800	over 800
2010–11	AFL-Levin	SFE	300–650 and 650 to 1000	over 1000
2012–13			300–600 and 600 to 1000	over 1000
2014–15			300–500 and 500 to 1000	over 1000
2010–11	Independent	SFE	Migrating males (below 300 g)	
				–

Table 6: Summary of landings (Lndg) and species landed weights from North Island processors from 2003–04 to 2014–15, South Island ANG 15 from 2006–07 to 2014–15, and the entire South Island from 2010–11 to 2014–15. % samp. = percent of total reported landed weight sampled where the reported landings are from ECLR catch in tables 5 to 6 of the 2016 plenary document for the North Island, MHR data in table 2 for the South Island, and ECLR data in table 4 for ANG 15. No. Lndg, number of landings; SFE, shortfin eel; LFE, longfin eel.

North Island																
Vanderdrift					New Zealand Eel					AFL-Levin				All processors combined		
Year	No. Lndg	Weight (kg)		No. Lndg	Weight (kg)		No. Lndg	Weight (kg)		No. Lndg	Weight (kg)		No. Lndg	Weight (kg)		%SFE
		SFE	LFE		SFE	LFE		SFE	LFE		SFE	LFE		SFE	LFE	
2003-04	176	18 072	21 878	511	15 1947	28 007	736	129 367	55 396	1423	299 386	105 281	89.0	74.0		
2004-05	-	-	-	549	12 4980	42 351	595	140 903	77 889	1144	265 883	120 240	90.2	68.9		
2005-06	-	-	-	561	16 0725	38 654	694	173 725	63 948	1255	334 450	102 602	89.3	76.5		
2006-07	-	-	-	532	15 2902	29 572	773	185 996	70 265	1305	338 898	99 837	99.0	77.2		
2007-08	-	-	-	525	14 8891	26 488	460	148 652	46 572	985	297 543	73 060	98.8	80.3		
2008-09	-	-	-	306	13 0366	15 711	407	122 352	26 586	713	252 718	42 297	97.7	85.7		
2009-10	-	-	-	417	14 0544	15 702	359	123 879	30 592	776	264 423	46 294	97.7	85.1		
2010-11	-	-	-	474	20 2940	23 883	399	125 155	17 248	873	328 095	41 131	110.5	88.9		
2011-12	-	-	-	537	19 3235	36 862	465	145 830	39 944	1002	339 065	76 806	99.7	81.5		
2012-13	-	-	-	461	16 7290	26 397	409	125 339	41 600	870	292 629	67 997	99.3	81.1		
2013-14	-	-	-	457	16 4502	23 409	372	136 507	39 128	829	301 009	62 537	99.1	82.8		
2014-15	-	-	-	477	16 9481	12 552	291	92 792	21 897	768	262 273	34 449	94.6	88.4		
Totals	175	18 072	21 878	5807	1 907 803	319 588	5960	1 650 497	531 065	11943	3 576 372	872 531		80.4		

Table 6 – continued

South Island (ANG 15)

Year	Mossburn				AFL-Levin				All processors combined			
	No. Lndg	Weight (kg)		No. Lndg	Weight (kg)		No. Lndg	Weight (kg)		No. Lndg	Weight (kg)	
		SFE	LFE		SFE	LFE		SFE	LFE		% samp.	% SFE
2006–07	299	17 425	63 941	0	–	–	299	17 425	63 941	101.2	21.4	21.4
2007–08	367	21 033	69 132	0	–	–	367	21 033	69 132	95.7	23.3	23.3
2008–09	204	14 879	34 882	0	–	–	204	14 879	34 882	98.9	29.9	29.9
2009–10	314	28 427	38 515	0	–	–	314	28 427	38 515	96.9	42.5	42.5
2010–11	276	21 442	71 657	0	–	–	276	21 442	71 657	99.8	23.0	23.0
2011–12	381	19 883	78 829	3	1354	3054	384	21 237	81 883	96.6	20.6	20.6
2012–13	365	17 511	89 596	2	680	1796	367	18 191	91 392	104.1	16.6	16.6
2013–14	281	11 034	70 375	5	2180	1130	286	13 214	71 505	94.6	15.6	15.6
2014–15	268	14 283	54 209	3	1354	3054	268	14 283	54 209	96.9	20.9	20.9
Totals	2 755	165 917	571 135	10	4214	5980	2765	170 131	577 115		22.8	22.8

South Island

Year	Mossburn				AFL-Levin				Independent				All processors combined			
	No.	Weight (kg)		No.	Weight (kg)		No.	Weight (kg)		No.	Weight (kg)		No.	Weight (kg)		
		Lndg	SFE		LFE	Lndg		SFE	LFE		Lndg	SFE		LFE	Lndg	SFE
2010–11	363	101 232	94 631	33	30 547	14 463	100	61 115		496	192 894	109 094	102.0	63.9		
2011–12	513	85 466	133 669	39	34 050	13 905	98	58 415		650	177 931	147 574	96.6	54.6		
2012–13	558	92 454	140 752	65	38 356	18 862	18	13 250		641	144 060	159 614	86.0	47.4		
2013–14	522	118 801	117 278	46	45 904	11 488	14	13 890		582	178 595	128 766	98.8	58.1		
2014–15	429	82 673	69 702	57	70 582	6 755	8	4 347		494	157 602	76 457	97.1	67.3		
Totals	2 385	480 626	556 032	240	219 439	65 473	238	151 017		2 863	851 082	621 505		57.8		

Table 7: Estimated total number of shortfins (SFE) and longfins (LFE) landed for North Island processors from 2003–04 to 2014–15, for South Island ANG 15 from 2006–07 to 2014–15, and the entire South Island from 2010–11 to 2014–15. The proportion (%) of shortfin in the catch and the estimated mean weight of individual eels (i.e., total weight divided by the number of eels) are also shown.

North Island

Fishing year	Numbers		% SFE	Mean eel weight (kg)	
	SFE	LFE		SFE	LFE
2003–04	628 027	184 360	77.3	0.477	0.571
2004–05	546 491	200 716	73.1	0.487	0.599
2005–06	680 971	167 177	80.3	0.491	0.614
2006–07	710 267	162 416	81.4	0.477	0.615
2007–08	610 114	124 396	83.1	0.488	0.587
2008–09	545 231	70 963	88.5	0.464	0.596
2009–10	542 389	71 838	88.3	0.488	0.644
2010–11	655 583	49 082	93.0	0.500	0.838
2011–12	676 403	105 935	86.5	0.501	0.725
2012–13	584 299	106 518	84.6	0.501	0.638
2013–14	596 883	103 775	85.2	0.504	0.603
2014–15	508 118	56 442	90.0	0.516	0.610
Total	7 284 777	1 403 619	83.8	0.491	0.622

South Island (ANG 15)

Fishing year	Numbers		% SFE	Mean eel weight (kg)	
	SFE	LFE		SFE	LFE
2006–07	28 229	116 466	19.5	0.617	0.549
2007–08	33 749	127 363	20.9	0.623	0.543
2008–09	22 662	65 368	25.7	0.657	0.534
2009–10	43 998	52 056	45.8	0.646	0.740
2010–11	34 846	120 758	22.4	0.615	0.593
2011–12	31 907	126 853	20.1	0.666	0.645
2012–13	30 716	173 273	15.1	0.592	0.527
2013–14	25 530	133 838	16.0	0.518	0.534
2014–15	24 790	104 104	19.2	0.576	0.521
Total	276 426	1 020 079	21.3	0.615	0.566

South Island

Fishing year	Numbers		% SFE	Mean eel weight (kg)	
	SFE	LFE		SFE	LFE
2010–11	356 152	178 283	66.6	0.542	0.612
2011–12	311 468	209 182	59.8	0.571	0.705
2012–13	253 551	292 535	46.4	0.568	0.546
2013–14	297 886	235 720	55.8	0.600	0.546
2014–15	277 075	143 701	65.8	0.569	0.532
Total	1 496 132	1 059 421	59.0	0.569	0.587

Table 8: Distribution (%) of landed shortfin catch by weight and estimated number for each size grade for the North Island (2003–04 to 2014–15), South Island ANG 15 (2006–07 to 2014–15), and for the entire South Island (2010–11 to 2014–15). See methods for weight grades that correspond to small, medium, and large categories.

North Island (shortfin)

Fishing year	Percent of landed shortfin catch			Percent of landed shortfin numbers		
	Size grade			Size grade		
	Small	Medium	Large	Small	Medium	Large
2003–04	56.4	31.1	12.5	72.1	22.9	5.0
2004–05	54.5	31.8	13.8	70.7	23.7	5.6
2005–06	53.7	30.9	15.4	70.4	23.3	6.3
2006–07	57.4	29.9	12.7	73.0	21.9	5.1
2007–08	53.6	33.2	13.1	69.8	24.9	5.4
2008–09	62.7	24.9	12.4	77.5	17.7	4.8
2009–10	54.5	31.0	14.4	70.9	23.2	5.9
2010–11	49.9	35.6	14.5	66.5	27.4	6.1
2011–12	49.0	37.4	13.6	65.5	28.8	5.7
2012–13	49.0	37.7	13.3	65.5	29.0	5.6
2013–14	47.2	40.5	12.3	63.4	31.4	5.2
2014–15	43.9	42.4	13.6	60.5	33.6	5.9

South Island (ANG 15 shortfin)

Fishing year	Percent of landed shortfin catch		Percent of landed shortfin numbers	
	Size grade		Size grade	
	Small	Large	Small	Large
2006–07	53.0	47.0	75.8	24.2
2007–08	52.0	48.0	75.0	25.0
2008–09	46.5	53.5	70.6	29.4
2009–10	48.1	51.9	72.0	28.0
2010–11	54.5	45.5	76.9	23.1
2011–12	45.1	54.9	69.5	30.5
2012–13	57.7	42.3	79.1	20.9
2013–14	74.1	25.9	88.8	11.2
2014–15	60.8	39.2	81.2	18.8

All South Island (shortfin)

Fishing year	Percent of landed shortfin catch		Percent of landed shortfin numbers	
	Size grade		Size grade	
	Small	Large	Small	Large
2010–11	68.5	31.5	85.8	14.2
2011–12	62.1	37.9	82.0	18.0
2012–13	62.5	37.5	82.2	17.8
2013–14	56.3	43.7	78.1	21.9
2014–15	62.4	37.6	82.1	17.9

Table 9: Distribution (%) of landed longfin catch by weight and estimated number for each size grade for the North Island (2003–04 to 2014–15), South Island ANG 15 (2006–07 to 2014–15), and for the entire South Island (2010–11 to 2014–15). See methods for weight grades that correspond to small, medium, and large categories.

North Island (longfin)

Fishing year	Percent of landed longfin catch			Percent of landed longfin numbers		
	Size grade			Size grade		
	Small	Medium	Large	Small	Medium	Large
2003–04	47.5	14.6	37.9	72.6	12.1	15.3
2004–05	46.2	17.6	36.2	70.8	14.6	14.6
2005–06	43.8	18.2	38.0	68.8	15.5	15.7
2006–07	44.6	15.9	39.5	70.1	13.6	16.4
2007–08	47.8	17.9	34.3	71.9	14.6	13.6
2008–09	49.8	9.3	40.9	75.9	7.7	16.4
2009–10	44.4	5.9	49.7	73.1	5.3	21.6
2010–11	26.2	3.6	70.2	56.2	4.2	39.6
2011–12	29.6	20.6	49.7	55.0	20.7	24.3
2012–13	39.5	20.9	39.6	64.4	18.5	17.0
2013–14	45.0	19.5	35.6	69.3	16.3	14.5
2014–15	42.4	23.3	34.3	66.2	19.7	14.1

South Island (ANG 15 longfin)

Fishing year	Percent of landed longfin catch		Percent of landed longfin numbers	
	Size grade		Size grade	
	Small	Large	Small	Large
2006–07	72.0	28.0	89.6	10.4
2007–08	73.3	26.7	90.2	9.8
2008–09	75.3	24.7	91.1	8.9
2009–10	42.5	57.5	71.3	28.7
2010–11	63.8	36.2	85.6	14.4
2011–12	57.5	42.5	82.0	18.0
2012–13	76.7	23.3	91.7	8.3
2013–14	75.2	24.8	91.1	8.9
2014–15	78.2	21.8	92.4	7.6

All South Island (longfin)

Fishing year	Percent of landed longfin catch		Percent of landed longfin numbers	
	Size grade		Size grade	
	Small	Large	Small	Large
2010–11	60.5	39.5	83.7	16.3
2011–12	49.5	50.5	76.7	23.3
2012–13	72.7	27.3	90.0	10.0
2013–14	72.6	27.4	89.9	10.1
2014–15	75.7	24.3	91.3	8.7

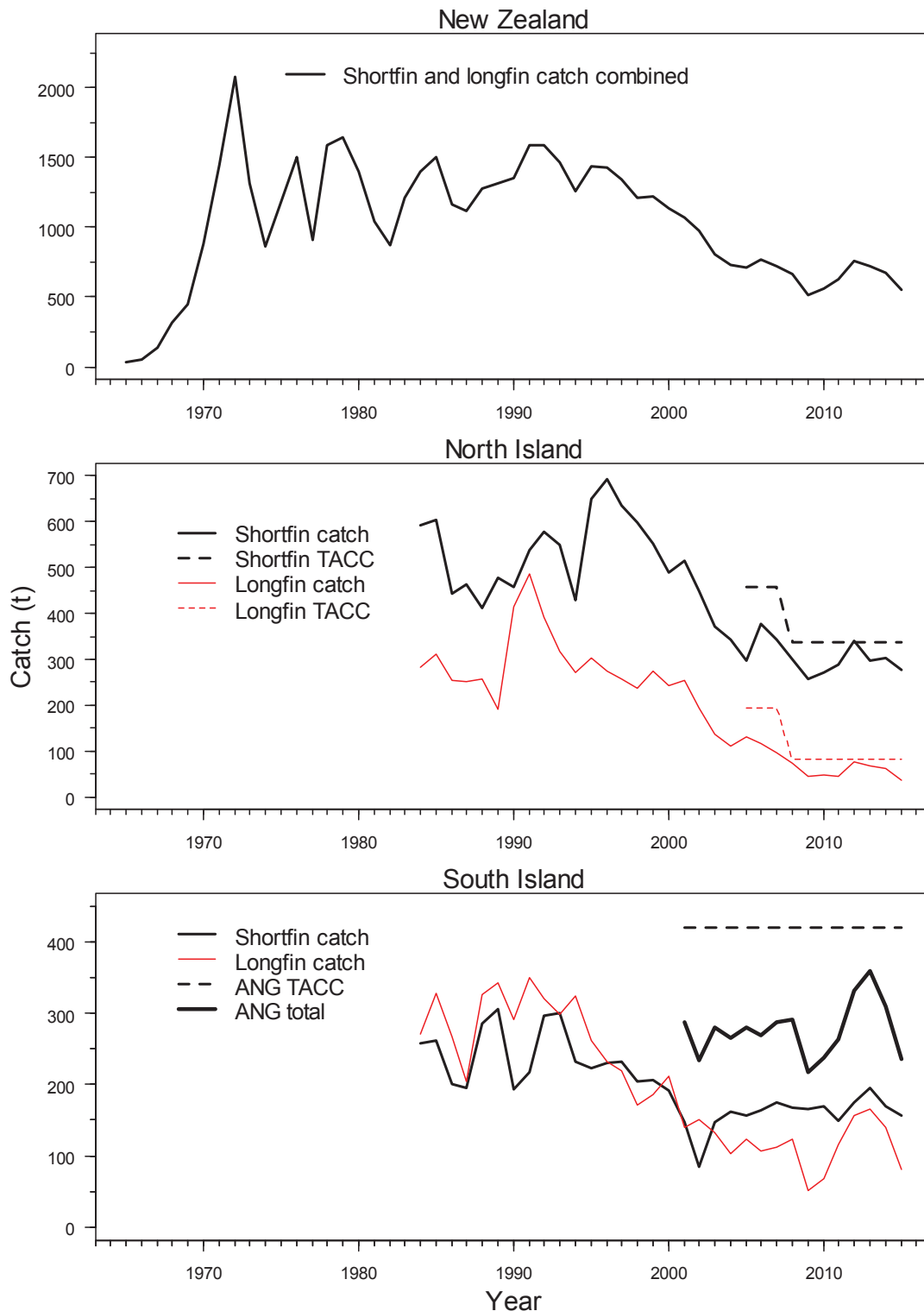


Figure 1: New Zealand eel catch from 1965 to 2014–15 (top), and North Island (centre) and South Island (bottom) catch by species from 1984 to 2014–15, and TACCs. Species catch was estimated from species proportions in catch effort data (FSU, CELR, ECER) in the South Island before 2001, and in the North Island before 2005. Subsequent species data are from landings reported on ECLRs (Ministry for Primary Industries 2016). In the South Island there is no separation of species under the QMS and ANG is used for both shortfin and longfin eels. Catches are expressed by calendar year until 1988, and thereafter by fishing year. 2010 = 2009–10.

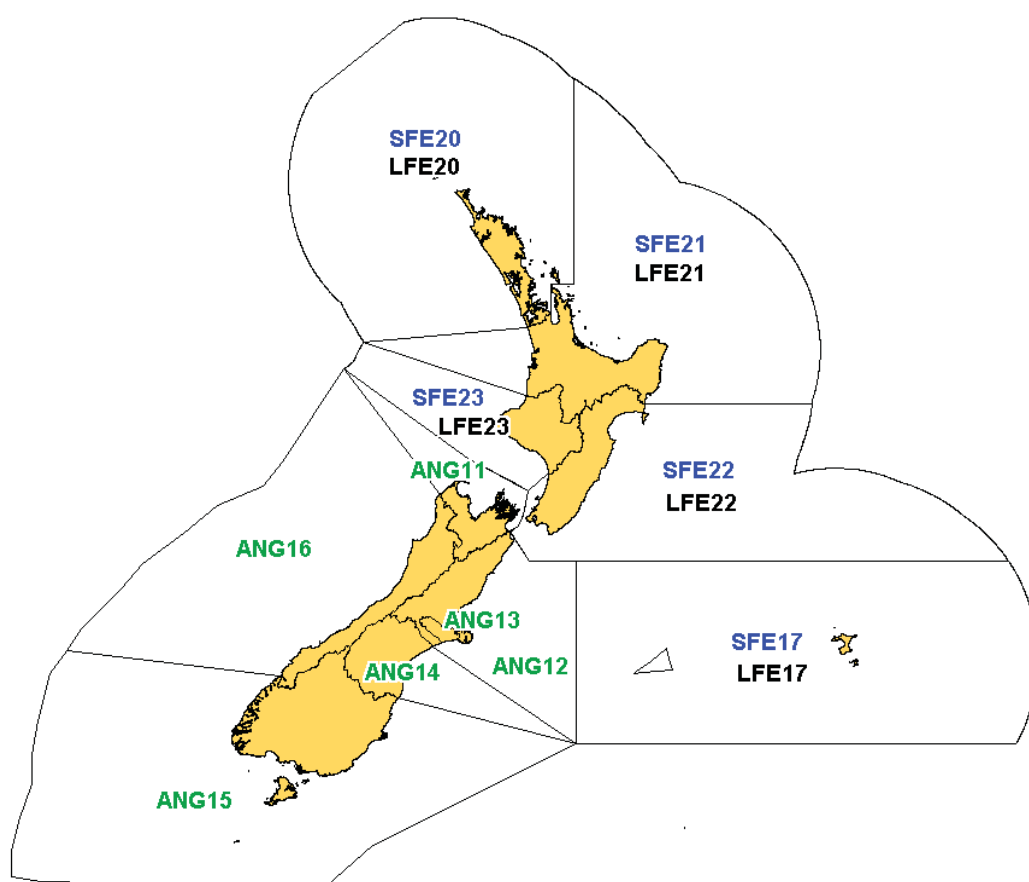


Figure 2: Quota Management Areas for the New Zealand eel fishery (see Table 1 for breakdown by Eel Statistical Areas). Shortfin stocks are denoted by the prefix SFE, and longfin by LFE. ANG comprises both shortfin and longfin combined (Ministry for Primary Industries 2016).

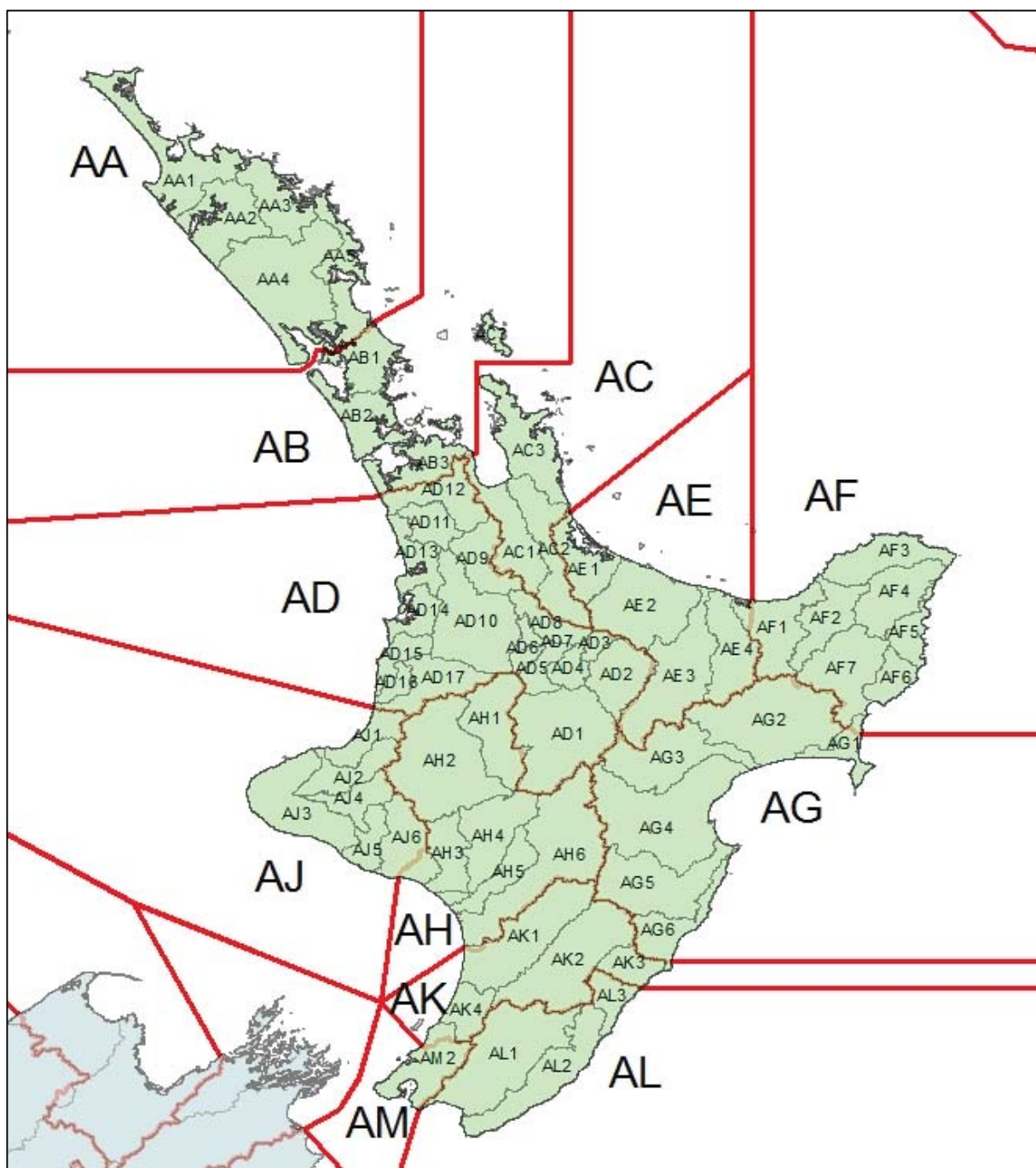


Figure 3: North Island Eel Statistical Area subareas (AA1 to AM4) and Eel Statistical Areas (ESAs AA to AM) overlaid, showing the shared boundaries (red). Subarea locations are defined in Appendix 2 and ESA areas defined in Table 1.

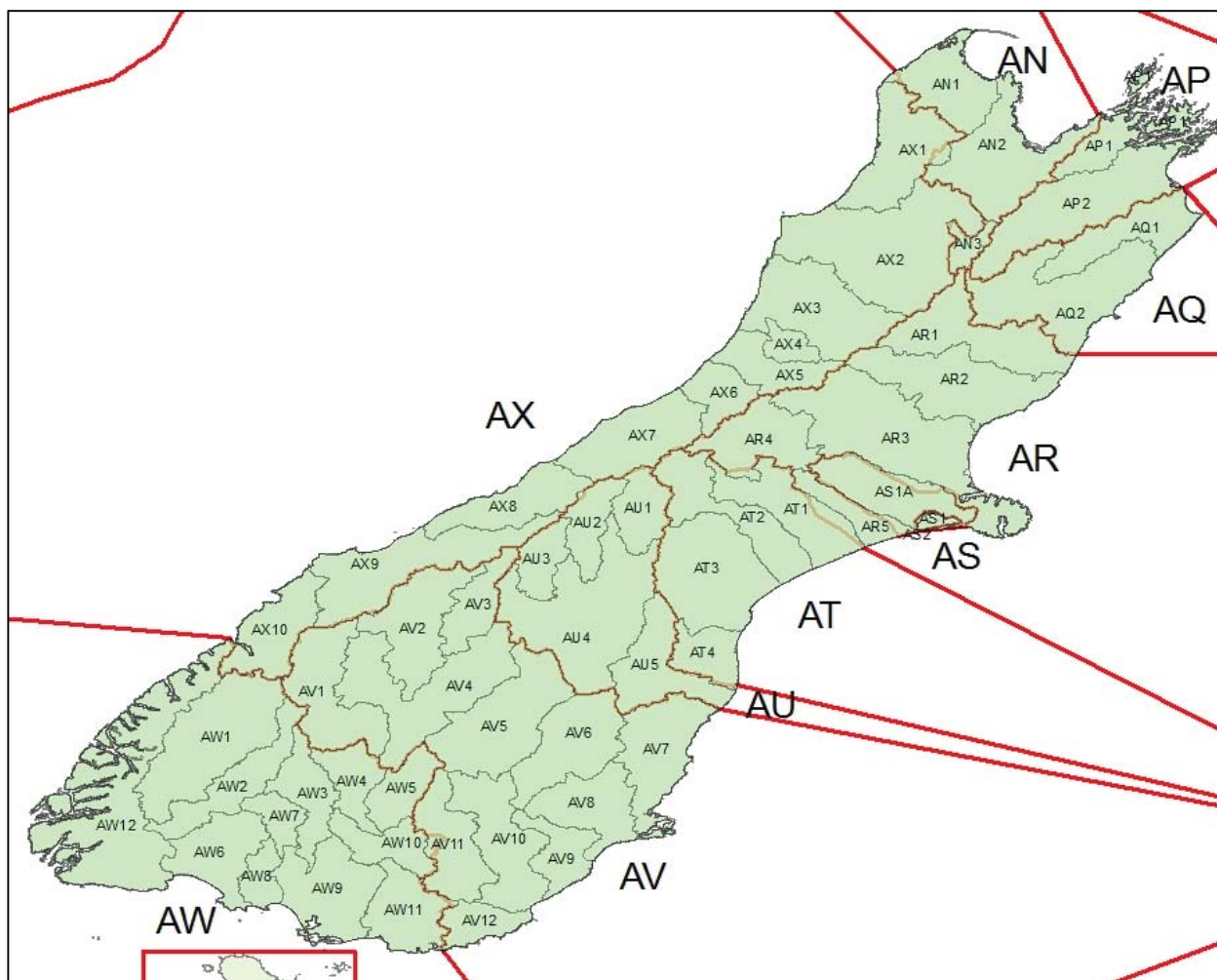


Figure 4: South Island Eel Statistical Area subareas (AN1 to AX10) and Eel Statistical Areas (AN to AX) overlaid, showing the shared boundaries (red). Subarea locations are defined in Appendix 2 and ESA areas defined in Table 1.

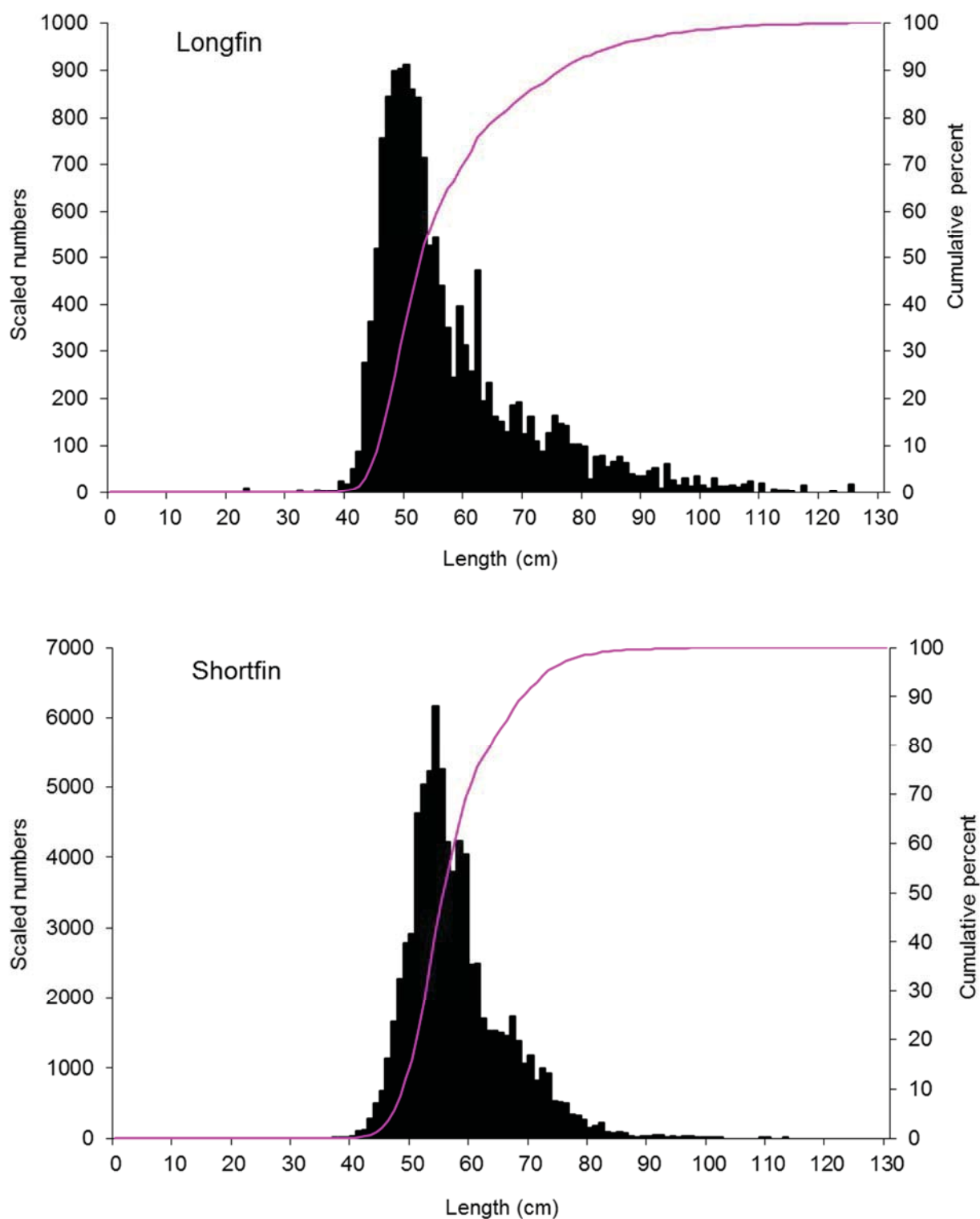


Figure 5: Scaled length frequency distribution and cumulative percent of longfin (top) and shortfin (bottom) from North Island catch sampling in 1995–96, 1996–97, and 1997–98.

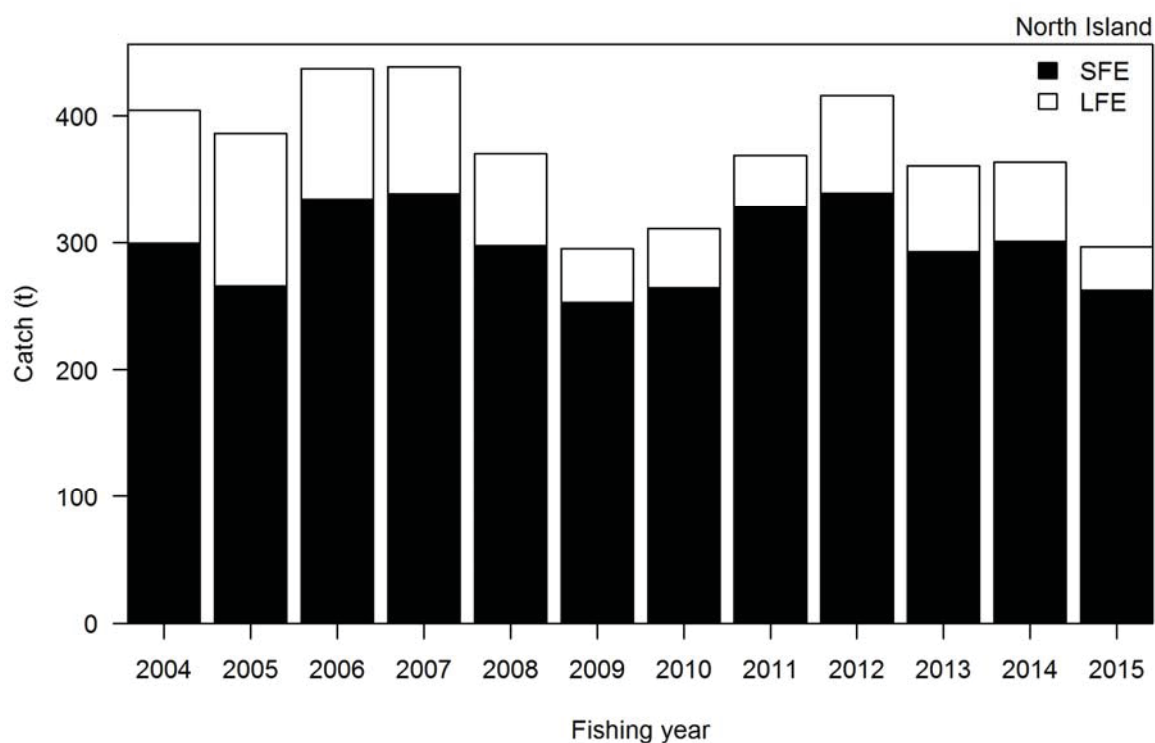


Figure 6: North Island total commercial catch (t) of shortfin (SFE) and longfin (LFE) eels for the years 2003–04 to 2014–15.

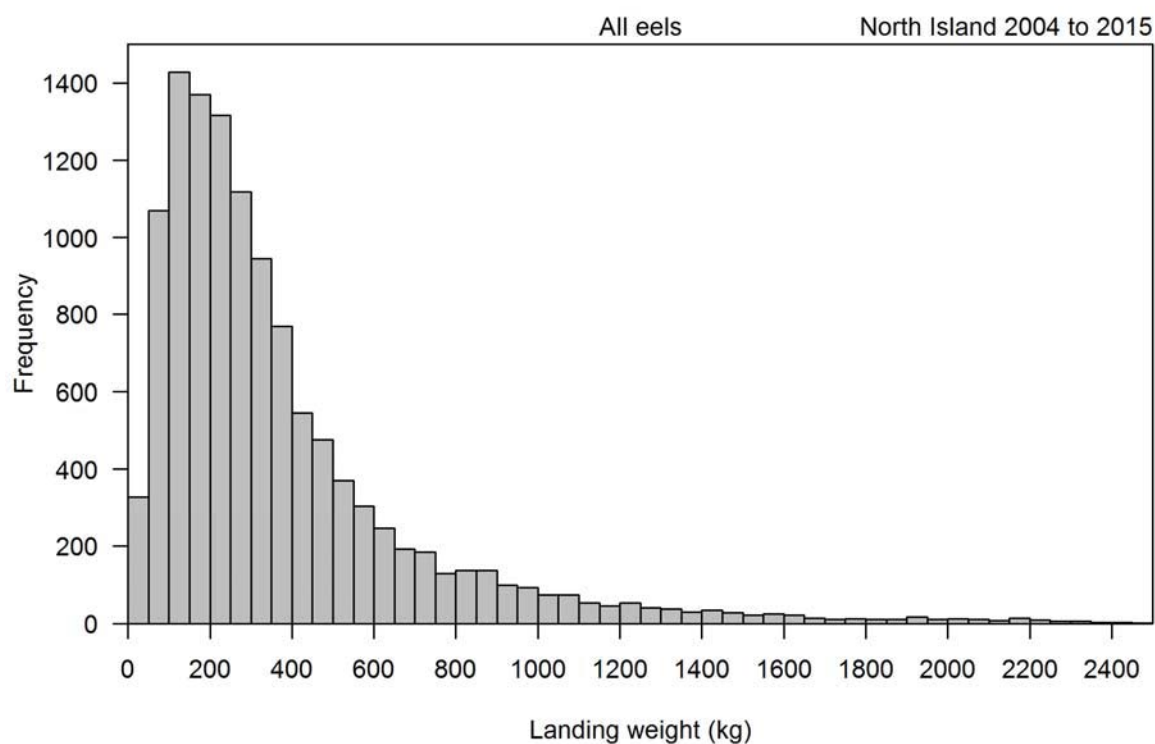


Figure 7: Distribution of individual eel landing weights in the North Island from 2003–04 to 2014–15. Landings include both shortfin and longfin eels.

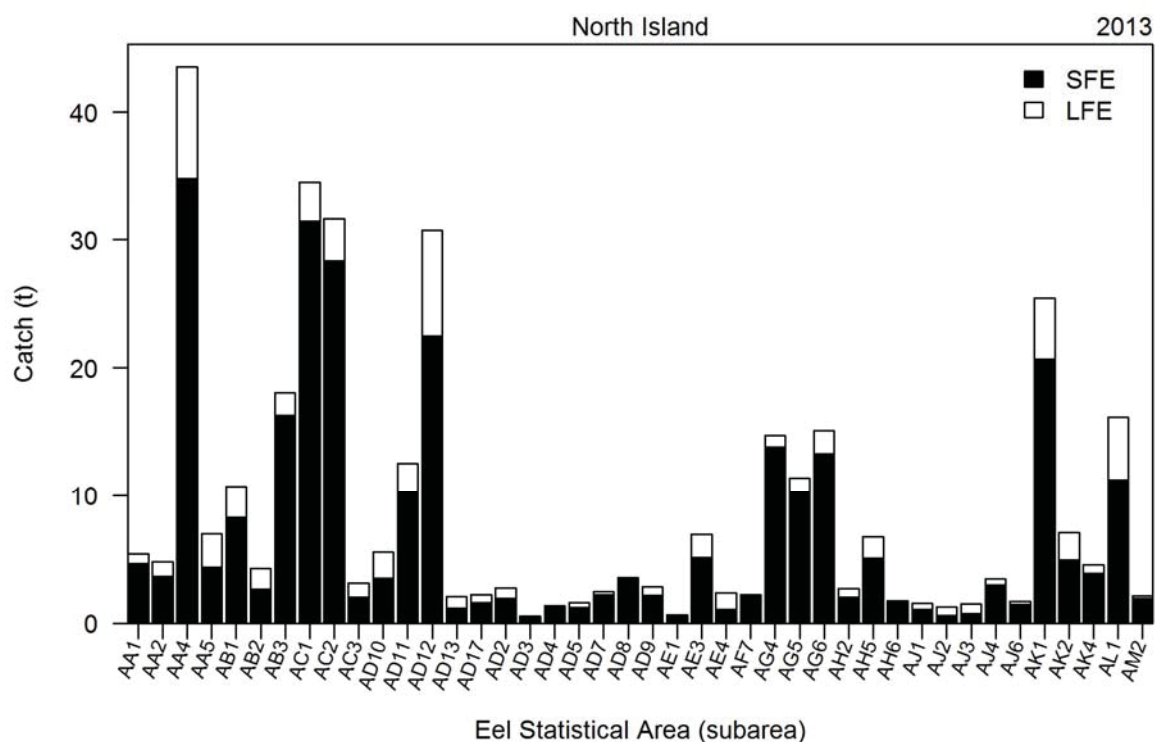


Figure 8: Catch of North Island shortfin (SFE) and longfin (LFE) eels by Eel Statistical Area subarea for fishing years 2012–13 (2013), 2013–14 (2014), and 2014–15 (2015). Only subareas with recorded catch are presented.

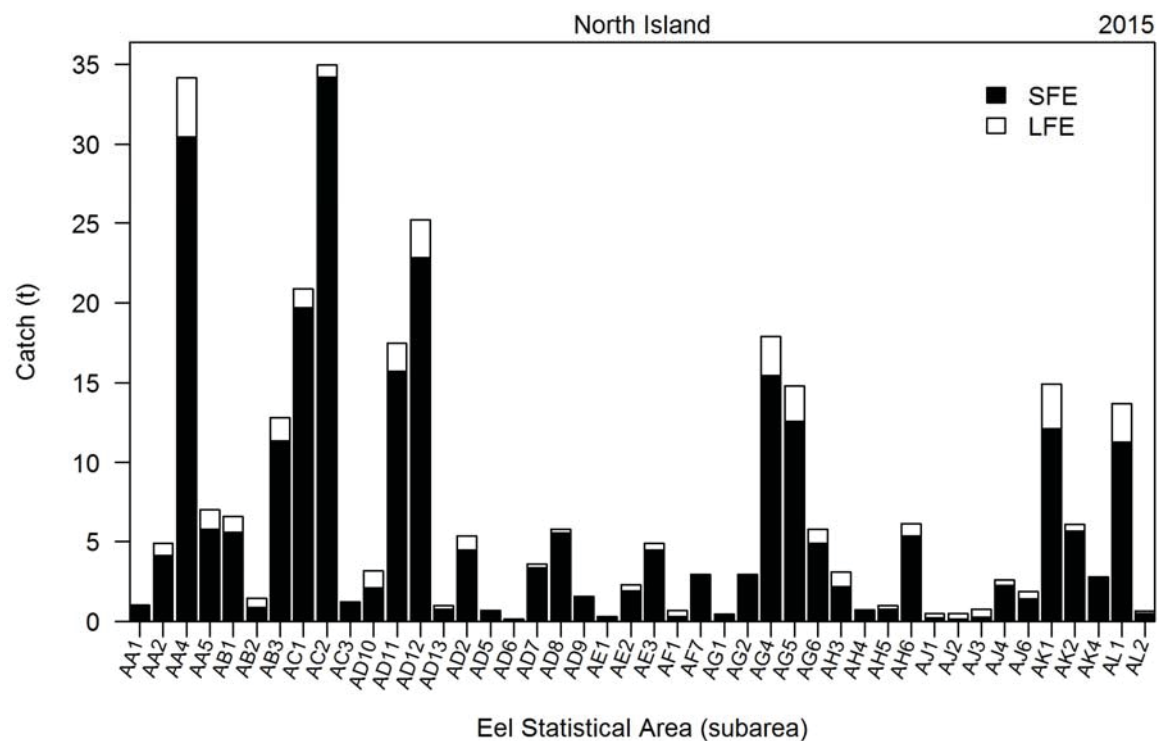
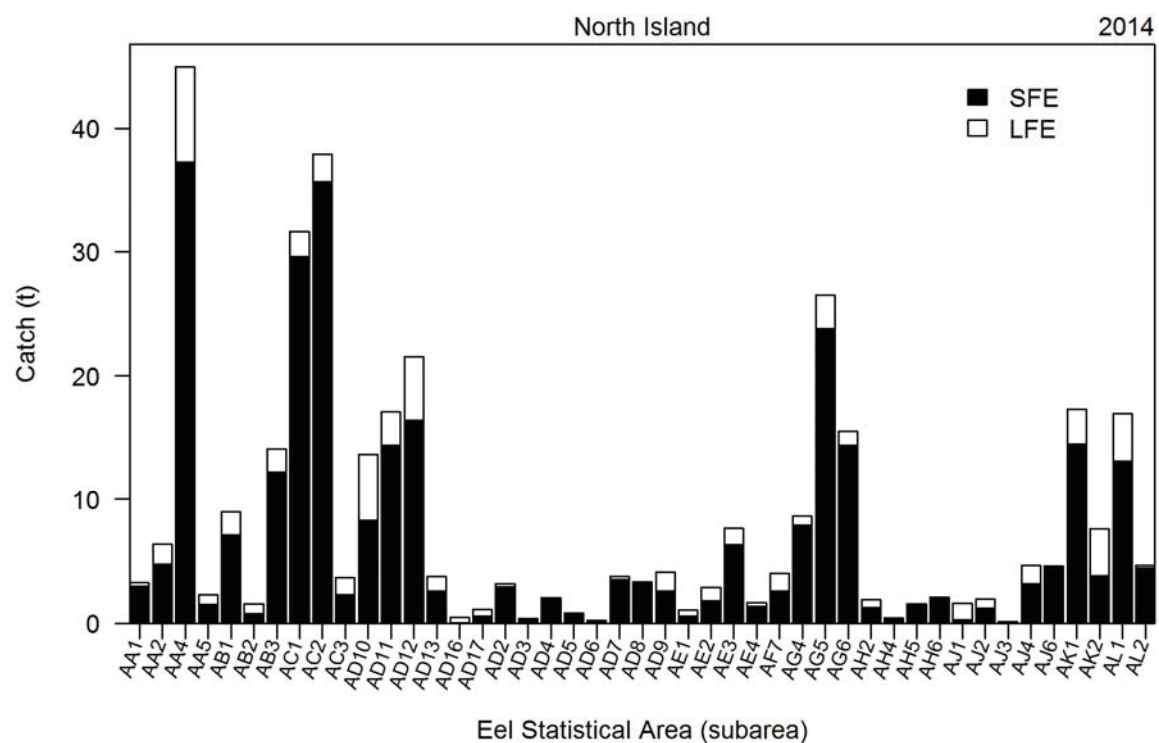


Figure 8– continued

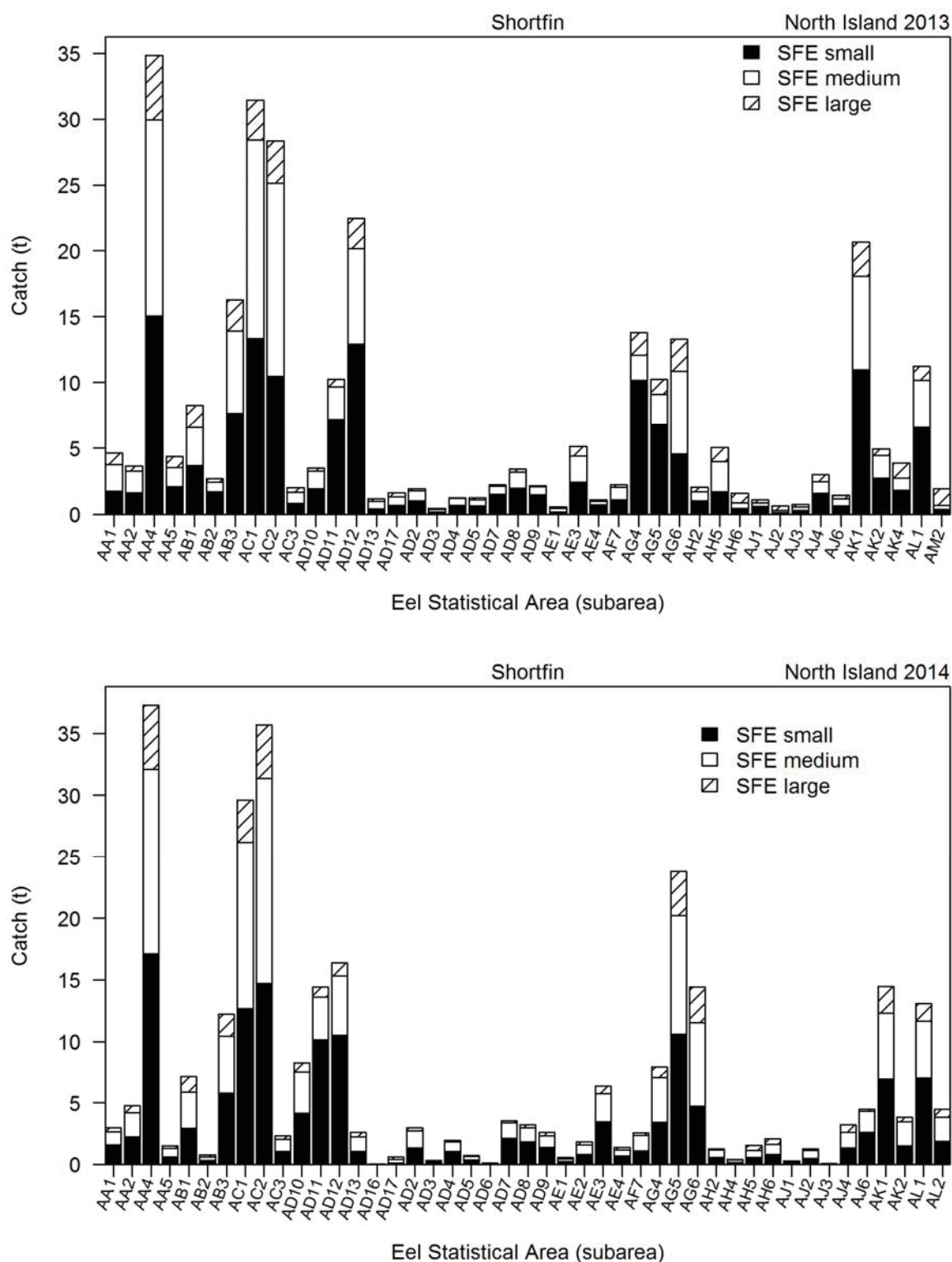


Figure 9: Catch of shortfin (SFE) eels by size grade for North Island Eel Statistical Area subareas for fishing years 2012–13 (2013), 2013–14 (2014), and 2014–15 (2015). Only subareas with recorded catch are presented.

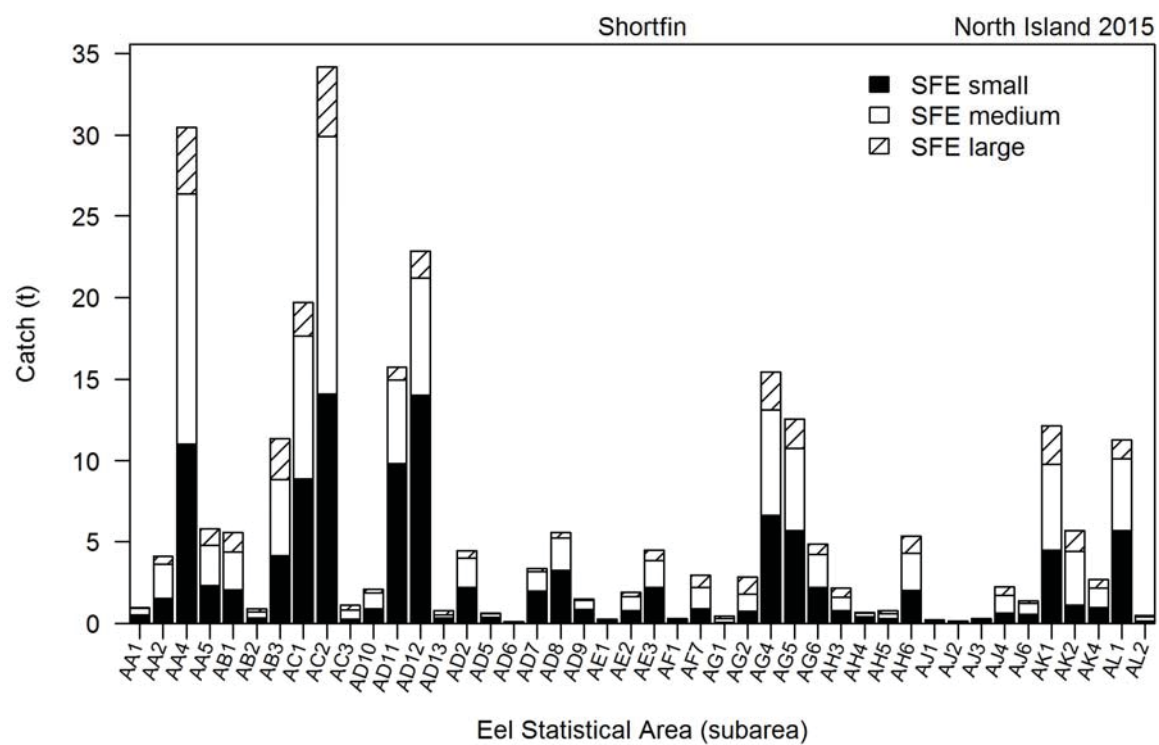


Figure 9 – continued

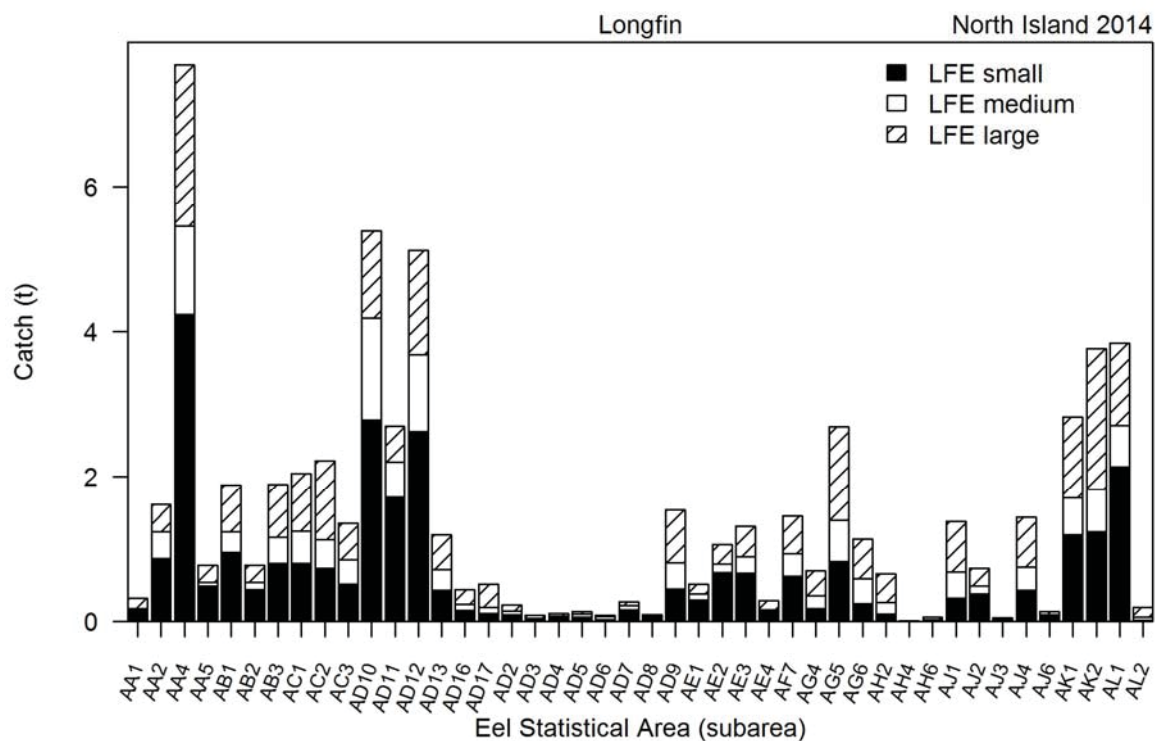
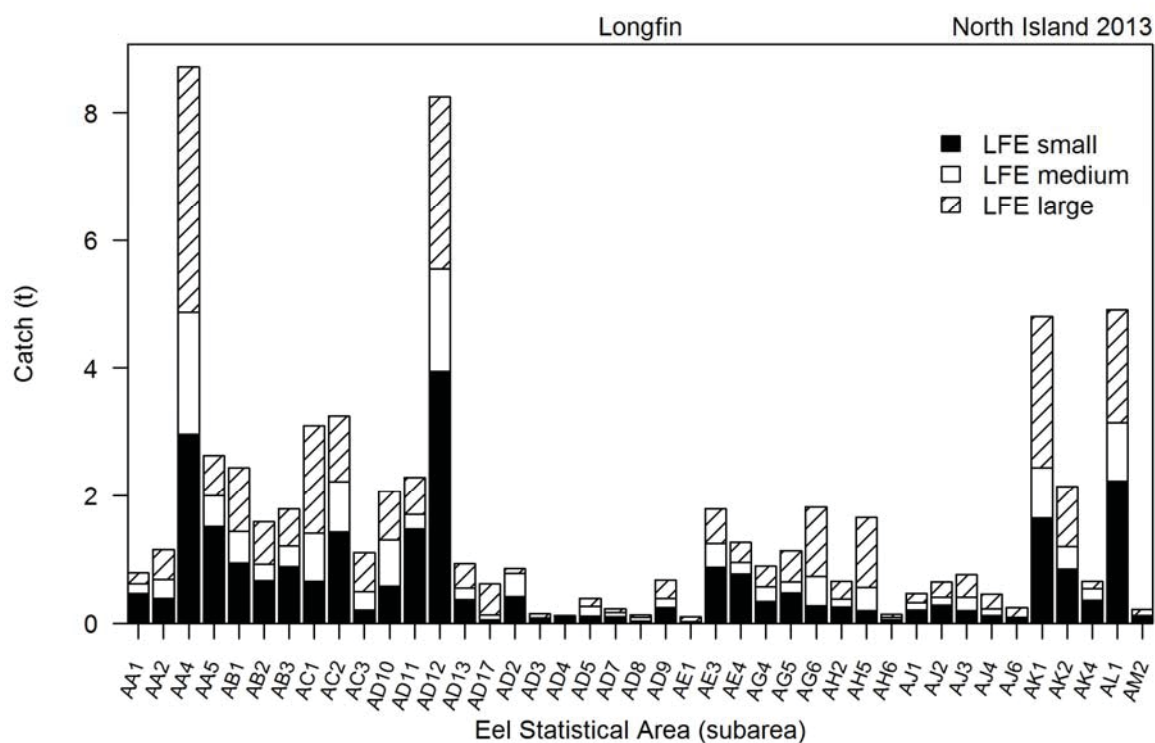


Figure 10: Catch of longfin (LFE) eels by size grade and North Island Eel Statistical Area subarea for fishing years 2012–13 (2013), 2013–14 (2014), and 2014–15 (2015). Only subareas with recorded catch are presented.

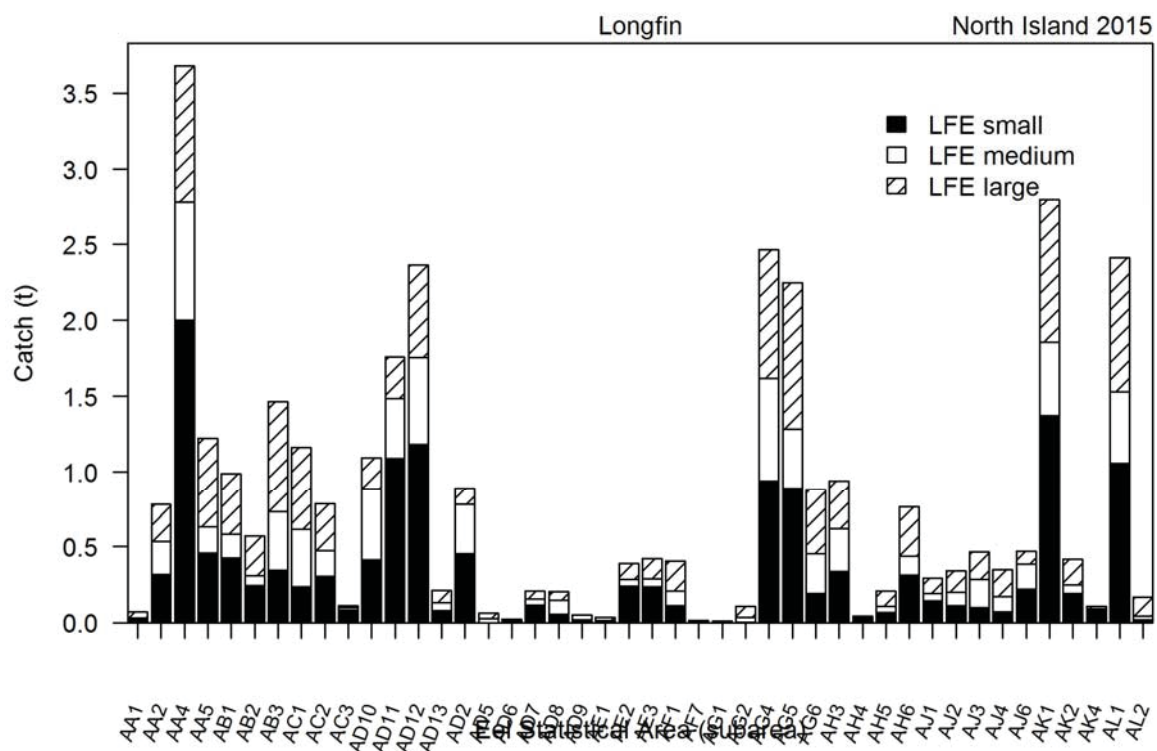


Figure 10 – *continued*

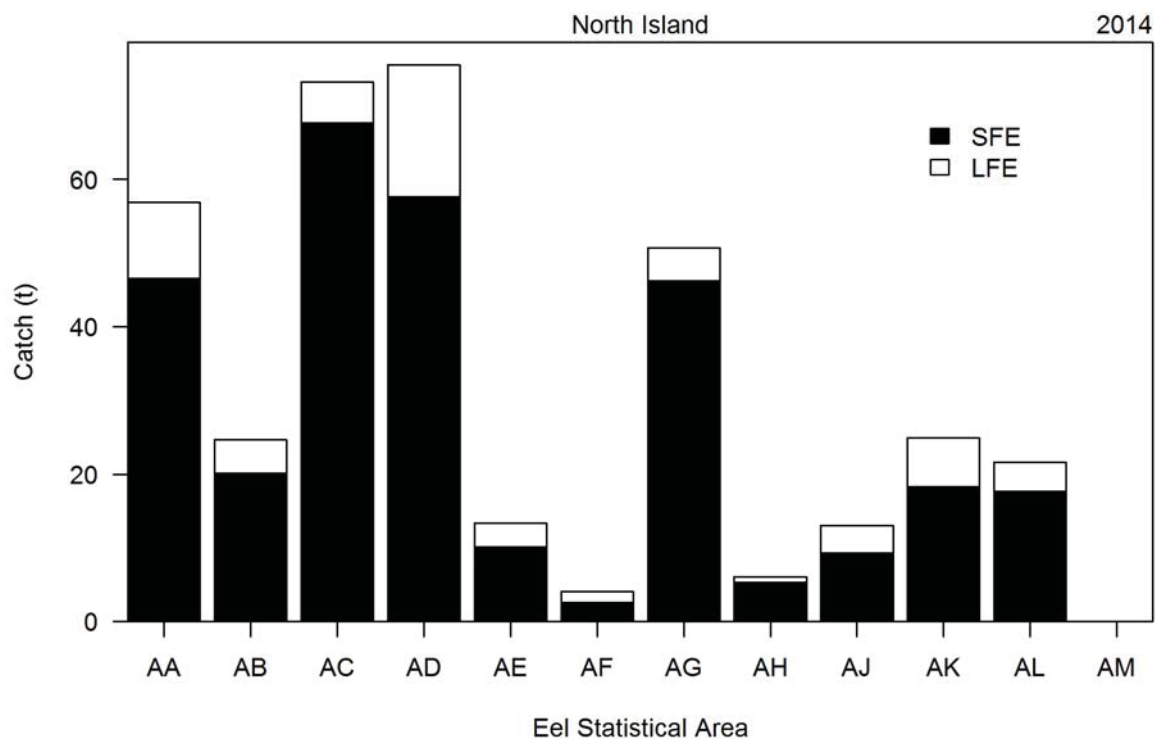
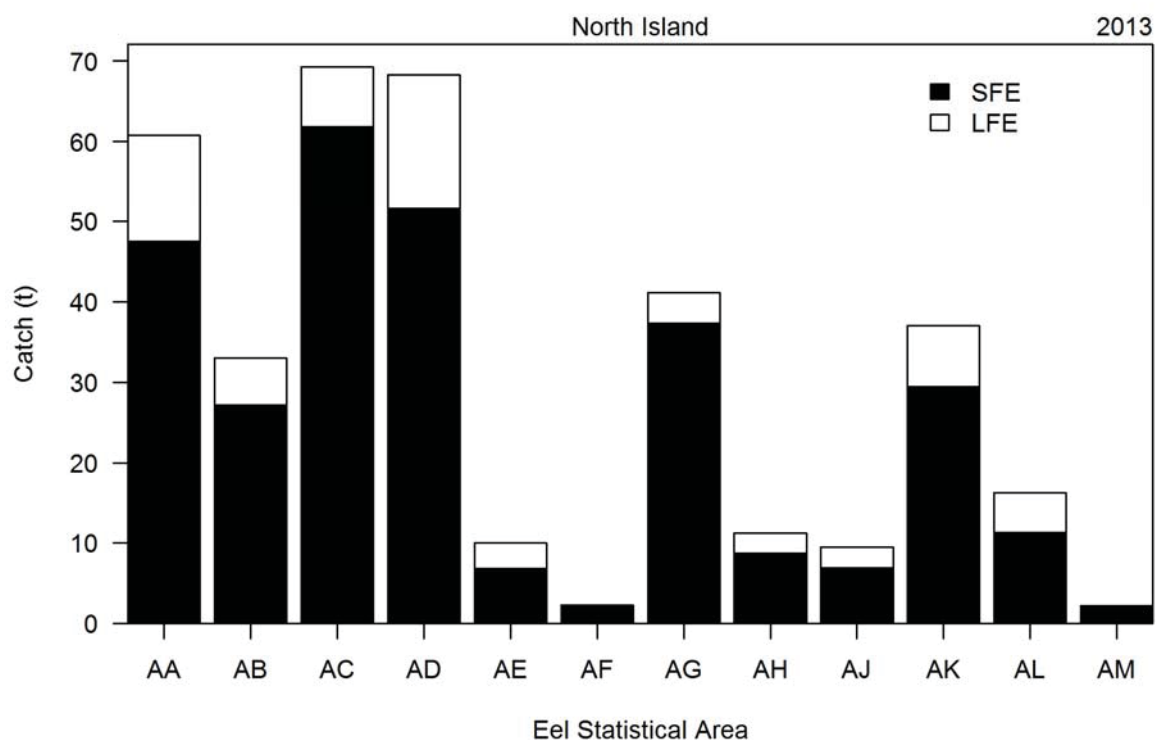


Figure 11: Catch of North Island shortfin (SFE) and longfin (LFE) eels by Eel Statistical Area for fishing years 2012–13 (2013), 2013–14 (2014), and 2014–15 (2015).

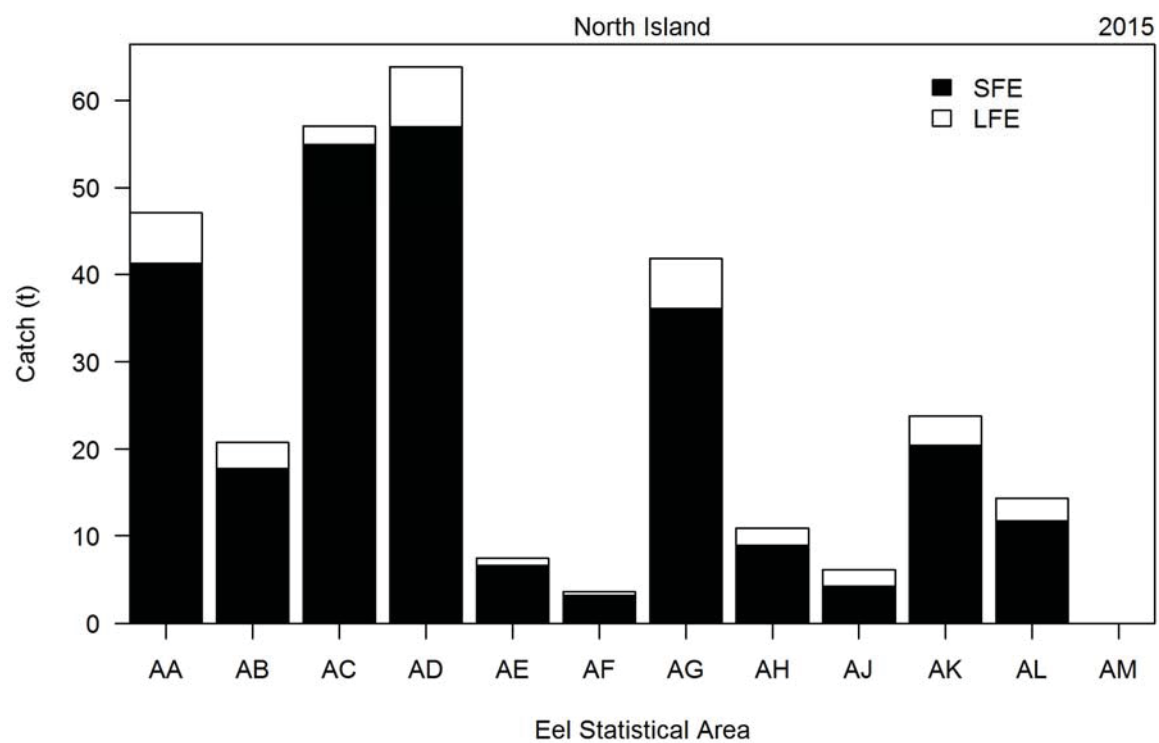


Figure 11 – *continued*

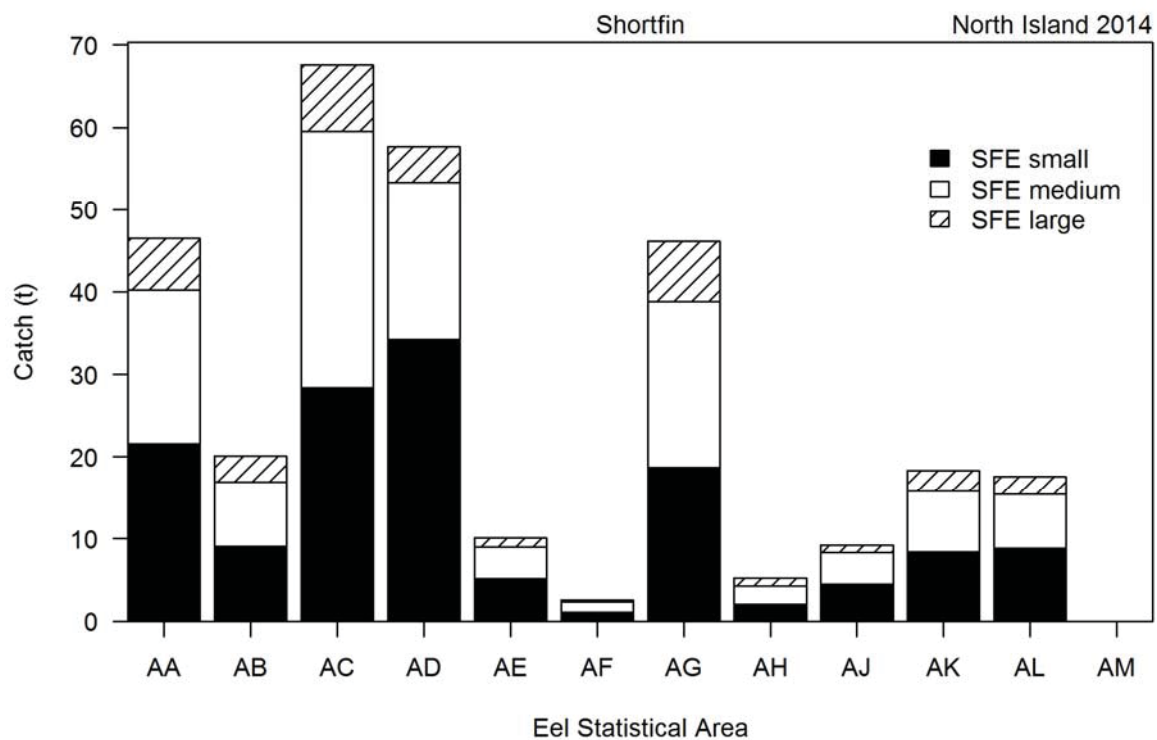
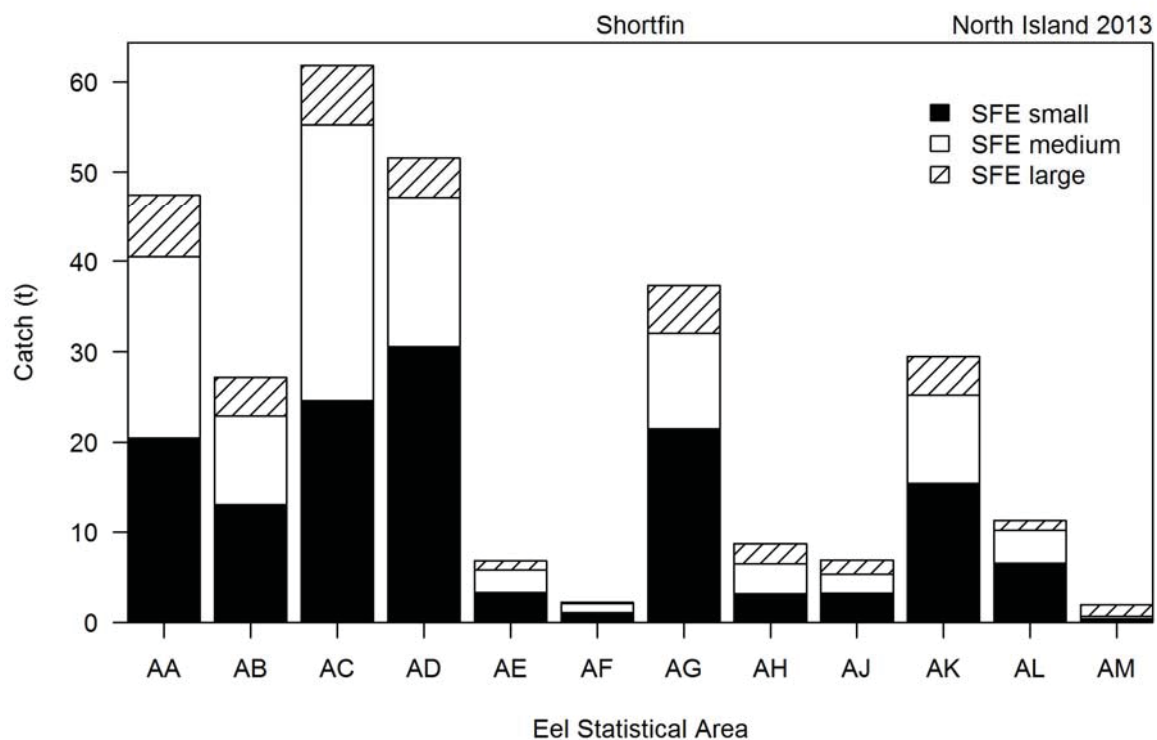


Figure 12: Catch of shortfin (SFE) eels by size grade for North Island Eel Statistical Area for fishing years 2012–13 (2013), 2013–14 (2014), and 2014–15 (2015).

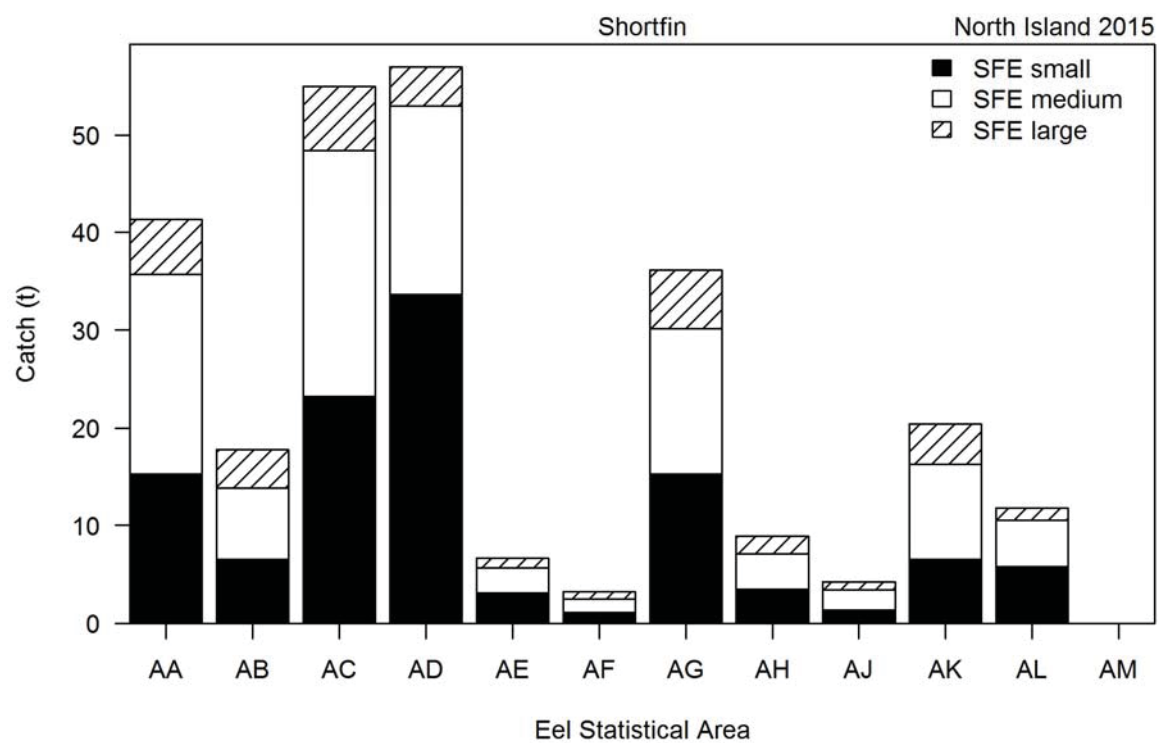


Figure 12 – *continued*

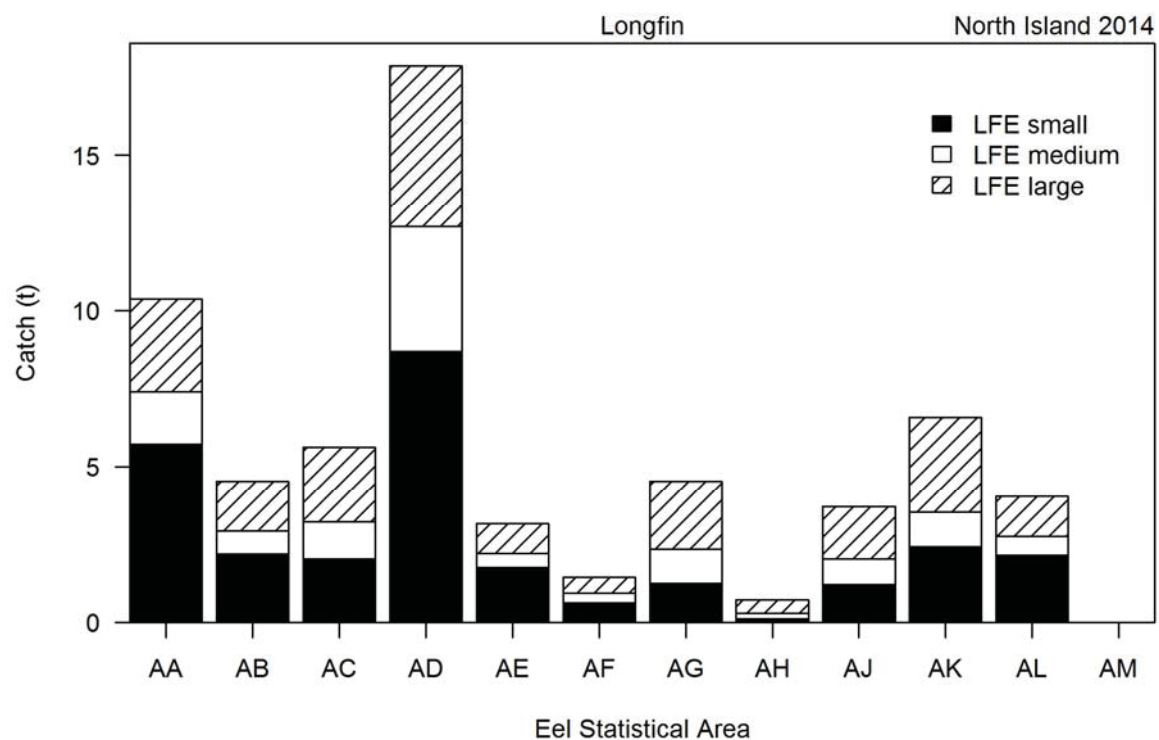
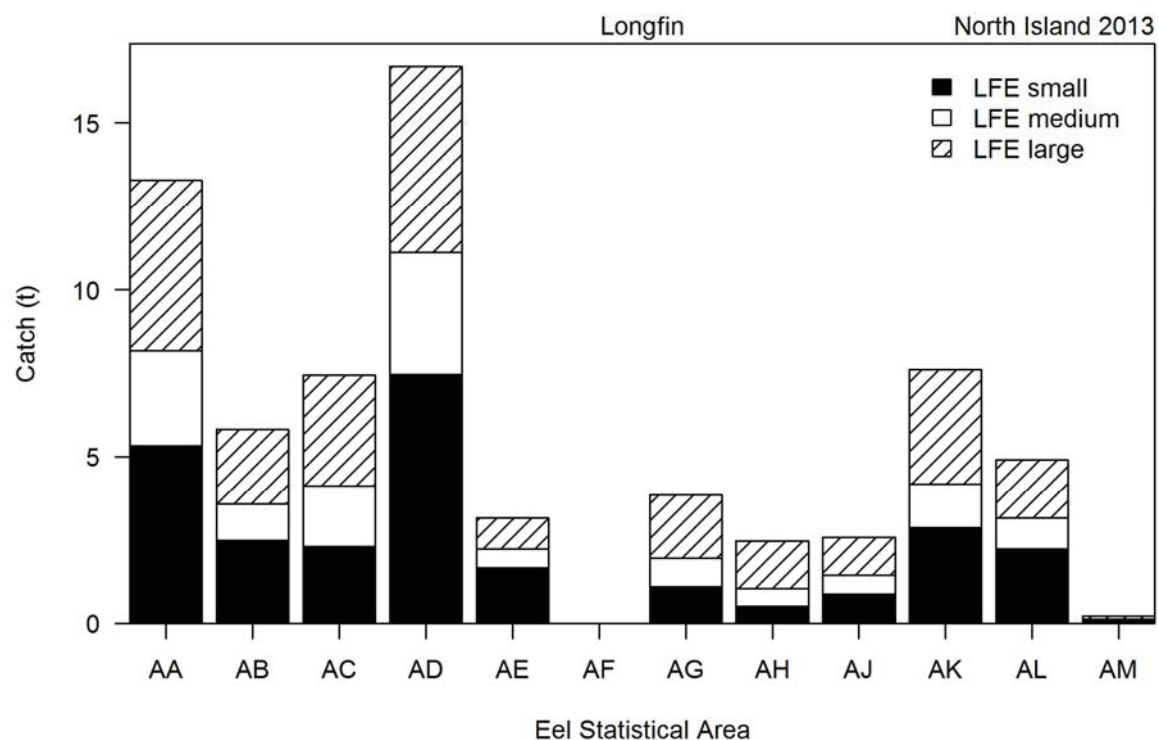


Figure 13: Catch of longfin (LFE) eels by size grade and North Island Eel Statistical Area for fishing years 2012–13 (2013), 2013–14 (2014), and 2014–15 (2015).

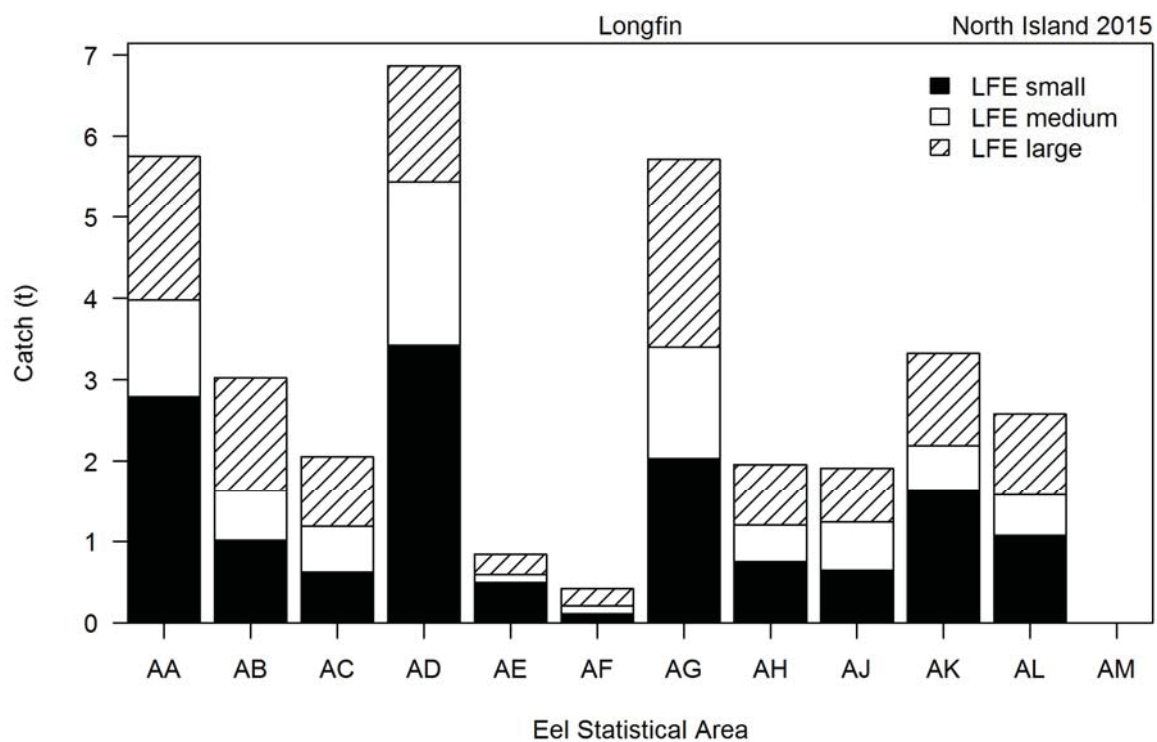


Figure 13 – *continued*

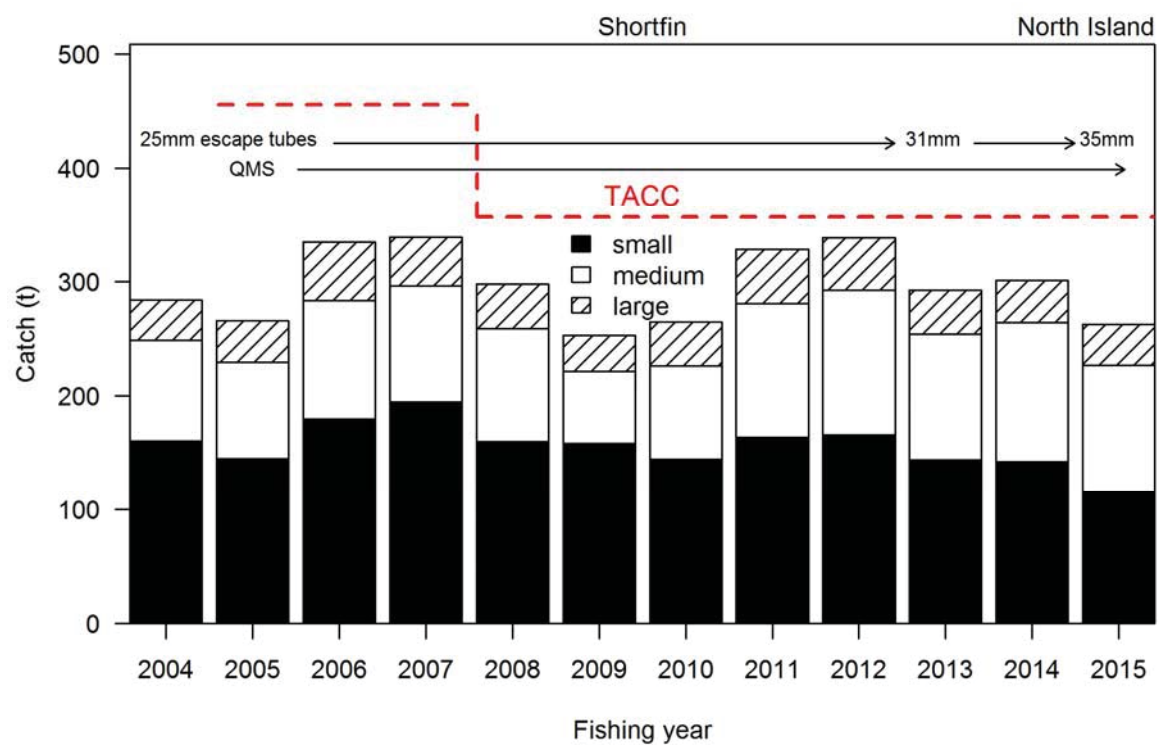


Figure 14: North Island shortfin eel catch by weight (t) for each size grade from 2003–04 to 2014–15. Events that may have impacted on the catch are annotated on the plot.

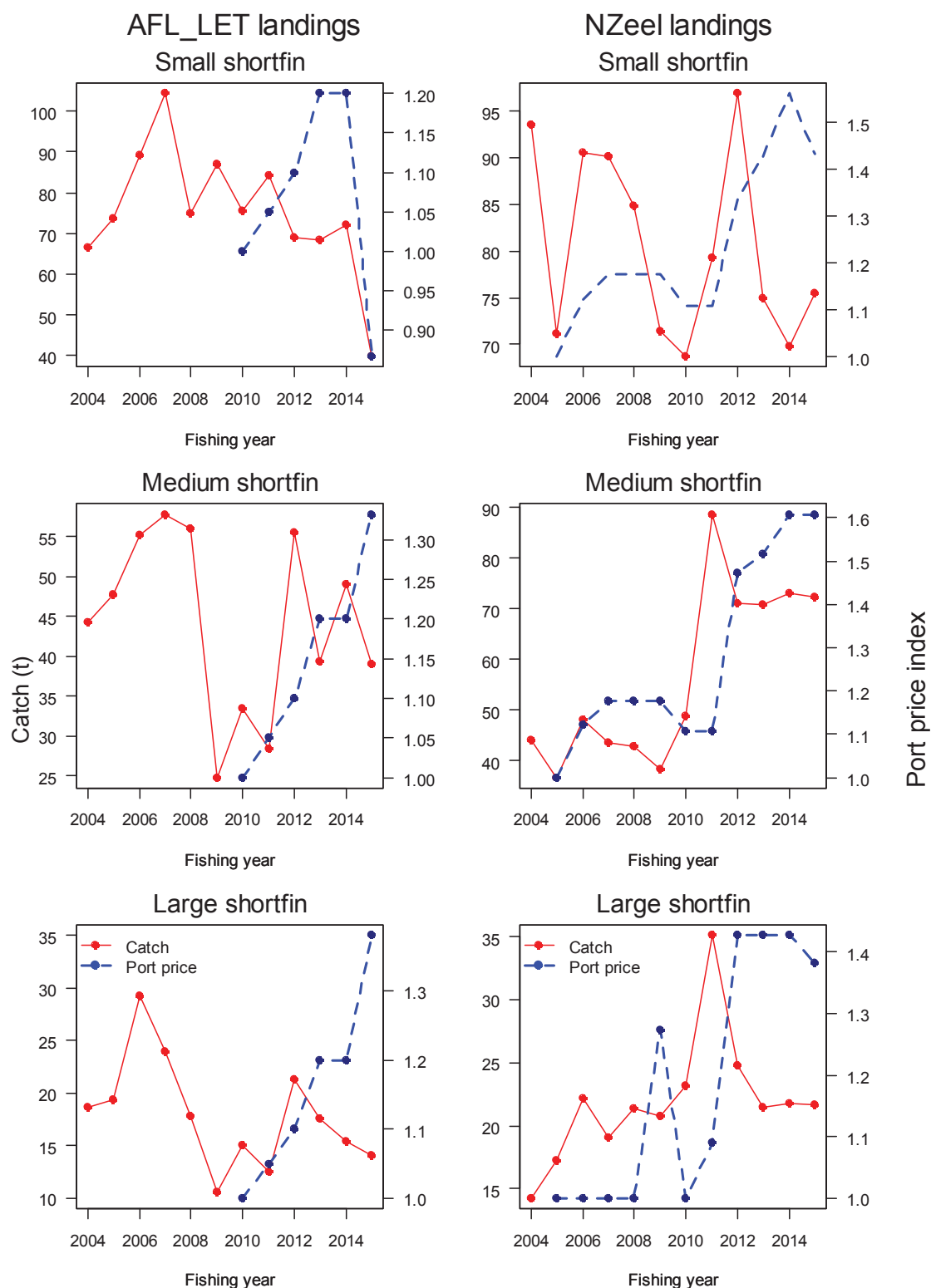


Figure 15: Port price index versus and catch for three grades of shortfin eel for both North Island eel processors. AFL-LET port price data begins in 2009–10 fishing year.

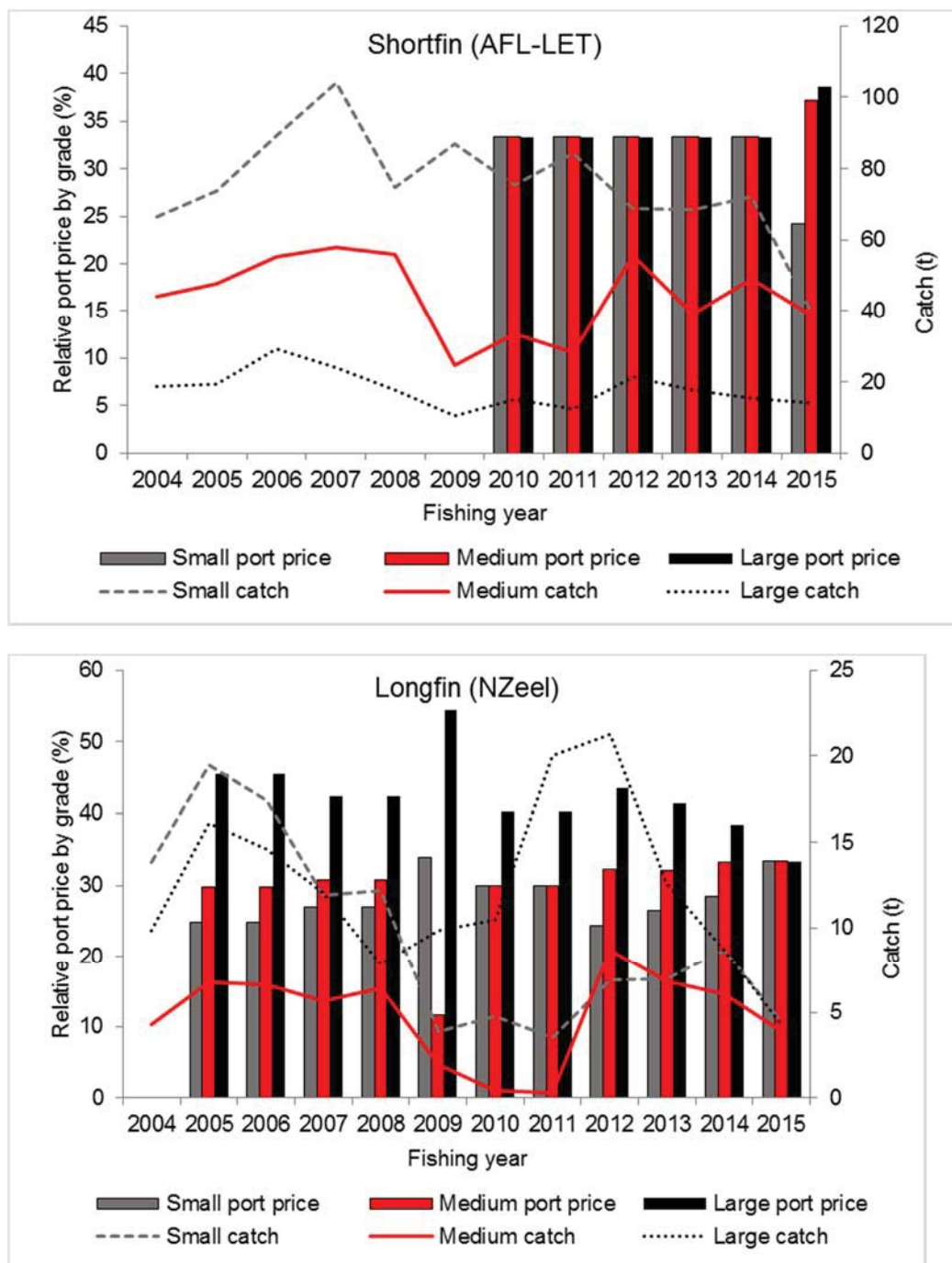


Figure 16. Shortfin catch and relative port price by size grade for NZeel and AFL-LET eel processors. Catch data are from 2003–04 to 2014–15, but port price data begin in 2009–10 for AFL-LET and 2004–05 for NZeel. The port price proportions per year add up to 100%.

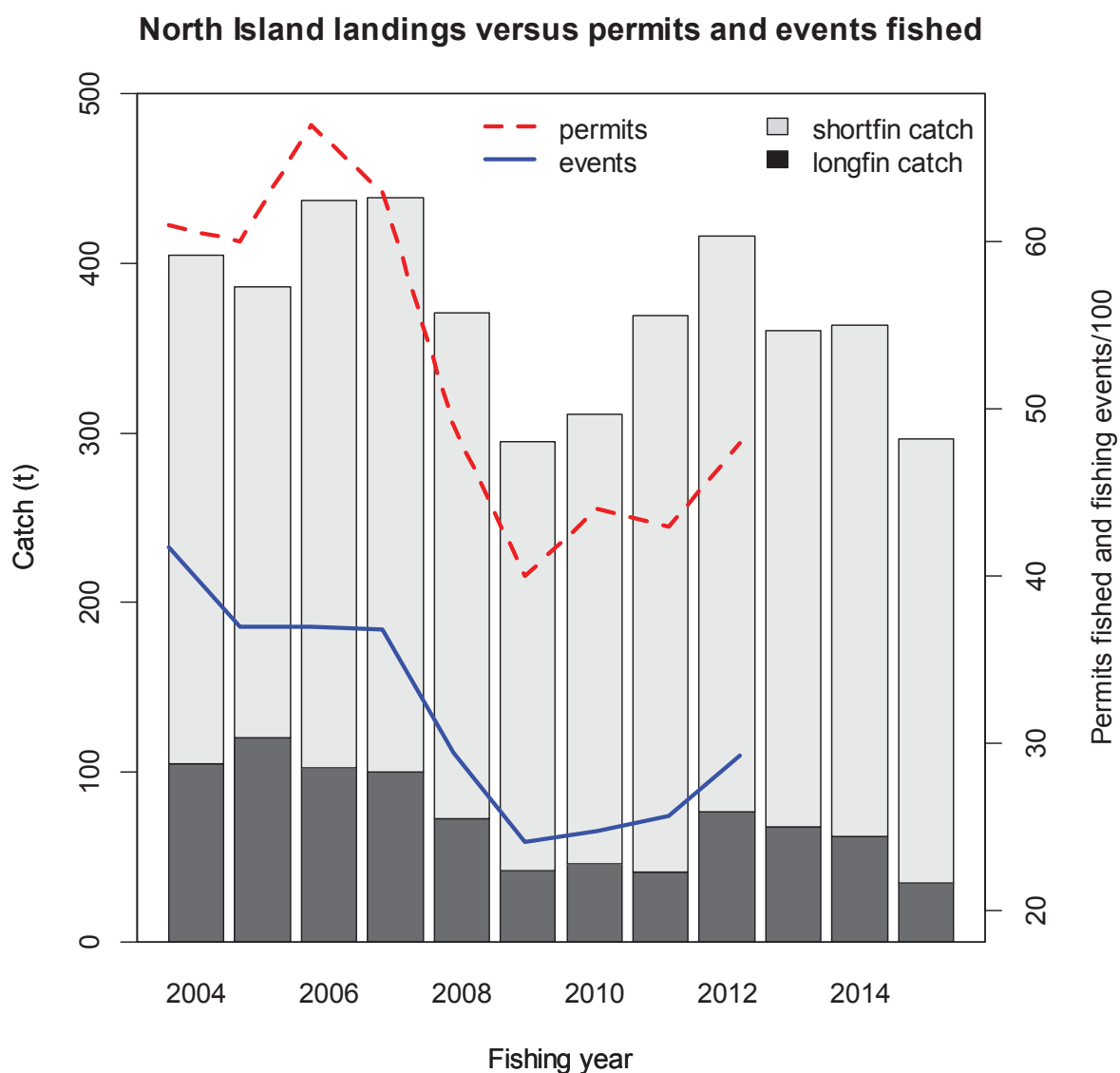


Figure 17: Catch of shortfin and longfin eel by fishing year compared to number of permits fished and fishing events. Data from Beentjes & Dunn (2013b).

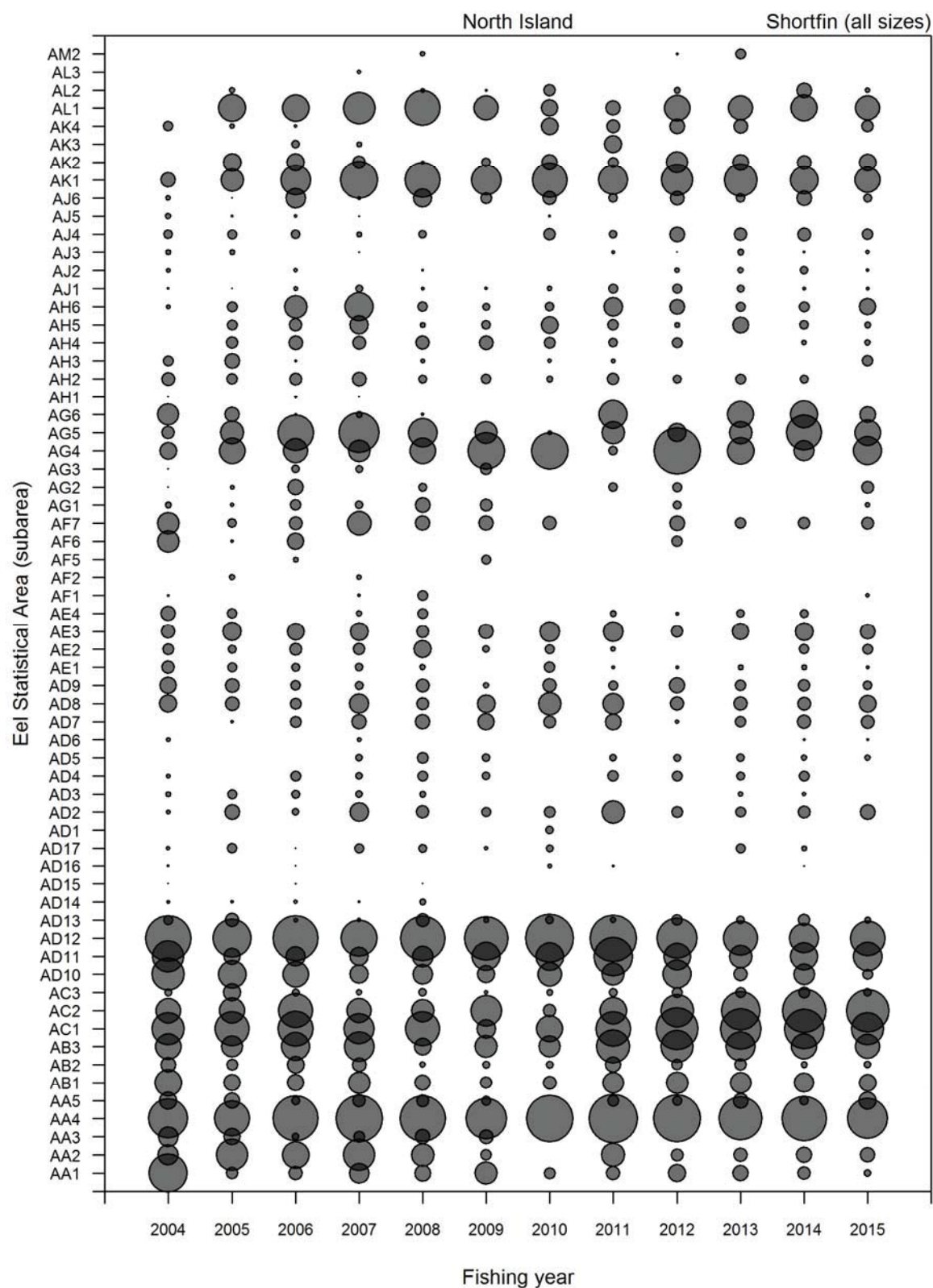


Figure 18: North Island shortfin catch by Eel Statistical Area subarea from 2003–04 to 2014–15. Maximum = 44.7 t.

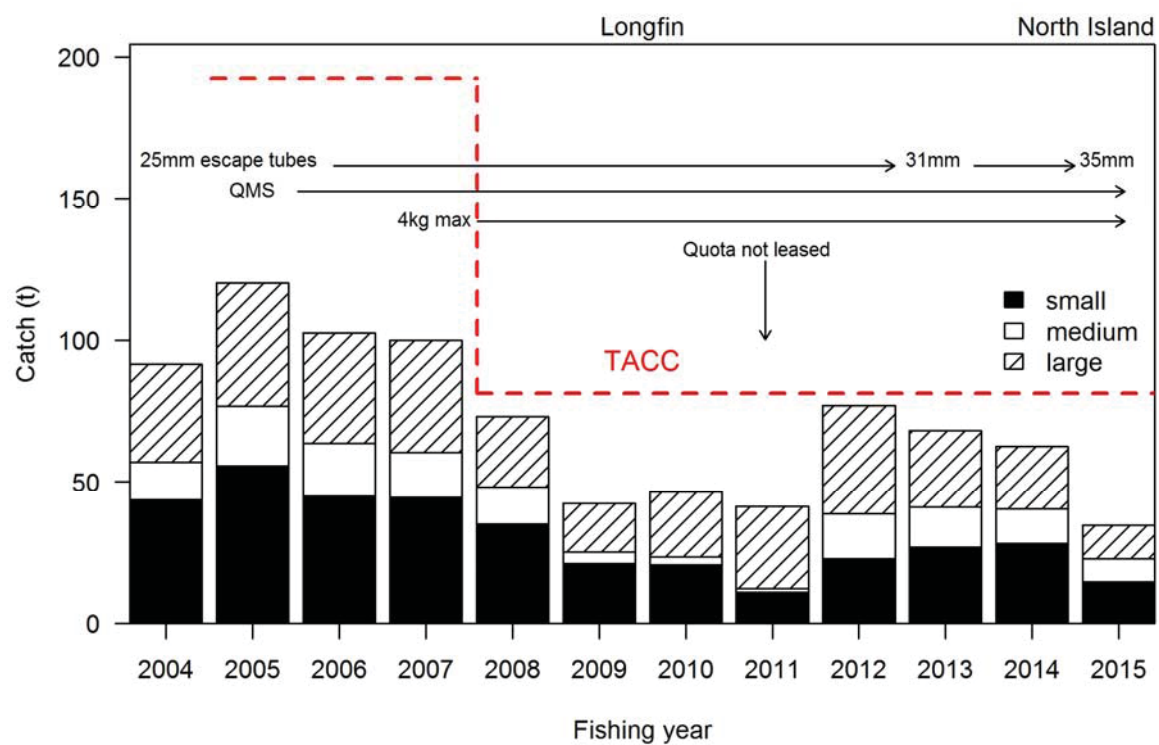


Figure 19: North Island longfin eel catch by weight (t) for the three size grades from 2003–04 to 2014–15.

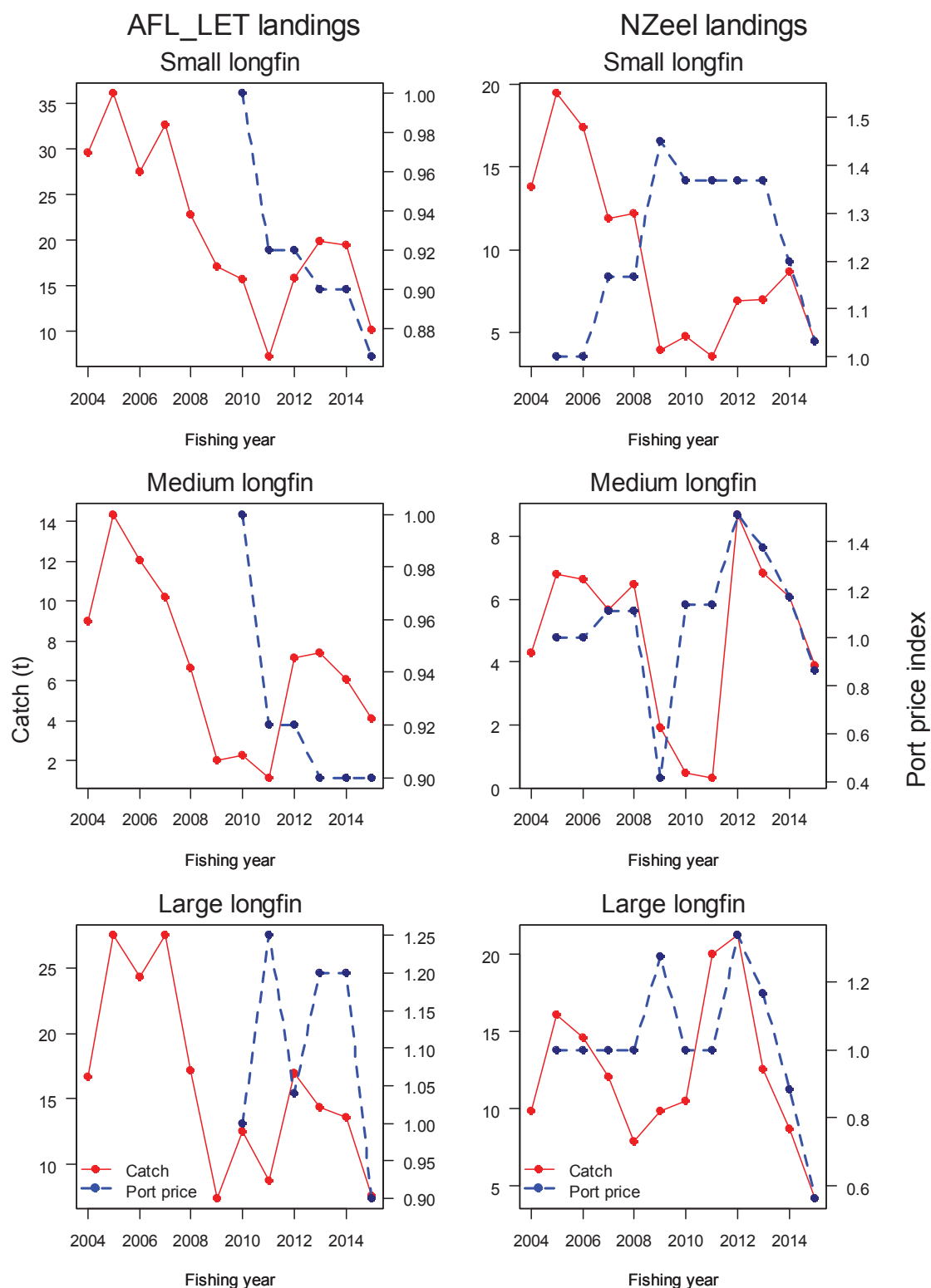


Figure 20: Port price index versus and catch for three grades of longfin eel for both North Island eel processors. AFL-LET port price data begins in 2009–10 fishing year.

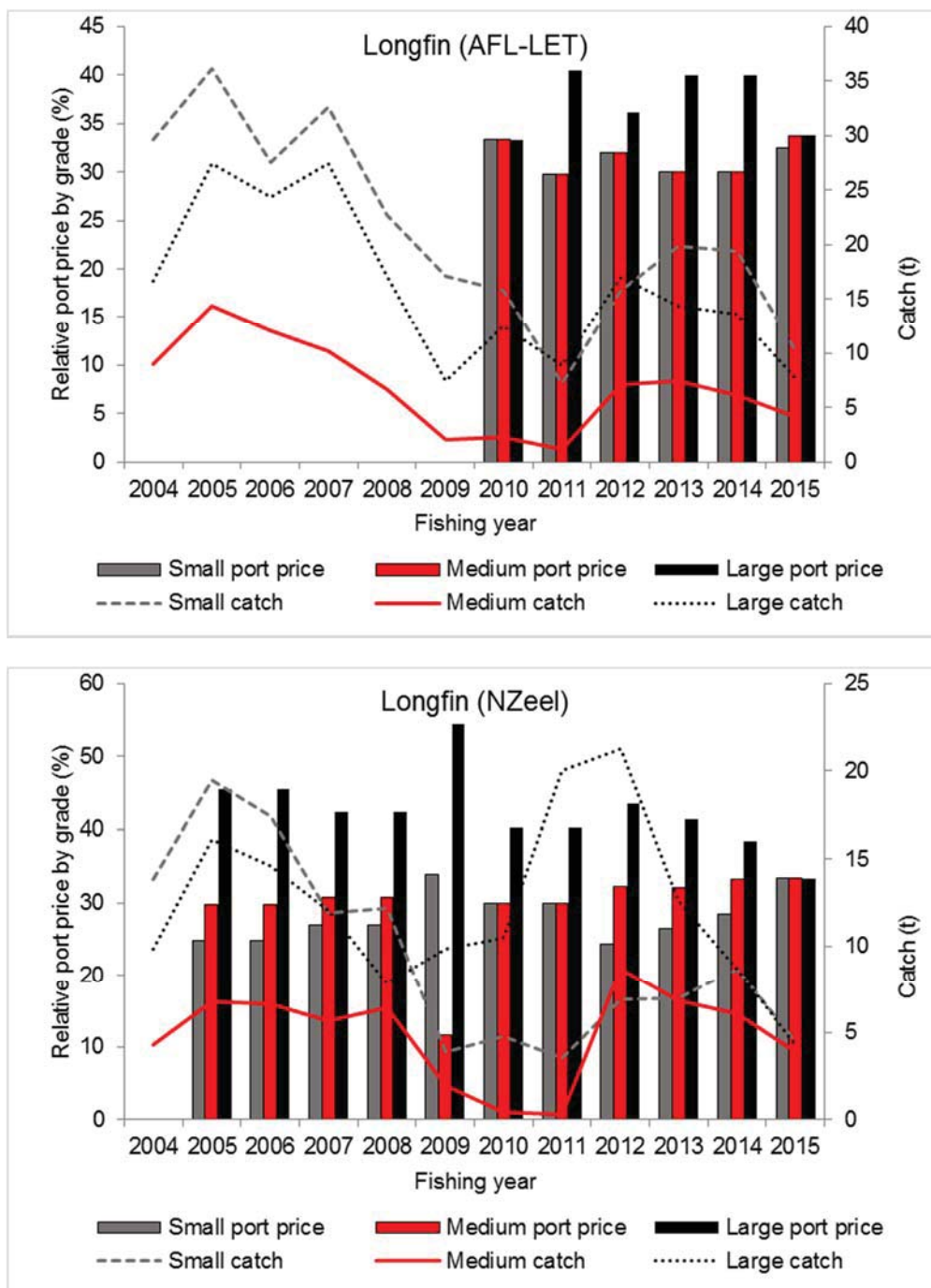


Figure 21. Longfin catch and relative port price by size grade for NZeel and AFL-LET eel processors. Catch data are from 2003–04 to 2014–15, but port price data begin in 2009–10 for AFL-LET and 2004–05 for NZeel. The port price proportions per year add up to 100%.

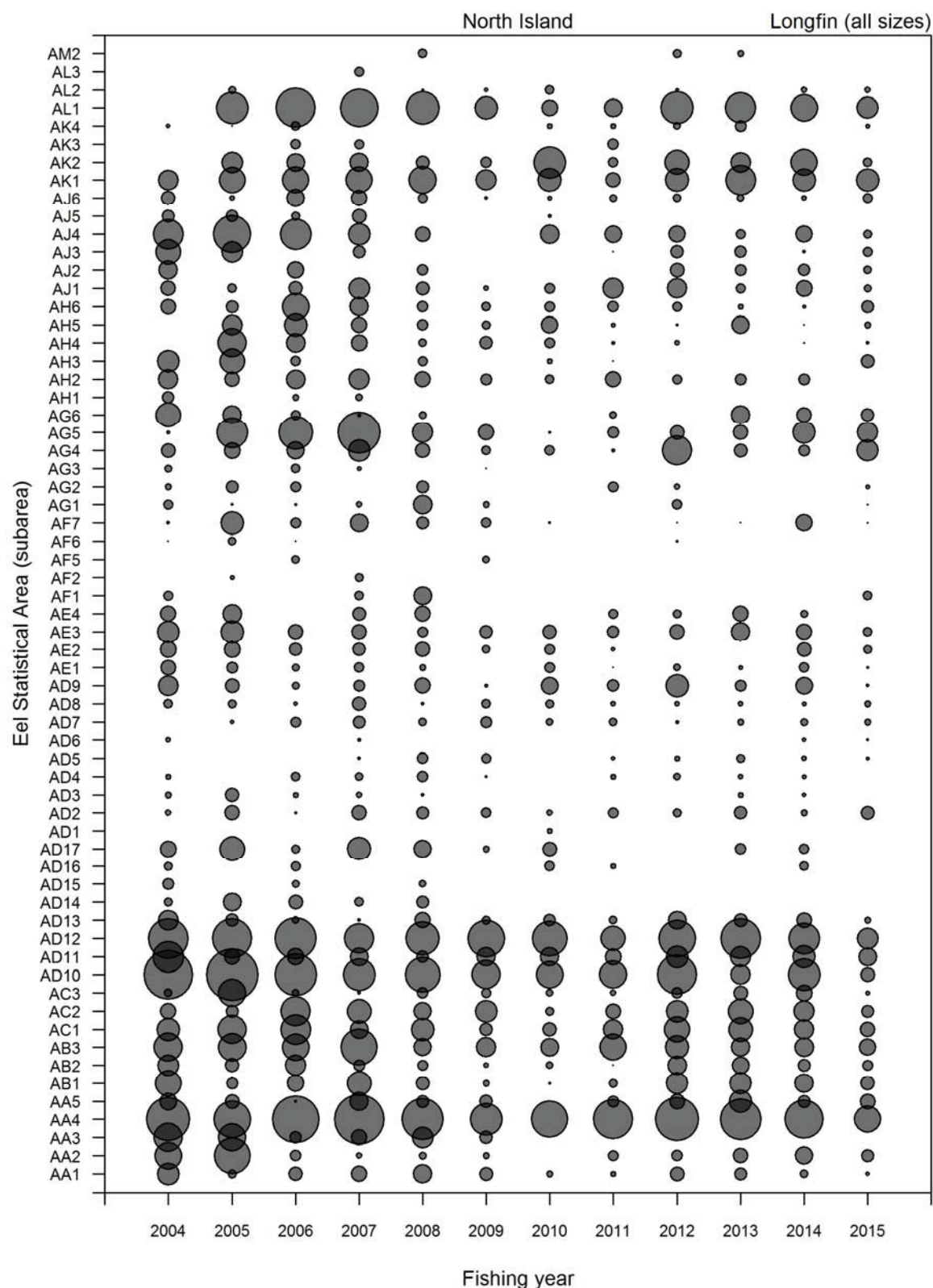


Figure 22: North Island longfin catch by Eel Statistical Area subarea from 2003–04 to 2014–15. Maximum = 13.9 t.

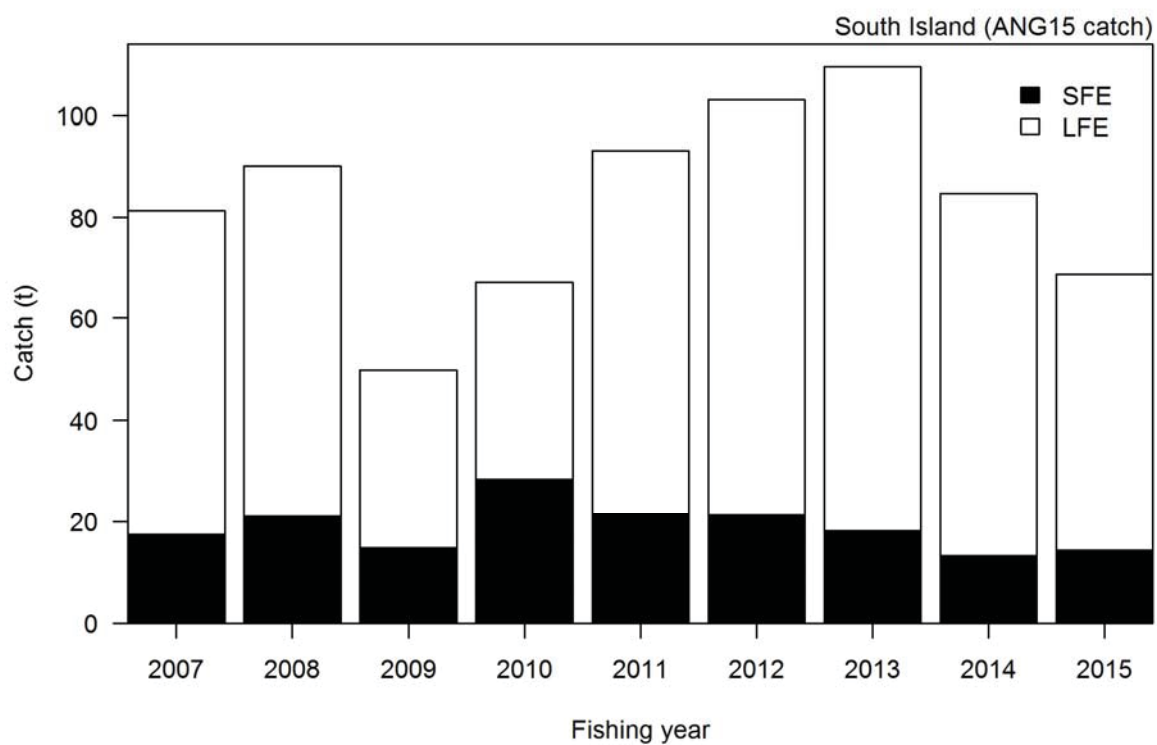


Figure 23: ANG 15 total commercial catch (t) of shortfin (SFE), longfin (LFE) for the years 2006–07 to 2014–15.

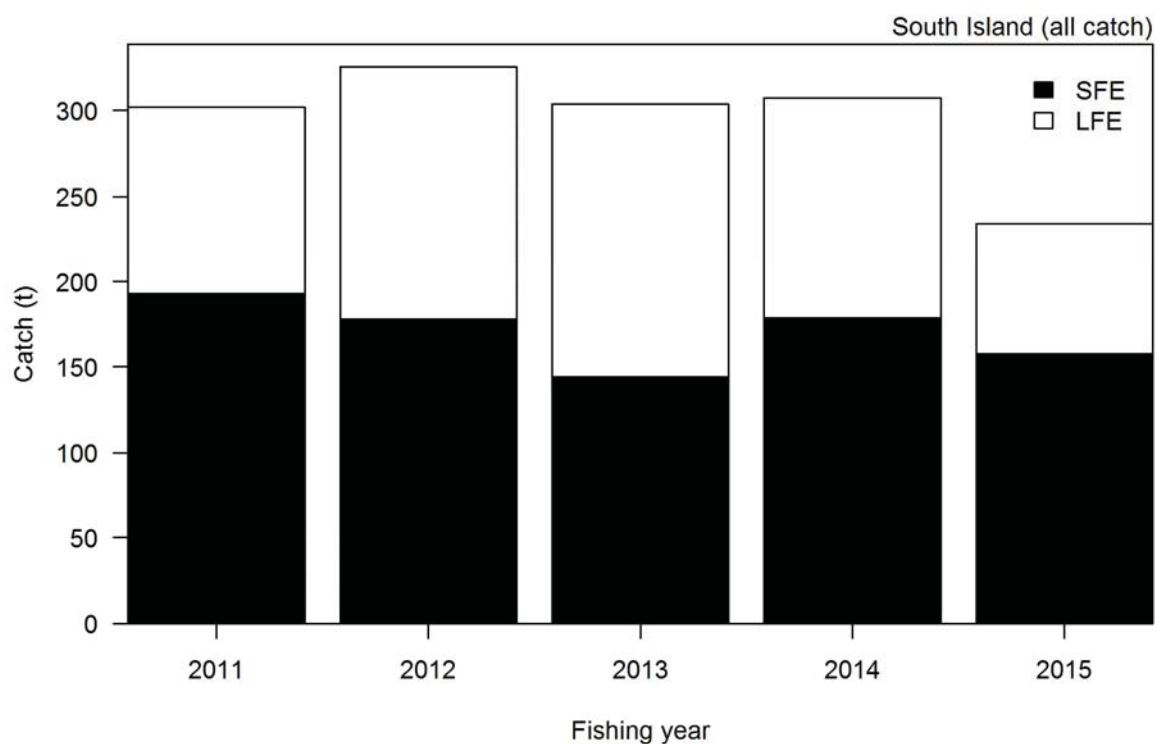


Figure 24: South Island commercial catch (t) of shortfin (SFE) and longfin (LFE) eels for the years 2010–11 to 2014–15.

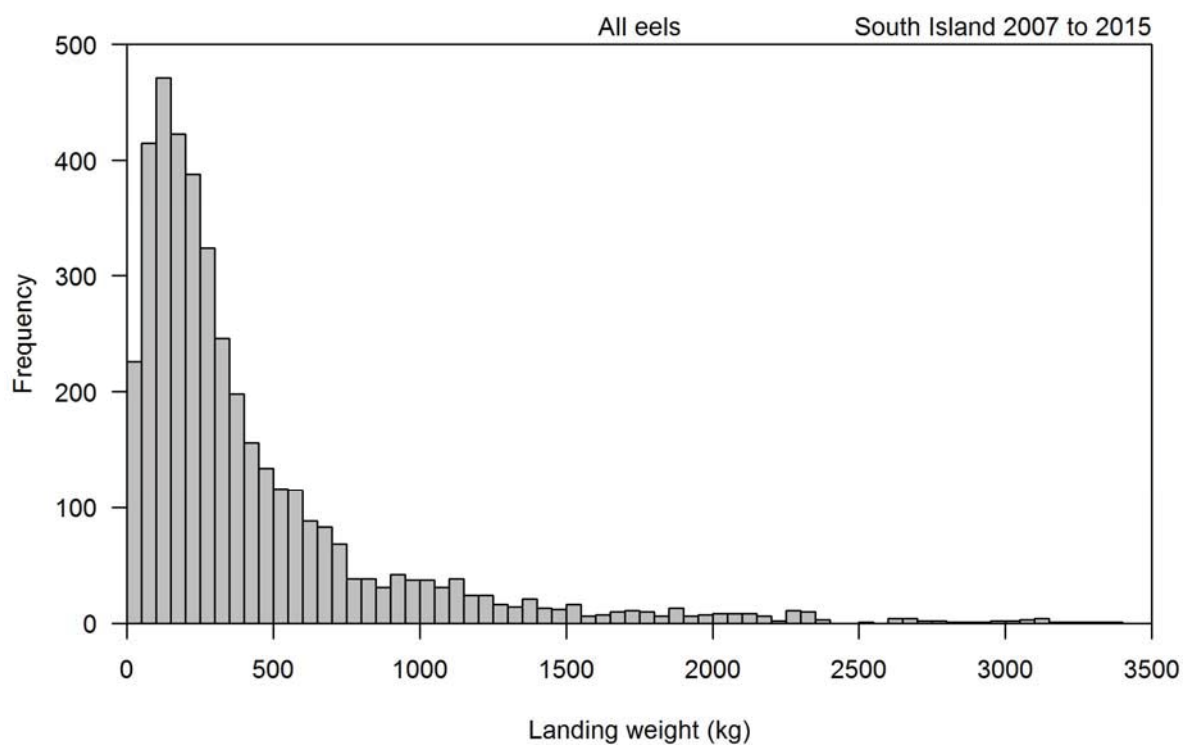


Figure 25: Distribution of individual eel landing weights in the South Island for 2006–07 to 2014–15. Landings include both shortfin and longfin eels, and the period 2006–07 to 2009–10 is for ANG 15 only.

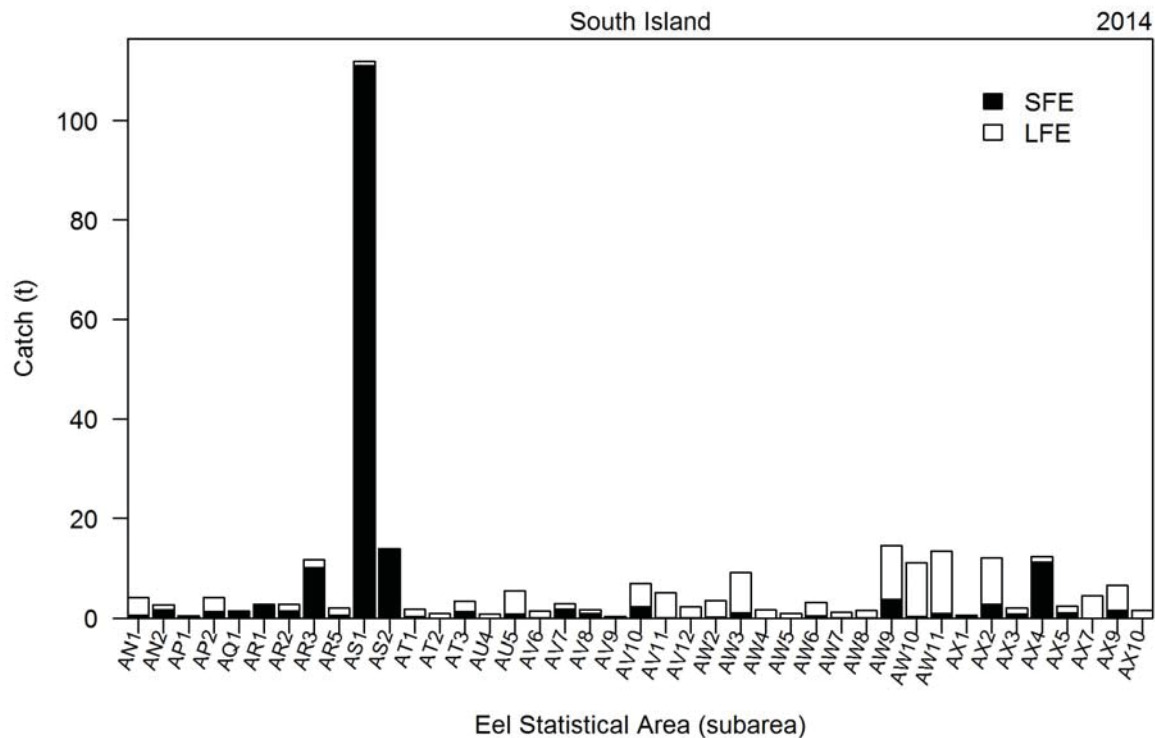
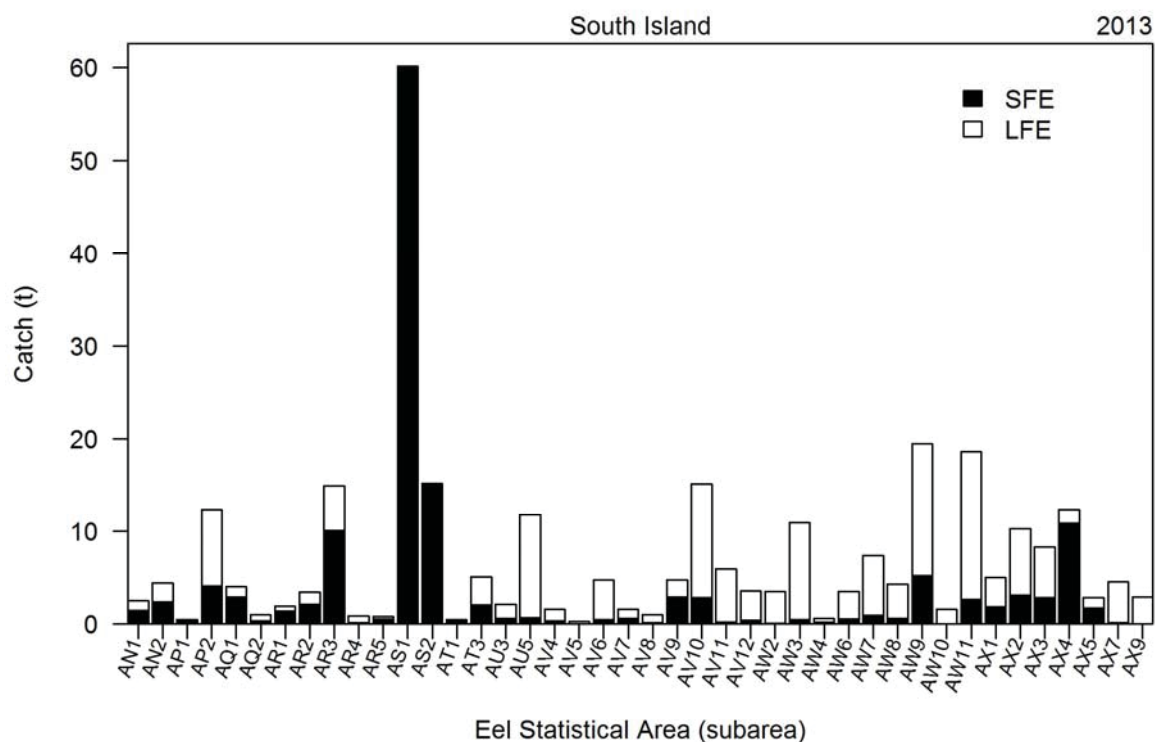


Figure 26: Catch of South Island shortfin (SFE) and longfin (LFE) eels by Eel Statistical Area subarea for 2012–13 (2013), 2013–14 (2014), and 2014–15 (2015).

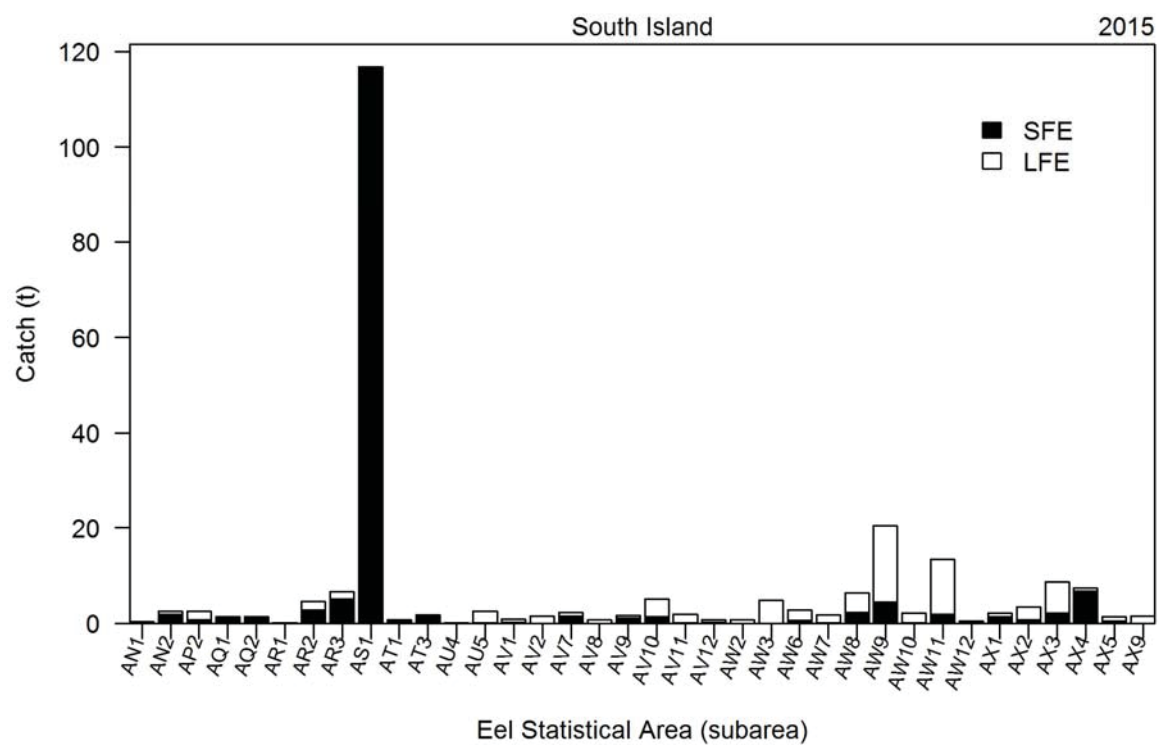


Figure 26 – *continued*

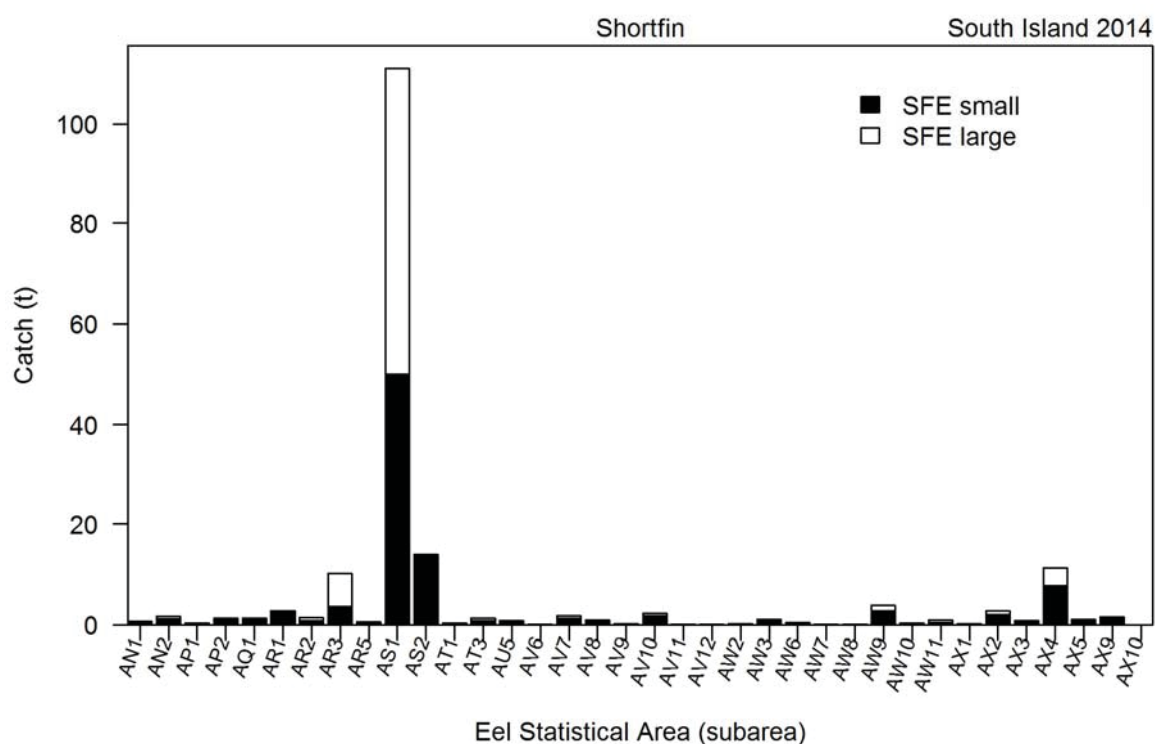
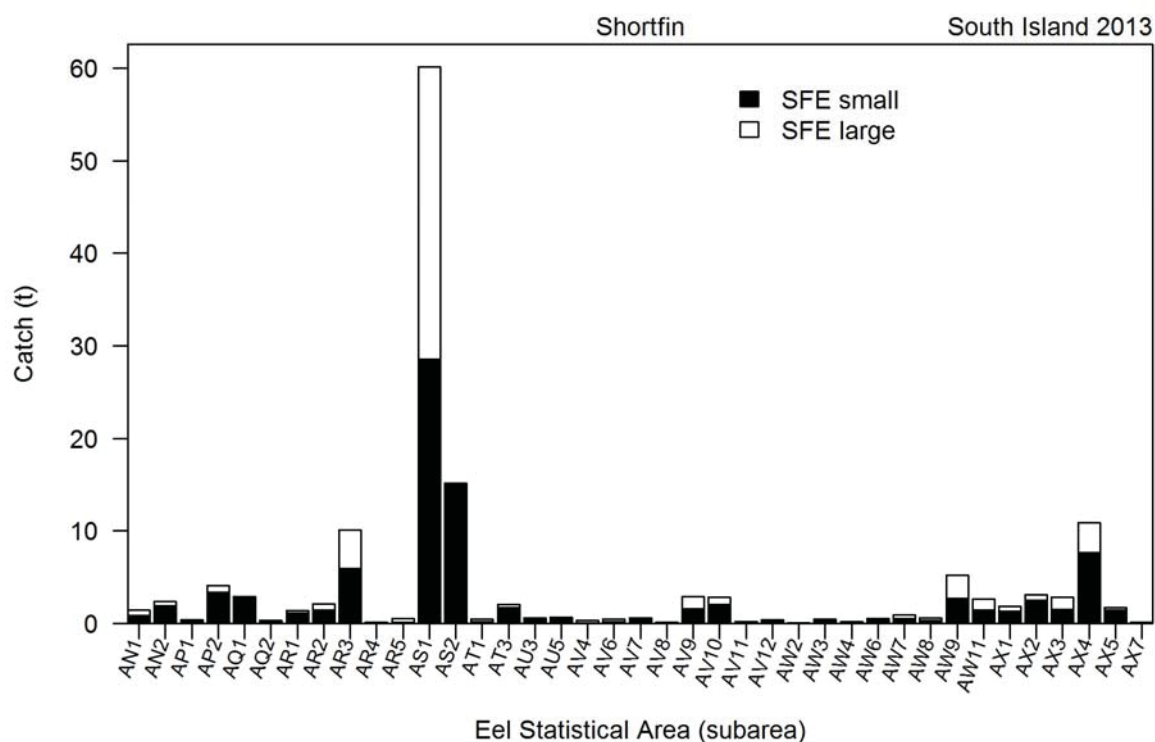


Figure 27: Catch of shortfin (SFE) eels by size grade for South Island Eel Statistical Area subareas for fishing years 2012–13 (2013), 2013–14 (2014), and 2014–15 (2015). Only subareas with recorded catch are presented.

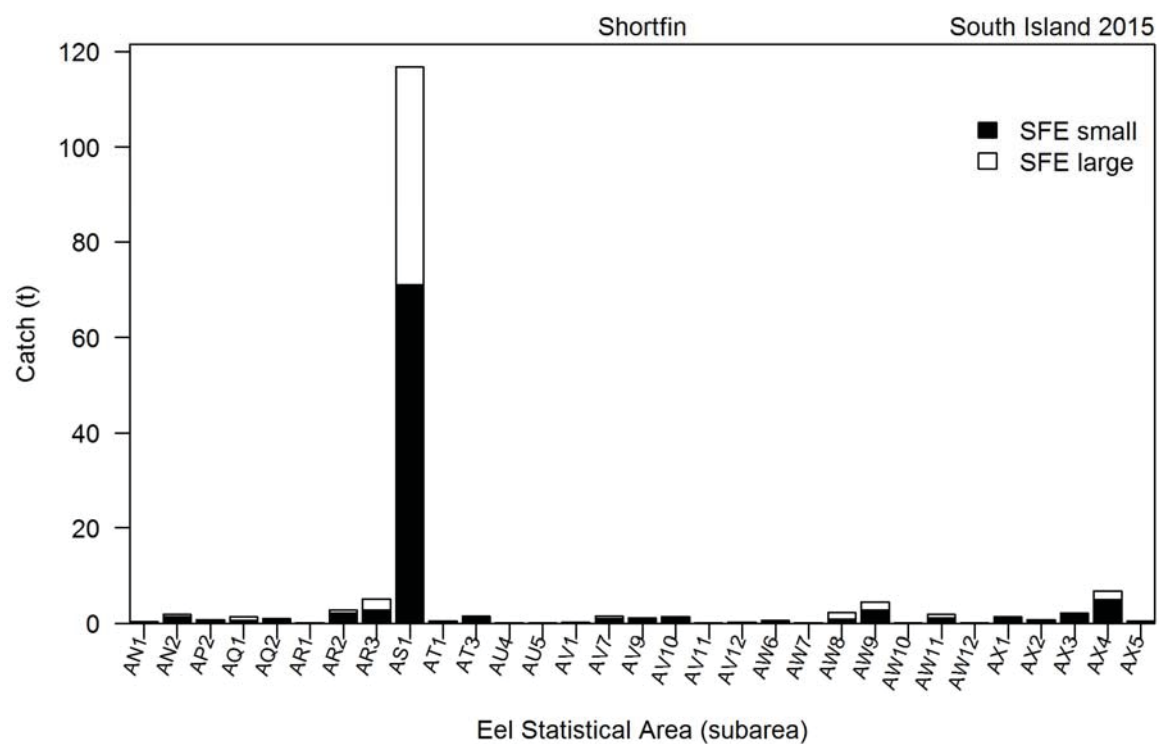


Figure 27 – *continued*

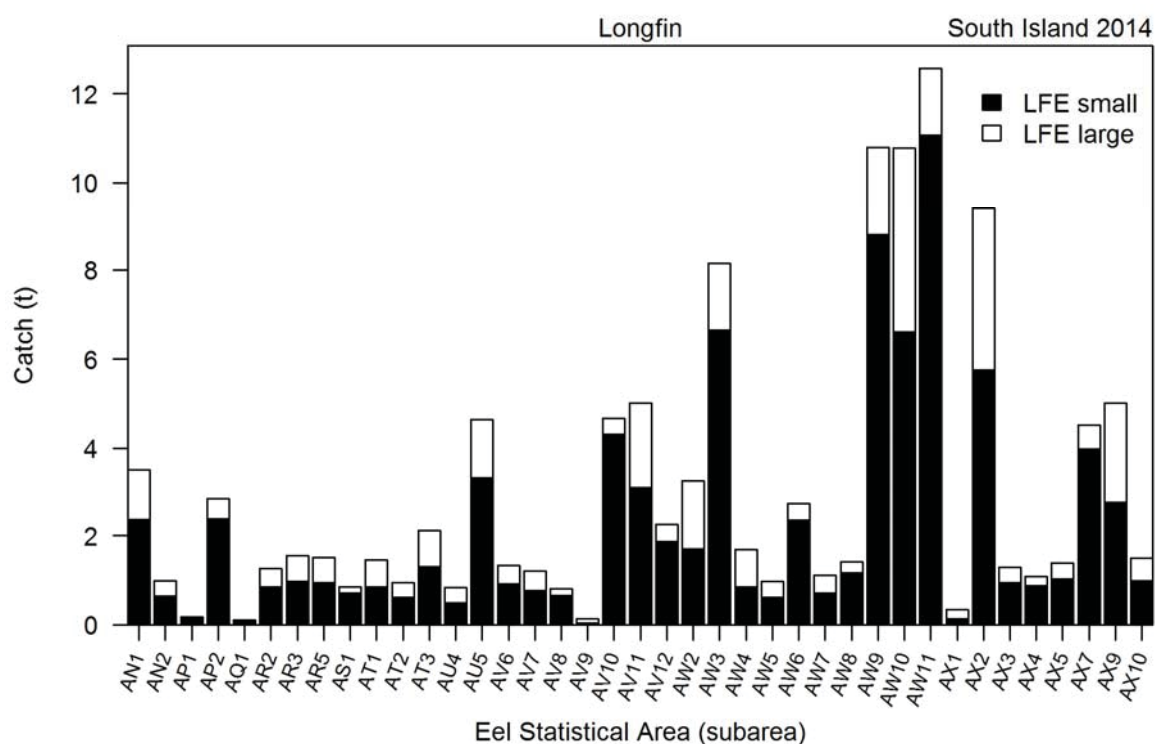
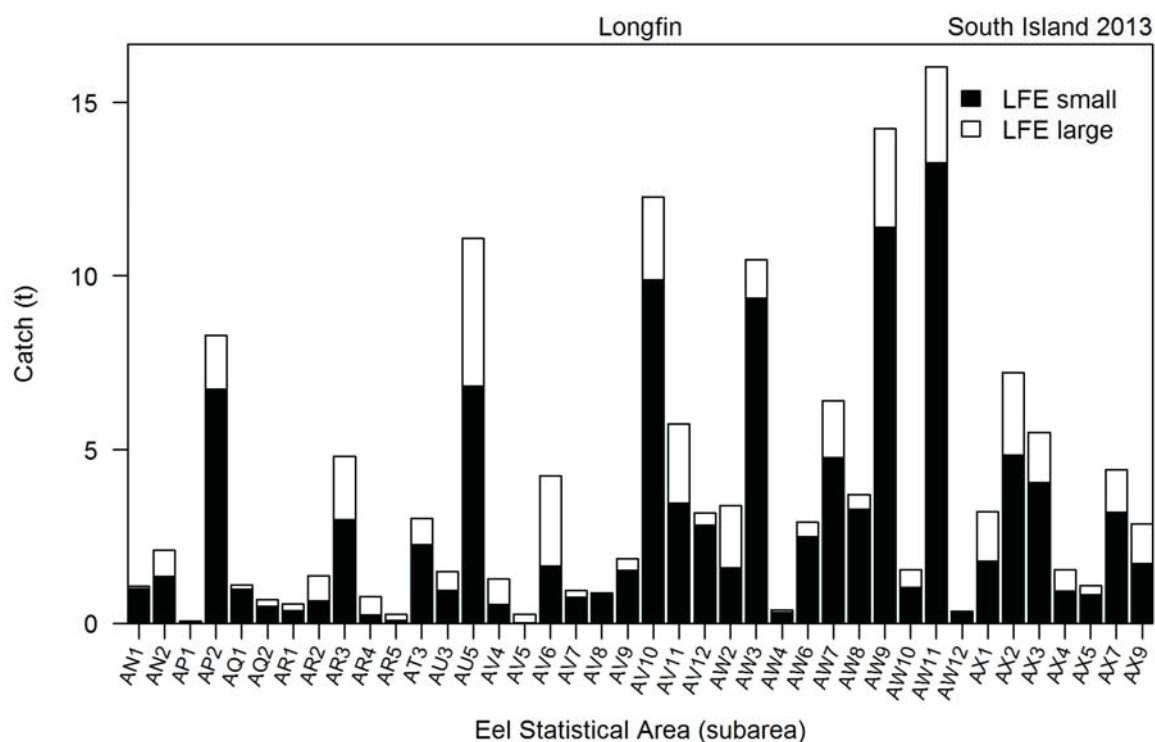


Figure 28: Catch of longfin (LFE) eels by size grade for South Island Eel Statistical Area subareas for fishing years 2012–13 (2013), 2013–14 (2014), and 2014–15 (2015).

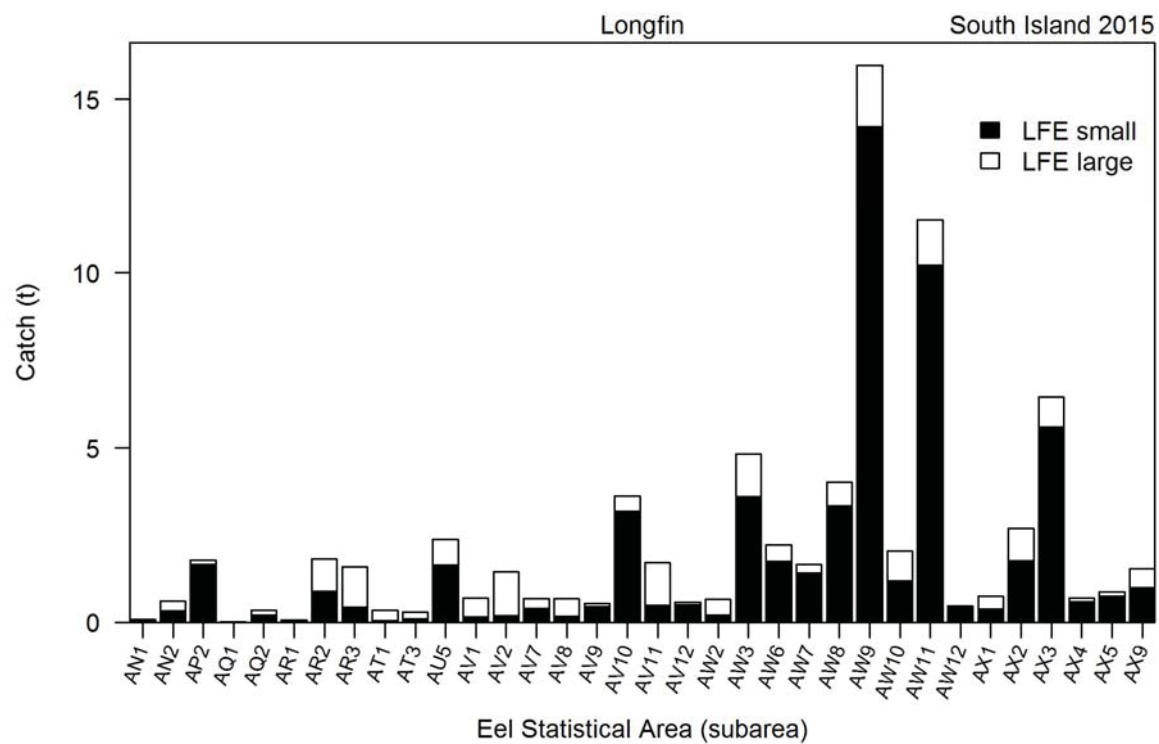


Figure 28 – *continued*

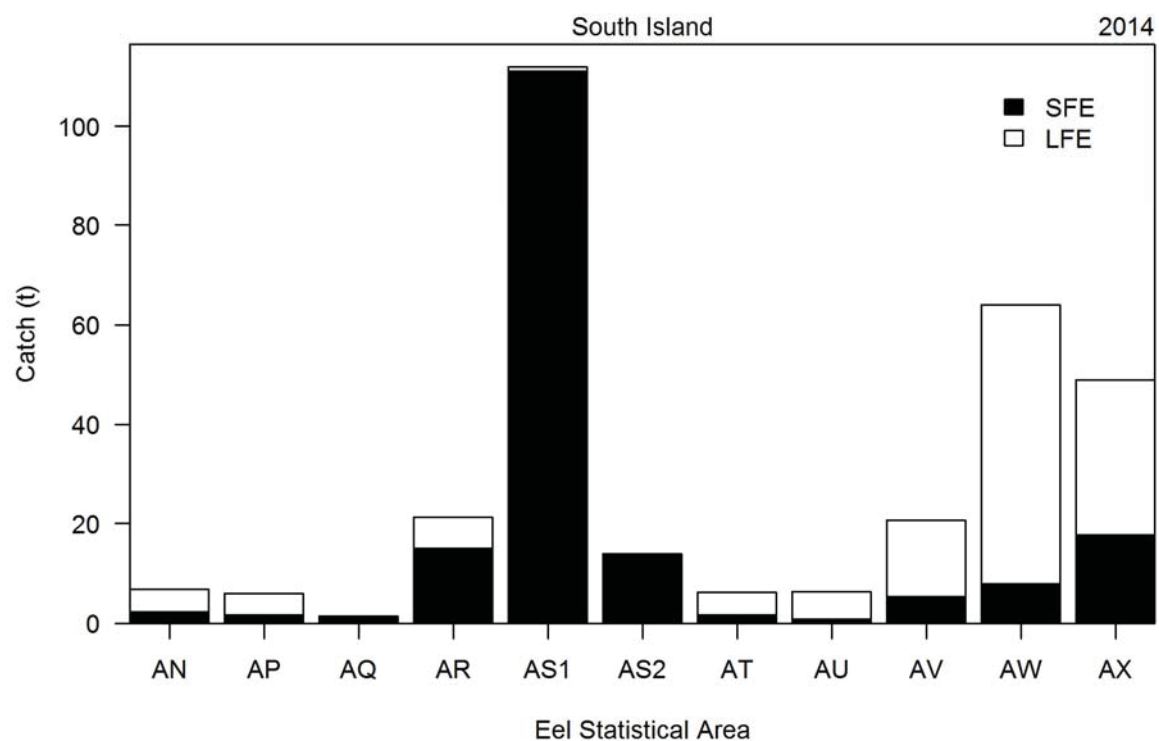
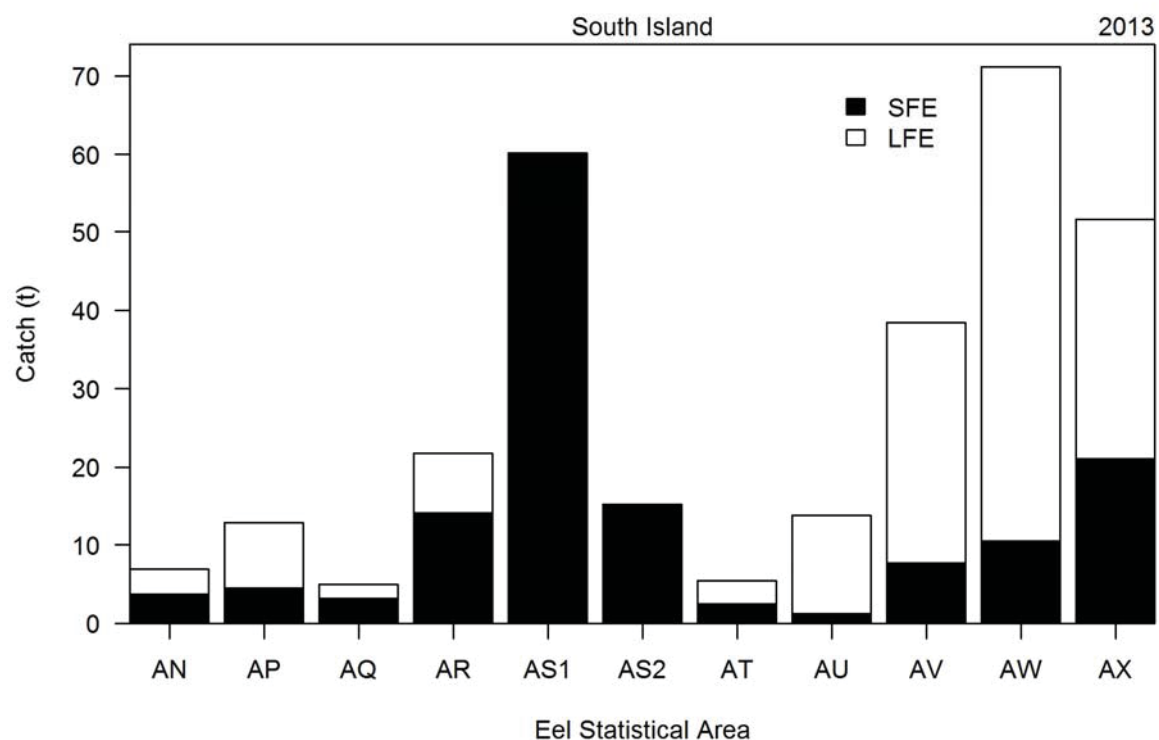


Figure 29: Catch of South Island shortfin (SFE) and longfin (LFE) eels by Eel Statistical Area for 2012–13 (2013), 2013–14 (2014), and 2014–15 (2015).

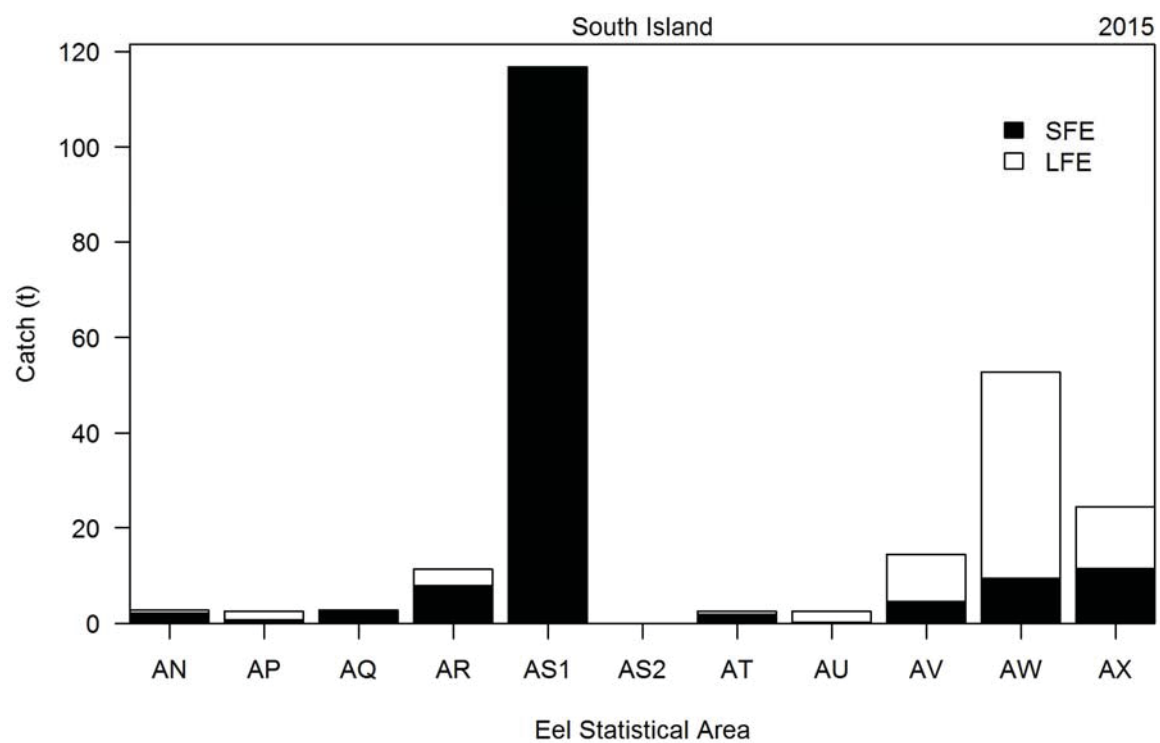


Figure 29 – continued

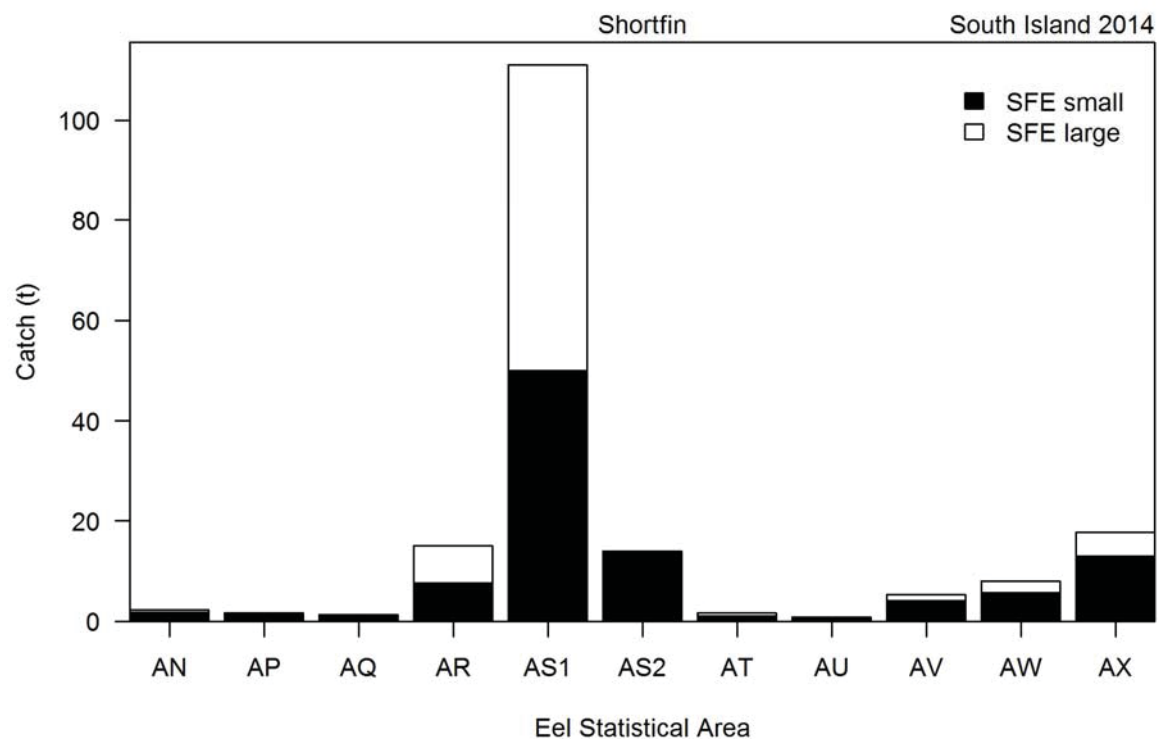
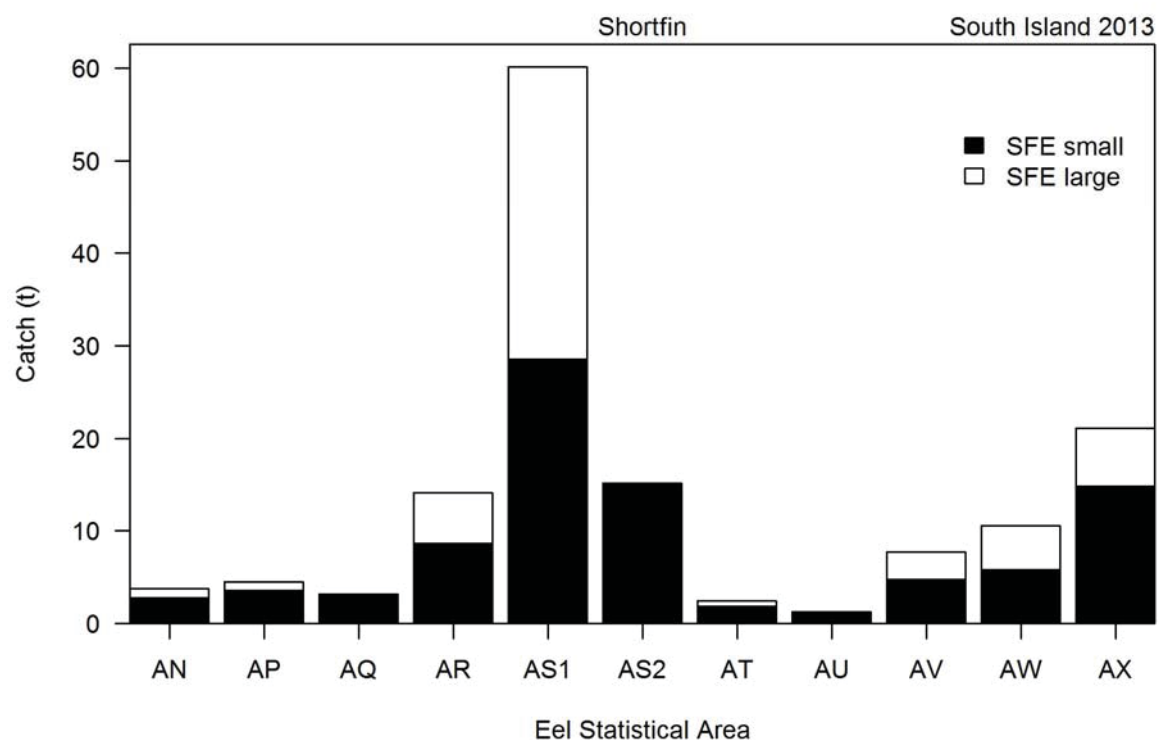


Figure 30: Catch of South Island shortfin (SFE) by size grade by Eel Statistical Area for 2012–13 (2013), 2013–14 (2014), and 2014–15 (2015).

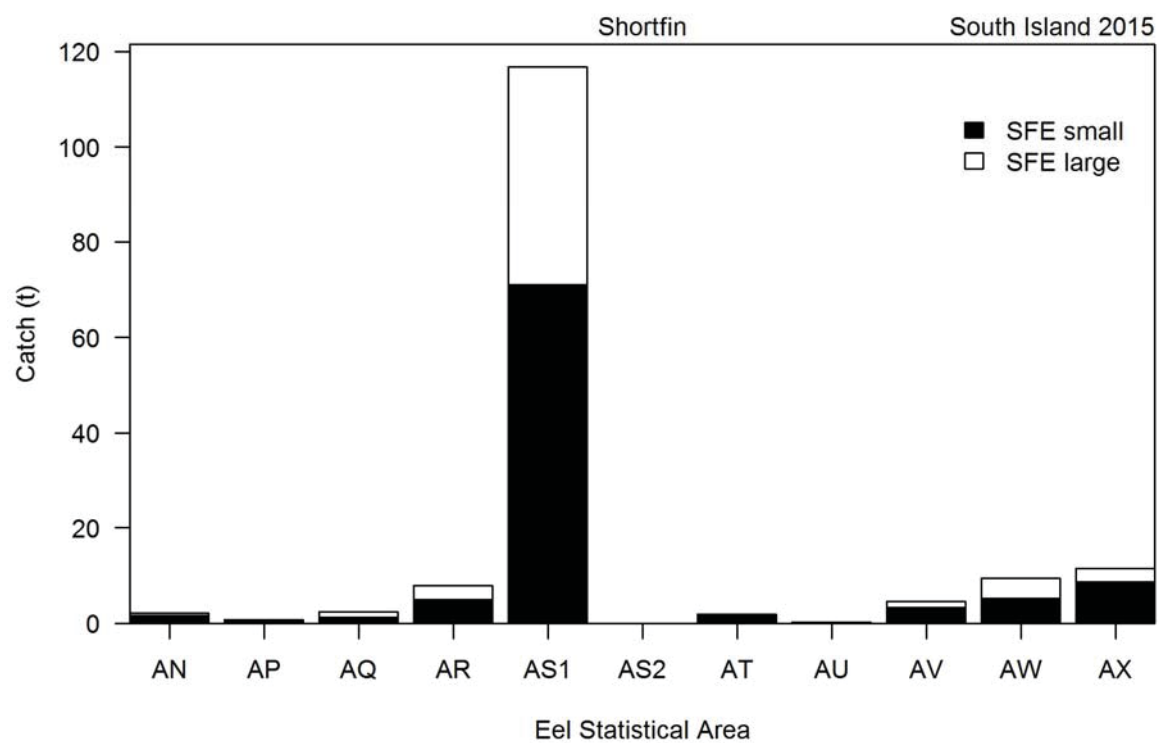


Figure 30 – continued

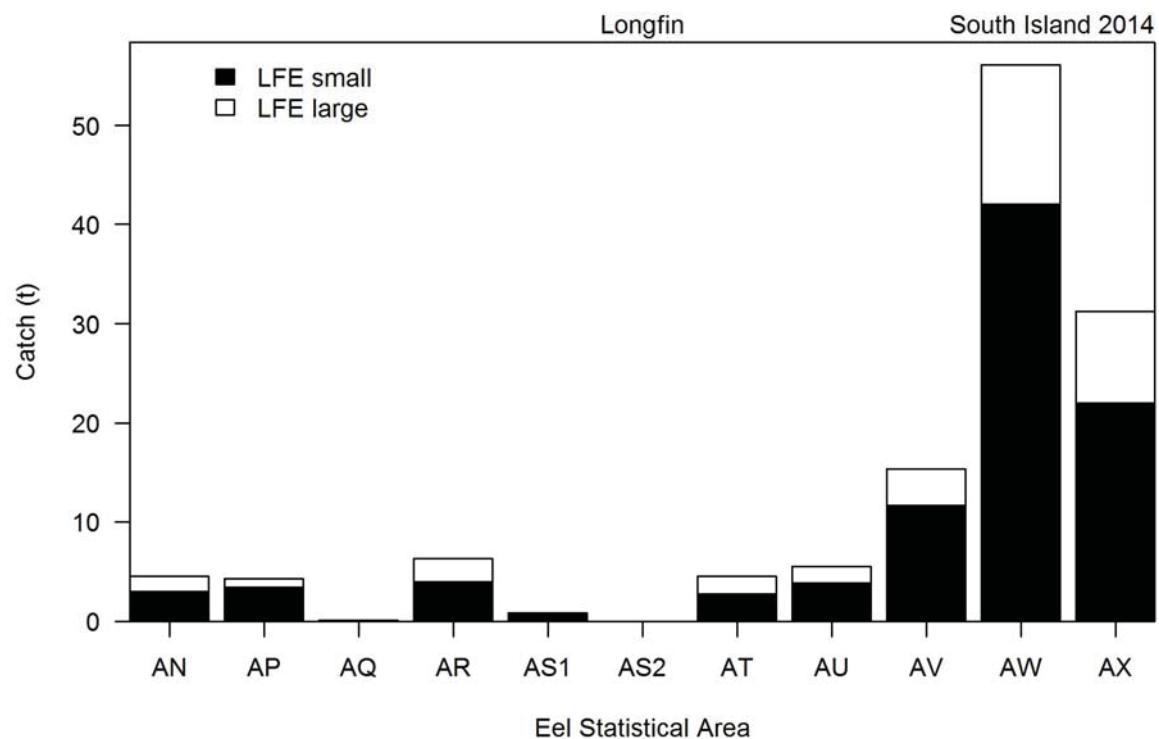
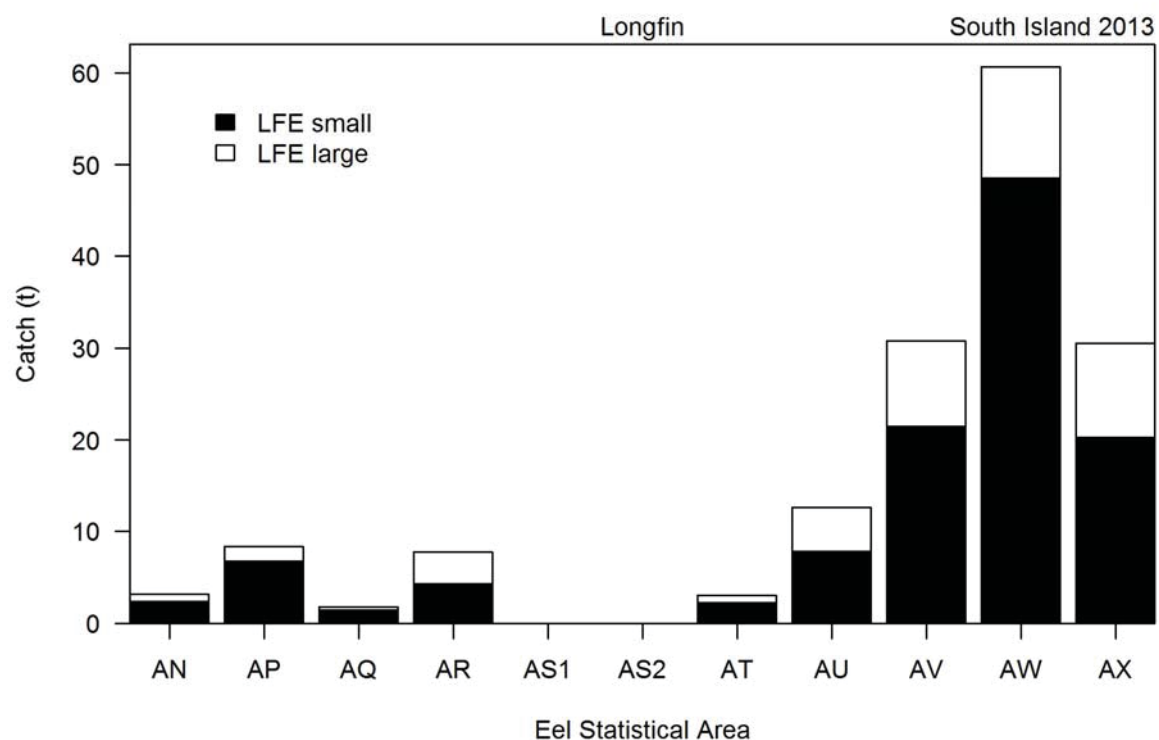


Figure 31: Catch of South Island longfin (LFE) by size grade by Eel Statistical Area for 2012–13 (2013), 2013–14 (2014), and 2014–15 (2015).

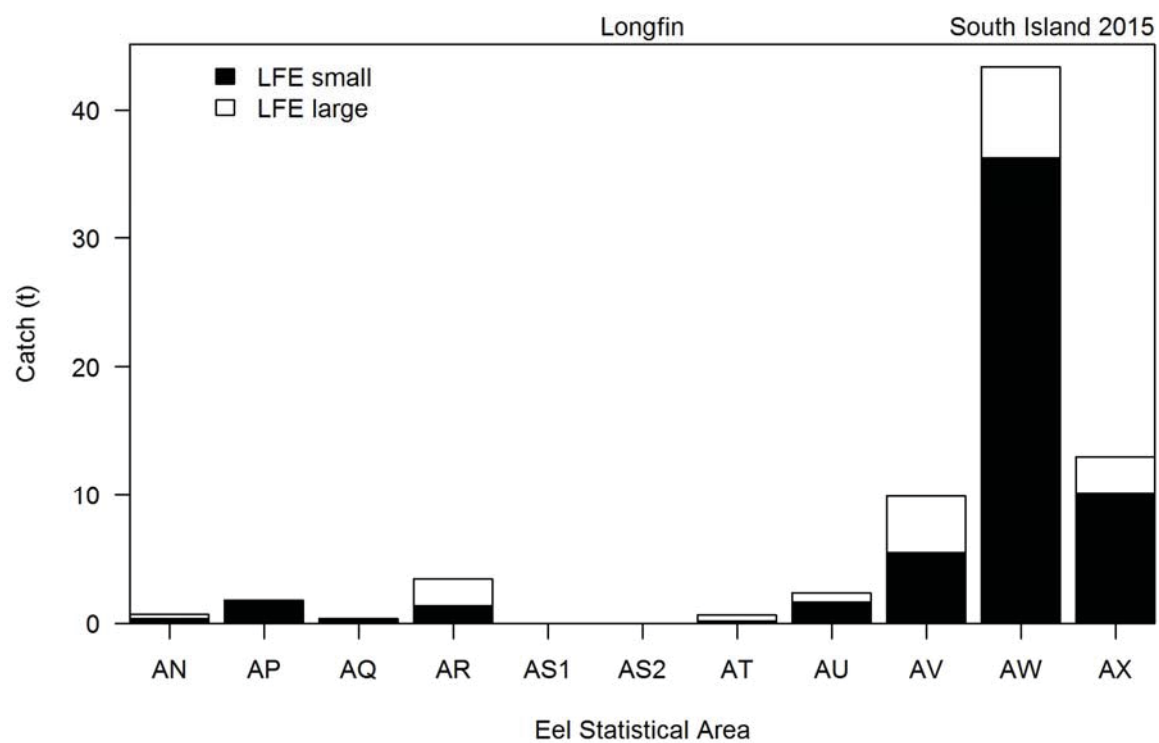


Figure 31 – *continued*

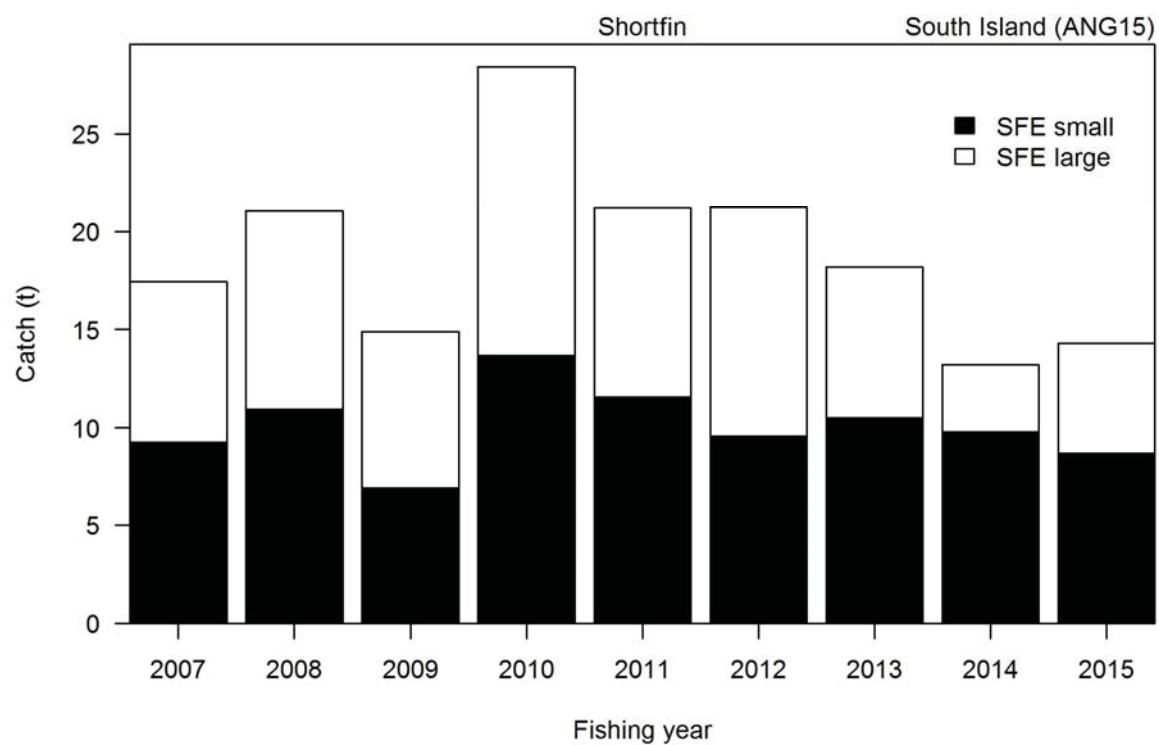


Figure 32: ANG 15 shortfin eel (SFE) catch by weight (t) by size grade from 2006–07 to 2014–15.

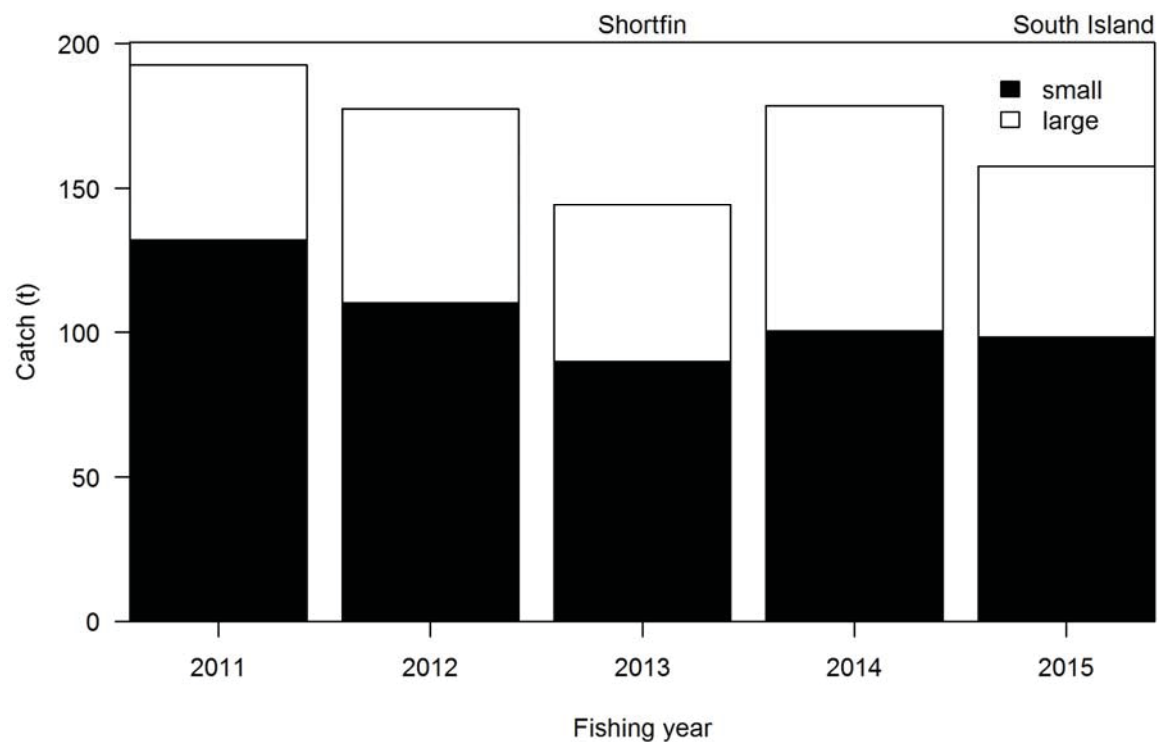


Figure 33: South Island shortfin eel (SFE) catch by weight (t) by size grade from 2010–11 to 2014–15.

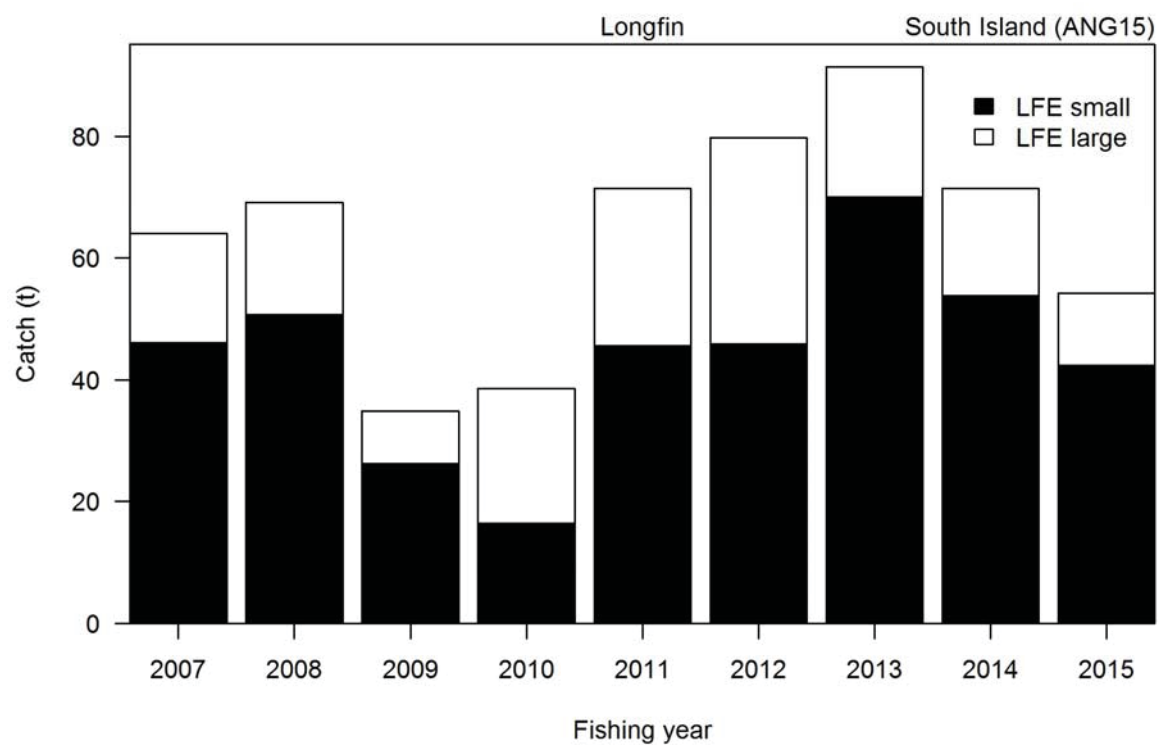


Figure 34: ANG 15 longfin eel (SFE) catch by weight (t) by size grade from 2006–07 to 2014–15.

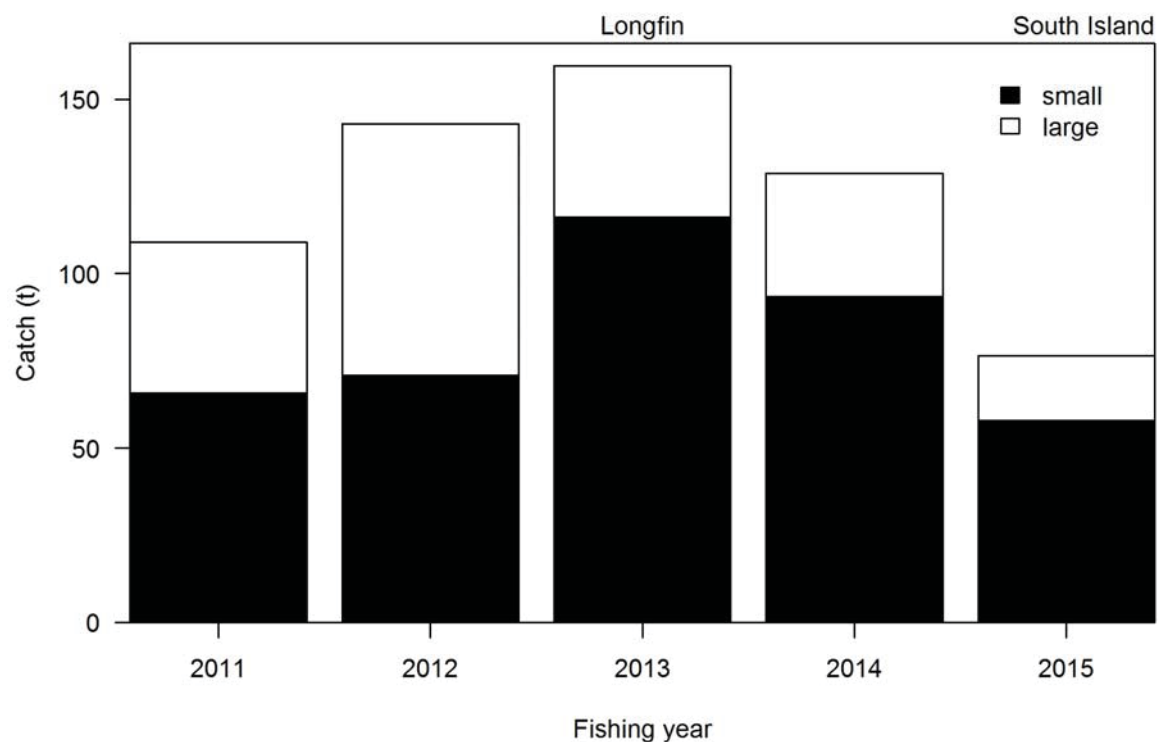


Figure 35: South Island longfin eel (LFE) catch by weight (t) by size grade from 2010–11 to 2014–15.

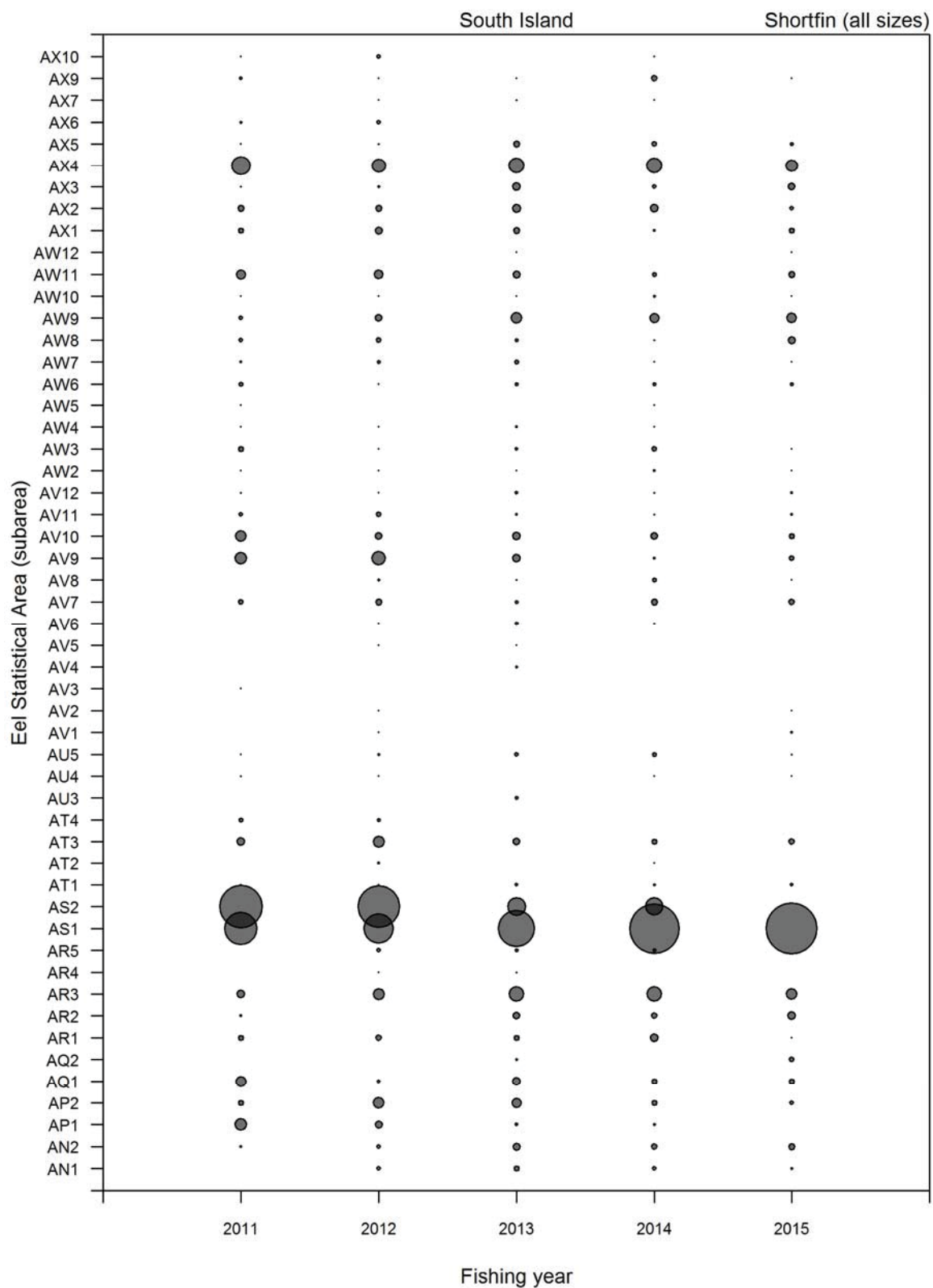


Figure 36: South Island shortfin catch by Eel Statistical Area subarea from 2010–11 to 2014–15.
Maximum = 117 t.

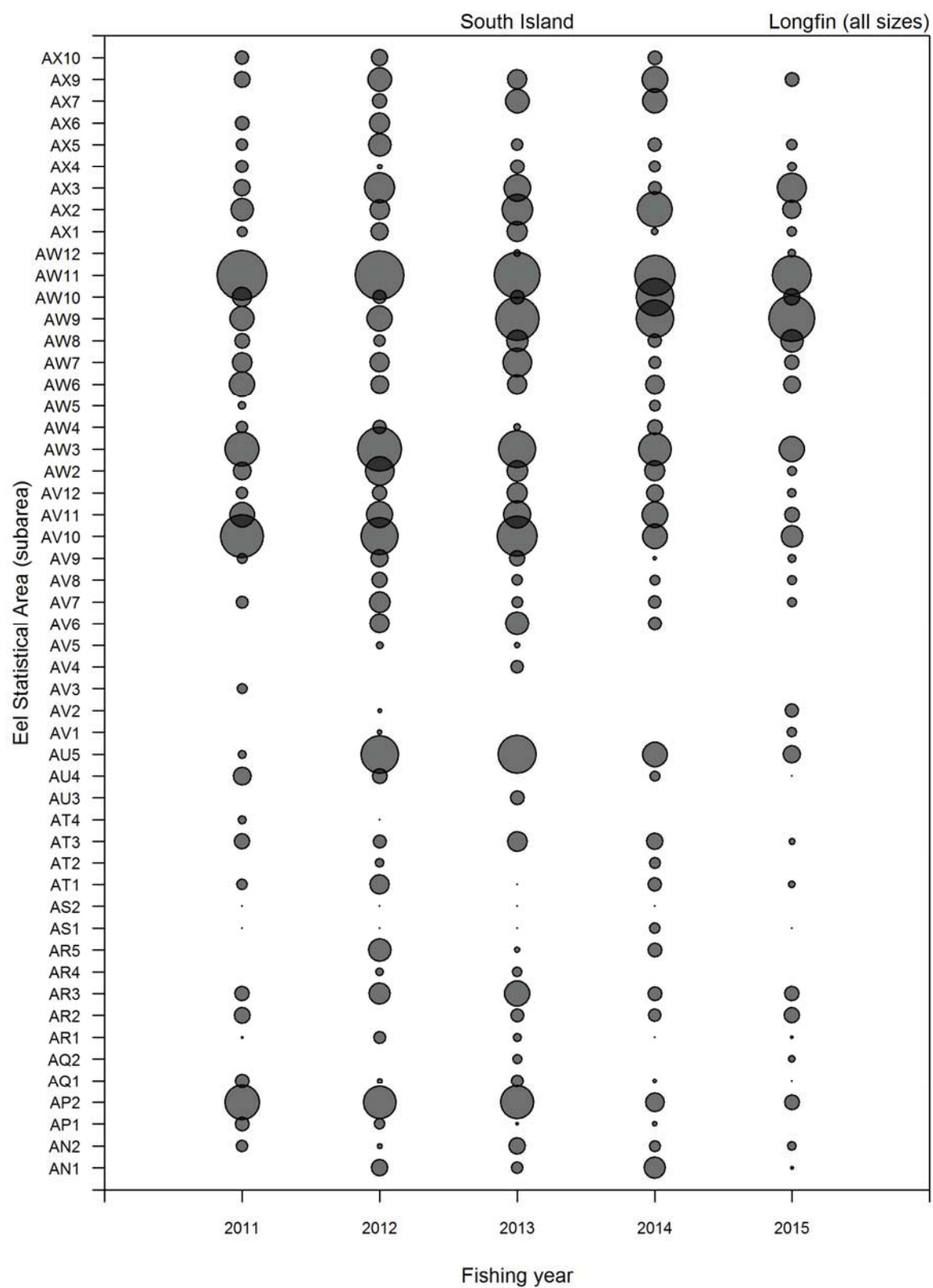


Figure 37: South Island longfin catch by Eel Statistical Area subarea from 2010–11 to 2014–15. Maximum = 19 t.

Shortfin catch (2004–2015)

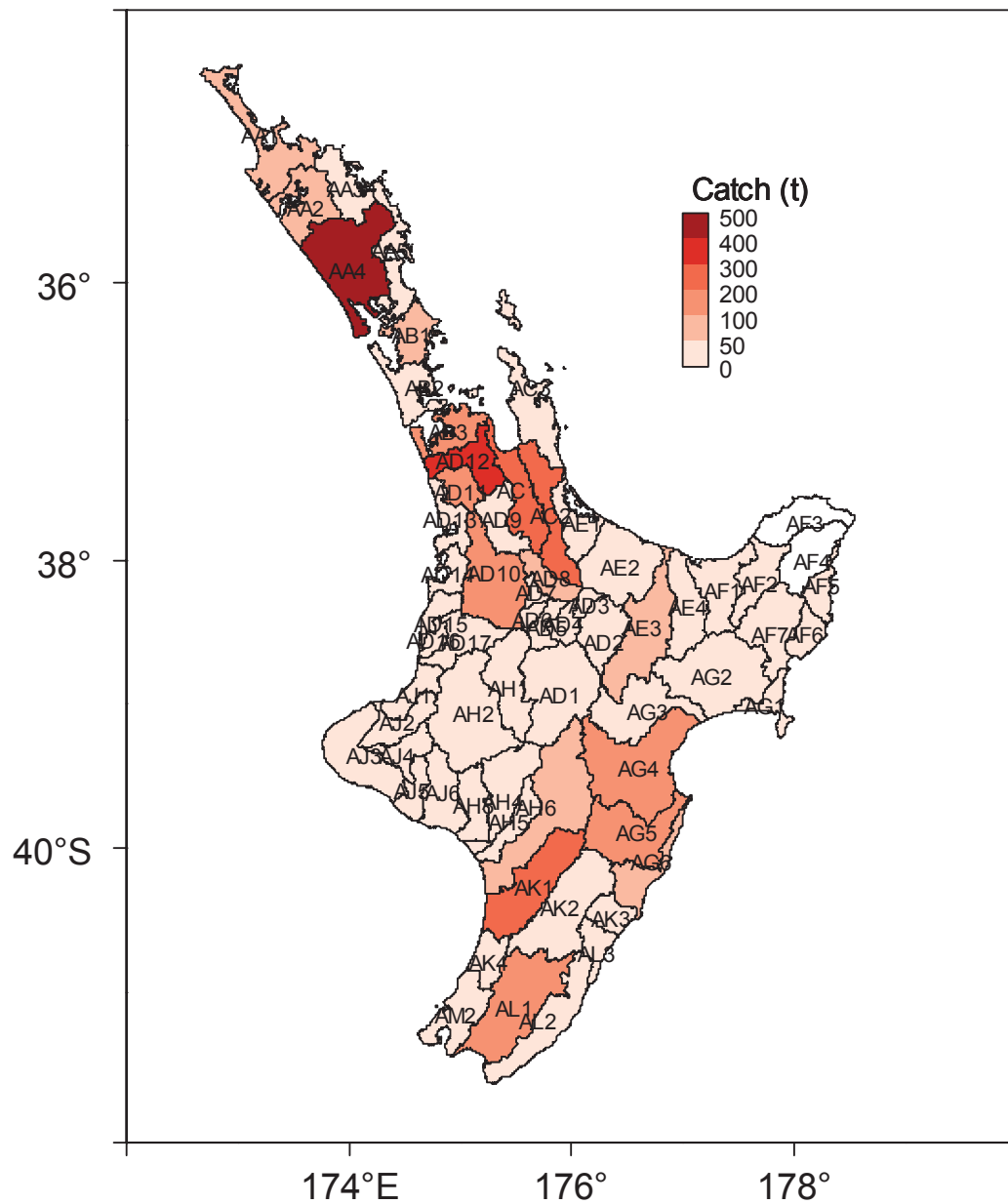


Figure 38: Catch of North Island shortfin plotted by subarea aggregated for the fishing years 2003–04 to 2014–15. Darker colour indicates more catch. Max = 432 t.

Longfin catch (2004–2015)

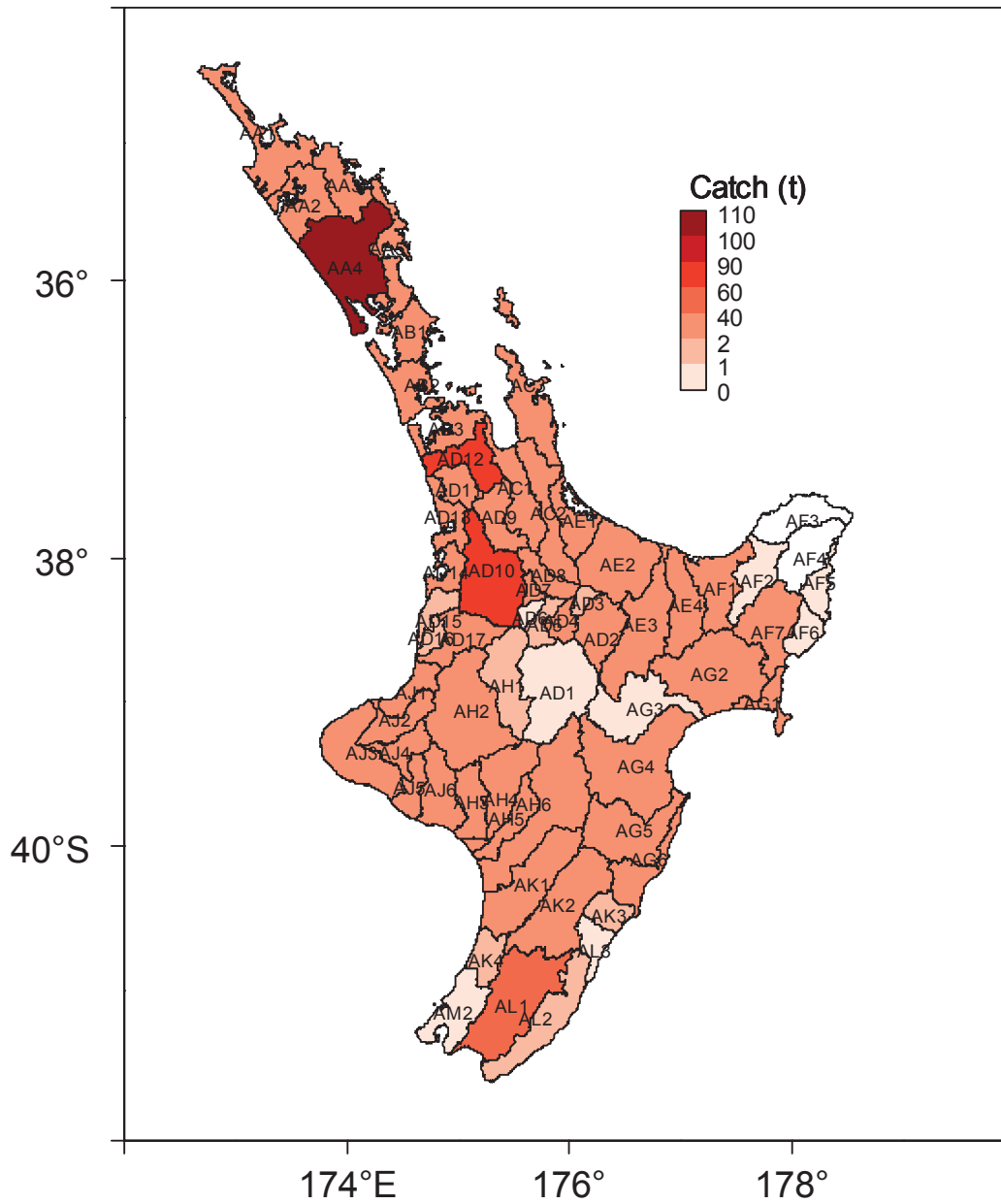


Figure 39: Catch of North Island longfin plotted by subarea aggregated for the fishing years 2003–04 to 2014–15. Darker colour indicates more catch. Max = 101 t.

Shortfin catch (2011–2015)

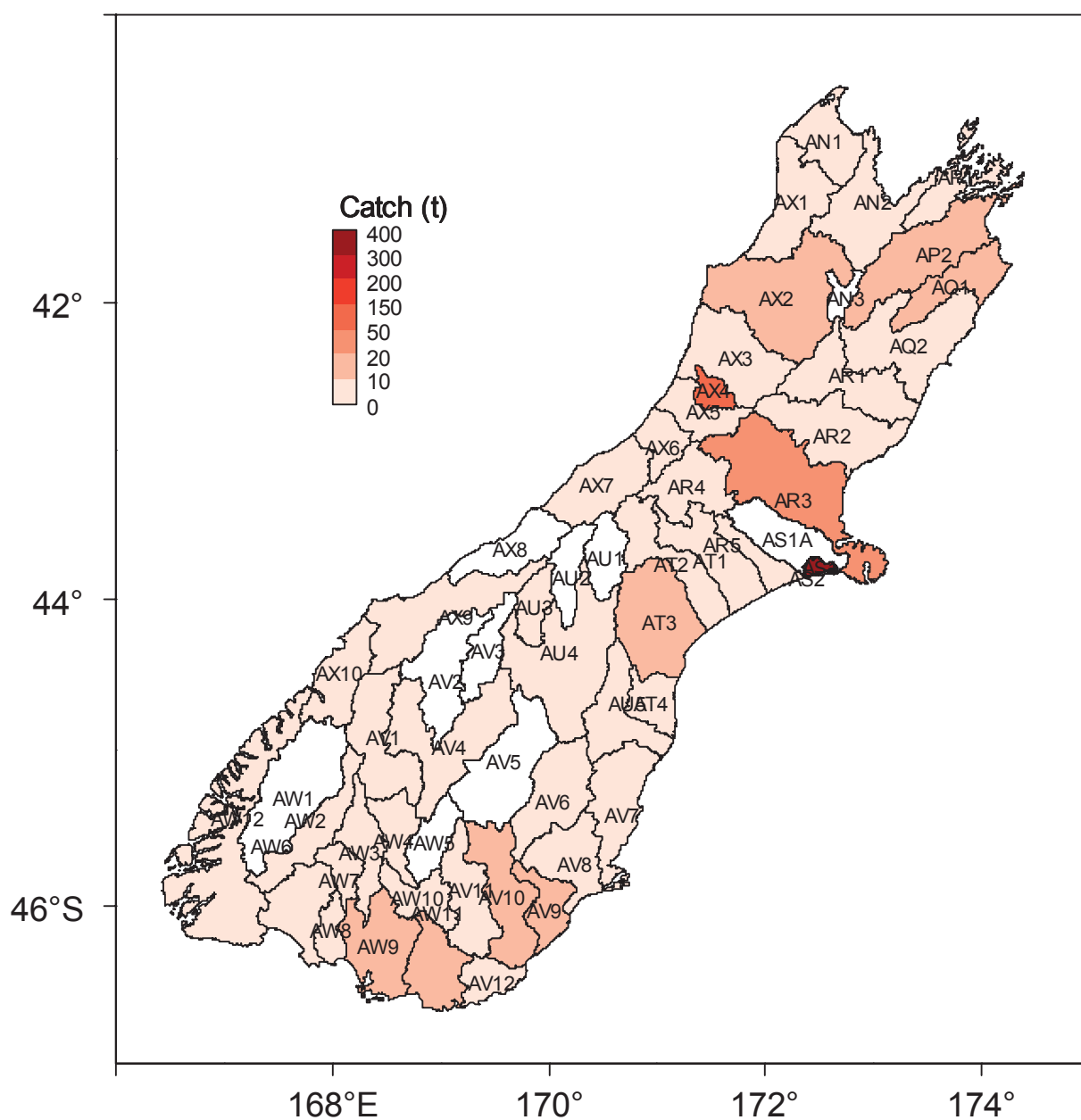


Figure 40: Catch of South Island shortfin plotted by subarea aggregated for the fishing years 2010–11 to 2014–15. Darker colour indicates more catch. Max = 375 t.

Longfin catch (2011–2015)

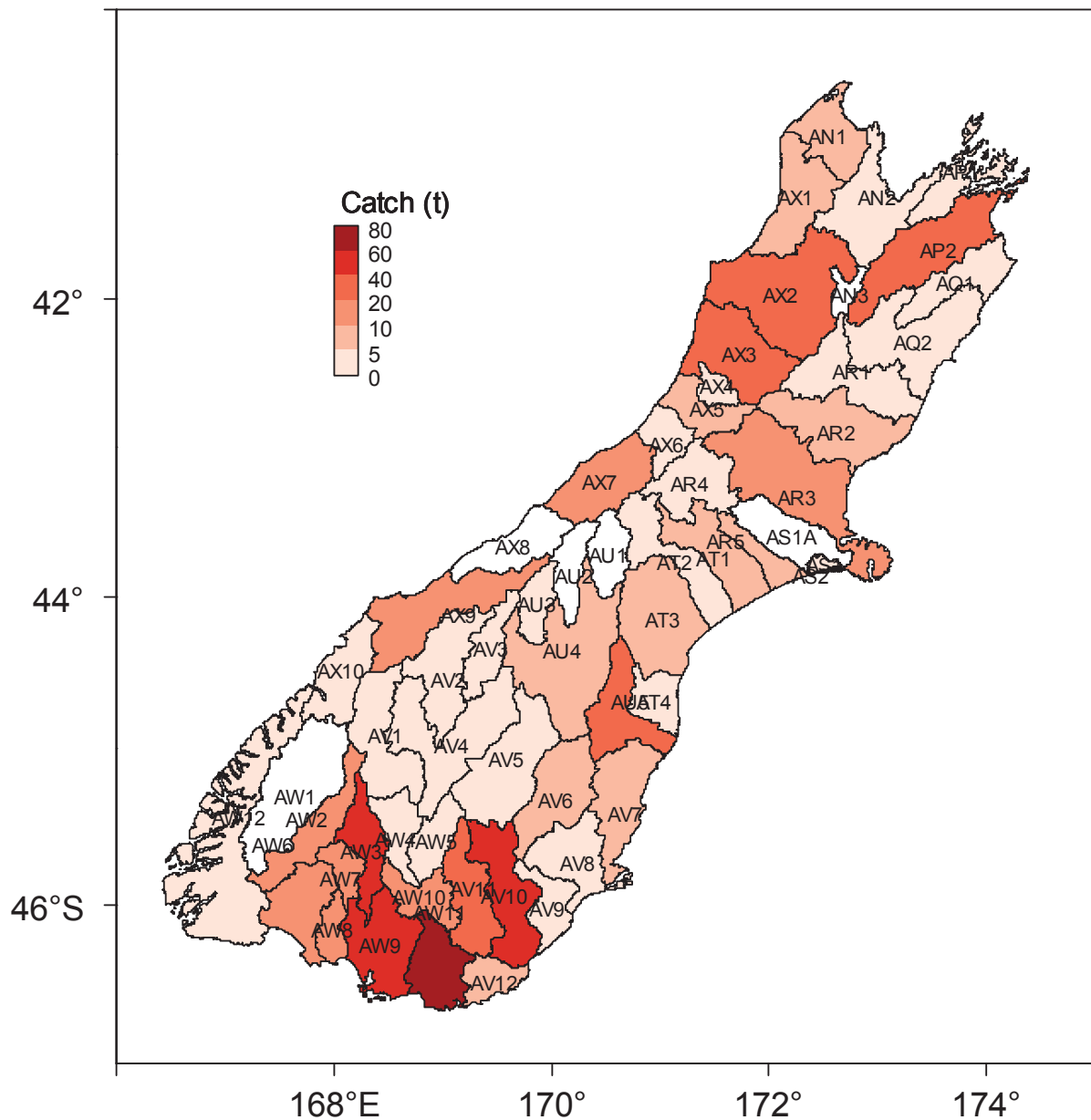


Figure 41: Catch of South Island longfin plotted by subarea aggregated for the fishing years 2010–11 to 2014–15. Darker colour indicates more catch. Max = 77 t.

Appendix 1: Summary of the commercial eel monitoring programme. *ANG 15 only from 2006–07.

Fishing year	North Island	South Island	Data collected	Project code
2003–04 (pilot)	All landings	No data	Species size, landing weight, location	EEL200204
2004–05	All landings	No data	Species size, landing weight, location	EEL200402
2005–06 and 2006–07*	All landings	ANG 15	Species size, landing weight, location	EEL200501
2007–08 and 2008–09	All landings	ANG 15	Species size, landing weight, location	EEL200708
2009–10	All landings	ANG 15	Species size, landing weight, location	IPA200907
2010–11 and 2011–12	All landings	All landings	Species size, landing weight, location	EEL201002
2012–13 to 2014–15	All landings	All landings	Species size, landing weight, location	EEL201202
2015–16 to 2017–18	All landings	All landings	In progress	EEL201502

Appendix 2: North Island and South Island subarea codes (n = 65, n = 58) with general locations and the matching Eel Statistical Area (ESA) and Quota Management area (QMA). The number of the alphanumeric “subarea” code refers to the historical numeric ESA within which the subarea is located, and subarea2 the letters refer to the current alpha code of the ESA. In our reporting we have used the variable “Subarea2” codes. These labels are included in the digitised shape files.

Subarea	Subarea2	Subarea location	Island	ESA	QMA (LFE)	QMS (SFE)
1A	AA1	Kaitia	North	AA	LFE 20	SFE 20
1B	AA2	Hokianga Harbour	North	AA	LFE 20	SFE 20
1C	AA3	Bay of Islands	North	AA	LFE 20	SFE 20
1D	AA4	Dargaville	North	AA	LFE 20	SFE 20
1E	AA5	Bream Bay	North	AA	LFE 20	SFE 20
2A	AB1	Warkworth	North	AB	LFE 20	SFE 20
2B	AB2	Auckland	North	AB	LFE 20	SFE 20
2C	AB3	Manukau Harbour	North	AB	LFE 20	SFE 20
3A	AC1	Hauraki Plains west	North	AC	LFE 21	SFE 21
3B	AC2	Hauraki Plains east	North	AC	LFE 21	SFE 21
3C	AC3	Coromandel Peninsula	North	AC	LFE 21	SFE 21
4A	AD1	Lake Taupo	North	AD	LFE 21	SFE 21
4B	AD2	Lake Ohakuri	North	AD	LFE 21	SFE 21
4C	AD3	Lake Atiamuri	North	AD	LFE 21	SFE 21
4D	AD4	Lake Whakamaru	North	AD	LFE 21	SFE 21
4E	AD5	Lake Maraetai	North	AD	LFE 21	SFE 21
4F	AD6	Lake Waipapa	North	AD	LFE 21	SFE 21
4G	AD7	Lake Arapuni	North	AD	LFE 21	SFE 21
4H	AD8	Lake Karapiro	North	AD	LFE 21	SFE 21
4I	AD9	Hamilton	North	AD	LFE 21	SFE 21
4J	AD10	Waipa River (formerly Pirongia Forest)	North	AD	LFE 21	SFE 21
4K	AD11	Lakes Whangape, Waahi and Rotongaro	North	AD	LFE 21	SFE 21
4L	AD12	Lake Waikare/Port Waikato	North	AD	LFE 21	SFE 21
4M	AD13	Raglan Harbour	North	AD	LFE 21	SFE 21
4N	AD14	Kawhia Harbour	North	AD	LFE 21	SFE 21
4O	AD15	Marakopa River	North	AD	LFE 21	SFE 21
4P	AD16	Awakino River	North	AD	LFE 21	SFE 21
4Q	AD17	Mokau River	North	AD	LFE 21	SFE 21
5A	AE1	Tauranga	North	AE	LFE 21	SFE 21
5B	AE2	Rotorua Lakes	North	AE	LFE 21	SFE 21
5C	AE3	Rangitaiki River	North	AE	LFE 21	SFE 21
5D	AE4	Whakatane River	North	AE	LFE 21	SFE 21
6A	AF1	Ohiwa Harbour	North	AF	LFE 21	SFE 21
6B	AF2	Motu River	North	AF	LFE 21	SFE 21
6C	AF3	Cape Runaway	North	AF	LFE 21	SFE 21
6D	AF4	Waipu River	North	AF	LFE 21	SFE 21
6E	AF5	Tolaga Bay	North	AF	LFE 21	SFE 21

Subarea	Subarea2	Subarea location	Island	ESA	QMA (LFE)	QMS (SFE)
6F	AF6	Gisborne	North	AF	LFE 21	SFE 21
6G	AF7	Waipaoa River	North	AF	LFE 21	SFE 21
7A	AG1	Mahia Peninsula	North	AG	LFE 22	SFE 22
7B	AG2	Lake Waikaremoana	North	AG	LFE 22	SFE 22
7C	AG3	Mohaka River	North	AG	LFE 22	SFE 22
7D	AG4	Napier	North	AG	LFE 22	SFE 22
7E	AG5	Tukituki River	North	AG	LFE 22	SFE 22
7F	AG6	Waimarama/Porangahau	North	AG	LFE 22	SFE 22
8A	AH1	Taumarunui	North	AH	LFE 23	SFE 23
8B	AH2	Whanganui River inland	North	AH	LFE 23	SFE 23
8C	AH3	Whanganui River coast	North	AH	LFE 23	SFE 23
8D	AH4	Whangaehu River	North	AH	LFE 23	SFE 23
8E	AH5	Turakina River	North	AH	LFE 23	SFE 23
8F	AH6	Rangitikei River	North	AH	LFE 23	SFE 23
9A	AJ1	North Taranaki Bight	North	AJ	LFE 23	SFE 23
9B	AJ2	Waitara River	North	AJ	LFE 23	SFE 23
9C	AJ3	Mount Taranaki coast	North	AJ	LFE 23	SFE 23
9D	AJ4	Patea River inland	North	AJ	LFE 23	SFE 23
9E	AJ5	Patea River coast	North	AJ	LFE 23	SFE 23
9F	AJ6	Waitotara River	North	AJ	LFE 23	SFE 23
10A	AK1	Manawatu River coast	North	AK	LFE 22	SFE 22
10B	AK2	Manawatu River Inland	North	AK	LFE 22	SFE 22
10C	AK3	Akitio River	North	AK	LFE 22	SFE 22
10D	AK4	Otaki	North	AM	LFE 22	SFE 22
11A	AL1	Lake Wairarapa	North	AL	LFE 22	SFE 22
11B	AL2	Wairarapa coast	North	AL	LFE 22	SFE 22
11C	AL3	Castle point	North	AL	LFE 22	SFE 22
12B	AM2	Wellington	North	AM	LFE 22	SFE 22
AN1	AN1	Kahurangi National Park/Takaka	South	AN	ANG 11	ANG 11
AN2	AN2	Motueka River/Tasman Bay	South	AN	ANG 11	ANG 11
AN3	AN3	Lakes Rotoroa and Rotoiti	South	AN	ANG 11	ANG 11
AP1	AP1	Pelorus River/Pelorus Sounds	South	AP	ANG 11	ANG 11
AP2	AP2	Wairau River	South	AP	ANG 11	ANG 11
AQ1	AQ1	Awatere River	South	AQ	ANG 12	ANG 12
AQ2	AQ2	Clarence and Conway Rivers	South	AQ	ANG 12	ANG 12
AR1	AR1	Waiau River (north)	South	AR	ANG 12	ANG 12
AR2	AR2	Hurunui River	South	AR	ANG 12	ANG 12
AR3	AR3	Waimakariri River	South	AR	ANG 12	ANG 12
AR4	AR4	Upper Rakaia River/Lake Coleridge	South	AR	ANG 12	ANG 12
AR5	AR5	Rakaia River coast	South	AR	ANG 12	ANG 12
AS1	AS1	Te Waihora (lake only)	South	AS1	ANG13	ANG13
AS2	AS2	Te Waihora Concession Area	South	AS2	ANG 13	ANG 13
AS1A	ASA	Selwyn catchment (excluding the lake)	South	AS1	ANG 13	ANG 13
AT1	AT1	Ashburton River	South	AT	ANG 14	ANG 14
AT2	AT2	Rangitata River	South	AT	ANG 14	ANG 14
AT3	AT3	Opihi and Orari Rivers	South	AT	ANG 14	ANG 14
AT4	AT4	Wainono Lagoon/Pareora River	South	AT	ANG 14	ANG 14
AU1	AU1	Lake Tekapo	South	AU	ANG 14	ANG 14
AU2	AU2	Lake Pukaki	South	AU	ANG 14	ANG 14
AU3	AU3	Lake Ohau	South	AU	ANG 14	ANG 14
AU4	AU4	Lakes Benmore, Aviemore and Waitaki	South	AU	ANG 14	ANG 14
AU5	AU5	Waitaki River	South	AU	ANG 14	ANG 14
AV1	AV1	Lake Wakatipu	South	AV	ANG 15	ANG 15
AV2	AV2	Lake Wanaka	South	AV	ANG 15	ANG 15
AV3	AV3	Lake Hawea	South	AV	ANG 15	ANG 15
AV4	AV4	Kawarau and upper Clutha Rivers down to Cromwell	South	AV	ANG 15	ANG 15
AV5	AV5	Clutha River from Cromwell to Roxburgh Dam	South	AV	ANG 15	ANG 15
AV6	AV6	Taieri River above Middelmarsh	South	AV	ANG 15	ANG 15

Subarea	Subarea2	Subarea location	Island	ESA	QMA (LFE)	QMS (SFE)
AV7	AV7	Kakanui, Shag and Waikouaiti Rivers	South	AV	ANG 15	ANG 15
AV8	AV8	Taieri River coast	South	AV	ANG 15	ANG 15
AV9	AV9	Lake Waihola and Waipori River	South	AV	ANG 15	ANG 15
AV10	AV10	Clutha River coast	South	AV	ANG 15	ANG 15
AV11	AV11	Pomahaka River	South	AV	ANG 15	ANG 15
AV12	AV12	Catlins and Tahakopa River	South	AV	ANG 15	ANG 15
AW1	AW1	Lakes Te Anau and Manapouri	South	AW	ANG 15	ANG 15
AW2	AW2	Waiau and Mararoa Rivers down to Monawai	South	AW	ANG 15	ANG 15
AW3	AW3	Oreti River inland down to Bog Burn	South	AW	ANG 15	ANG 15
AW4	AW4	Mataura River inland down to Riversdale	South	AW	ANG 15	ANG 15
AW5	AW5	Waikaka River	South	AW	ANG 15	ANG 15
AW6	AW6	Waiau River coast	South	AW	ANG 15	ANG 15
AW7	AW7	Aparima River inland down to Wreys Bush	South	AW	ANG 15	ANG 15
AW8	AW8	Aparima River coast	South	AW	ANG 15	ANG 15
AW9	AW9	Oreti River coast	South	AW	ANG 15	ANG 15
AW10	AW10	Mataura River from Riversdale to Gore	South	AW	ANG 15	ANG 15
AW11	AW11	Mataura River coast	South	AW	ANG 15	ANG 15
AW12	AW12	Fiordland National Park	South	AW	ANG 15	ANG 15
AX1	AX1	Karamea and Mokihinui Rivers	South	AX	ANG 16	ANG 16
AX2	AX2	Buller River	South	AX	ANG 16	ANG 16
AX3	AX3	Grey River Arnold River	South	AX	ANG 16	ANG 16
AX4	AX4	Lake Brunner	South	AX	ANG 16	ANG 16
AX5	AX5	Taramakau River	South	AX	ANG 16	ANG 16
AX6	AX6	Hokitika River	South	AX	ANG 16	ANG 16
AX7	AX7	Mikonui River to Waikukupa River	South	AX	ANG 16	ANG 16
AX8	AX8	Cook River to Waita River	South	AX	ANG 16	ANG 16
AX9	AX9	Arawata and Haast Rivers	South	AX	ANG 16	ANG 16
AX10	AX10	Sutherland Sound to George River	South	AX	ANG 16	ANG 16