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Monitoring commercial eel fisheries: 2015–16 to 2017–18

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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, processor data were provided initially in 2006–07 for the Quota Management area (QMA) ANG 15 only (Southland/Otago), but no details on specific catch locations were recorded. 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 2015–16, 2016–17 and 2017–18 fishing years, and also examines trends in the 15 years of landing data from the North Island, 12 years of landing data from ANG 15, and 8 years of landing data from the entire South Island. Additionally, trends from historic eel landing data dating back to the 1970s are examined.

North Island shortfin

Shortfin in the North Island were caught from nearly all subareas (63 of the possible 65) over the 15 years, 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) contributed 509 t or 12% of the total North Island shortfin catch over the 15 years and is the most productive subarea in the North Island. There was no consistent trend in the total North Island shortfin annual landed catch over the 15 years or in the distribution of catch 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 TACC reductions, market fluctuations, annual rainfall, escape tube increases, and most importantly in recent years, by quota/ACE availability. 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 42 subareas per year on average for the last six years), indicating a slight contraction in the spatial distribution of fishing effort over time consistent with a decline in both the number of permits fished and the fishing events over time. Despite the reduction in effort over time, the landed catch of shortfin has been spatially stable in the key subareas over the fifteen years, with no apparent trends.

North Island longfin

Longfin in the North Island were caught from nearly all subareas (63 of the possible 65) over the 15 years, but more than one-third of the catch originated from just four subareas, AA4 (Dargaville), AD10 (Waipa River), AD12 (Lake Waikare, Port Waikato), and AL1 (Lake Wairarapa). The most important subarea (AA4, Dargaville) contributed 107 t or 12% of North Island longfin catch over the 15 years. North Island commercial longfin landed catches over the fifteen-year period have fluctuated more than shortfin and are characterised by particularly low catches in 2008–09 to 2010–11 and since 2014–15, with an overall trend of declining catch. Factors that may have influenced annual longfin catches, overall and within size ranges include the 58% TACC reductions for North Island longfin stocks for the 2007–08 fishing year, fluctuating market demands, annual rainfall, and more recently and most importantly, a progressive decline in the availability of ACE to fishers. The North Island longfin fishery is more prone to fluctuating market demand than shortfin because it is a less marketable species of eel. As for shortfin there has been a reduction and contraction in fishing effort (from 49 subareas per year, on average for the first six years, to 41 subareas per year on average for the last six years). The landed catch of longfin has been stable in the key subareas over the 15 years with no apparent trends.

South Island shortfin

Shortfin in the South Island were caught from most subareas (51 of the possible 58) over the eight years, but over three-quarters of the catch originated from Te Waihora (AS1 and AS2), and Lake Brunner (AX4). Te Waihora contributed 698 t or 63% of South Island shortfin catch over the eight years. There is no consistent trend in annual landed catch, although the proportions of large eels appears to be declining. There are a number of factors that might be responsible, including: flood conditions in recent

years that can increase the catch of smaller shortfin, the increase in size grade range in 2017–18, and the split into separate shortfin and longfin stocks in 2016–17. The shortfin landed catch has been well below the current shortfin TACC (introduced in 2016–17) as a result of fisher retirements, withheld quota, variable catch contribution from AS2 (Te Waihora migration area), and ACE imbalances resulting from the nominal 1 t TACCs set in LFE 11 to LFE 14. The pattern of South Island shortfin landed catch by subarea is generally similar over the eight years, except that AS1 and AS2 catches tend to display opposite trends because fishers can catch their quota from either.

South Island longfin

Longfin in the South Island were caught from most subareas (53 of the possible 58) over the eight years, and although less aggregated than shortfin, 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), AX3 (Grey River Arnold River), AU5 (Waitaki River), and AP2 (Wairau River). The three southland subareas from the Mataura and Oreti Rivers (AW11, AW9 and AW3) have contributed 236 t or 30% of South Island longfin catch over the eight years. The commercial longfin catch in ANG 15 over the twelve year period is highly variable and shows no consistent trend in annual landed catch, although there are indications of a decline in the largest weight grade in recent years. For the South Island overall, there is a trend of declining longfin landed catch and in the largest weight grade over the eight-year time series. The lower landed catch in recent years can be attributed to lower port price for large longfin, and primarily the split into separate shortfin and longfin stocks in 2016–17. The longfin landed catch is also well below the current TACC, introduced in 2016–17, as a result of fisher retirements, withheld quota, and ACE imbalances resulting from the nominal 1 t TACCs set in LFE 11 to LFE 14. The longfin catch was stable in the key subareas, but for subareas within LFE 11 to LFE 14 (Nelson, Marlborough and north east of Otago) the pattern has changed dramatically in the last two years as the longfin quota (1 t) is now too low to make it economic or practical to fish these areas.

Long-term trends

Historic eel landings data from eel processors dating back to the 1970s indicate that longfin catch has declined relative to shortfin, and has also been subject to a greater reduction in mean size throughout New Zealand. The reasons for the decline in longfin catch over time are unknown, but are likely to be related to targeting and market demand.

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 weight 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 2015–16, 2016–17 and 2017–18 are presented, as well as trends in 15 years of landing data from the North Island, 12 years of landings data from ANG 15, and 8 years of landing data from the entire 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 native 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, and since then have fluctuated with no trend.

The North Island has contributed 61% (range 52 to 72%) of the total New Zealand eel catch since 1984 (Figure 1). In the North Island, shortfin has consistently been the dominant species, representing 73% of the catch since 1984. This proportion has been increasing, and over the last 10 years the average proportion was 86% shortfin. North Island shortfin catch steadily declined after 1995–96 to a low of 258 t in 2008–09, after which it has fluctuated with no trend (Figure 1). Similarly, North Island longfin catch peaked at 480 t in 1990–91 and then declined steadily over the next 19 years, stabilising at about 20 to 80 t over the last ten years (Figure 1).

In the South Island, there was initially little difference between the reported longfin and shortfin catches, but in the last 10 years shortfin landings have exceeded those of longfin, comprising two-thirds (66%, range 53 to 78%) of the South Island landed catch. South Island catches of both species gradually declined since the mid-1990s. Shortfin catch stabilised with the introduction of the Quota Management System (QMS) in the 2000–01 fishing year, whereas longfin landings have fluctuated more than three-fold over the last 10 years with the smallest catch of 48 t recorded in the two most recent fishing 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.).

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–ANG 16) for both species combined, totalling 421 t (Table 1, Figures 1 and 2). ANG TACCs were consistently under-caught in all South Island QMAs, with the exception of ANG 13 (Te Waihora) in 2005–05 and 2006–07 years (Fisheries New Zealand 2019). On average the South Island TACC was about two-thirds caught (range 51 to 85%) with the highest proportion of the TACC caught in 2012–13. In 2016–17, shortfin and longfin in the South Island were split into separate stocks (SFE 11–SFE 16, and LFE 11–LFE 16). For shortfin the total South Island TACC was set at 242 t and the longfin TACC at 81 t, representing a net 98 t (23%) reduction in the South Island total eel TACC. Further the longfin TACCs in LFE 11–LFE 14 were set at a nominal 1 t, in effect closing the longfin target fishery in the north and north east of the South Island.

The North Island eel fishery was introduced into the QMS on 1 October 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 467 t was reduced to 347 t in 2007–08 and overall has been 79% caught (range 64 to 98 %) over the last 14 years (Figure 1). The initial longfin TACC was also reduced in 2007–08 from 194 t to 82 t, a 58% reduction. The North Island longfin TACC has been on average 59% caught (range 26 to 94%) with the lowest catch and proportion of the TACC caught in two of the last three fishing years (Fisheries New Zealand 2019) (Figure 1). In 2018–19 the TACCs for the four longfin stocks were all reduced with an overall reduction of 32%. This equates to a TACC reductions of 71% since longfin were introduced into the QMS.

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. More recently improved knowledge has stemmed from sampling of commercial landings (Beentjes & Chisnall 1997, 1998, Beentjes 1999, Speed et al. 2001, Beentjes 2005), and ongoing monitoring recruitment of elvers and glass eels (Jellyman et al. 2000, Boubée et al. 2002, Martin et al. 2009, Martin & Bowman 2016), and the collection of data on catch by size-grade, species composition and catch location from commercial landings (i.e., the subject of this report) (Beentjes 2005, 2008a, 2008b, 2011, 2013, 2016). 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, 2013, 2014a, 2014b, 2015, Beentjes & McKenzie 2017), 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

This in the final reporting requirement for Fisheries New Zealand research project EEL2015-02.

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 in 2015–16, 2016–17 and 2017–18.

2. METHODS

2.1 North Island

Sampling

The commercial eel monitoring programme catch database and analyses were updated with North Island landings from 2015–16, 2016–17 and 2017–18 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 weight grades are processor specific, usually determined by market demands, and hence have changed slightly over time (Table 2).

Catch location is recorded at the subarea level, e.g., the Waikato River catchment has twelve subareas that correspond to individual waterbodies, 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). Maps showing the marked subareas and ESAs were provided to each processor to assist fishers and processors with assignment of the location that the eels were caught. Data were provided to the National Institute of Water and Atmospheric Research Ltd (NIWA) by the eel processors on a regular basis (usually monthly) for checking, collation, and entry onto a customised database.

For each of the most recent three fishing years (2015–16, 2016–17 and 2017–18) the catch of longfin and shortfin, from both processors combined, was plotted by subarea and ESA. To allow for the slightly different weight 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 Fisheries New Zealand in the plenary document (Fisheries New Zealand 2019) to determine the proportion included in the analyses.

Catch data that predates this programme were provided to NIWA by NZ Eel and AFL-LET. These data were analysed and presented to give an historic perspective to species composition and size.

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). To simplify the estimation of eel numbers, it was assumed that the North Island shortfin and longfin

[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.

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 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, 2016), 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 throughout the time series, even though this did not come into effect in the North Island until March 2007.

The total landed catch by species, and catch in each weight grade by species are tabulated and plotted by year for the North Island (2003–04 to 2017–18). In addition, landed catch data are plotted by location (subarea and ESA) for the three most recent years (2015–16 to 2017–18). To further examine both temporal trends in catch, and spatial distribution of catch and fishing effort over the 15-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 before (Beentjes 2016), 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

South Island analyses are updated with landings from 2015–16 to 2017–18 (Appendix 1). Collection of species weight 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 2017–18 (twelve years without subarea location), and all South Island from 2010–11 to 2018–19 (eight years), which has complete catch location data.

Sampling

In the same way as 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 provided by the fisher at the time of landing using maps showing ESAs and subareas. 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).

Analyses

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 weight grade by species are tabulated and plotted by year for ANG 15 (2006–07 to 2017–18) and the South Island (2010–11 to 2017–18). In addition, South Island data are plotted by location (subarea and ESA) for the three most recent years (2015–16 to 2017–18). To further examine both temporal trends in catch, and spatial distribution of catch and fishing effort over the eight 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 weight grades. Data were also requested on port prices paid to fishers for each species and weight 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.

3. RESULTS

3.1 North Island

3.1.1 Landings and catch (2003–04 to 2017–18)

A summary of landings, species tonnages, sampling proportions, and species composition from North Island processors between 2003–04 and 2017–18 is shown in Table 6, and the catch by species plotted in Figure 6. Catches of shortfin have remained reasonably stable at between 230 to 340 t over the fifteen years with no trend. Longfin catch was between 100 and 120 t at the start of the monitored period, but has generally declined since 2006–07 with catches in the last four years between 20 and 39 t. The proportion of shortfin overall is 82%, and the continued decline in longfin and stabilisation of shortfin has caused the shortfin proportion of the catch to rise in recent years. Comparison of catches reported to Fisheries New Zealand from ECERs and/or MHRs (Fisheries New Zealand 2019), and those provided to NIWA by processors in this programme show a close match from 2006–07 onward. The value of 111% in 2010–11 is anomalous (Table 6).

Estimated numbers of eels, and species composition from North Island landings between 2003–04 and 2017–18 are shown in Table 7. The estimated commercial landings for each season has varied from about 500 000 to 700 000 shortfin eels and from about 30 000 to 200 000 longfin eels. 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 weight 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 2015–16 fishing year (North Island)

Catch location

Subarea – The catches of each species by subarea for 2015–16 are shown in Figure 8. Shortfin were landed from 42 of the 65 North Island subareas (65%), but about half (52%) of the catch was from just six subareas, in decreasing order of catch: AA4 (Dargaville), AC2 (Hauraki Plains east), AD12 (Lake Waikare/Port Waikato), AC1 (Hauraki Plains west), AK1 (Manawatu River coast) and AB3 (Manukau Harbour) (Figures 8 and 9). Longfin were also landed from 42 of the 65 North Island subareas (65%), but about half (53%) of the catch was from just five subareas, in decreasing order of catch: AA4

(Dargaville), AD12 (Lake Waikare/Port Waikato), AB3 (Manukau Harbour), AD10 (Waipa River), AL1 (Lake Wairarapa), (Figures 8 and 10).

ESA – The catches of each species by ESA for 2015–16 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 AD (Waikato), AC (Hauraki), AA (Northland), AG (Hawkes's Bay), and AK (Manawatu) which together accounted about three-quarters (77%) 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), AB (Auckland) AC (Hauraki), and AK (Manawatu) which together accounted for three quarters (76%) of the longfin catch.

Species and size composition

The overall species composition of the North Island catch in 2015–16 was 91.9% shortfin (Table 6, Figure 8). Shortfin was also the dominant species in all subareas and ESAs in 2015–16 (Figure 11).

The overall proportions by weight of shortfin in the three weight grades for 2015–16 were 51.5%, 38.9%, and 9.7% for small, medium, and large, respectively (Table 8). The equivalent proportions by number of shortfin were 66.9%, 29.1%, and 3.9%, respectively (Table 8). The three weight grades were present in all subareas and in all ESAs where shortfin was landed (Figures 9 and 12).

The overall proportions by weight of longfin in the three weight grades were 37.6%, 23.4%, and 39.0% for the small, medium, and large, respectively (Table 9). The equivalent proportions by number of longfin were 62.1%, 21.0%, and 16.9%, respectively (Table 9). Where longfin was landed, the three weight grades were present in all but four subareas, where catches were negligible, and in all ESAs (Figures 10 and 13).

3.1.3 2016–17 fishing year (North Island)

Catch location

Subarea – The catches of each species by subarea for 2016–17 are shown in Figure 8. Shortfin were landed from 39 of the 65 North Island subareas (60%), but about half (47%) of the catch was from just five subareas, in decreasing order of catch: AD12 (Lake Waikare/Port Waikato), AG1 (Mahia Peninsula), AK1 (Manawatu River coast), AA4 (Dargaville), and AC2 (Hauraki Plains east) (Figures 8 and 9). Longfin were landed from 39 of the 65 North Island subareas (60%), but about half (50%) of the catch was from just four subareas, in decreasing order of catch: AD10 (Waipa River), AA4 (Dargaville), AD12 (Lake Waikare/Port Waikato), AK1 (Manawatu River coast) (Figure 8 and 10).

ESA – The catches of each species by ESA for 2016–17 are shown in Figure 11. Shortfin was landed from all ESAs (Figures 11 and 12). The major contributors by statistical area, in descending catch order, were AD (Waikato), AG (Hawkes's Bay), AC (Hauraki), AK (Manawatu), and AA (Northland), which together accounted for about three-quarters (76%) of the shortfin catch. Longfin was landed from all ESAs except AF (Poverty Bay) (Figures 11 and 13). The major contributors by statistical area, in descending catch order, were AD (Waikato), AA (Northland), AB (Auckland), AK (Manawatu), and AG (Hawkes's Bay) which together accounted for three quarters (76%) of the longfin catch.

Species and size composition

The overall species composition of the North Island catch in 2016–17 was 89.0% shortfin (Table 6, Figure 8). Shortfin was also the dominant species in all but two subareas (AH2, Whanganui River inland; AJ1, North Taranaki Bight). Shortfin was the dominant species in all ESAs in 2016–17 (Figure 11).

The overall proportions by weight of shortfin in the three weight grades for 2016–17 were 50.5%, 41.0%, and 8.4% for small, medium, and large, respectively (Table 8). The equivalent proportions by number of shortfin were 65.8%, 30.8%, and 3.4%, respectively (Table 8). The three weight 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 weight grades were 40.7%, 23.8%, and 35.4% for small, medium, and large, respectively (Table 9). The equivalent proportions by number of longfin were 64.7%, 20.3%, and 14.8%, respectively (Table 9). Where longfin was landed, the three weight grades were present in all but two subareas, where the catches were negligible, and in all ESAs (Figures 10 and 13).

3.1.4 2017–18 fishing year (North Island)

Catch location

Subarea – The catches of each species by subarea for 2017–18 are shown in Figure 8. Shortfin were landed from 41 of the 65 North Island subareas (63%), but about half (52%) of the catch was from just four subareas, in decreasing order of catch: AA4 (Dargaville), AD12 (Lake Waikare/Port Waikato), AC2 (Hauraki Plains east), AG5 (Tukituki River), AG1 (Mahia Peninsula), and AC1 (Hauraki Plains west) (Figures 8 and 9). Longfin were landed from 41 of the 65 North Island subareas (63%), but about half (50%) of the catch was from just four subareas, in decreasing order of catch: AA4 (Dargaville), AL1 (Lake Wairarapa), AD12 (Lake Waikare/Port Waikato), and AD10 (Waipa River) (Figure 8 and 10).

ESA – The catches of each species by ESA for 2017–18 are shown in Figure 11. Shortfin was landed from all ESAs (Figures 11 and 12). The major contributors by statistical area, in descending catch order, were AD (Waikato), AG (Hawkes's Bay), AC (Hauraki), and AA (Northland) which together accounted for about three-quarters (75%) of the shortfin catch. Longfin was landed from all ESAs (Figures 11 and 13). The major contributors by statistical area, in descending catch order, were AA (Northland), AD (Waikato), AL (Wairarapa), AB (Auckland), and AC (Hauraki) which together accounted for about three quarters (75%) of the longfin catch.

Species and size composition

The overall species composition of the North Island catch in 2017–18 was 86.7% shortfin (Table 6, Figure 8). Shortfin was also the dominant species in all but five subareas (AJ1, AJ2, AJ4, AL1 and AM2). Shortfin was the dominant species in all ESAs except AJ (Taranaki) and AM (Wellington) in 2017–18 (Figure 11).

The overall proportions by weight of shortfin in the three weight grades were 54.6%, 37.8%, and 7.7% for small, medium, and large, respectively (Table 8). The equivalent proportions by number of shortfin were 69.3%, 27.6%, and 3.1%, respectively (Table 8). Where shortfin was landed, the three weight grades were present in all subareas except AJ6, where catch was negligible, and in all ESAs (Figures 9 and 12).

The overall proportions by weight of longfin in the three weight grades 2017–18 were 44%, 22.6%, and 33.4% for small, medium, and large, respectively (Table 9). The equivalent proportions by number of longfin were 67.6%, 18.8%, and 13.5%, respectively (Table 9). Where longfin was landed, the three weight grades were present in all but three subareas, where catches were negligible, and in all ESAs (Figures 10 and 13).

3.1.5 Time series trends in the North Island (2003–04 to 2017–18)

3.1.5.1 Shortfin

Temporal trends in shortfin catch and size of eels

The North Island commercial shortfin catch over the fifteen-year period from 2003–04 to 2017–18 shows no consistent trend in annual catch weight or in the distribution of these catches in the three weight grades used (Figure 14). Despite the generally stable temporal pattern in North Island shortfin

catch there are a number of regulatory changes and economic drivers 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. 2008–09 to 2010–11: Shelving of SFE 22 begins (about 10% shelved)
5. 2007–08 to 2018–19: Shelving of SFE 23 begins and increases each year (14% to 41%)
6. 1 October 2013: fyke net escape tube size increase from 25 mm to 31 mm (legislated).
7. 2012–13: strong demand from Russian markets.
8. 2013–14 and 2014–15: weak demand from Russian markets due to conflicts in Ukraine and weak Chinese market demand due to increased supply of glass eels from Europe. Longfin more affected than shortfin because the latter is the preferred species.
9. 2014–15: 35 mm escape tubes used voluntarily by some fishers to reduce catch of small eels, mainly in the south of North Island. Most fishers have continued to use the 31 mm escape tubes.
10. 2014–15 to 2018–19: Shelving of SFE 22 (range 14% to 24%).
11. 2015–16: European and Russian frozen eel demand low but improving.
12. 2015–16 to 2017–2018: Demand for shortfin high across the weight ranges.
13. 2016–17 to 2017–18: Dry summers reduced catch.
14. 2018–19: Live eel exports continue to Korea, the US, China, Canada, and Europe.

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 weight grade which are surprisingly stable over time. Currently the international market demand for shortfin eels is high for all sizes, including a strong live export market.

Impact of port price, effort, and ACE shelving on shortfin catch

Market demand often drives the port price of eels paid to fishers and it might be expected to also impact the effort applied to the fishery. Shortfin eel port price can differ for the three weight grades (small, medium, and large) among and within fishing years with higher prices offered for larger eels. Shortfin port price indices by weight grade for both North Island eel processors are shown in Figure 15. Within each weight grade the catch and the port price index are not well correlated over time. The catch of medium sized shortfin appears to be most sensitive to port price. There have been strong markets for shortfin of all sizes in recent years and as all three weight grades are generally caught in all subareas, it seems likely that fishers land their entire legal sized ungraded shortfin catch without regard to the port price.

The total eel catch shows good correlation with both the numbers of permits that have been fished and the number of fishing events in a year, suggesting that the catches of both species are related to effort (Figure 16).

For each QMA the total quota shares are converted into ACE which is required by a commercial fisher to legally fish and land eels. There is provision to carry over an amount of unfished ACE[2] into the following fishing year so the total ACE can be greater than the TACC in a given fishing year. There is no legal requirement for Quota holders to lease their shares as ACE and if this is not done the ACE is termed ‘shelved’. Quantities of total ACE are compared with catch (data from FishServe), and ACE available to fishers (Dale Walters, NZEel Processors Ltd, Pers. comm.) (Figure 17). For shortfin eels in SFE 20 and SFE 21 (Northland and Auckland), the available ACE was close to the total ACE until the last four years when the proportion of available ACE has been progressively declining, averaging 9%

[2]For ACE holders, if their annual catch is less than their ACE holding, they are entitled to an underfishing allocation of 10% of the ACE they held at the end of the fishing year, or the difference between their ACE and the reported catch for that year, whichever is the lesser. These is referred to as a ‘carry over’ and is allocated in the following fishing year.

shelved in SFE 20 and 5% shelved in SFE 21. Proportionally more ACE has been shelved in SFE 22 and SFE 23 (lower east coast North Island and Taranaki/Manawatu) and this began in 2007–08 and 2006–07 respectively (Figure 17). In the last four years the average amount shelved has been 17% for SFE 22 and 40% for SFE 23. The shelving is predominantly by owners of Maori held quota. The total catch is not always the same as the total available ACE because fishers are usually allocated ACE at the beginning of the season and this may not reflect the required ACE balance (i.e., species and area) for the year. Economics may also be a factor when the cost of catching exceeds the return to fishers, or when ACE is limited. Hence, one of the key drivers of the annual shortfin landed catch is the availability of ACE and the amount of ACE allocated to individual fishers.

Spatial trends in shortfin catch

Spatial and temporal trends in the North Island catch of shortfin by subarea from 2003–04 to 2017–18 are shown in Figure 18. Shortfin was landed from 63 of the possible 65 subareas (no landings from AF3 (Cape Runaway) or 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 fifteen years (Figure 18). For other subareas, catches are more variable among years, but the most important subareas, in descending order of catch, include: AC2 (Hauraki Plains east), AK1 (Manawatu River coast), AG4 (Napier), and AG5 (Tukituki River). Together these seven subareas have contributed over half (51.5%) of the shortfin catch from 2003–04 to 2017–18. The pattern of catches by subarea is generally similar over the fifteen years (Figure 18).

3.1.5.2 Longfin

Temporal trends in longfin catch and size

North Island commercial longfin catches over the fifteen year period from 2003–04 to 2017–18 have fluctuated more than six-fold and are characterised by low catches from 2008–09 to 2010–11 but with the four lowest catches in the time series recorded over the last four years to 2017–18 (Figure 19). The overall trend is of declining landed catch. The medium longfin weight grade is poorly represented in the first three years of low catches (2008–09 to 2010–11). There are a number of regulatory changes and economic drivers that may have influenced annual longfin catches, overall and within size ranges. Some of these factors are annotated on Figure 18 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. 2007–08 to 2018–19: Shelving of LFE 23 begins and generally increases each year (28% to 86% shelved)
5. 2008–09 to 2017–18: Shelving of LFE 22 begins and generally increases each year (range 11% to 44% shelved)
6. 2008–09 to 2010–11: Limited market for longfin eels in the medium weight grade (500–1000 g) and fishers actively discouraged from landing eels in this grade (both AFL-Levin and NZ Eel).
7. 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.
8. 2011–12: access to AFL longfin quota restored to North Island fishers.
9. 2011–12: all weight grades of both species in high demand and there were no restrictions imposed on fishers not to land medium sized longfin.
10. September 2011: Access to Taiwan market lost. Predominantly longfin market.
11. 2012–13: strong demand from Russian market
12. 1 October 2013: Fyke net escape tube size increased from 25 mm to 31 mm (legislated).
13. 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.

15. 2014–15: 35 mm escape tubes used voluntarily by some fishers to reduce catch of small eels, mainly in the south of North Island. Most fishers continued to use the 31 mm escape tubes.
16. 2015–16 fishing year: European and Russian frozen eel demand low but improving.
17. 2015–16: Smaller weight grade of longfin not wanted by AFL-LET and fishers advised not to land longfin of this size.
18. 2016–17 to 2017–18: Dry summers reduced catch.
19. 2016–17 to 2017–18: NZEel Processors indicates that longfin demand is reasonably high for gutted and de-slimed eel across the size ranges, but no markets for live export in last few years.
20. Last four years up to 2018–19: AFL-LET has a market in Europe for eels under 700 g, but no market for eels over 700 g, and has discouraged fishers from targeting longfins by avoiding longfin areas.
21. 2018–19: TACC reductions of 32% for North Island longfin stocks.
22. 2018–19: Marked increase in ACE shelving in all areas (LFE 20 59%, LFE 21, 44%, LFE 22 52%, and LFE 3 86% shelved). This has had major impact on the longfin fisheries in the lower North Island.

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 weight 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). The longfin landed catch in the last four years up to 2017–18 has been partly a result of the poor demand for large longfin by AFL-LET who have advised fishers to avoid targeting longfin and catches have originated from the mixed shortfin/longfin fisheries.

Impact of port price, effort and ACE shelving on longfin catch

Longfin eel port price can differ for the three weight grades (small, medium, and large) among and within fishing years but have generally been higher for larger eels. Longfin port price indices by weight grade for both North Island eel processors are shown in Figure 20. Within each weight 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). For longfin eels, port prices and markets are not the key driver for landed catch as fishers tend to land all legal sized eels caught in the net, assuming they have ACE, which is usually allocated to fishers at the start of the season. If ACE is used up they either need to acquire more ACE, or return the eels to the water.

The total eel catch, and especially longfin, shows good correlation with both the numbers of permits that have been fished and the number of fishing events in a year, suggesting that the catches of both species are related to effort (see Figure 16).

For longfin eels in LFE 20 and LFE 21 (Northland and Auckland) the available ACE was close to the total ACE until the last three to four years, with the exception of 2010–11 when AFL ACE was shelved (Figure 21). The proportion of available ACE has generally declined over the last four years (to 2017–18), averaging 11% shelved in both LFE 20 and SFE 21 (Figure 21). Proportionally more ACE has been shelved in SFE 22 and SFE 23 (lower east coast North Island and Taranaki/Manawatu) and this began in 2008–09 and 2007–08, respectively (Figure 21), with half the LFE 22 ACE shelved in 2010–11 by AFL. In the last four years (to 2017–18) the average amount of ACE shelved has been 16% for LFE 22 and 43% for LFE 23. The shelving is predominantly by owners of Maori held quota. As described for shortfin, the total catch is not always the same as the total available ACE (see above) Hence, the key drivers of the annual longfin landed catch is a combination of fluctuating market demand, the availability of ACE and the amount of ACE allocated to individual fishers.

Spatial trends in longfin catch

Spatial and temporal trends in the North Island catch of longfin by subarea from 2003–04 to 2017–18 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 (35.7%) 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 AC1 (Hauraki Plains west). Together these eight subareas have contributed half (51.8%) of the longfin catch from 2003–04 to 2017–18 (Figure 22). The catches for the four main subareas (AA4, AD10, AD12, and AL1) vary among years but there is no clear pattern of declining or increasing catch in these areas. 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 41 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 (2006–07 to 2017–18)

A summary of landings, species tonnages, sampling proportions, and species composition from eel processors between 2006–07 and 2017–18 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 33 t and 91 t, with lowest catches in 2008–09 to 2009–10 and over the last two years. The proportion of shortfin in the total eel catch over this twelve year period is 25%, but has varied annually between 16% and 42%. Comparison of catches reported to Fisheries New Zealand from ECERs and/or MHRs (Fisheries New Zealand 2019) 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 by number is estimated to have varied between about 23 000 and 45 000 shortfin and 52 000 to 173 000 longfin over the twelve 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 individual weight for shortfin has been reasonably stable at just under 600 g, with a decline in the last few years to about 500 g. For longfins mean individual weight has been more variable, ranging from 520 g to 740 g, averaging about 620 g (Table 7).

All South Island (2010–11 to 2017–18)

A summary of landings, tonnages by species, proportion of landings examined, and species composition from 2010–11 to 2017–18 for all South Island catches is shown in Table 6. Catch by species from the same records is plotted in Figure 24. Catches of shortfin have ranged from about 144 t to 193 t with no consistent trend. Longfin catch was between 47 t and 160 t, with the lowest catches in the last two years. The proportion of shortfin is 63% overall, increasing from 58% to 78% over the last five years. Comparison of catches reported to Fisheries New Zealand from ECERs and/or MHRs (Fisheries New Zealand 2019) and those provided to NIWA, as part of this project, show a reasonable match for most years (Table 6), suggesting that the data used in the present report is an accurate reflection of the commercial catches.

Estimated numbers of eels, and species composition from all South Island landings from 2010–11 to 2017–18 are shown in Table 7. The annual commercial catch has ranged from 253 000 to 375 000 shortfin and 86 000 to 292 000 longfin over the five years. The proportions of shortfin in the estimated total

number of eels are similar to those derived from actual catch weights (compare Table 6 and 7). The mean weight for shortfin is about 545 g and for longfin 570 g (Table 7).

Individual landing weight (both species combined) was most commonly between 50 and 300 kg, with the largest landings over 2500 kg (Figure 25). The largest landings are likely to be from extended fishing periods with the catch from multiple days fishing landed to the processors.

3.2.2 2015–16 fishing year (South Island)

Catch location

Subarea – The catches of each species by subarea for 2015–16 are shown in Figure 26. Shortfin were landed from 29 of the 58 South Island subareas (50%), but three-quarters (75%) of the catch was from Te Waihora (AS1, excludes migration area; AS2, migration area). Other key areas in decreasing order of catch were: AW9 (Oreti River coast), AX4 (Lake Brunner), AW11 (Mataura River coast), AV10 (Clutha River coast) and AV9 (Lake Waihola and Waipori River) (Figures 26 and 27). Longfin were landed from 25 of the 58 South Island subareas (43%), but about half (49%) of the catch was from just three subareas, in decreasing order of catch: AW11 (Mataura River coast), AW9 (Oreti River coast), and AW8 (Aparima River coast). Other key areas in decreasing order of catch: AW3 (Oreti River inland down to Bog Burn), AU5 (Waitaki River), AX6 (Hokitika River), AX3 (Grey and Arnold Rivers), AW6 (Waiau River coast), and AW10 (Clutha River coast) (Figures 26 and 28).

ESA – The catches of each species by ESA for 2015–16 are shown in Figure 29. Shortfin was landed from all South Island ESAs except AQ (south Marlborough) (Figures 29 and 30), but more than three quarters (77%) of the South Island shortfin catch was from just two ESAs, in decreasing order of catch: AS1 (Te Waihora, excluding migration area) and AW (Southland). Longfin was landed from eight ESAs, with no catch in Te Waihora (AS1 and AS2) or AQ (south Marlborough (Figures 29 and 31). The major contributors by statistical area, in decreasing catch order, were AW (Southland), AX (Westland), AU (Waitaki), and AV (Otago), which together accounted for 97% of the longfin catch.

Species and size composition

The overall species composition of the South Island catch in 2015–16 was 70.6% shortfin (Table 6, Figure 26). Longfin was the dominant species in 18 of the 29 subareas where eels were caught, with only shortfin landed from AS1, AS2 (Te Waihora), AV9 (Lake Waihola and Waipori River), and AW5 (Waikaka River). Longfin was the dominant species in ESAs in AN, AU AT and AW (Figure 29).

The overall proportions by weight of shortfin in the two weight grades in 2015–16 were 63% and 37% for small and large, respectively (Table 8). The equivalent proportions by eel numbers were 83% and 17%, respectively (Table 8). The two weight grades were present in all subareas and ESAs where shortfin catch was over 5 kg, 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 weight grades were 84% and 16% for the small and large, respectively (Table 9). The equivalent proportions by eel numbers were 95% and 5% respectively (Table 9). The two weight grades were present in all subareas and ESAs where longfin was landed (Figures 28 and 31).

3.2.3 2016–17 fishing year (South Island)

Catch location

Subarea – The catches of each species by subarea for 2016–17 are shown in Figure 26. Shortfin were landed from 22 of the 58 South Island subareas (38%), but more than three quarters (76%) of the catch was from just two subareas, in decreasing order of catch: AS1 (Te Waihora, excluding migration area) and AS2 (Te Waihora migration area). Other key areas in decreasing order of catch were: AX4 (Lake

Brunner), AW11 (Mataura River coast), and AW10 (Mataura River inland to Riversdale). Longfin were landed from 24 of the 58 South Island subareas (41%), but over half (53%) of the catch was from just five subareas, in decreasing order of catch: AW11 (Mataura River coast), AW9 (Oreti River coast), AW8 (Aparima River coast), AX6 (Hokitika River), and AW3 (Oreti River inland down to Bog Burn) (Figure 26 and 28).

ESA – The catches of each species by ESA for 2016–17 are shown in Figure 29. Shortfin was landed from six of the eleven South Island ESAs (Figures 29 and 30), but more than three quarters (80%) of catch was from just AS1 (Te Waihora, excluding migration area) and AW (Southland) (Figures 29 and 30). Longfin was landed from only four of the eleven ESAs, with 99.9% of the catch from AW (Southland), AX (Westland), and AV (Otago) (Figures 29 and 31).

Species and size composition

The overall species composition of the South Island catch in 2016–17 was 75% shortfin (Table 6). Shortfin was the dominant species in 8 of the 26 subareas where eels were caught, with only shortfin landed from AS1 and AS2 (Figure 26). Shortfin was the dominant species in ESAs AS1, AS2 and AR, and longfin in AW, AX and AV (Figure 29).

The overall proportions by weight of shortfin in the two weight grades in 2017–18 were 78% and 22% for small and large, respectively (Table 8). The equivalent proportions by eel numbers were 91% and 9%, respectively (Table 8). The two weight grades were present in all subareas and ESAs where shortfin was landed except AS2 (Te Waihora migration area) and AV10, where only small shortfin eels were landed (Figures 27 and 30).

The overall proportions by weight of longfin in the two weight grades were 95% and 5% for the small and large, respectively (Table 9). The equivalent proportions by eel numbers were 98.5% and 1.5% respectively (Table 9). Longfins in the large weight grade were absent from 14 of the subareas where longfin was landed, and only ESA AX had a notable amount of large longfins (Figures 28 and 31).

3.2.4 2017–18 fishing year (South Island)

Catch location

Subarea – The catches of each species by subarea for 2017–18 are shown in Figure 26. Shortfin were landed from 28 of the 58 South Island subareas (48%), but nearly three quarters (74%) of the catch was from AS1 (Te Waihora, excluding migration area) (Figures 26 and 27). Longfin were landed from 25 of the 58 South Island subareas (43%), but just over half (55%) of the catch was from just five subareas, in decreasing order of catch: AW11 (Mataura River coast), AW10 (Mataura River from Riversdale to Gore), AW9 (Oreti River coast), AX3 (Grey and Arnold Rivers), and AW3 (Oreti River inland to Bog Burn) (Figures 26 and 28).

ESA – The catches of each species by ESA for 2017–18 are shown in Figure 29. Shortfin was landed from ten of the eleven South Island ESAs, except AT (south Canterbury) (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 five of the eleven ESAs with 98% of the catch from AW(Southland), AX (Westland), and AV (Otago) (Figures 29 and 31).

Species and size composition

The overall species composition of the South Island catch in 2017–18 was 78% shortfin (Table 6). Shortfin was the dominant species in 11 of the 32 subareas where eels were caught. Shortfin were the only eel species landed from seven subareas, mainly from the northeast of the South Island and in Te Waihora (AS1 and AS2) (Figure 26), but were absent in landings from AU4, AW4, and AW5. Shortfin was the dominant species in all ten ESAs where eels were caught, except AW, AX, and AV (Figure 29).

The overall proportions by weight of shortfin in the two weight grades in 2017–18 were 89% and 11% for small and large, respectively (Table 8). The equivalent proportions by eel numbers were 96% and 4%, respectively (Table 8). The two weight grades were present in all subareas except AX9, AW2, and AS2 where there were no large eels, and in all ESAs where shortfin was landed (Figures 27 and 30).

The overall proportions by weight of longfin in the two weight grades were 70.5% and 29.5% for the small and large, respectively (Table 9). The equivalent proportions by eel numbers were 89% and 11% respectively (Table 9). The two weight grades were present in all subareas and ESAs where longfin was landed (Figures 28 and 31).

3.2.5 Time series trends in the South Island

3.2.5.1 Temporal trends in catch and size of eels

Shortfin – The ANG 15 commercial shortfin catch over the twelve-year period from 2006–07 to 2017– 18 has varied nearly two-fold among years, while the proportion of large shortfin has varied more than four-fold and shows indications of a declining trend (Figure 32). The lowest proportion of large eels in the most recent year is likely to be due, in part, to the increase in the upper range from over 800 g to over 1000 g (see Table 5). The South Island commercial shortfin catch over the eight-year period from 2010–11 to 2017–18 shows no consistent trend in annual catch although the proportions in the large weight grade for the three most recent years are the lowest of the eight years (Figure 33). As for ANG 15, the lowest proportion of large eels in the most recent year is likely to be due to the increase in the upper range from over 800 g to over 1000 g (see Table 5).

Longfin – The ANG 15 commercial longfin catch over the twelve-year period from 2006–07 to 2017–18 has varied nearly three-fold among years while the proportion of large longfin has varied more than four-fold, excluding 2016–17 where landings of large longfin were negligible (Figure 34). Both the ANG 15 and the South Island commercial longfin catch shows recent trends of declining annual catch and a reduction in the proportions of large eels (Figures 34 and 35). The reduction in the proportions of large eels was despite the reduction in the upper range of large eels (1000 g to 750 g) in 2017–18 (see Table 5).

Factors affecting South Island eel catch

The port price for shortfin eels paid by Mossburn Enterprises to fishers in the South Island has been largely stable over the period for which there are data (since 2010–11), with little difference paid for small and large shortfins. Markets have been consistently strong for shortfins which are exported to Germany, Asia, the US and the UK, either live or frozen. Longfin markets and demand are similar to those for shortfin, but there is no live export of this species and in the last 4 to 5 years the port price for larger eels has been less than half that of small eels, reflecting market demands. South Island longfin are more marketable than those from the North Island because they tend to be in better condition, and there are different markets for these eels.

Before 2016–17 the catch of shortfin relative to longfin could vary in the South Island as both eel species were managed under a single eel catch quota for each QMA (ANG 13 to ANG 16) and hence the entire annual catch could conceivably have been made up of a single species. The proportion of the South Island catch that was shortfin or longfin in a year was dependent on areas fished (whether shortfin or longfin fisheries, or mixed fisheries) and environmental conditions; with shortfins targeted more often when rivers were high, and longfins targeted during dry conditions. The high proportions of small shortfin in the last two years may be partly a result of high rainfall and flood conditions which tend to favour capture of small shortfin (Pers. Comm. Vic Thompson - Mossburn Enterprises) (see Figures 32 and 33). The low proportions of large longfin in the last few years is in part because fishers were advised not to land eels over 2 kg, as these can potentially be migrating females, thus effectively reducing the maximum size landed to 2 kg (see Figures 34 and 35).

The introduction of separate TACCs for South Island shortfin and longfin in 2016–17 is likely to have had an impact on both the amount of catch and the size composition in the last two years. A number of long-term experienced fishers retired at this time, resulting in a marked reduction in effort (Pers. Comm. Vic Thompson - Mossburn Enterprises). Further, because the TACCs in ANG 11, ANG 12, ANG 13 and ANG 14 were set at a nominal 1 t, this has essentially closed these fisheries to longfin targeting and discouraged fishers from targeting shortfin in these areas because of the bycatch of legal sized longfin which, without ACE, must be released and catch entered as destination X on ECERs. While availability of ACE in the South Island is not generally an issue, 20% of ACE in LFE 11 and SFE 11 has been shelved by the eight Iwi of the Te Tau Ihu area (top of the South Island) (i.e., 200 kg of longfin and 3.8 t of shortfin), and some retired fishes have not leased their quota in the last two years. To catch the entire TACC for each species each year, all ACE would need to be available, and fishers would require a balanced and flexible ACE portfolio that allows fishing for both species throughout the year.

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.

3.2.5.2 Spatial trends in catch

Shortfin

Spatial and temporal trends in the South Island landed catch of shortfin by subarea from 2010–11 to 2017–18 are shown in Figure 36. Shortfin were landed from 51 of the possible 58 subareas. Of these 51 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 three-quarters (75.8%) of the catch over the eight years (Figure 36). For other subareas, catches are more variable among years, and only AR3 (Waimakariri River), AW9 (Oreti River coast), and AW11 (Mataura River coast) have contributed more than 2% of the shortfin catch over the eight years. The pattern of landed catches by subareas is generally similar over the eight 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 landed catch of longfin by subarea from 2010–11 to 2017–18 are shown in Figure 37. Longfin were 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), AX3 (Grey River Arnold River), AU5 (Waitaki River), and AP2 (Wairau River) are consistently the main contributors to the South Island longfin annual landings making up half (49.4%) of the catch over the eight years (Figure 37). For other subareas, catches are more variable among years, and only AX2 (Buller River), AW10 (Mataura River from Riversdale to Gore), AV11 (Pomahaka River), and AW8 (Aparima River coast) have contributed more than 3% of the longfin catch over the eight years. The pattern of landed catches by subareas is generally similar over the first six years, but more variable for the smaller contributors of catch. In the last two years there has been a clear change in the spatial pattern of catches with little or no catch in subareas from the east coast north of Otago, and from Nelson/Marlborough (AU5 to AN1) where the longfin TACCs from these QMAs is only 1 t (Figure 37).

4. DISCUSSION

4.1 Current data collection

Eel landed catch data are analysed and presented in detail for fishing years 2015–16 to 2017–18 of the commercial eel fishery monitoring programme, meeting the objective to monitor size and species of eels by recording quantities of eels in the different commercial size grades and link this to catch location.

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 weight grades, species composition, and catch location from individual commercial eel landings.

4.2 Data quality

Captured data

The eel catches included in our analyses do not always match the reported landed catch for the North Island as documented by Fisheries New Zealand (Fisheries New Zealand 2019) (see Table 6). It is not clear which dataset is more accurate since Fisheries New Zealand 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 in this programme.

Limitations of the data

The shortcomings of the commercial eel monitoring programme are: 1) weight grade data are coarse with only two to three weight 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., the 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 weight grade are female; and 5) data are provided voluntarily by processors with no guarantee of long-term participation.

Dealing with different size grades

In the present and the two previous commercial eel monitoring reports (Beentjes 2013, 2016), the weight grade catch data were combined for all processors, despite some minor differences in the grades used (i.e., those processors landing North Island caught eels, or those processors landing South Island caught eels). In the South Island there are currently three processors (Mossburn, AFL-LET, and Independent Fisheries) and because of the difference in weight grades used between Mossburn and AFL-LET, it was necessary to amalgamate each species into two weight grades, not three as for the North Island. The rationale for using generic weight grades is that weight grades have changed 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 weight grade are not likely to mask any gross changes in size that might be occurring over time. 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 (until 2017–18 when it changed to 1000 g), and 1000 g for the North Island shortfin. Further, the small shortfin grade in the South Island also includes male 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 weight grades for either species between North and South Islands is not valid, perhaps with the exception of large longfin over 1000 g.

Estimating eel numbers

Numbers of eels in the weight grades are not provided by the processors in the monitoring programme, but instead were estimated, allowing the overall mean weight of individual eels of each species in each year to be calculated. Estimates of eel numbers are particularly important for the North Island large weight grade where, until March 2007, there was no upper limit 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 weight grades. More accurate estimates of numbers would require collection of detailed length and weight records at regular intervals.

4.3 Efficacy of the data

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 15 years in the North Island and eight years in the South Island time series, these data can 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 commercial 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 weight 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[3]. Common practice, however, is for commercial fishers to voluntarily release eels that display morphological signs of migration, even if they are below 4 kg and in the South Island fishers are discouraged from landing all eels over 2 kg. Commercial fishers also tend to avoid waterways when mature longfins are migrating downstream.

Release of over 4 kg longfins

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. There are no subsequent quantitative data on numbers of 4 kg longfin eels released in the South Island.

In the North Island the practice of releasing 4 kg longfin eels is anecdotally reported by fishers to be increasing. A voluntary logbook programme administered by EECo (Eel Enhancement Company) has been in place since 2012–13 capturing data from commercial fishers on numbers of over 4 kg longfins released each fishing trip. While only a few fishers have provided these data, they are nonetheless informative. Data provided to NIWA by NZEel from seven fishers, fishing predominantly in the Waikato area (Statistical Area AD), recorded releases of 918 oversize eels between 2014–15 and 2018–19, equating to 3.7 tonnes of eels if all eels were 4 kg. While this is not representative of the entire North Island and all fishers, it suggests that the numbers released North Island wide, are substantial.

[3] In the Waikato-Tainui Fisheries Area, the legal size range for longfin eels is 0.4–2 kg, and taking longfin female migrant eels is also prohibited. The Waikato-Tainui Fisheries Area includes all tributaries, streams and water courses that flow into the Waikato River equivalent to subareas 4L, 4K, 4I and the northern third of 4J.

The planned introduction of electronic catch and position reporting for the eel fishery in October 2019 will require fishers to record the numbers and weight of all longfin eels over 4 kg released, as well as other information such as finer-scale catch location details.

4.4 Longfin spawning escapement

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 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 caught in 2011–12 was female, with the remainder being either male or female (see Figure 19, 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 weight 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, as discussed, fishers frequently release eels in spawning condition that are of legal size. Overall, however, both the North and South Island fisheries continue 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. The proportion of longfin habitat fished in 2012–13 to 2013–14 was estimated at 27% New Zealand wide, with much of the unfished habitat located in inaccessible back country areas, DOC estate and MPI closed areas where large female longfins are often abundant (Beentjes et al. 2016).

4.5 North Island eel fishery summary

In the North Island, data on eel catch weight, size, and capture location by species from commercial landings have now been collected continuously for 15 years (2003–04 to 2017–18).

4.5.1 Shortfin landings

Although shortfin in the North Island were caught from nearly all subareas (63 of the possible 65) over the fifteen years, the landed catch is highly aggregated with nearly one-third 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 the Wairoa, Wairua, Manganui, Awakino, and Mangakahia rivers, all of which are commercially fished (Beentjes et al. 2016). This subarea alone has contributed 509 t or 12% of North Island shortfin catch over the fifteen 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 landed catch over the fifteen-year period shows no consistent trend in annual catch weight or in the distribution of these catches in the three weight 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, annual rainfall, escape tube increases, and most importantly in recent years, by quota/ACE availability (see Figure 14). Market demand generally determines the port price that processors pay to fishers. While the correlation between catch and price paid within each weight 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). Low port

prices overall, can dictate the effort a fisher is prepared to expend to catch eels. Although more relevant to longfin, the total shortfin eel 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 16).

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 42 subareas per year on average for the last six years, indicating a slight 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 16). Despite the reduction in effort over time the catch of shortfin has been spatially stable in the key subareas over the fifteen years, with no apparent trends.

4.5.2 Longfin landings

Longfin in the North Island were caught from nearly all subareas (63 of the possible 65) over the fifteen years, although the catch is aggregated with more than one-third (36%) 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 117 t or 12% of the North Island longfin catch over the fifteen 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 landed catches over the fifteen-year period have fluctuated more than shortfin and are characterised by particularly low catches in 2008–09 to 2010–11 and since 2014–15, with an overall trend of declining catch (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, fluctuating market demands, annual rainfall, and more recently and most importantly, a progressive decline in the availability of ACE to fishers. In 2018–19 the proportions of ACE shelved has increased markedly for all longfin stocks, particularly in LFE 23 where 87% of the ACE has been shelved (see Figure 21). Coupled with a reduced TACC of only 5 t in 2018–19, this leaves 0.65 t available to be caught, effectively closing this fishery to longfin target fishing. Similarly, LFE 22 in 2018–19 has 51% of ACE shelved, and with a reduced TACC of 13 t this leaves only about 6 t to be caught (Figure 21). The North Island 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 landed catch and port price paid within each weight 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). 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 16). During a 2015 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. Hence for longfin, much of the fluctuation in catch is driven by the effort directed by commercial fishers and this may or may not be related to port price.

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 41 subareas per year on average for the last six years, indicating a slight contraction of effort over time (see Figures 22. Despite the reduction in effort over time the catch of longfin has been spatially stable in the key subareas over the fifteen years with no apparent trends.

4.6 South Island eel fishery summary

The South Island commercial eel monitoring programme began in 2006–07 with the provision of species catch and weight grade data for ANG 15 (Otago and Southland), with no breakdown by subarea or eel statistical area. The twelve-year ANG 15 time series is presented as it provides information on size and species catch from Otago and Southland that precedes the South Island time series by four years but assumes 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 eight years (2010–11 to 2017–18).

4.6.1 Shortfin landings

Although shortfin in the South Island were caught from most subareas (51 of the possible 58) over the eight years, the catch is highly aggregated with over three-quarters (76%) 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 Figures 36 and 40). Te Waihora alone has contributed 698 t or 63% of South Island shortfin catch over the eight 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 highlighting the concentrated nature of the shortfin eel stocks in the South Island and importance of these three subareas to the commercial shortfin fishery.

In ANG 15 and the South Island overall there is no consistent trend in annual landed catch, although the proportions of large eels appear to be declining (see Figures 32 and 33). This trend seems at odds with the consistently strong markets for shortfin and higher port prices for larger shortfin eels. There are a number of factors that might be responsible, including flood conditions in recent years that can increase the catch of smaller shortfin (Vic Thompson, Pers. comm.), the increase in weight grade range in 2017–18, and the split into separate shortfin and longfin stocks in 2016–17. The shortfin landed catch is well short of the current shortfin TACC since it was introduced in 2016–17 (see Figure 33) a result of fisher retirements, withheld quota, variable catch contribution from AS2 (Te Waihora migration area), and ACE imbalances resulting from the nominal 1 t TACCs set in LFE 11 to LFE 14.

The pattern of South Island shortfin landed catch by subarea is generally similar over the eight years, 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 (see Figure 36). This is because the Te Waihora quota (SFE 13) 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.

The shortfin landed catch from the South Island may have changed over the last two years as the longfin quota of just 1 t in within LFE 11 to LFE 14 (Nelson, Marlborough and north east of Otago) is too low to make it economic or practical to fish these areas for longfin, and this has also impacted fishing for shortfin. The contribution of landed shortfin catch over the last two years is shown in Figure 41.

4.6.2 Longfin landings

Longfin in the South Island were caught from most subareas (53 of the possible 58) over the eight years, and although less aggregated than shortfin, 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), AX3 (Grey River Arnold River), AU5 (Waitaki River), and AP2 (Wairau River) (see Figures 37 and 42). The three Southland subareas alone (AW11, AW9 and AW3) have contributed 236 t or 30% of South Island longfin catch over the eight years and Southland is by far the most productive area in the South Island for longfin (Figure 42). The bulk of the subareas in the South Island, however, have contributed individually, less than 2% of the annual longfin catch.

The annual commercial longfin eel landed catch in ANG 15 was highly variable over the twelve-year period with no overall trend, although there are indications of a decline in the largest weight grade in recent years (see Figure 34). For the South Island, there are declining trends in total longfin eel landed catch and in the largest weight grade over the eight-year time series (see Figure 35). The lower landed catches in recent years can be attributed to lower port price for large longfin, and primarily the split into separate shortfin and longfin stocks in 2016–17, resulting in an unmotivated fishing community (Vic Thompson, Pers. comm.). The longfin landed catch has been well short of the current TACC, introduced in 2016–17 (see Figure 35), as a result of fisher retirements, withheld quota, and ACE imbalances (i.e., species and area) caused by the nominal 1 t TACCs set in LFE 11 to LFE 14.

The longfin landed catch from the South Island eight year time series was stable in the key subareas, but for the smaller contributors and subareas within LFE 11 to LFE 14 (Nelson, Marlborough and north east of Otago) the pattern has changed dramatically in the last two years as the longfin quota of just 1 t in these areas is too low to make it economic or practical to fish these areas for longfin. The contribution of landed catch over the last two years is shown in Figure 43.

4.7 Long-term trends in species composition and size

Data on landed catch and weight grades by species from a lower North Island and South Island eel processor dating back to the 1970s were provided to NIWA before the commercial eel monitoring programme was officially implemented. These data were combined with the North Island eel monitoring data from 2003–04 and the South Island eel monitoring data from 2010–11. The historic weight grade data were provided in more than six grades for each species and these were re-grouped into those comparable with the current weight grades from the eel monitoring programme to make a continuous time series dating back to 1979 for the North Island and, except for some missing years, back to 1975 for the South Island.

The lower North Island data indicate that longfin eels initially contributed as much as half the landed eel catch (Figure 44), and the proportion of longfin to shortfin, with some fluctuations, has generally declined over forty years, averaging 14% longfin in the last four years. The longfin weight grade data indicate that the overall size of eels being captured has declined over time (Figure 44). The North Island shortfin weight grade data, apart from the first few years when medium and large eels dominate, have a reasonably stable mix of the three weight grades.

The South Island wide data show similar trends to the lower North Island, suggesting that longfin have become less abundant in the commercial catch than shortfin, and have also been subject to a greater reduction in mean size throughout New Zealand (Figure 45). These data begin about 10 to 15 years after commercial fishing for eels had begun, coinciding with a period of high catches nationwide (see Figure 1). It seems likely that had the data been collated at the start of the fishery in the mid-1960s the observed trends for longfin eel would be more pronounced.

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7. TABLES

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). Before 2016–17 South Island QMAs were not separated into shortfin and longfin and were both prefaced with ANG, e.g., ANG 15 for both SFE 15 and LFE 15.

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	LFE 11	SFE 11	AN		13
Marlborough	LFE 11	SFE 11	AP	}	14
South Marlborough	LFE 12	SFE 12	AQ	}	14
Westland	LFE 16	SFE 16	AX		15
North Canterbury	LFE 12	SFE 12	AR		16
South Canterbury	LFE 14	SFE 14	AT		17
Waitaki	LFE 14	SFE 14	AU		18
Otago	LFE 15	SFE 15	AV		19
Southland	LFE 15	SFE 15	AW		20
Te Waihora (outside Migration Area)	LFE 13	SFE 13	AS1	}	21
Te Waihora Migration Area	LFE 13	SFE 13	AS2	}	21
Chatham Islands	LFE 17	SFE 17	AZ		22
Stewart Island	LFE 15	SFE 15	AY		23

Table 2: Summary of chronology of weight grades for each species used by the two main North Island eel processors from 2003–04 to 2017–18. The various grades have been assigned to three weight grade categories: small, medium and large. LFE, longfin; SFE, shortfin; NZ Eel, New Zealand Eel Processors; AFL-LET, Aotearoa Fisheries and Levin Eel Trading.

Year	Processor	Species	Weight 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	AFL-LET	LFE	220–500	500–1000	over 1000
2009–10			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-LET	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.

		Subarea	Eel Statistical Area		
Island	Code	Number	Numeric	Alpha	QMA
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	11
	AP1–AP2	2	14	AP	11
	AQ1–AQ2	2	14	AQ	12
	AR1–AR5	5	16	AR	12
	AS1	1	21	AS1	13
	AS2	1	21	AS2	13
	AS1A	1	21	AS1	13
	AT1–AT4	4	17	AT	14
	AU1–AU5	5	18	AU	14
	AV1–AV12	12	19	AV	15
	AW1–AW12	12	20	AW	15
	AX1–AX10	10	15	AX	16
	Sub total	58	9	11	6
	Total	123	21	23	10

Table 4: Weight grades and equivalent length ranges, with mid-point length and weight derived from the cumulative length frequency distribution from the 1990s catch sampling data (see Figure 5). Mid-point weight was used to estimate total numbers of eels in each weight grade (total landed weight in each weight grade divided by the mid-point weight). See Tables 2 and 5 for weight grades corresponding to small, medium, and large categories. Maximum size of shortfin was about 100 cm for shortfin and 125 cm for longfin in the catch sampling data. For longfin, 108 cm length is equivalent to 4 kg, the maximum legal size. *Shortfin eels landed from AS2 (Te Waihora migration area) are under 300 g but are still included in the small grade.

		Weight grade			Mid-point	
Island	Species	Grade	Weight range (g)	Length range (cm)	Length (cm)	Weight (g)
North	SFE	Small	300–500	50–59	54	375
		Medium	500–1000	59–75	64.5	651
		Large	over 1000	75–100	78.5	1 197
North	LFE	Small	300–500 g	48–59	52	391
		Medium	500–1000 g	59–70	63	721
		Large	over 1000 g	70–108	79	1 484
South	SFE	Small	300–1000	*50–75	56.5	432
		Large	over 1000	75–100	78.8	1 197
South	LFE	Small	300–1000	48–70	54	441
		Large	over 1000	70–108	79	1 484

Table 5: Summary of chronology of weight grades used in the South Island from 2006–07 to 2017–18. Mossburn, Mossburn Enterprises; AFL-Levin, Aotearoa Fisheries and Levin Eel Trading; Independent, Independent Fisheries.

Year	Processor	Species	Weight grade (g)	
			Small	Large
2006–07	Mossburn	LFE	300–1000	1000–1500 and over 1500
2017–18			300–750	over 750
2010–11	AFL-Levin	LFE	300–500 and 500–1000	over 1000
2006–07	Mossburn	SFE	300–800	over 800
2017–18			300–1000	over 1000
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)	–
2015–16			AS2 migrating males (below 300 g) + AS1 eels 300–800 g	–

Table 6: Summary of landings and species landed weights from North Island processors from 2003–04 to 2017–18 (a), South Island ANG 15 from 2006–07 to 2017–18 (b), and the entire South Island from 2010–11 to 2017–18 (c). % catch sampled = percent of total reported landed weight sampled where the reported landings are from ECLR catch in tables 4 to 6 of the 2019 plenary document. No. Lndg, number of landings; SFE, shortfin eel; LFE, longfin eel; ECLR, eel catch effort landings.

(a) North Island

	Vanderdrift			New Zealand Eel			AFL-Levin			All processors combined				
	No.	Weight (kg)		No.	Weight (kg)		No.	Weight (kg)		No.	Weight (kg)		% catch	%
Year	Lndg	SFE	LFE	Lndg	SFE	LFE	Lndg	SFE	LFE	Lndg	SFE	LFE	sampled	SFE
2003–04	176	18 072	21 878	511	151 947	28 007	736	129 367	55 396	1423	299 386	105 281	89.0	74.0
2004–05	–	–	–	549	124 980	42 351	595	140 903	77 889	1144	265 883	120 240	90.3	68.9
2005–06	–	–	–	561	160 725	38 654	694	173 725	63 948	1255	334 450	102 602	87.5	76.5
2006–07	–	–	–	532	152 902	29 572	773	185 996	70 265	1305	338 898	99 837	99.7	77.2
2007–08	–	–	–	525	148 891	26 488	460	148 652	46 572	985	297 543	73 060	99.5	80.3
2008–09	–	–	–	306	130 366	15 711	407	122 352	26 586	713	252 718	42 297	97.6	85.7
2009–10	–	–	–	417	140 544	15 702	359	123 879	30 592	776	264 423	46 294	97.7	85.1
2010–11	–	–	–	474	202 940	23 883	399	125 155	17 248	873	328 095	41 131	111.9	88.9
2011–12	–	–	–	537	193 235	36 862	465	145 830	39 944	1002	339 065	76 806	99.4	81.5
2012–13	–	–	–	461	167 290	26 397	409	125 339	41 600	870	292 629	67 997	99.1	81.1
2013–14	–	–	–	457	164 502	23 409	372	136 507	39 128	829	301 009	62 537	99.0	82.8
2014–15	–	–	–	477	169 481	12 552	291	92 792	21 897	768	262 273	34 449	96.1	88.4
2015–16	–	–	–	373	145 858	11 882	236	81 734	8 186	609	227 592	20 068	97.5	91.9
2016–17	–	–	–	314	156 742	19 062	226	105 870	13 351	540	262 612	32 413	99.3	89.0
2017–18	–	–	–	373	163 354	20 425	178	90 356	18 512	551	253 710	38 937	98.7	86.7
Totals	175	18 072	21 878	5 807	2 373 757	370 957	5 960	1 928 457	571 114	13 643	4 320 286	963 949	97.7	81.7

Table 6 – *continued*

(b) South Island (ANG 15)

	Mossburn			AFL-Levin			All processors combined				
	No.	Weight (kg)		No.	Weight (kg)		No.	Weight (kg)		% catch	%
Year	Lndg	SFE	LFE	Lndg	SFE	LFE	Lndg	SFE	LFE	samp.	SFE
2006–07	299	17 425	63 941	–	–	–	299	17 425	63 941	101.2	21.4
2007–08	367	21 033	69 132	–	–	–	367	21 033	69 132	95.7	23.3
2008–09	204	14 879	34 882	–	–	–	204	14 879	34 882	98.9	29.9
2009–10	314	28 427	38 515	–	–	–	314	28 427	38 515	96.9	42.5
2010–11	276	21 442	71 657	–	–	–	276	21 442	71 657	99.8	23.0
2011–12	381	19 883	78 829	3	1 354	3054	384	21 237	81 883	96.6	20.6
2012–13	365	17 511	89 596	2	680	1796	367	18 191	91 392	104.1	16.6
2013–14	281	11 034	70 375	5	2 180	1130	286	13 214	71 505	94.6	15.6
2014–15	270	14 385	54 628	–	–	–	270	14 385	54 628	97.6	20.8
2015–16	227	22 018	42 467	–	–	–	227	22 018	42 467	98.2	34.1
2016–17	237	20 602	32 931	–	–	–	237	20 602	32 931	99.0	38.5
2017–18	238	14 574	36 975	–	–	–	238	14 574	36 975	100.5	28.3
Totals	3 459	223 213	683 927	10	4 214	5 980	3 469	227 427	689 907	98.6	24.8

Table 6 – *continued*

(c) South Island

	Mossburn			AFL-Levin			Independent		All processors combined				
	No.	Weight (kg)		No.	Weight (kg)		No.	Weight (kg)		Weight (kg)		% catch	%
Year	Lndg	SFE	LFE	Lndg	SFE	LFE	Lndg	SFE	Lndg	SFE	LFE	sampled	SFE
2010–11	363	101 232	94 631	33	30 547	14 463	100	61 115	496	192 894	109 094	114.3	63.9
2011–12	513	85 466	133 669	39	34 050	13 905	98	58 415	650	177 931	147 574	98.5	54.6
2012–13	558	92 454	140 752	65	38 356	18 862	18	13 250	641	144 060	159 614	84.6	47.4
2013–14	522	118 801	117 278	46	45 904	11 488	14	13 890	582	178 595	128 766	99.6	58.1
2014–15	431	82 775	70 121	57	70 582	6 755	8	4 347	496	157 704	76 876	99.4	67.2
2015–16	385	67 722	55 699	28	42 438	1 114	33	26 188	446	136 348	56 813	95.0	70.6
2016–17	513	83 955	47 037	4	17 960	0	42	37 382	559	139 297	47 037	87.0	74.8
2017–18	481	93 625	47 979	15	31 854	0	42	48 944	538	174 423	47 979	106.5	78.4
Totals	3 766	726 030	707 166	300	331 369	73 658	355	263 531	4 408	1 301 252	773 753	97.7	62.7

Table 7: Estimated total number of shortfins (SFE) and longfins (LFE) landed for North Island processors from 2003–04 to 2017–18 (a), for South Island ANG 15 from 2006–07 to 2017–18 (b), and the entire South Island from 2010–11 to 2017–18 (c). 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.

(a) North Island

	Numbers			Mean eel weight (kg)	
Fishing year	SFE	LFE	% SFE	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
2015–16	466 586	31 094	93.8	0.488	0.645
2016–17	537 982	52 230	91.2	0.488	0.621
2017–18	532 602	64 772	89.2	0.476	0.601
Total	8 821 946	1 551 715	85.0	0.490	0.621

(b) South Island (ANG 15)

	Numbers			Mean eel weight (kg)	
Fishing year	SFE	LFE	% SFE	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	24 925	104 761	19.2	0.577	0.521
2015–16	44 787	87 331	33.9	0.492	0.486
2016–17	43 531	74 084	37.0	0.473	0.445
2017–18	31 050	67 229	31.6	0.469	0.550
Total	395 929	1 249 380	24.1	0.574	0.552

Table 7 – *continued*

(c) South Island

Fishing year	Numbers SFE	Numbers LFE	% SFE	Mean eel weight (kg) SFE	Mean eel weight (kg) 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	277 211	144 358	65.8	0.569	0.533
2015–16	241 808	114 680	67.8	0.564	0.495
2016–17	276 473	103 096	72.8	0.504	0.456
2017–18	375 030	86 219	81.3	0.465	0.556
Total	2 389 578	1 364 074	63.7	0.545	0.567

Table 8: Distribution (%) of landed shortfin catch by weight and estimated number for each weight grade for the North Island (2003–04 to 2017–18) (a), South Island ANG 15 (2006–07 to 2017–18) (b), and for the entire South Island (2010–11 to 2017–18) (c). See methods for weight grades that correspond to small, medium, and large categories.

(a) North Island (shortfin)

Fishing year	Percent of landed shortfin catch, Weight grade: Small	Medium	Large	Percent of landed shortfin numbers, Weight grade: 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
2015–16	51.5	38.9	9.7	66.9	29.1	3.9
2016–17	50.5	41.0	8.4	65.8	30.8	3.4
2017–18	54.6	37.8	7.7	69.3	27.6	3.1

Table 8 – *continued*

(b) South Island (ANG 15 shortfin)

	Percent of landed shortfin catch Weight grade		Percent of landed shortfin numbers Weight grade	
Fishing year	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	60.7	39.3	81.0	19.0
2015–16	81.0	19.0	92.2	7.8
2016–17	86.4	13.6	94.6	5.4
2017–18	87.5	12.5	95.1	4.9

(c) All South Island (shortfin)

	Percent of landed shortfin catch Weight grade		Percent of landed shortfin numbers Weight grade	
Fishing year	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	62.3	37.7	82.1	17.9
2015–16	63.4	36.6	82.8	17.2
2016–17	77.7	22.3	90.6	9.4
2017–18	88.9	11.1	95.7	4.3

Table 9: Distribution (%) of landed longfin catch by weight and estimated number for each weight grade for the North Island (2003–04 to 2017–18) (a), South Island SFE 15 (2006–07 to 2017–18) (b), and for the entire South Island (2010–11 to 2017–18) (c). See methods for weight grades that correspond to small, medium, and large categories.

(a) North Island (longfin)

	Percent of landed longfin catch Weight grade			Percent of landed longfin numbers Weight grade		
Fishing year	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
2015–16	37.6	23.4	39.0	62.1	21.0	16.9
2016–17	40.7	23.8	35.4	64.7	20.5	14.8
2017–18	44.0	22.6	33.4	67.6	18.8	13.5

(b) South Island (ANG 15 longfin)

	Percent of landed longfin catch Weight grade		Percent of landed longfin numbers Weight grade	
Fishing year	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	78.0	22.0	92.3	7.7
2015–16	86.8	13.2	95.7	4.3
2016–17	98.9	1.1	99.7	0.3
2017–18	71.8	28.2	89.6	10.4

Table 9 – *continued*

(c) All South Island (longfin)

	Percent of landed longfin catch Weight grade		Percent of landed longfin numbers Weight grade	
Fishing year	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	75.5	24.5	91.2	8.8
2015–16	84.4	15.6	94.8	5.2
2016–17	95.2	4.8	98.5	1.5
2017–18	70.5	29.5	88.9	11.1

8. FIGURES

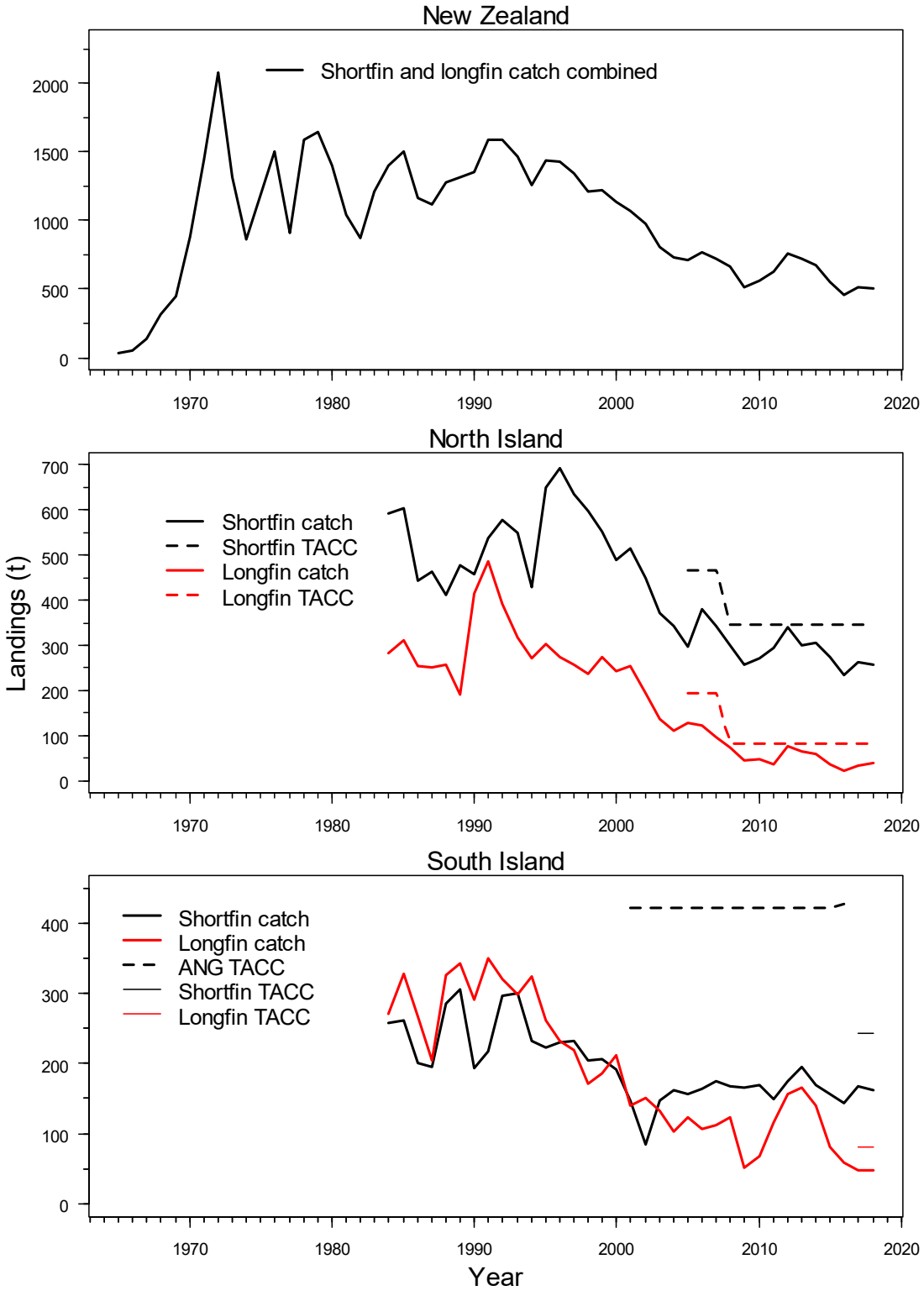


Figure 1: New Zealand eel catch from 1965 to 2017–18 (top), and North Island (centre) and South Island (bottom) catch by species from 1984 to 2017–18, and TACCs. Species catch was estimated from species proportions in catch effort data (FSU, CELR, ECER) in the South Island before 2001, and in the North Island before 2005. Subsequent species data are from landings reported on ECLRs (Fisheries New Zealand 2019). Before 2016–17 in the South Island, there was a single TACC (ANG) for both species combined. Catches are expressed by calendar year until 1988, and thereafter by fishing year. 2010 = 2009–10.

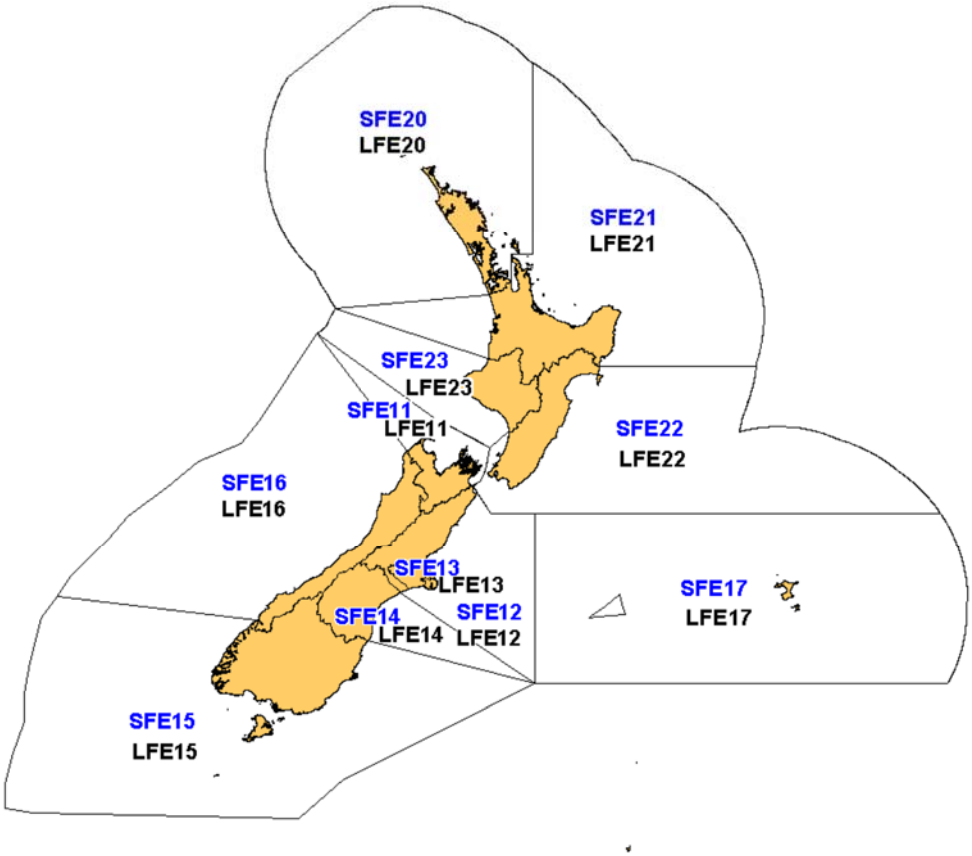


Figure 2: Quota Management Areas for the New Zealand eel fishery (see Table 1 for breakdown by Eel Statistical Areas and subareas). (Figure from Fisheries New Zealand 2019).

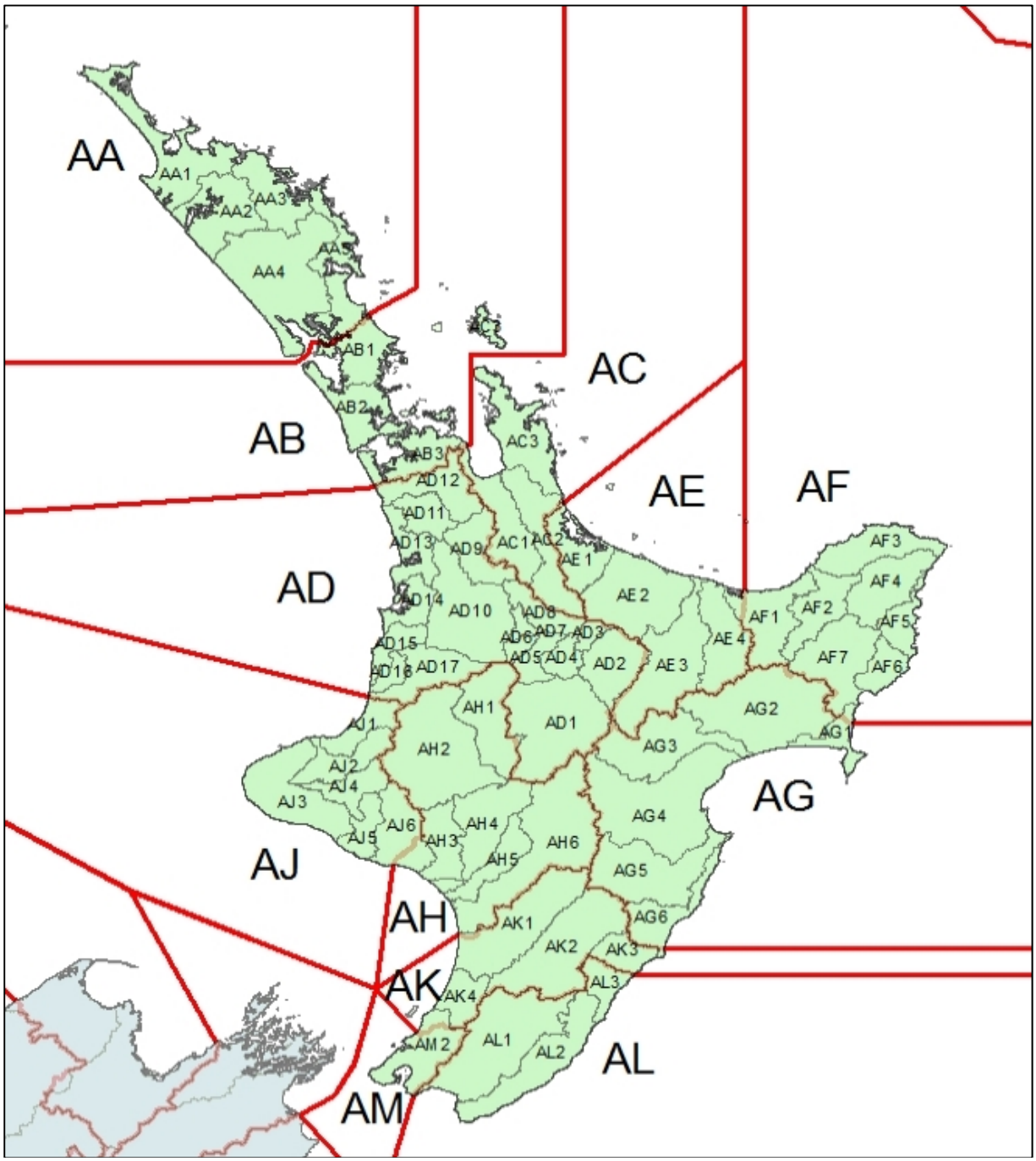


Figure 3: North Island Eel Statistical Area subareas (AA1 to AM2) and Eel Statistical Areas (ESAs AA to AM) overlaid, showing the shared boundaries (red). Subarea locations are defined in Appendix 2 and ESA areas defined in Table 1.

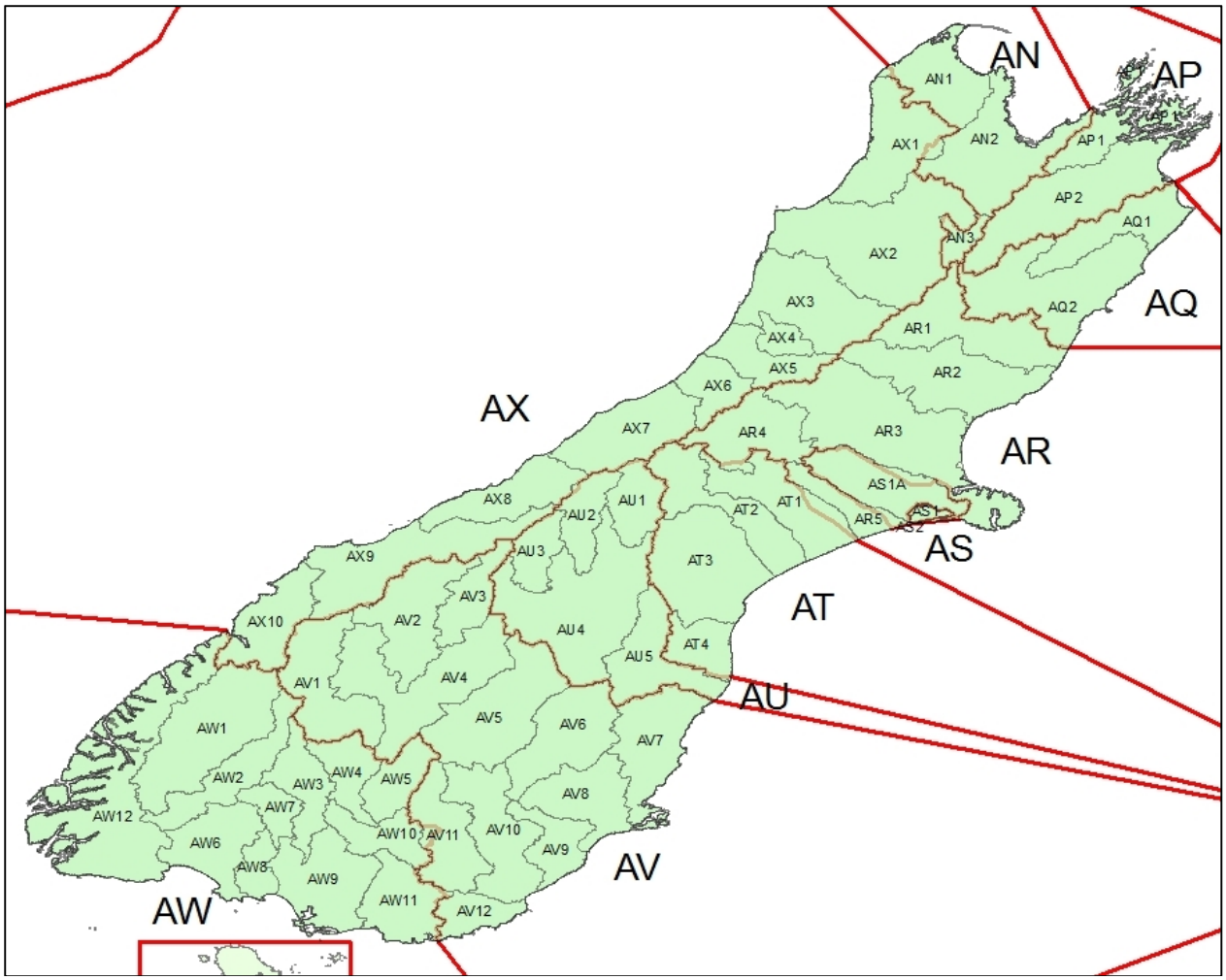


Figure 4: South Island Eel Statistical Area subareas (AN1 to AX10) and Eel Statistical Areas (AN to AX) overlaid, showing the shared boundaries (red). Subarea locations are defined in Appendix 2 and ESA areas defined in Table 1.

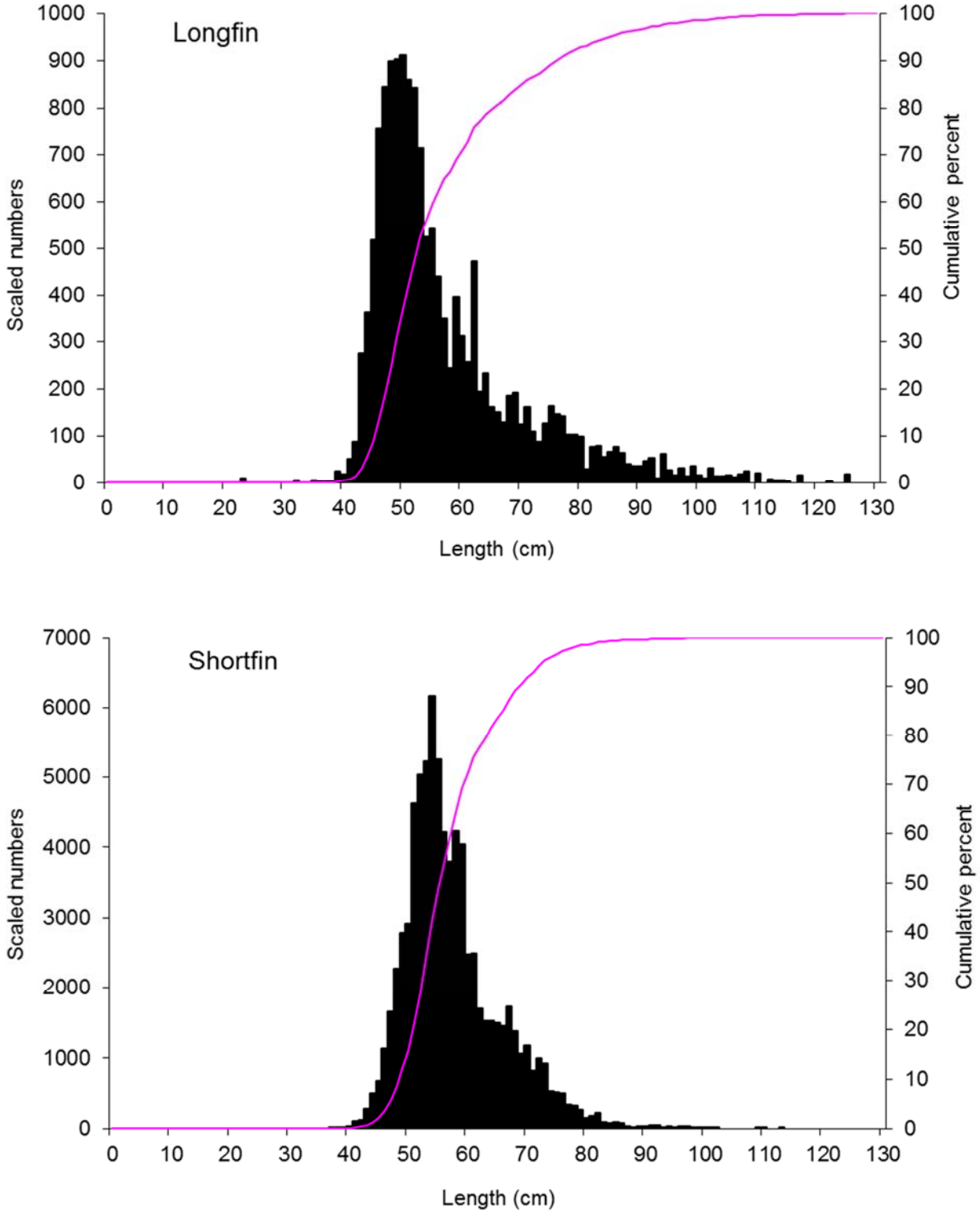


Figure 5: Scaled length frequency distributions and cumulative percent of longfin (top) and shortfin (bottom) from North Island commercial fishery catch sampling in 1995–96, 1996–97, and 1997– 98.

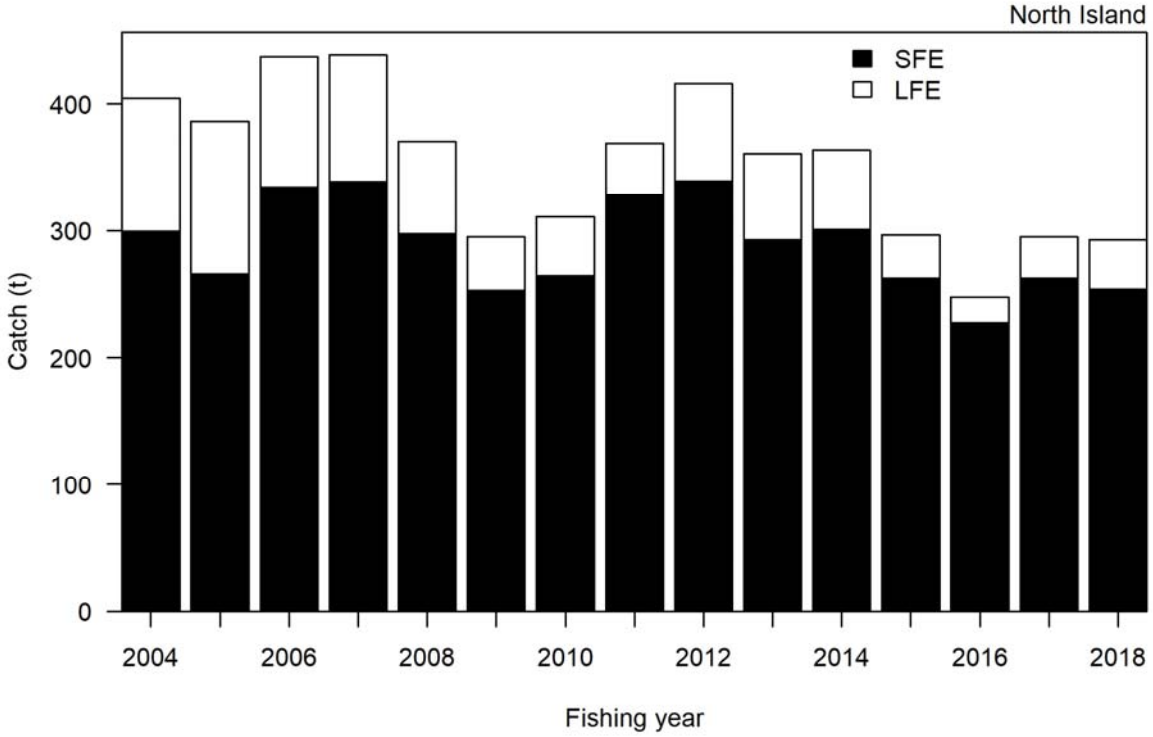


Figure 6: North Island total commercial catch (t) of shortfin (SFE) and longfin (LFE) eels for the years 2003–04 to 2017–18.

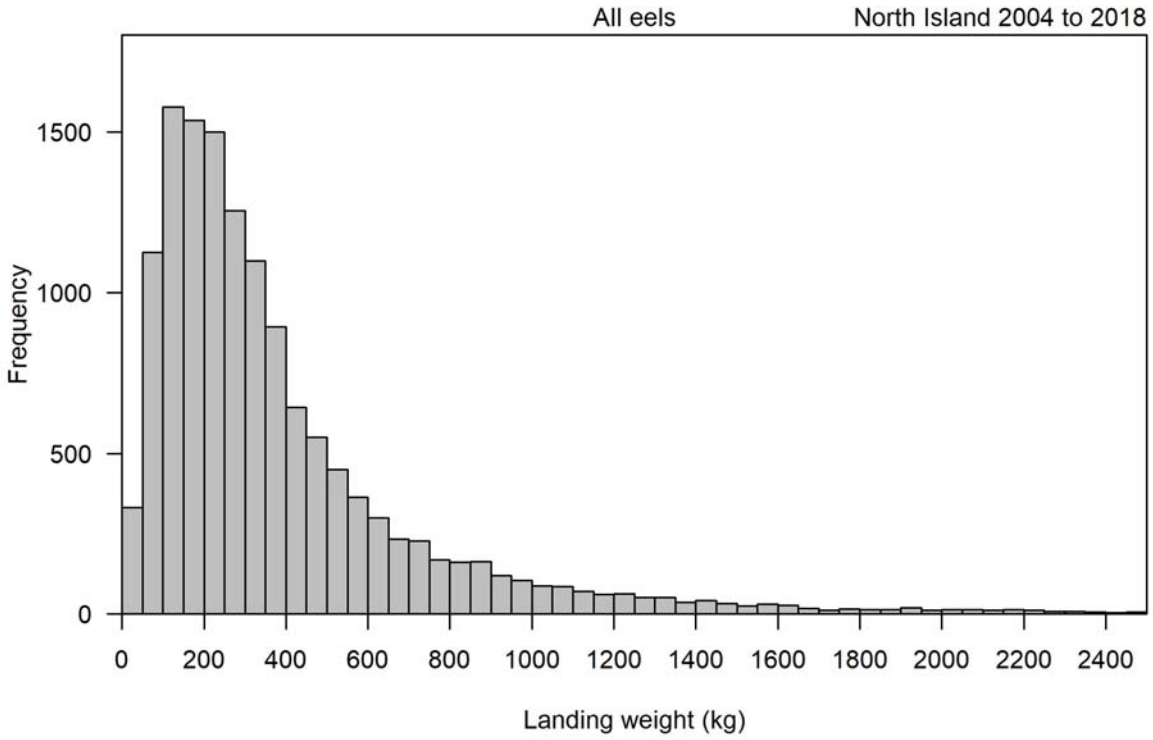


Figure 7: Distribution of individual eel landing weights in the North Island from 2003–04 to 2017–18. Landings include both shortfin and longfin eels.

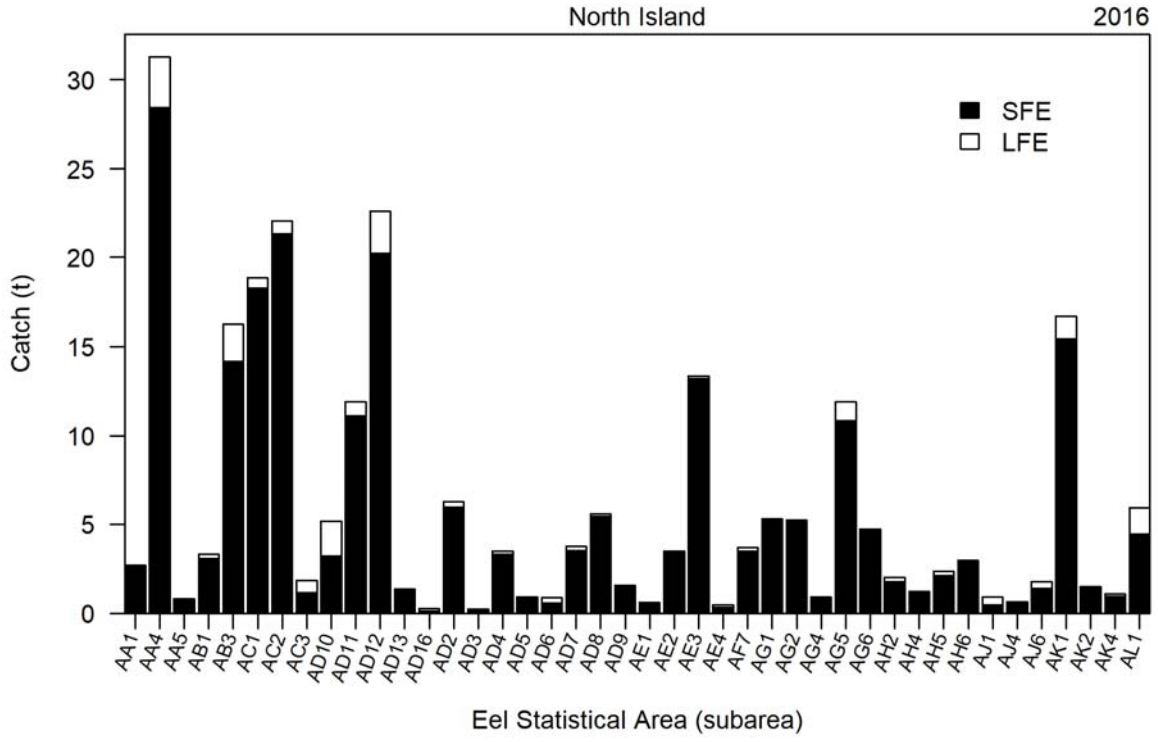
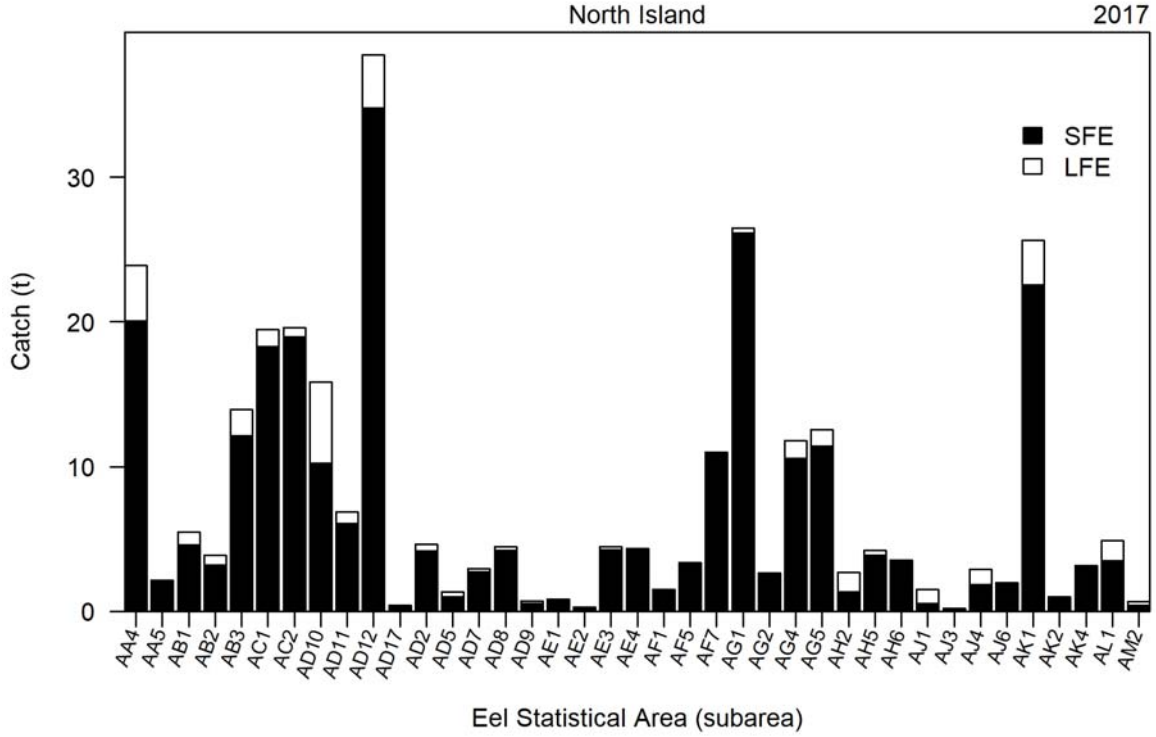


Figure 8: Catch of North Island shortfin (SFE) and longfin (LFE) eels by Eel Statistical Area subarea for fishing years 2015–16 (2016), 2016–17 (2017), and 2017–18 (2018). Only subareas with recorded catch are presented.



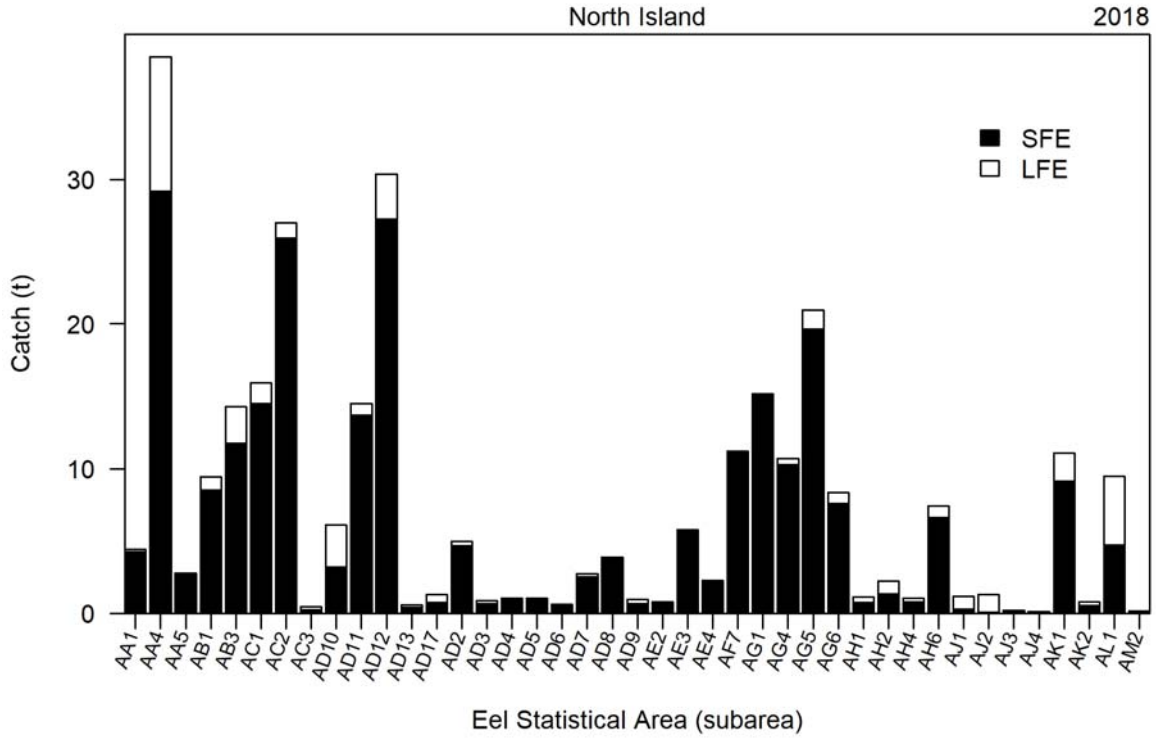


Figure 8– ***continued***

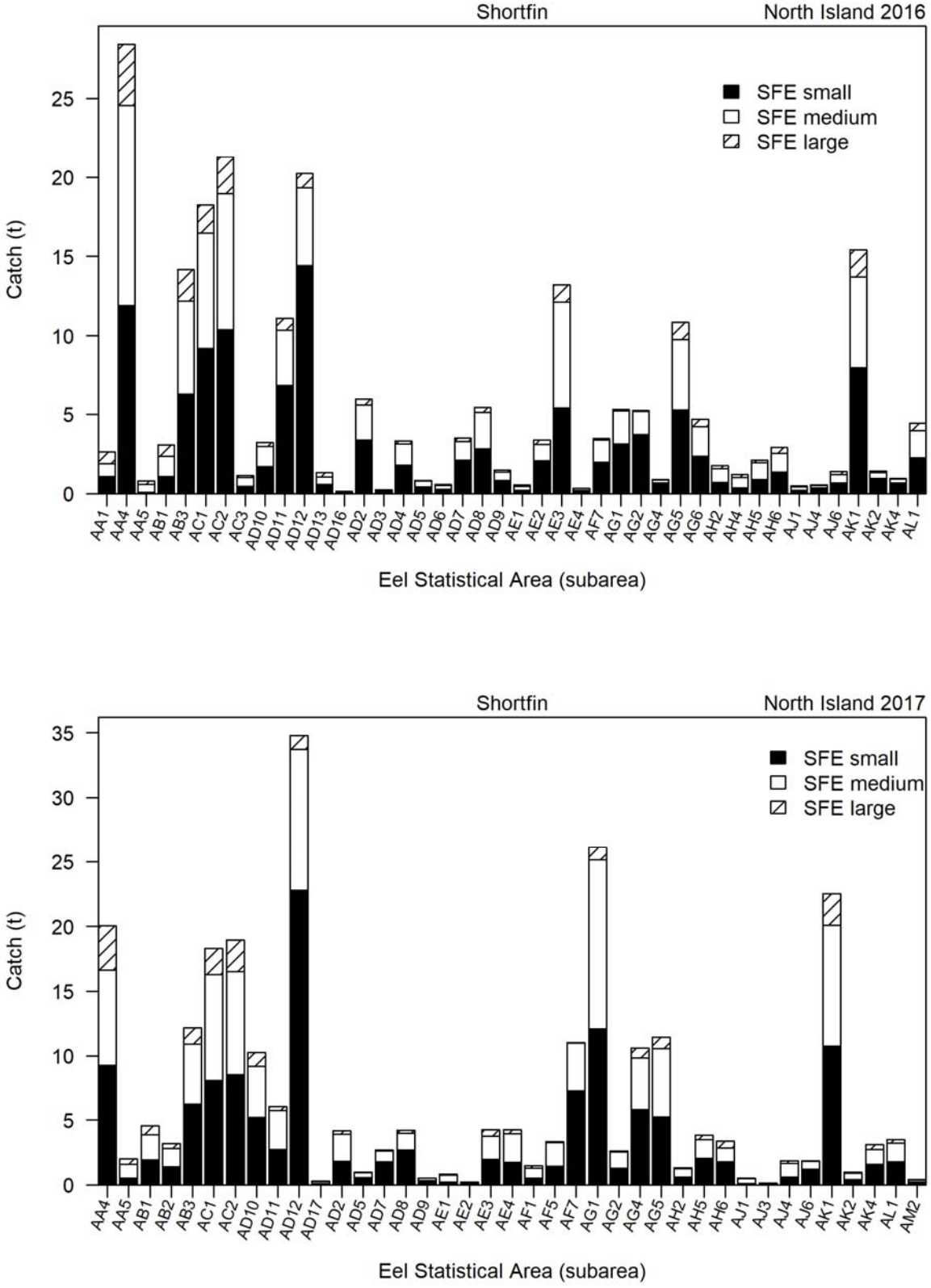


Figure 9: Catch of shortfin (SFE) eels by weight grade for North Island Eel Statistical Area subareas for fishing years 2015–16 (2016), 2016–17 (2017), and 2017–18 (2018). Only subareas with recorded catch are presented.

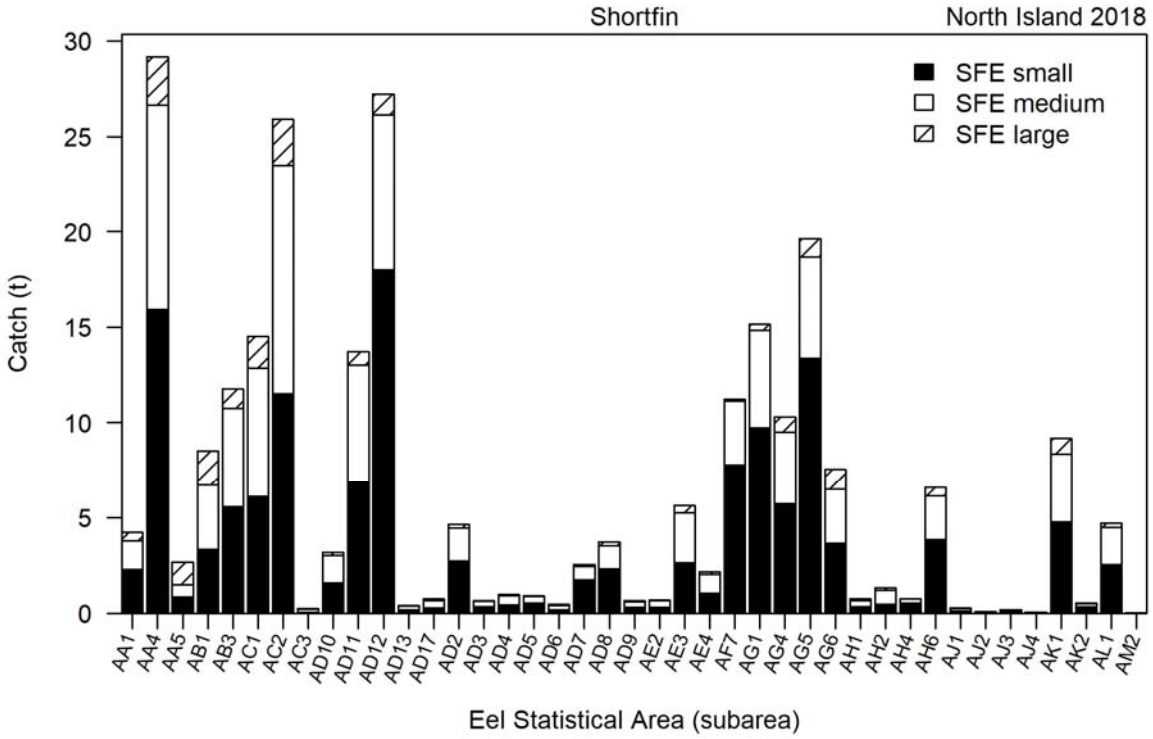


Figure 9 – ***continued***

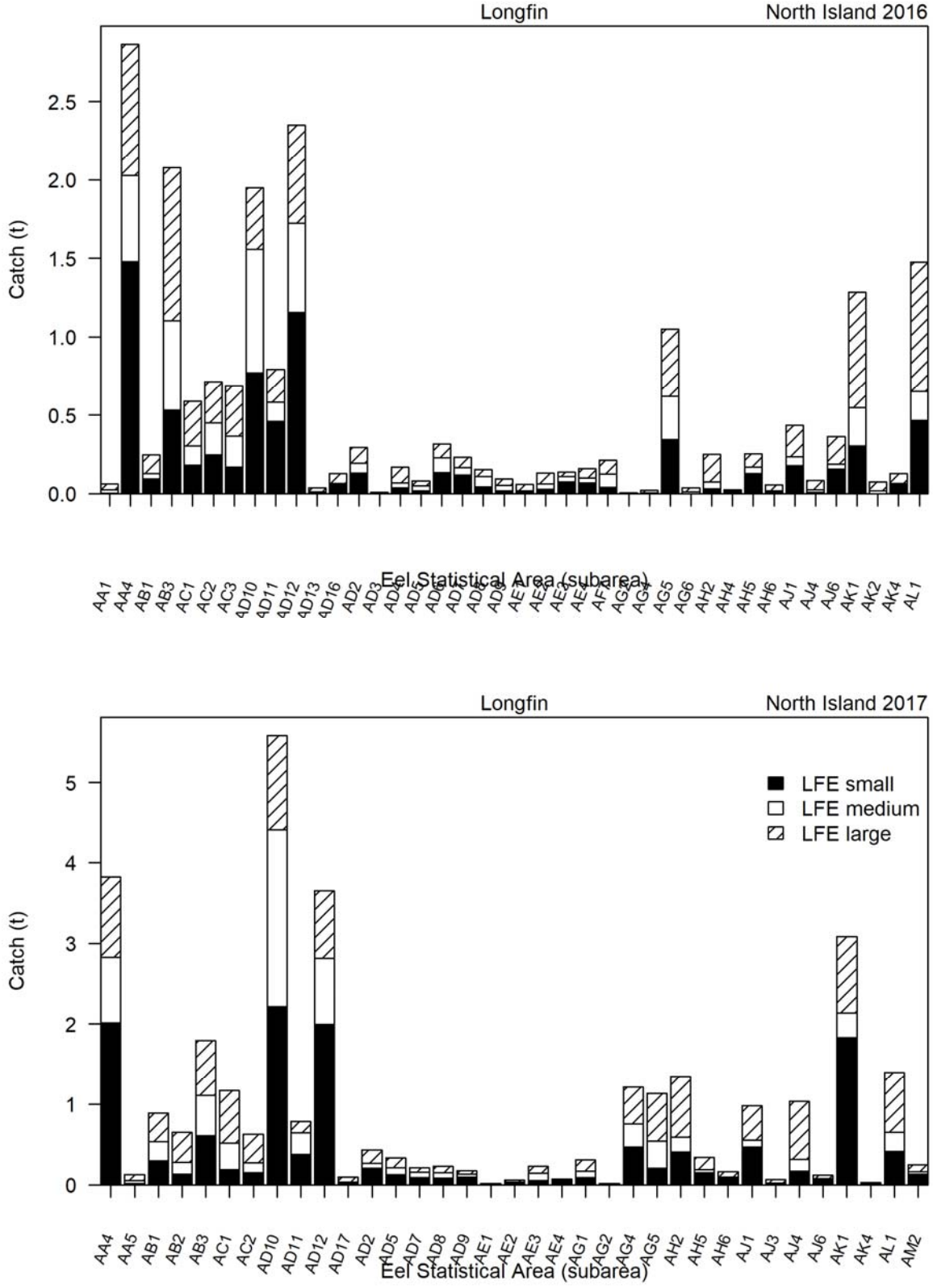


Figure 10: Catch of longfin (LFE) eels by weight grade and North Island Eel Statistical Area subarea for fishing years 2015–16 (2016), 2016–17 (2017), and 2017–18 (2018). Only subareas with recorded catch are presented.

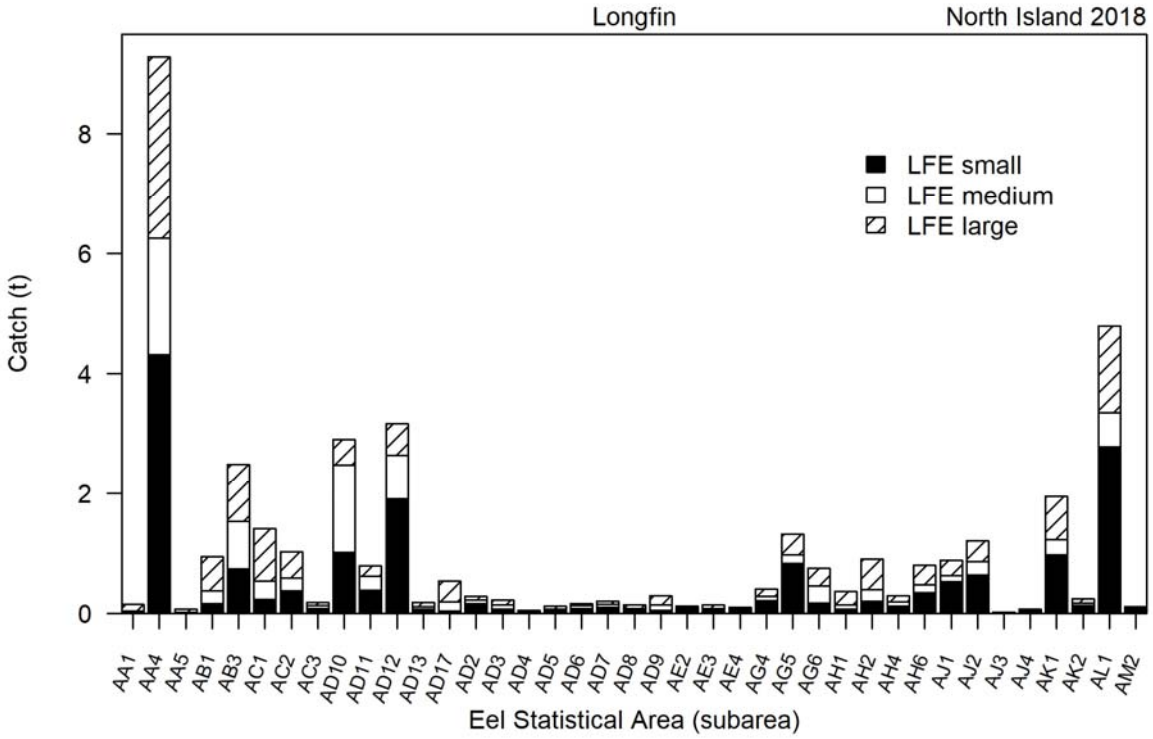


Figure 10 – ***continued***

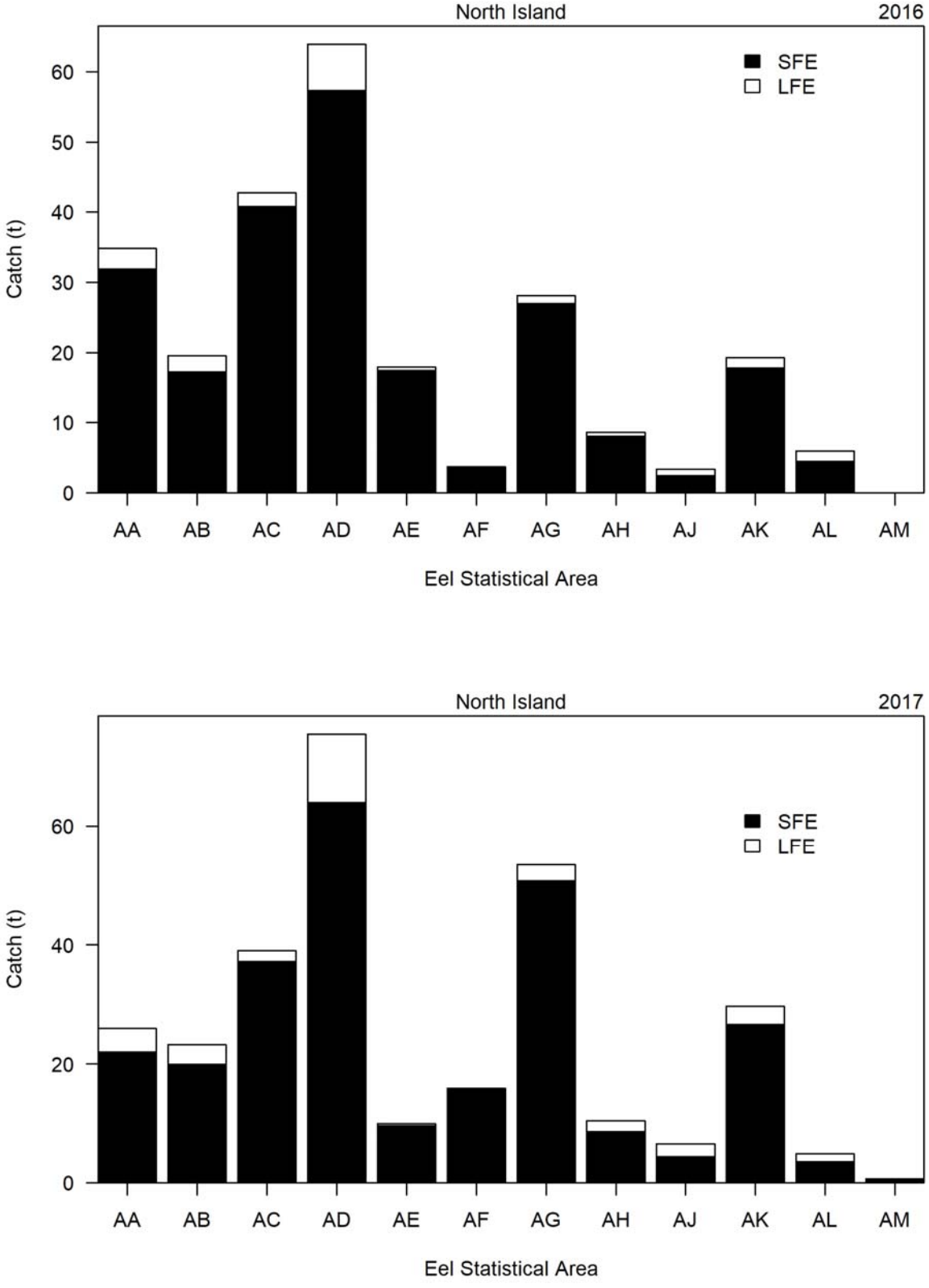
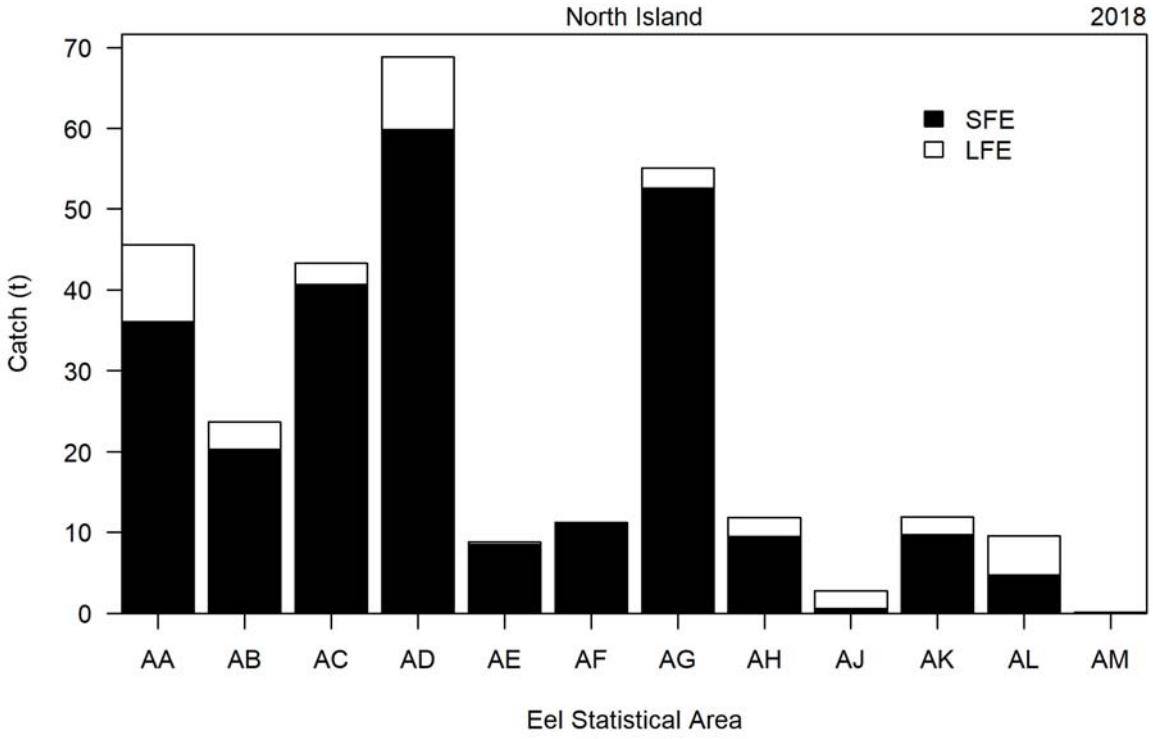


Figure 11: Catch of North Island shortfin (SFE) and longfin (LFE) eels by Eel Statistical Area for fishing years 2015–16 (2016), 2016–17 (2017), and 2017–18 (2018).



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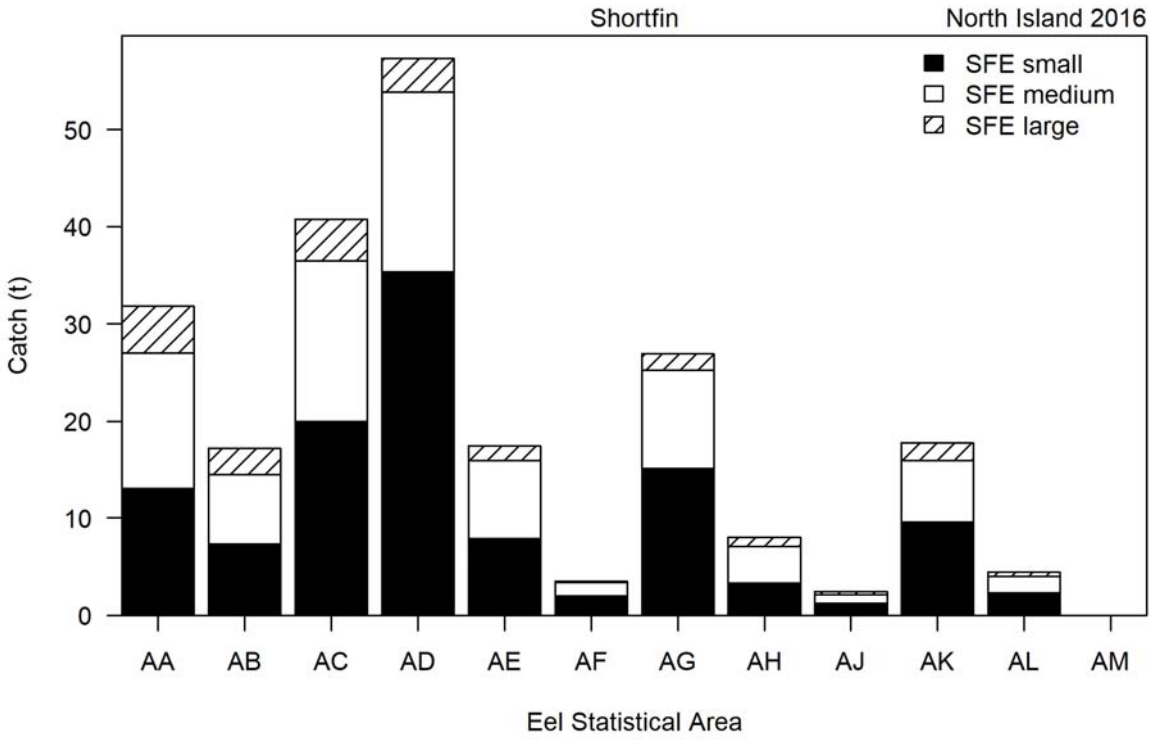


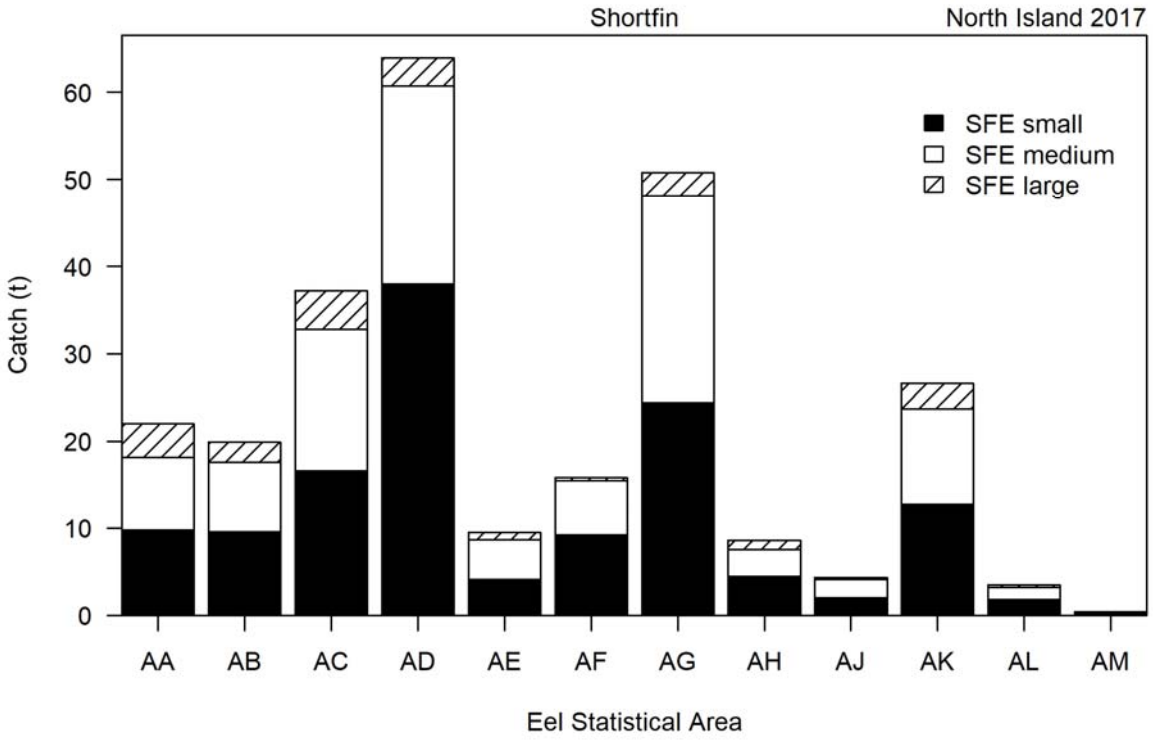
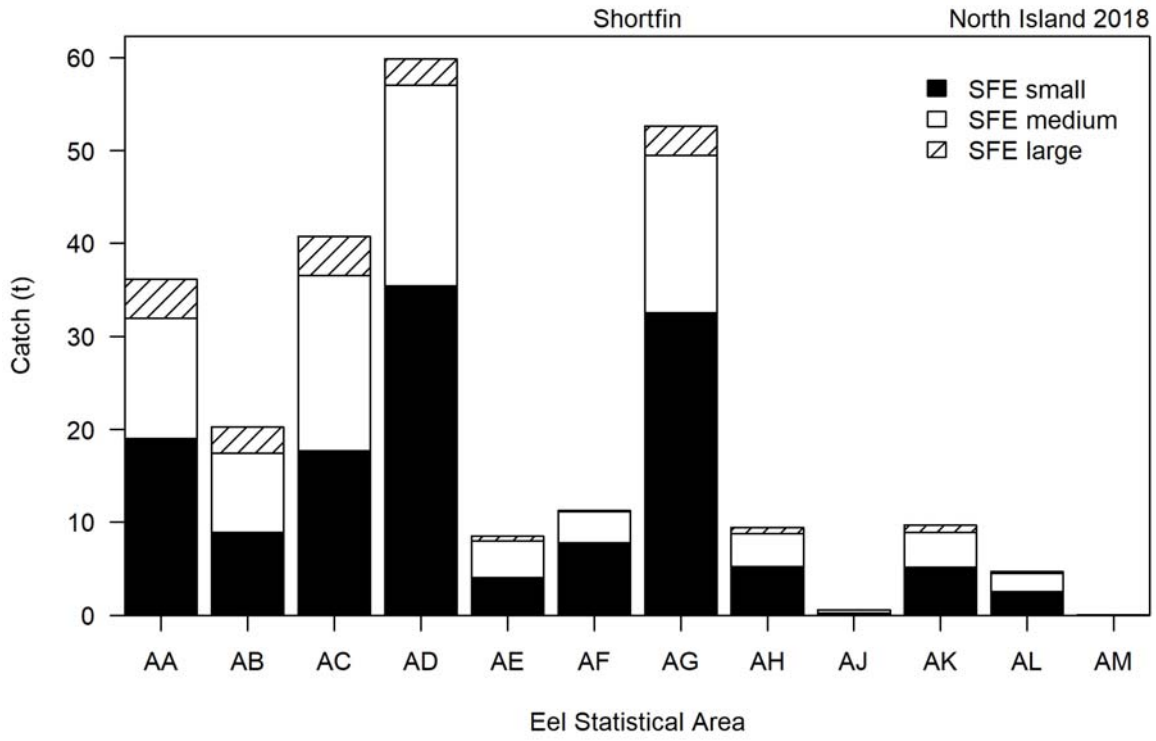


Figure 12: Catch of shortfin (SFE) eels by weight grade for North Island Eel Statistical Area for fishing years 2015–16 (2016), 2016–17 (2017), and 2017–18 (2018).



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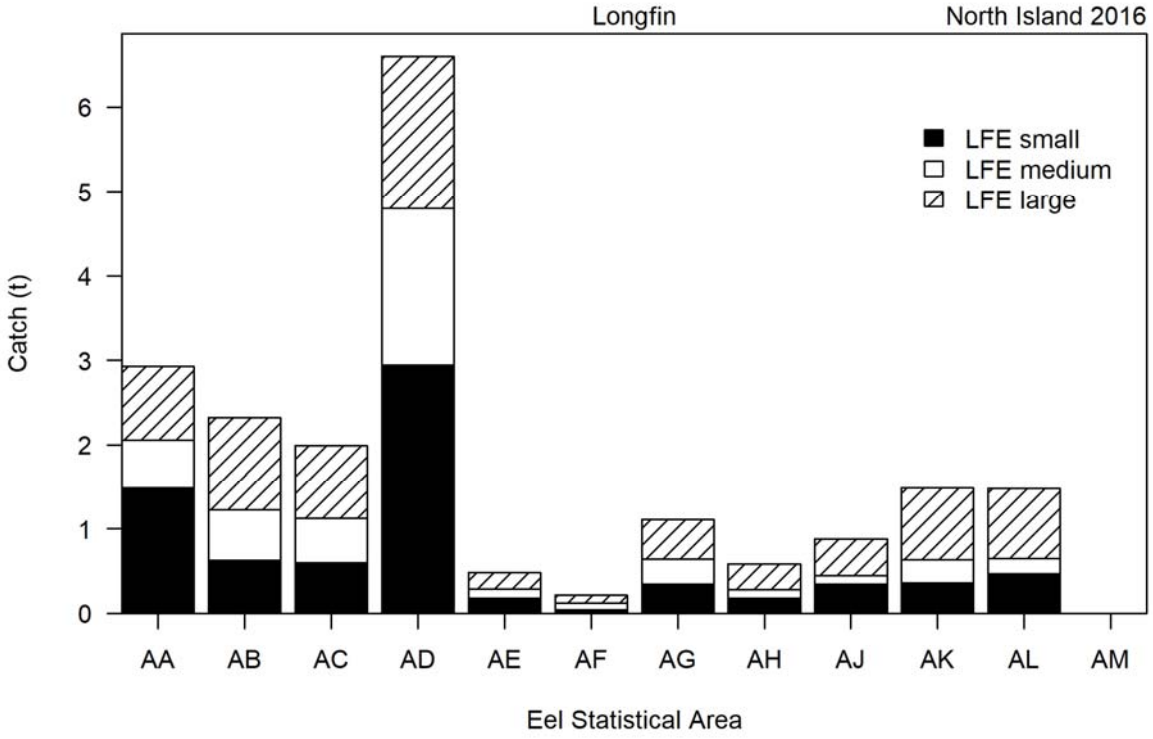


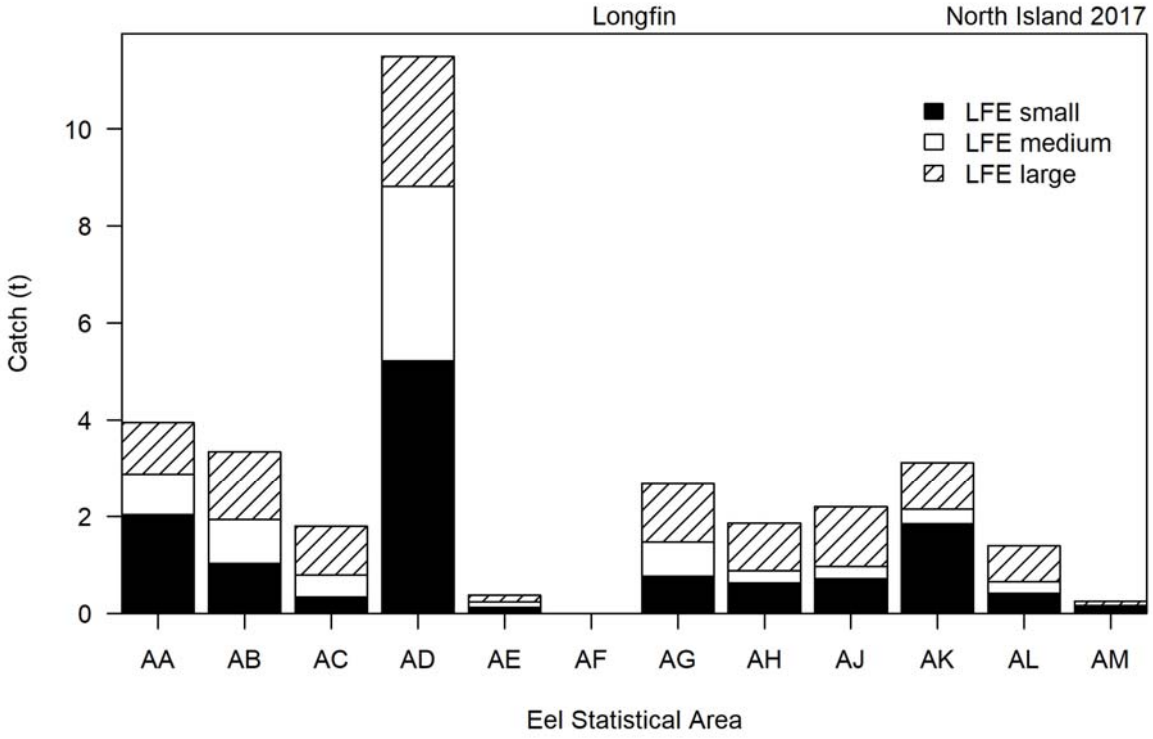
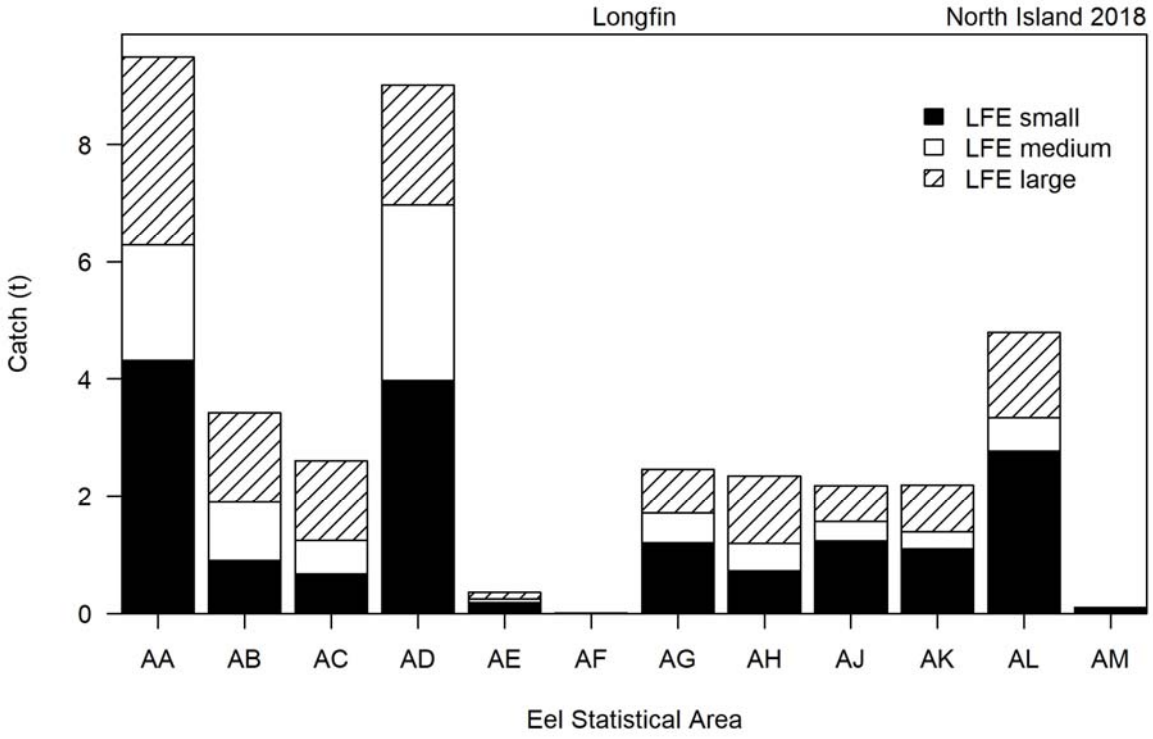


Figure 13: Catch of longfin (LFE) eels by weight grade and North Island Eel Statistical Area for fishing years 2015–16 (2016), 2016–17 (2017), and 2017–18 (2018).



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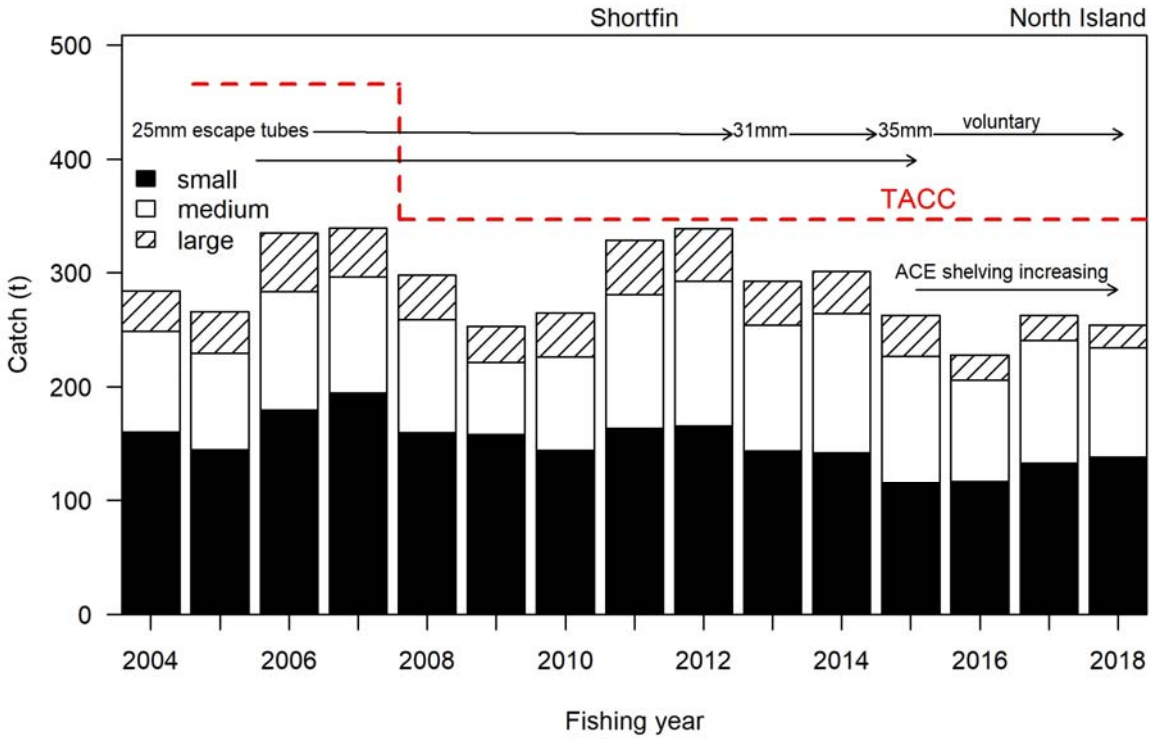


Figure 14: North Island shortfin eel catch by weight (t) for each weight grade from 2003–04 to 2017–18. Events that may have impacted on the catch are annotated on the plot.

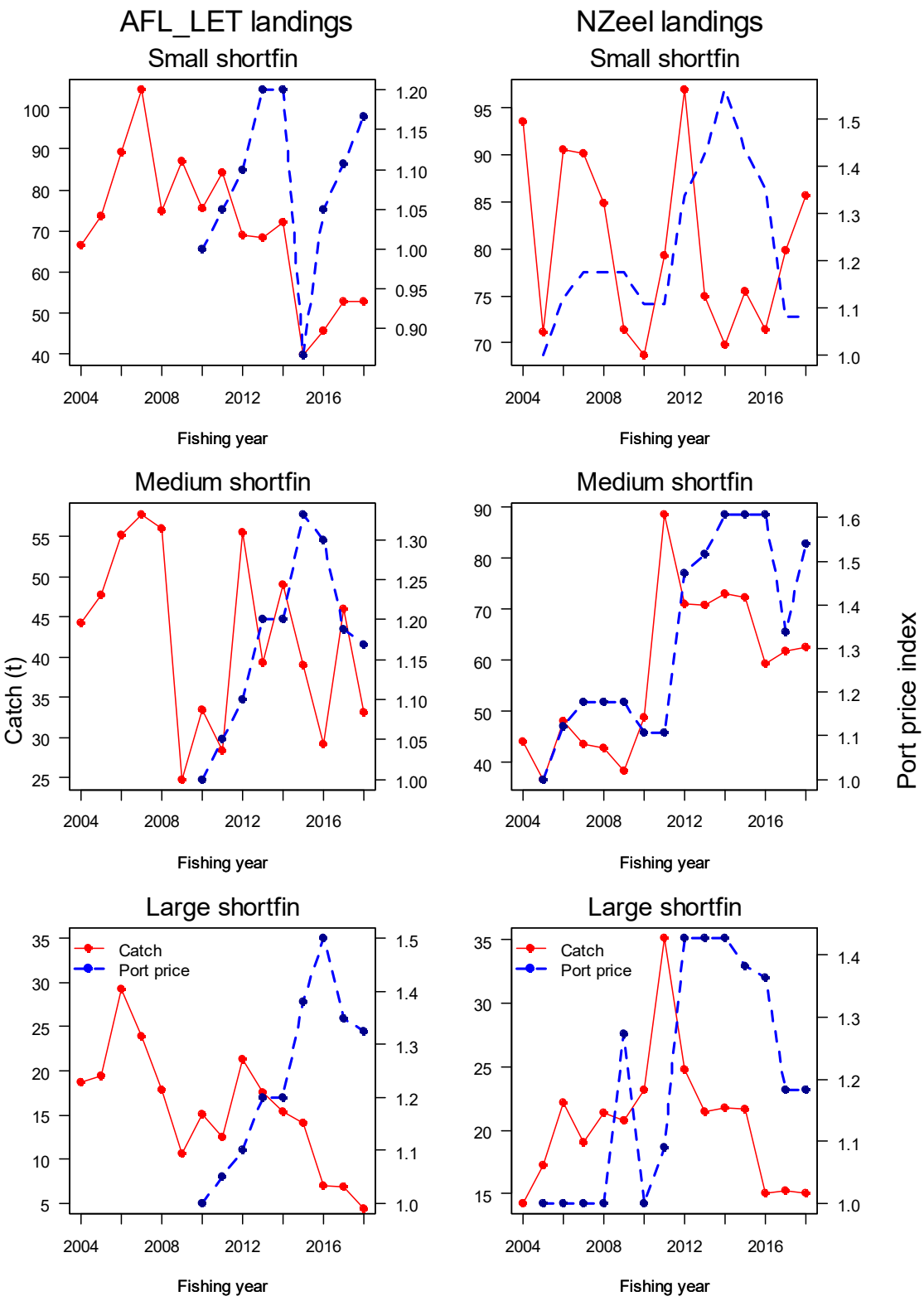


Figure 15: Port price index versus catch for three grades of shortfin eel for both North Island eel processors. AFL-LET port price data begins in 2009–10 fishing year.

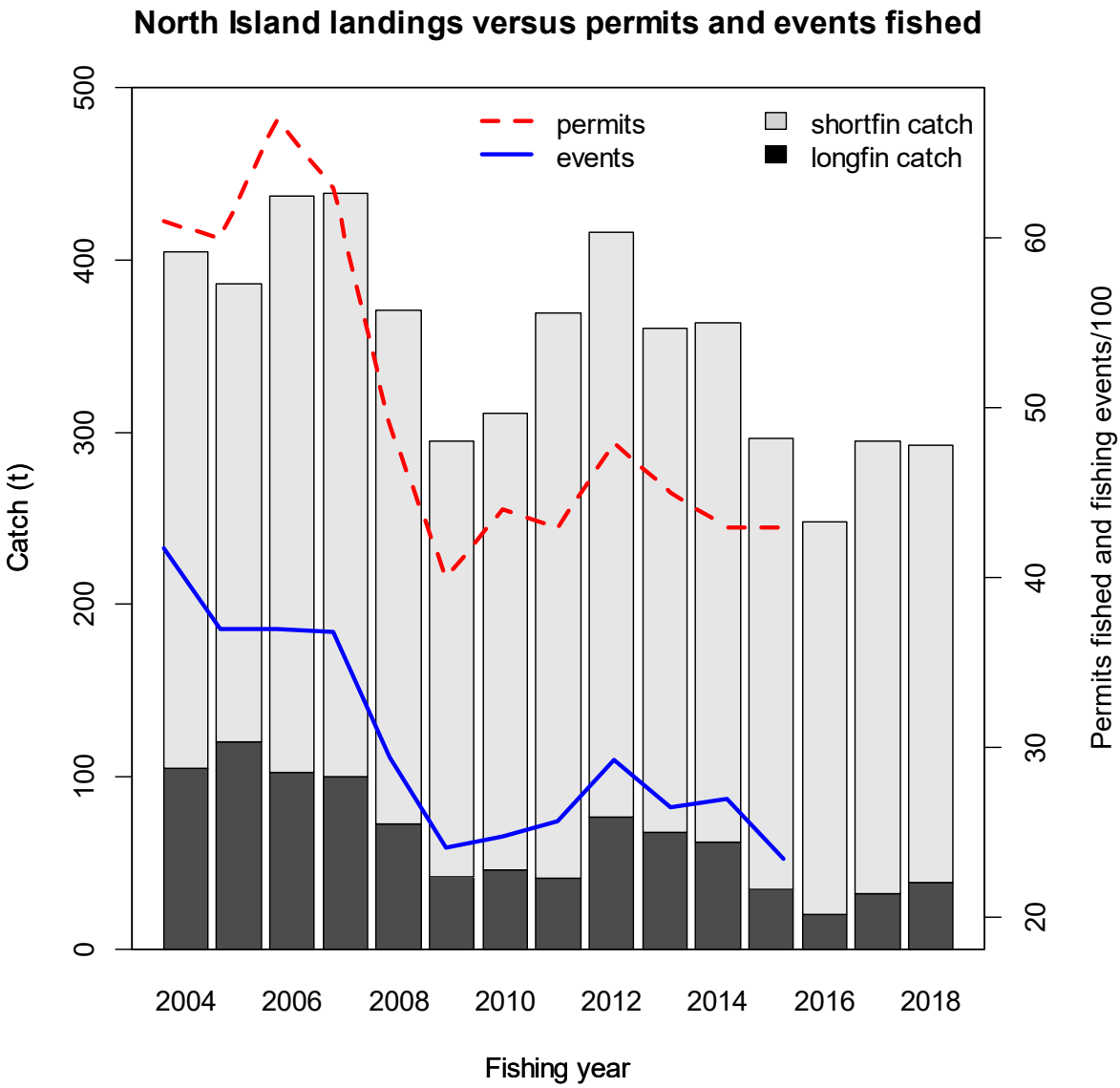


Figure 16: Catch of shortfin and longfin eels, number of permits fished and fishing events by fishing year. A fishing event is where a number of fyke nets were set overnight. Permit and event data are from Beentjes & McKenzie (2017).

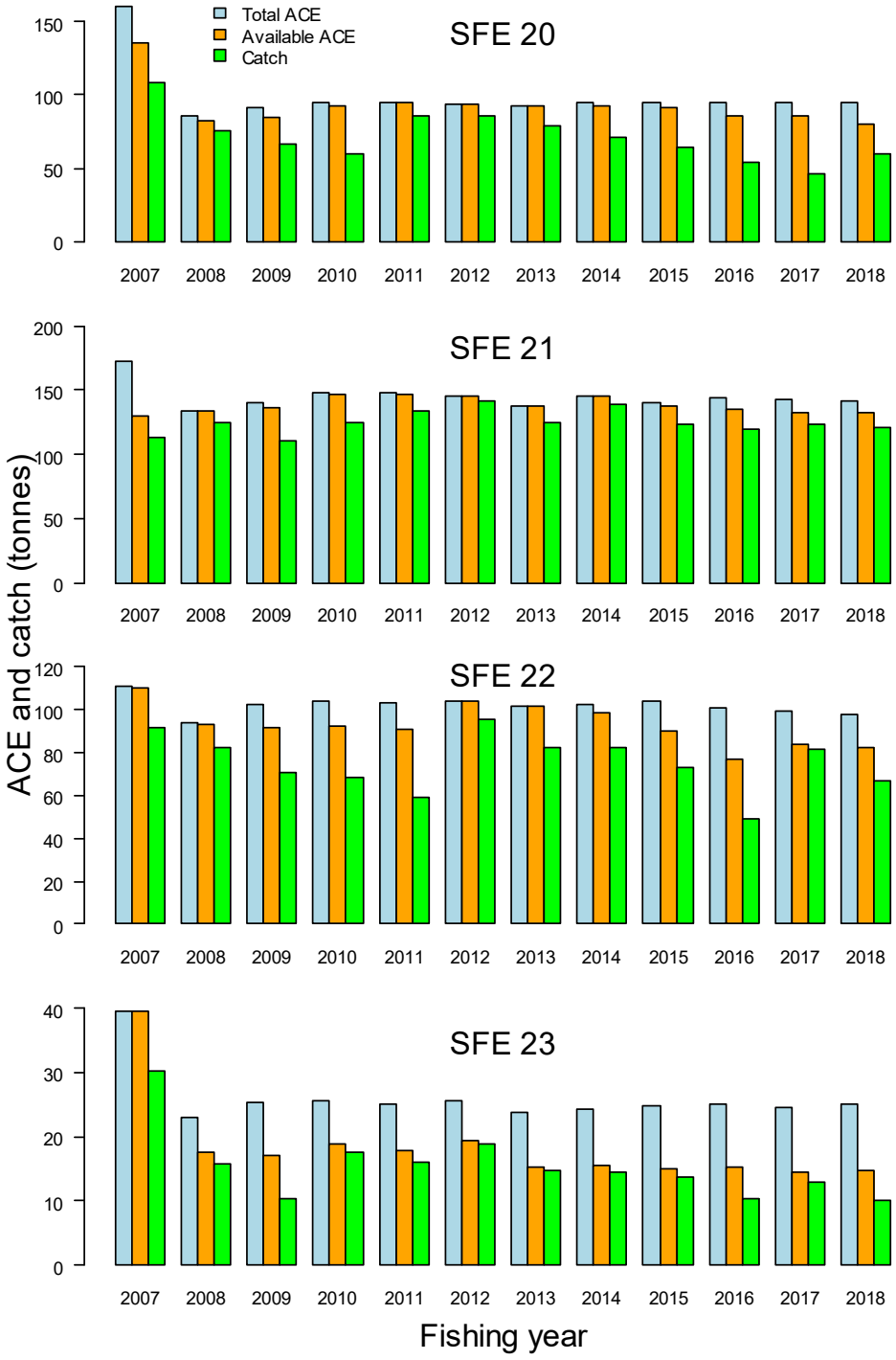


Figure 17: Shortfin data on shelving of ACE by Quota Management Area. Total ACE, the total amount of ACE that can potentially be leased to fishers based on quota shares and carry overs of ACE; ACE available, the total amount of ACE that is made available for lease to fishers; catch, the landed catch. Data are from FishServe and were provided to NIWA by NZEel Processors Ltd; ACE, annual catch entitlement.

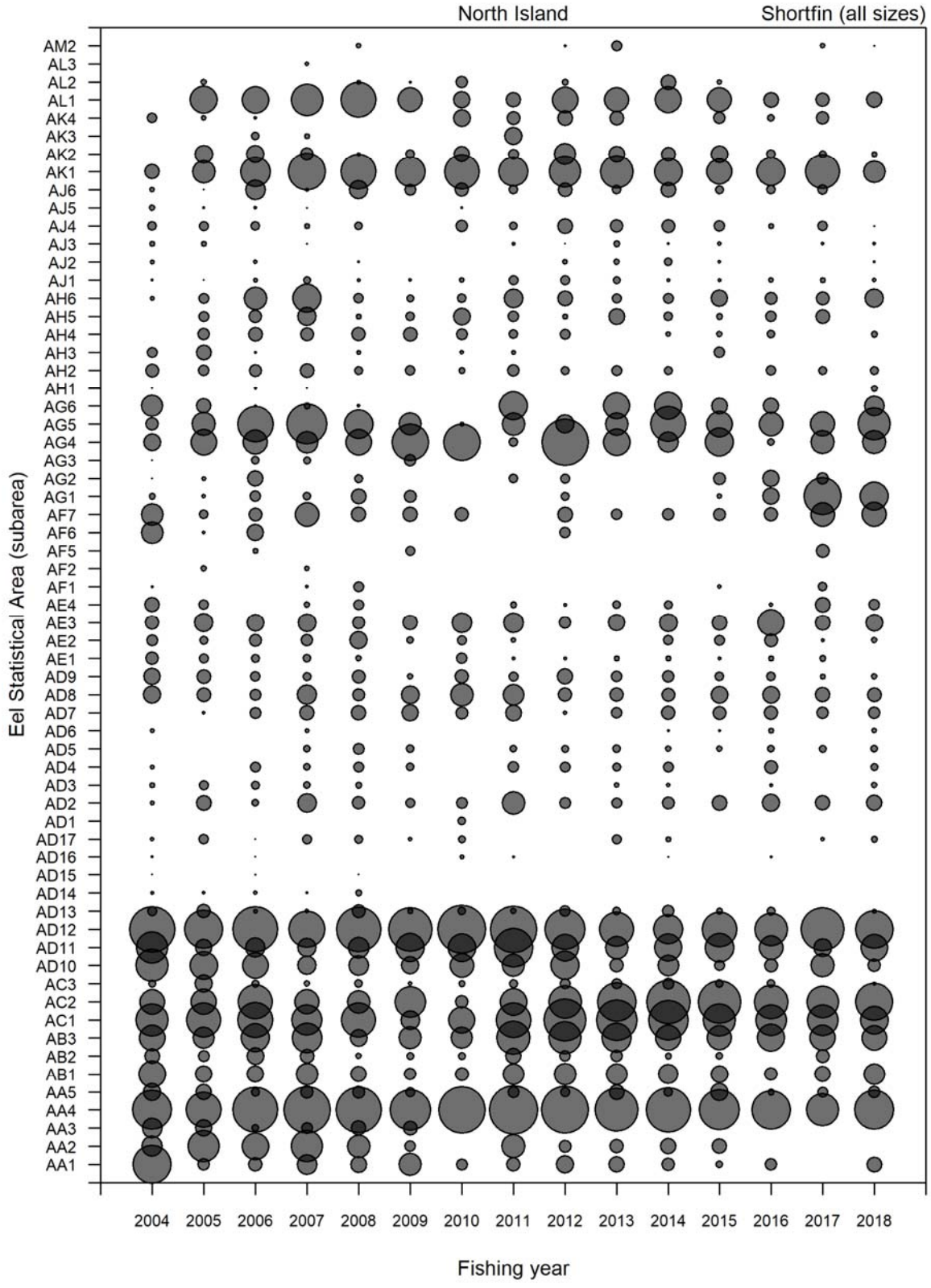


Figure 18: North Island shortfin catch by Eel Statistical Area subarea from 2003–04 to 2017–18. Maximum = 44.7 t.

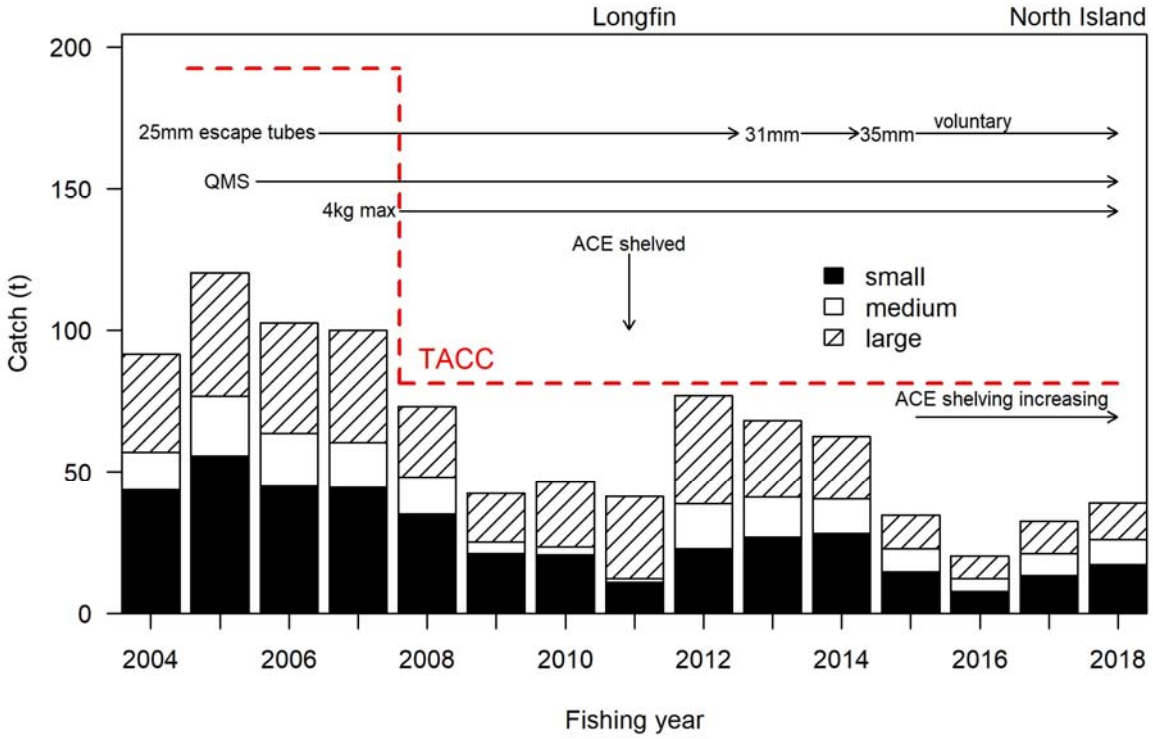


Figure 19: North Island longfin eel catch by weight (t) for the three weight grades from 2003–04 to 2017–18. Events that may have impacted on the catch are annotated on the plot.

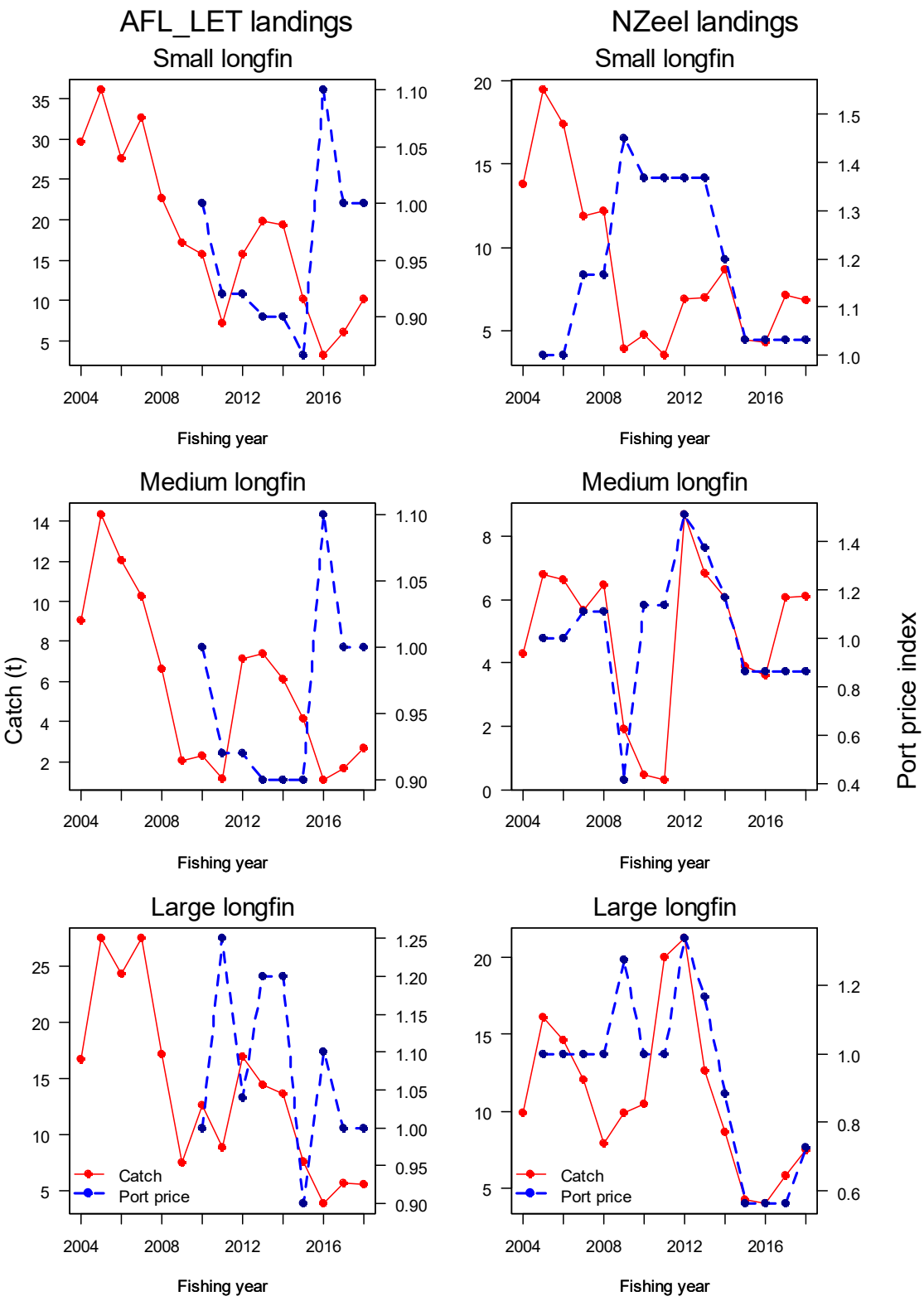


Figure 20: Port price index versus and catch for three grades of longfin eel for both North Island eel processors. AFL-LET port price data begins in 2009–10 fishing year.

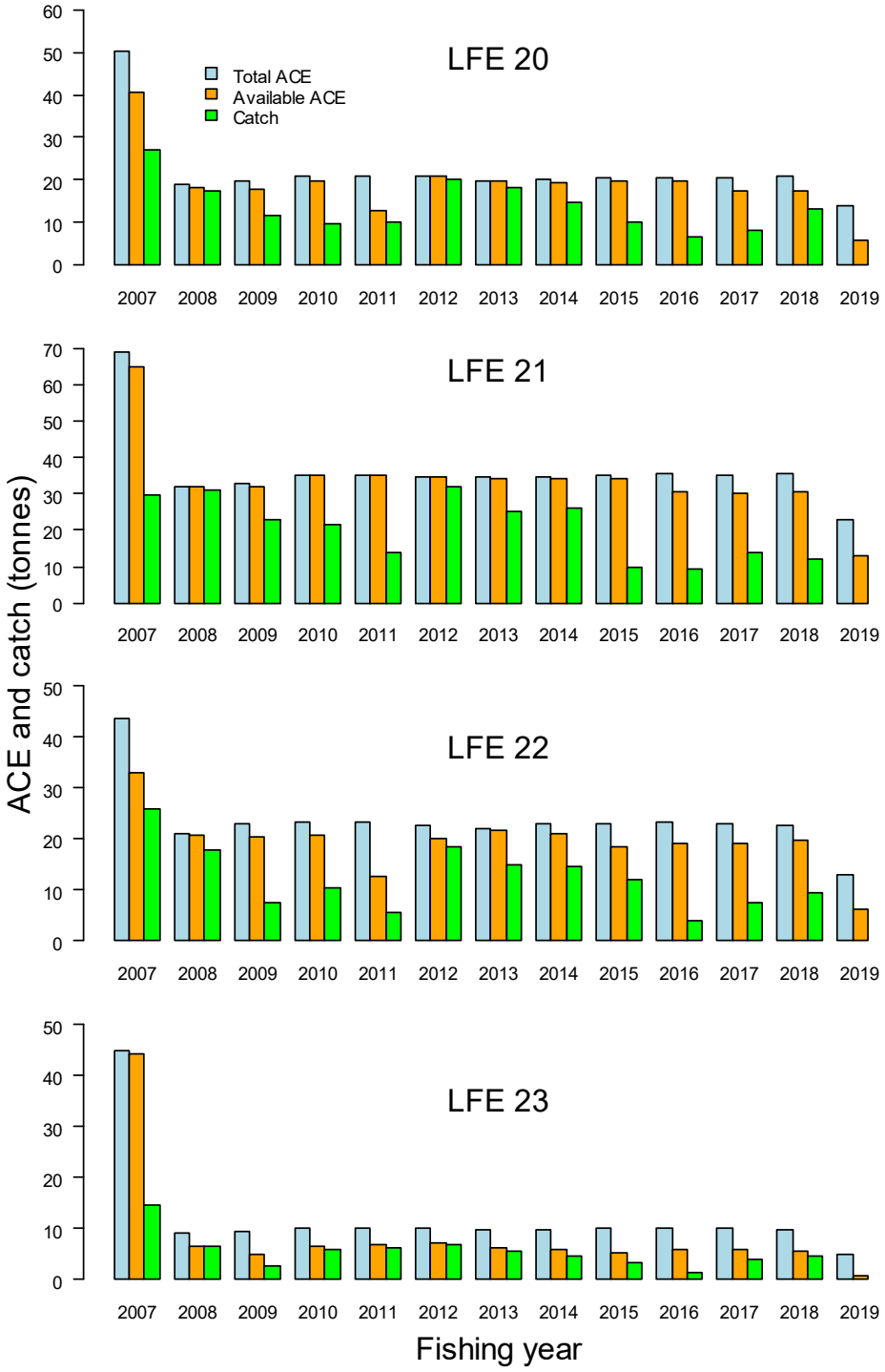


Figure 21: Longfin data on shelving of ACE by Quota Management Area. Total ACE, the total amount of ACE that can potentially be leased to fishers based on quota shares and carry overs of ACE; ACE available, the total amount of ACE that is made available for lease to fishers; catch, the landed catch. Data are from FishServe and were provided to NIWA by NZEel Processors Ltd; ACE, annual catch entitlement.

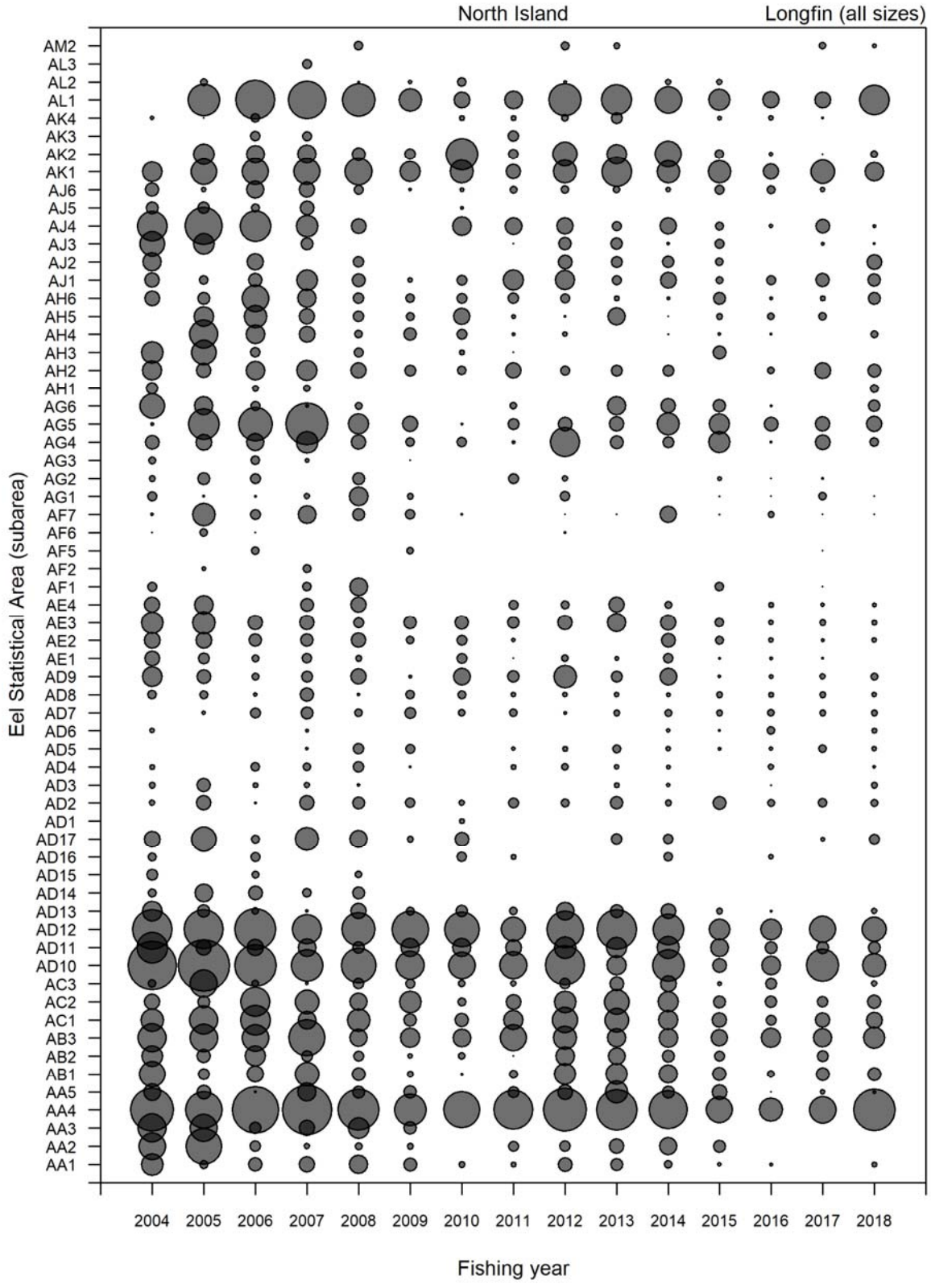


Figure 22: North Island longfin catch by Eel Statistical Area subarea from 2003–04 to 2017–18. Maximum = 13.9 t.

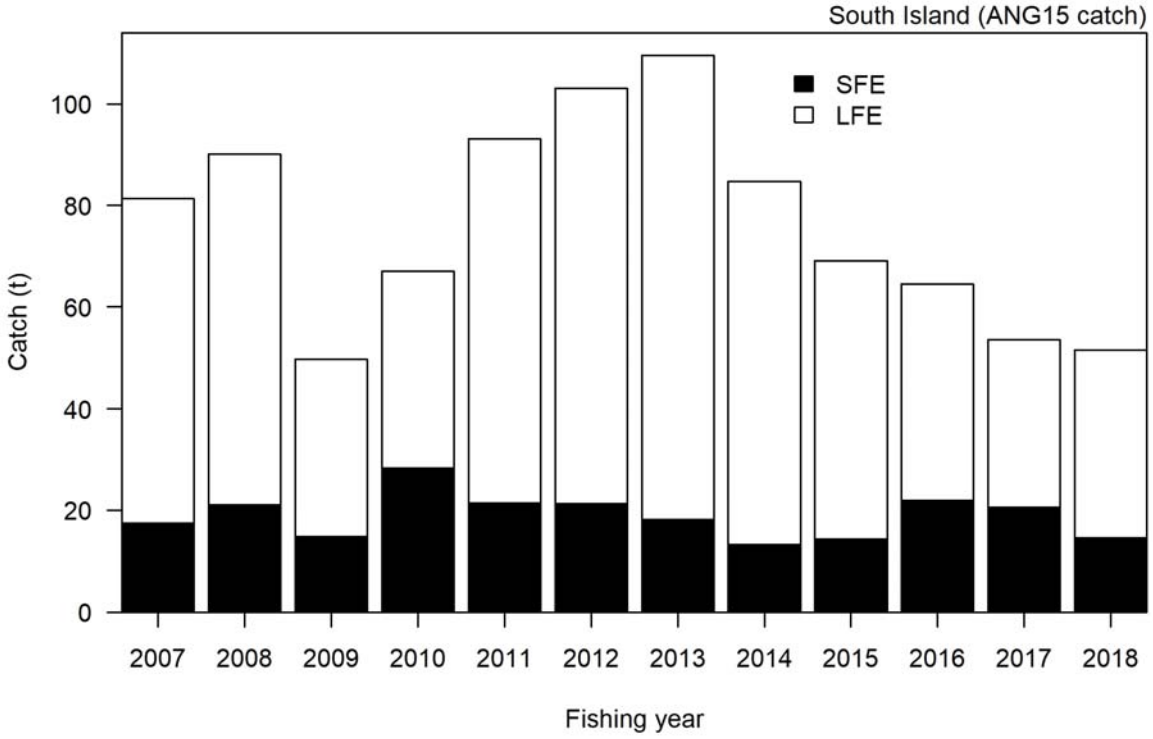


Figure 23: ANG 15 total commercial catch (t) of shortfin (SFE), longfin (LFE) for the years 2006–07 to 2017–18.

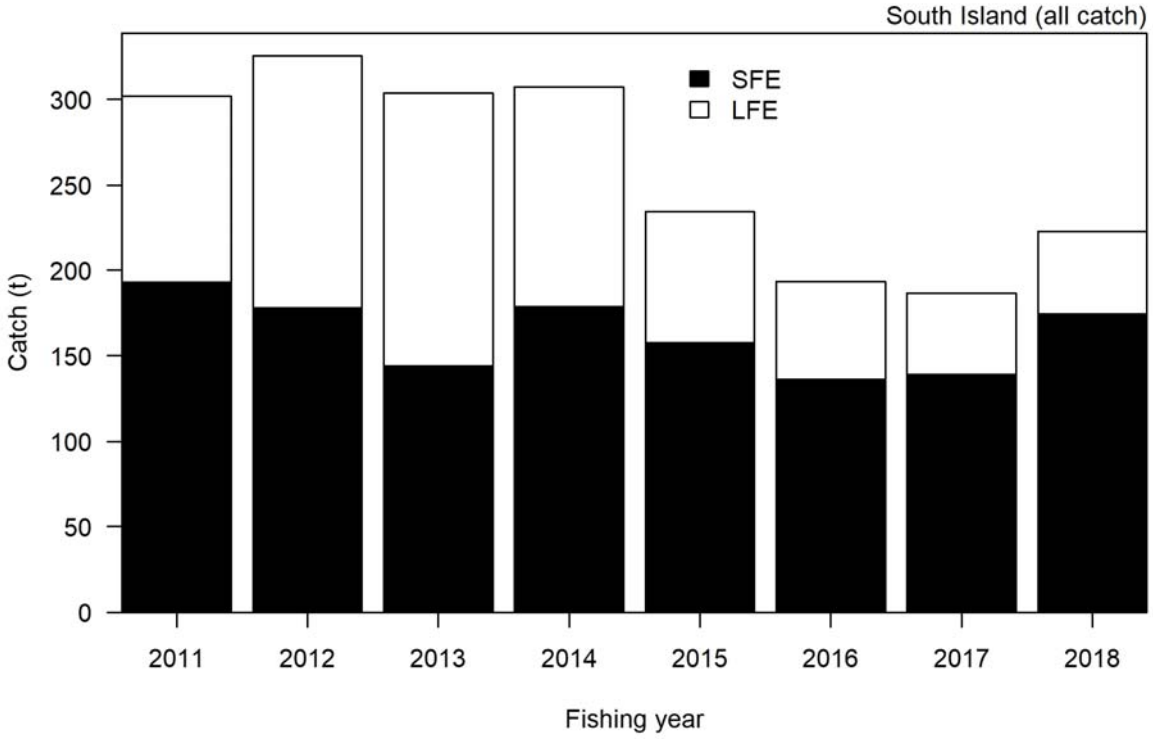


Figure 24: South Island commercial catch (t) of shortfin (SFE) and longfin (LFE) eels for the years 2010–11 to 2017–18.

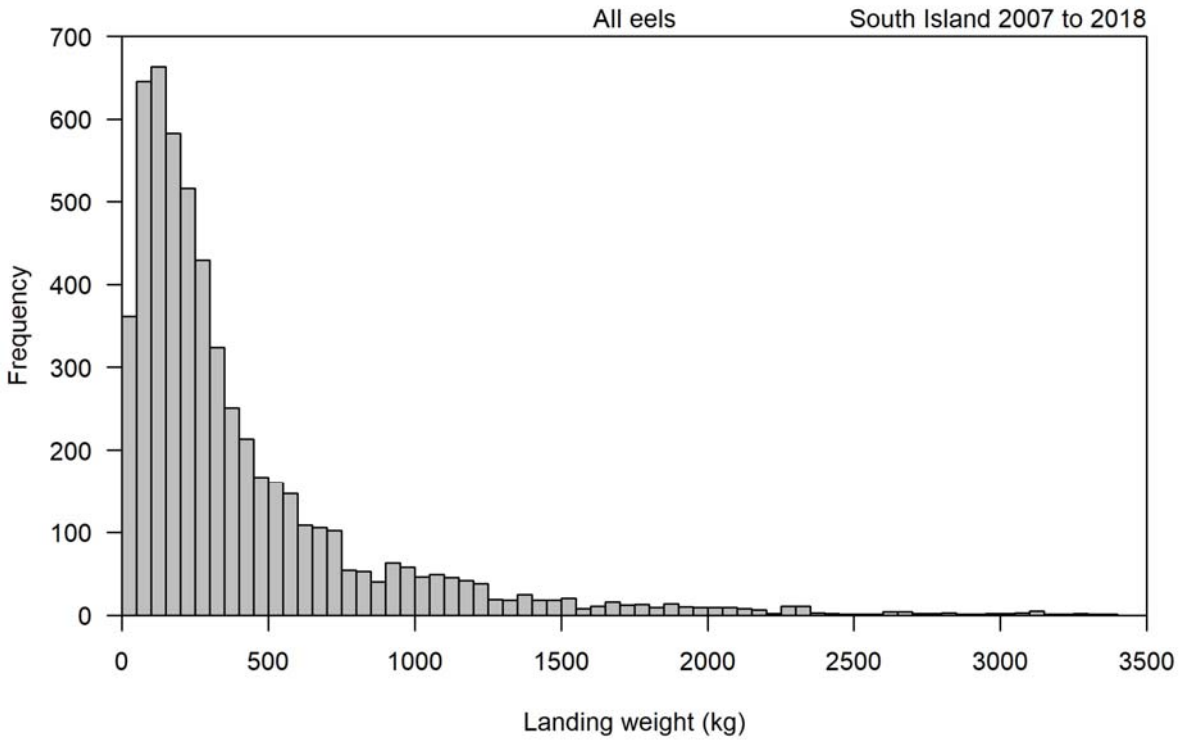


Figure 25: Distribution of individual eel landing weights in the South Island for 2006–07 to 2017–18. Landings include both shortfin and longfin eels, and the period 2006–07 to 2009–10 is for ANG 15 only.

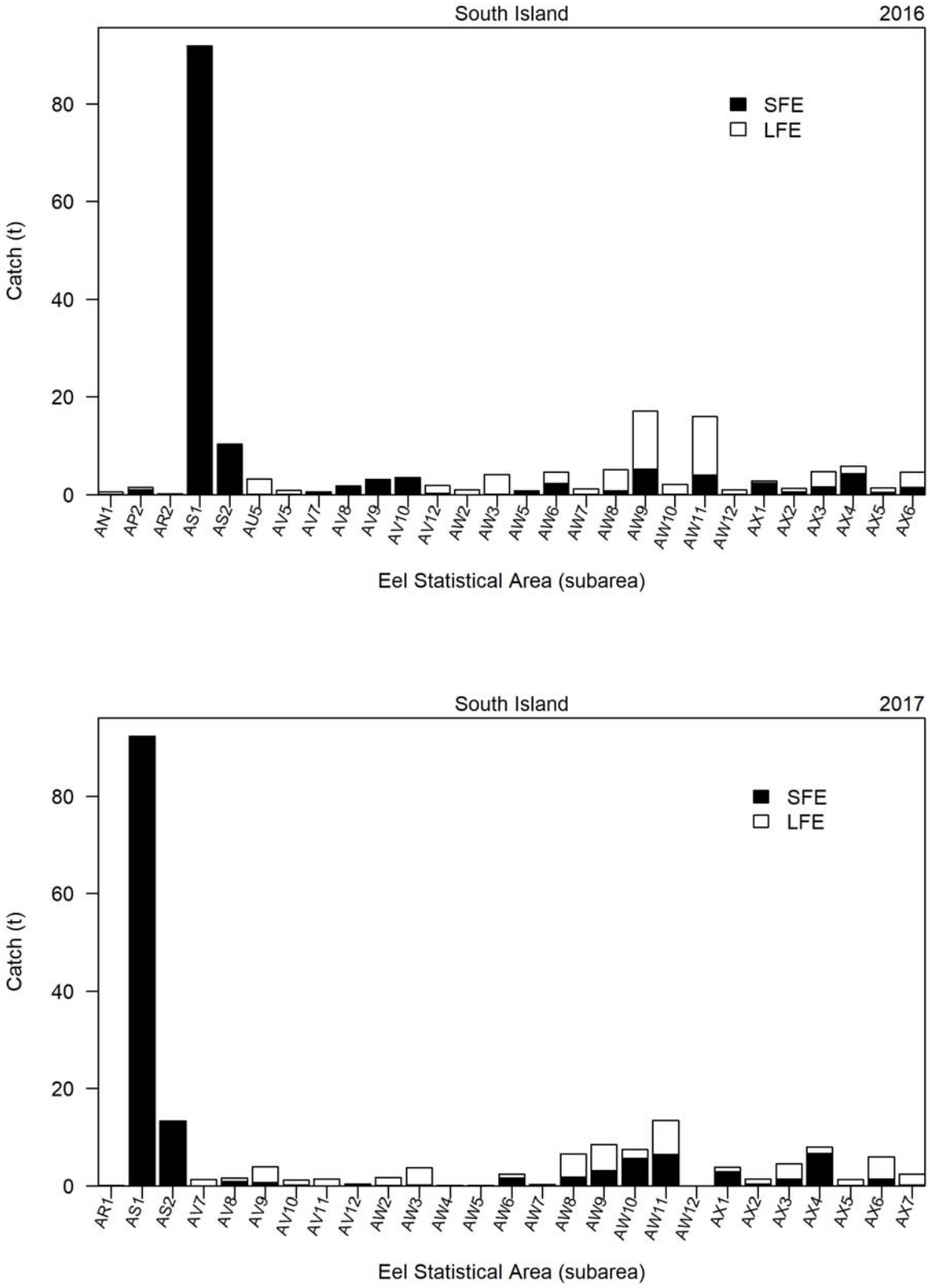


Figure 26: Catch of South Island shortfin (SFE) and longfin (LFE) eels by Eel Statistical Area subarea for 2015–16 (2016), 2016–17 (2017), and 2017–18 (2018).

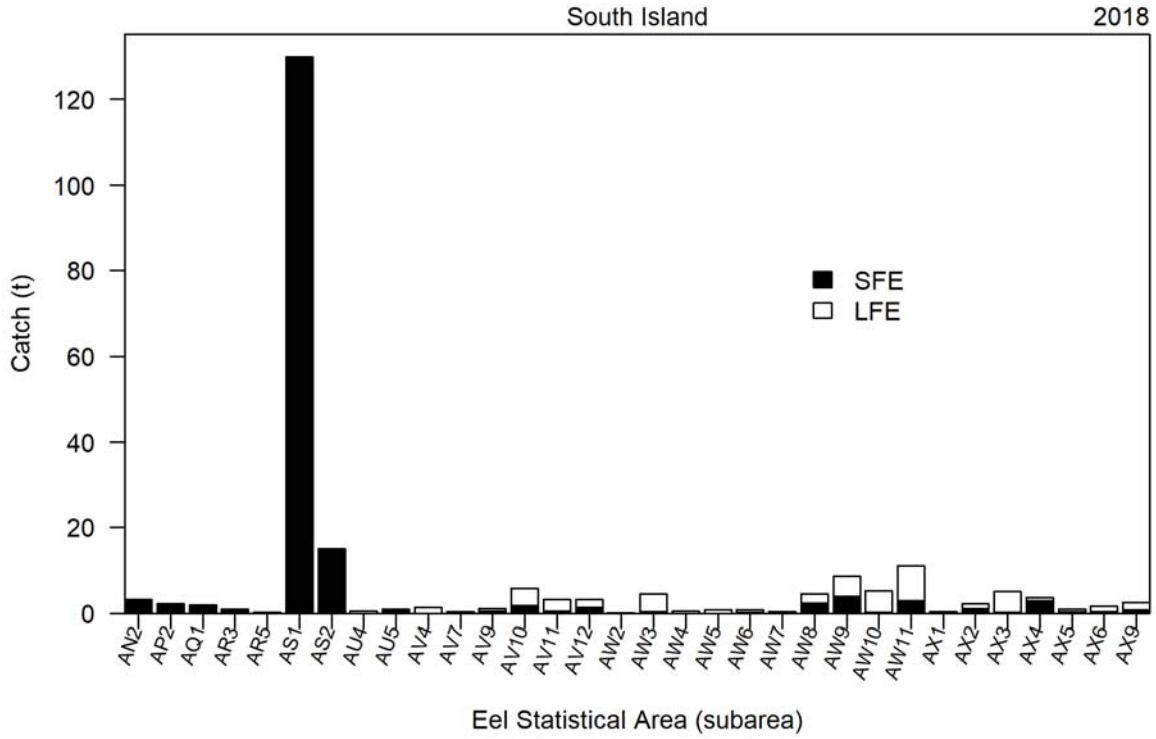


Figure 26 – *continued*

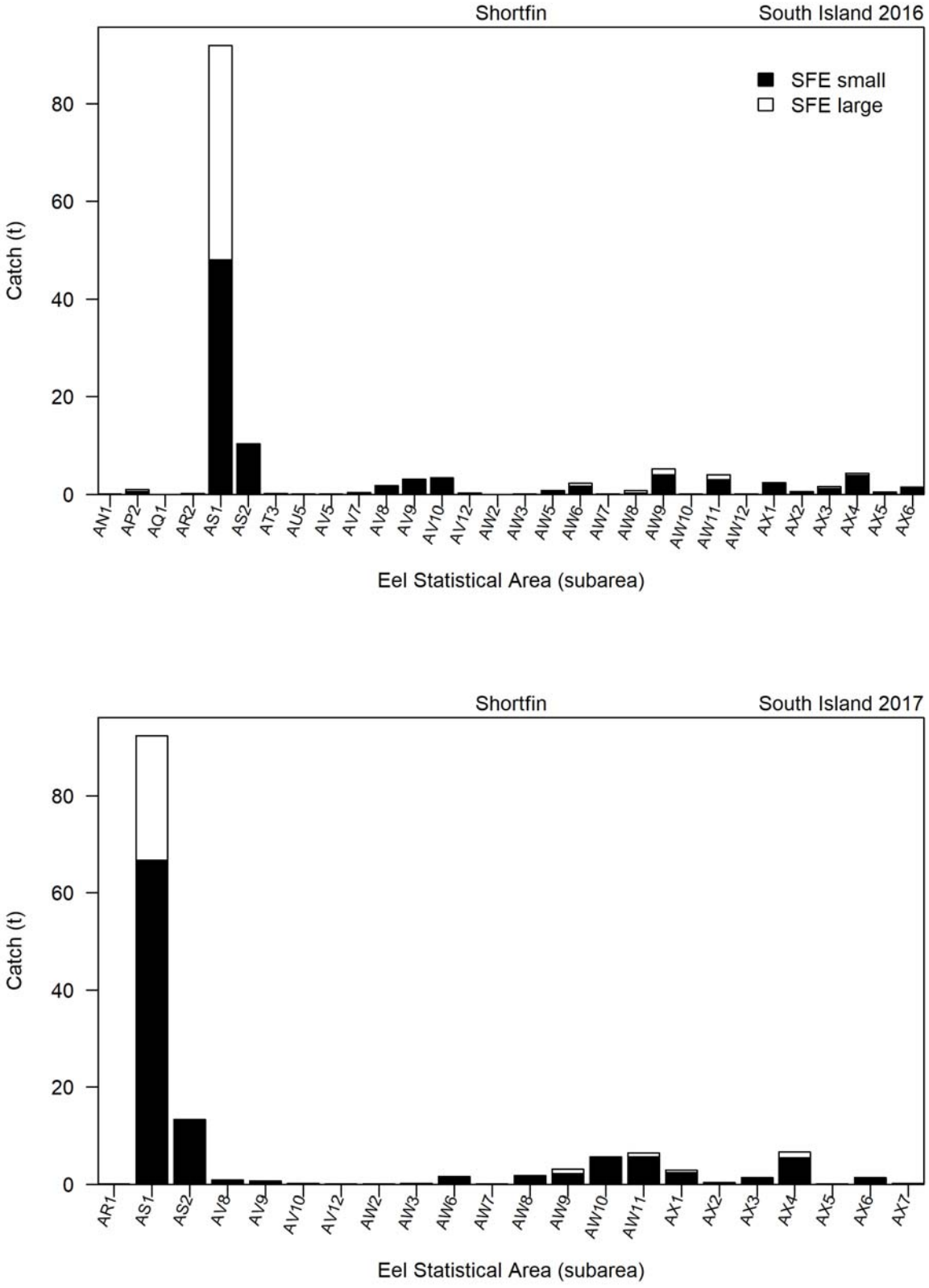


Figure 27: Catch of shortfin (SFE) eels by weight grade for South Island Eel Statistical Area subareas for fishing years 2015–16 (2016), 2016–17 (2017), and 2017–18 (2018). Only subareas with recorded catch are presented.

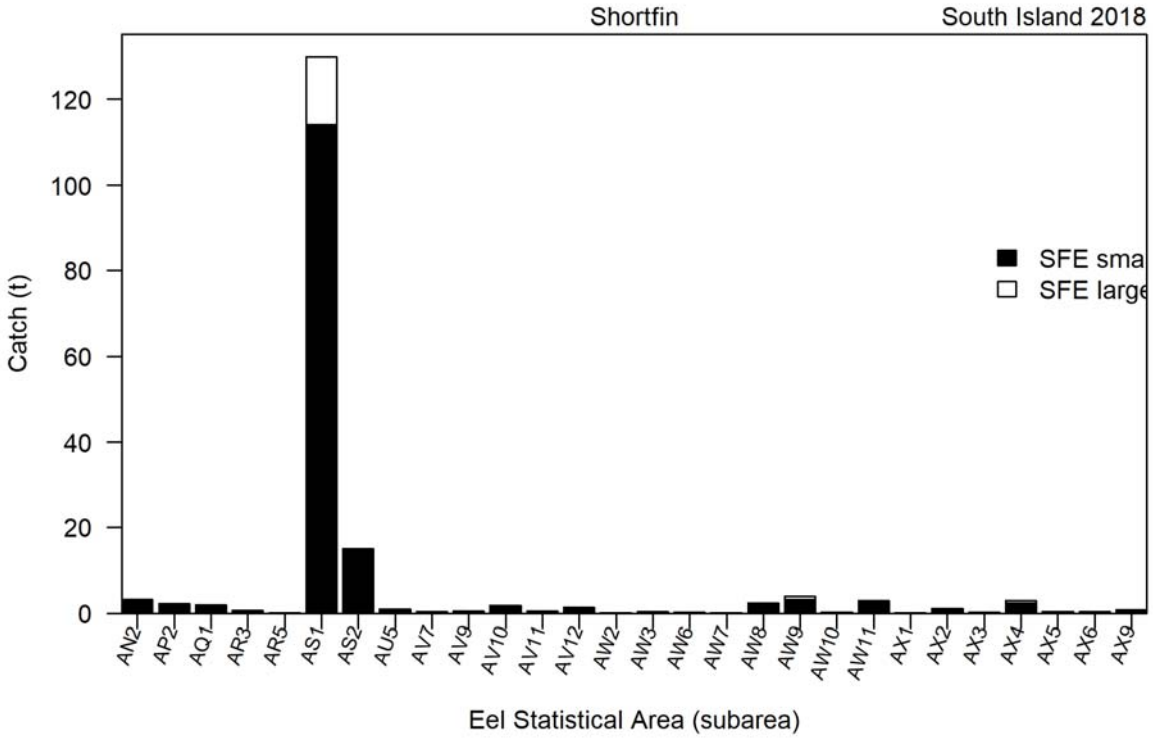


Figure 27 – *continued*

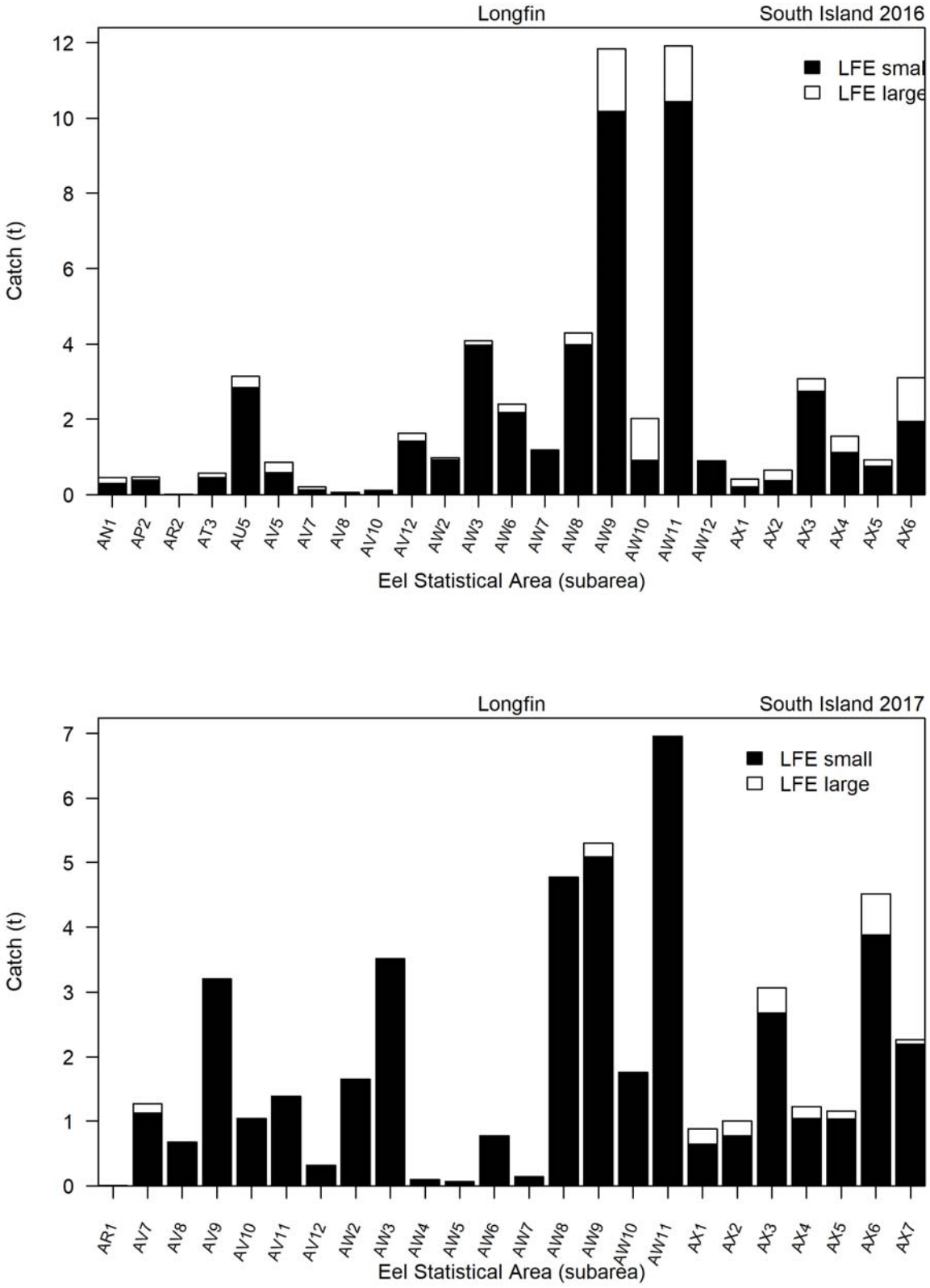


Figure 28: Catch of longfin (LFE) eels by weight grade for South Island Eel Statistical Area subareas for fishing years 2015–16 (2016), 2016–17 (2017), and 2017–18 (2018).

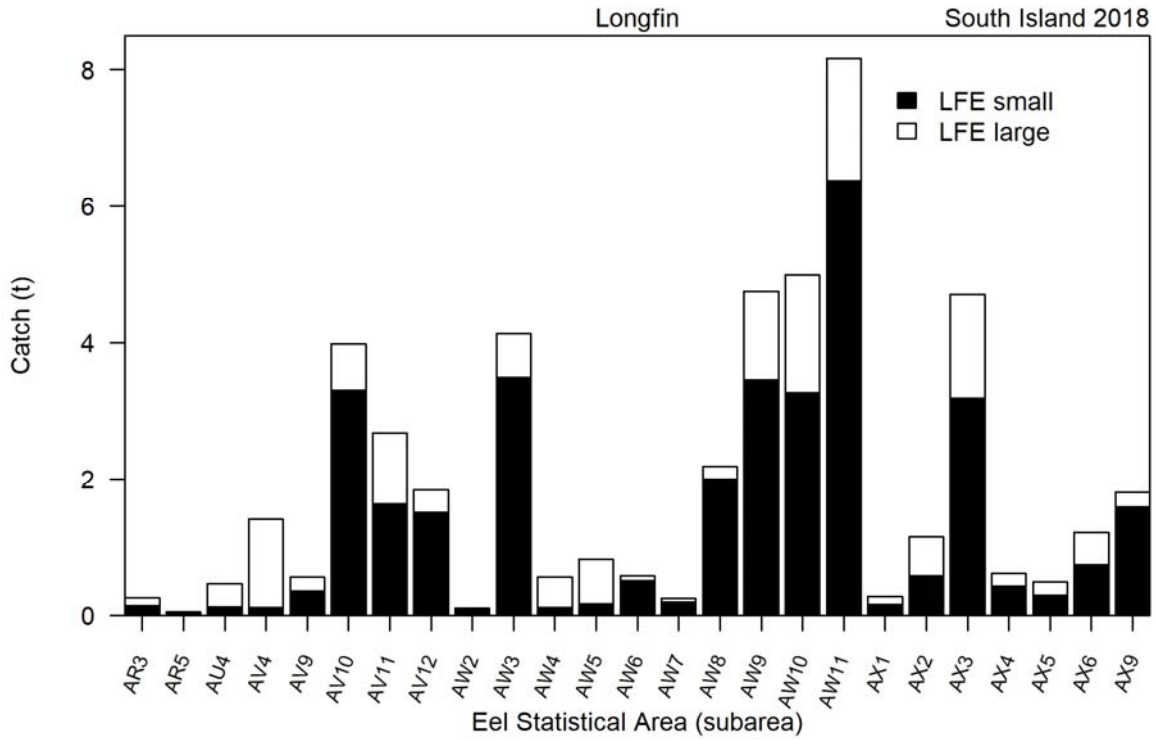


Figure 28 – ***continued***

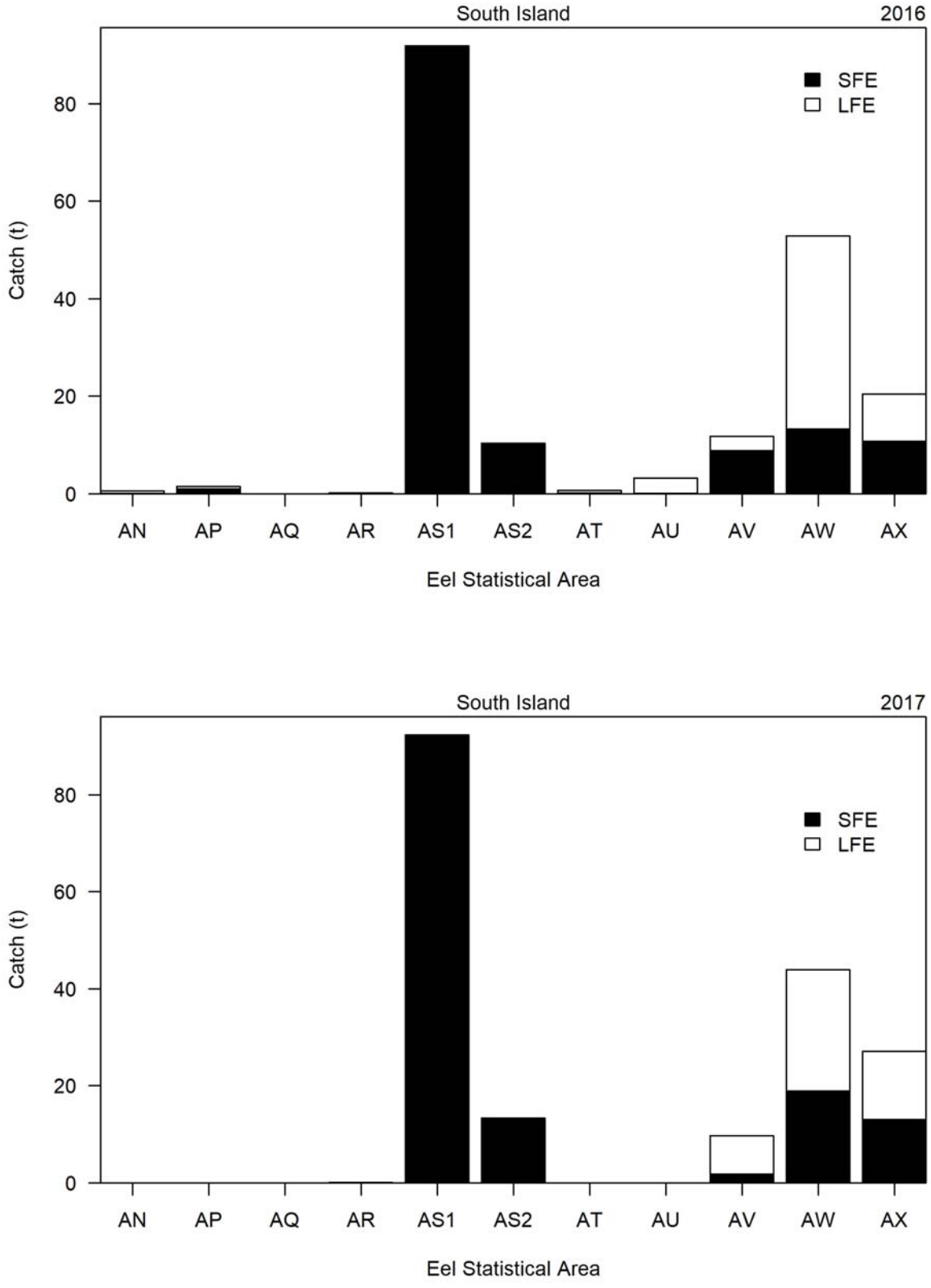
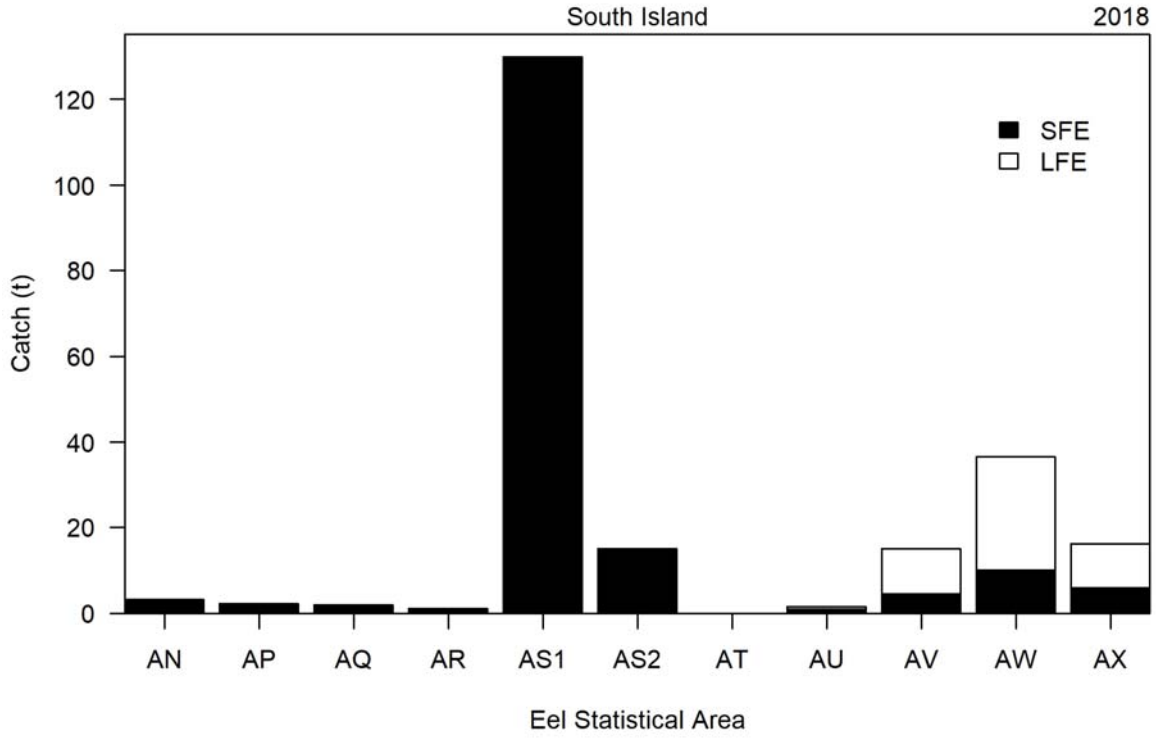


Figure 29: Catch of South Island shortfin (SFE) and longfin (LFE) eels by Eel Statistical Area for fishing years 2015–16 (2016), 2016–17 (2017), and 2017–18 (2018).



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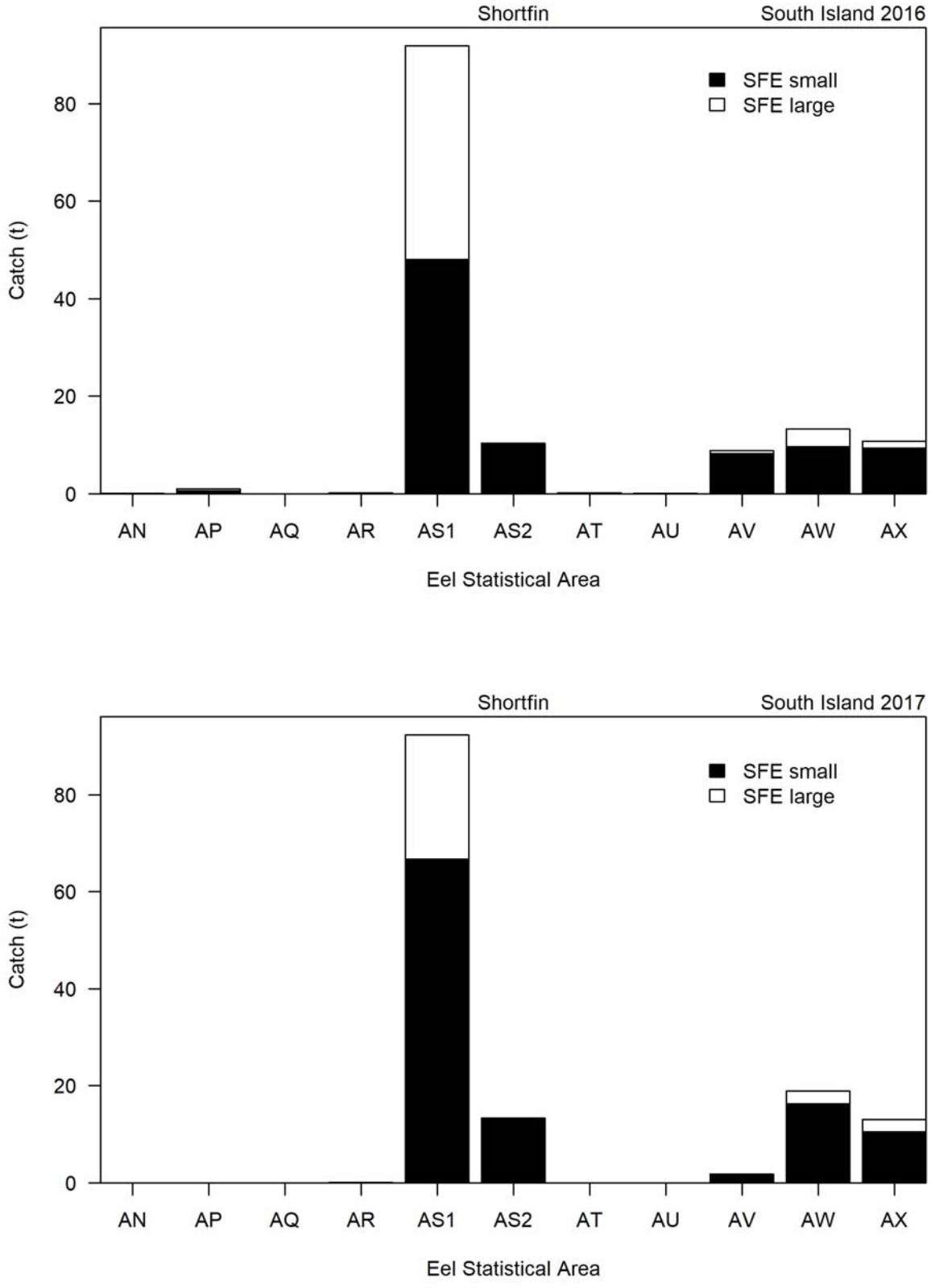
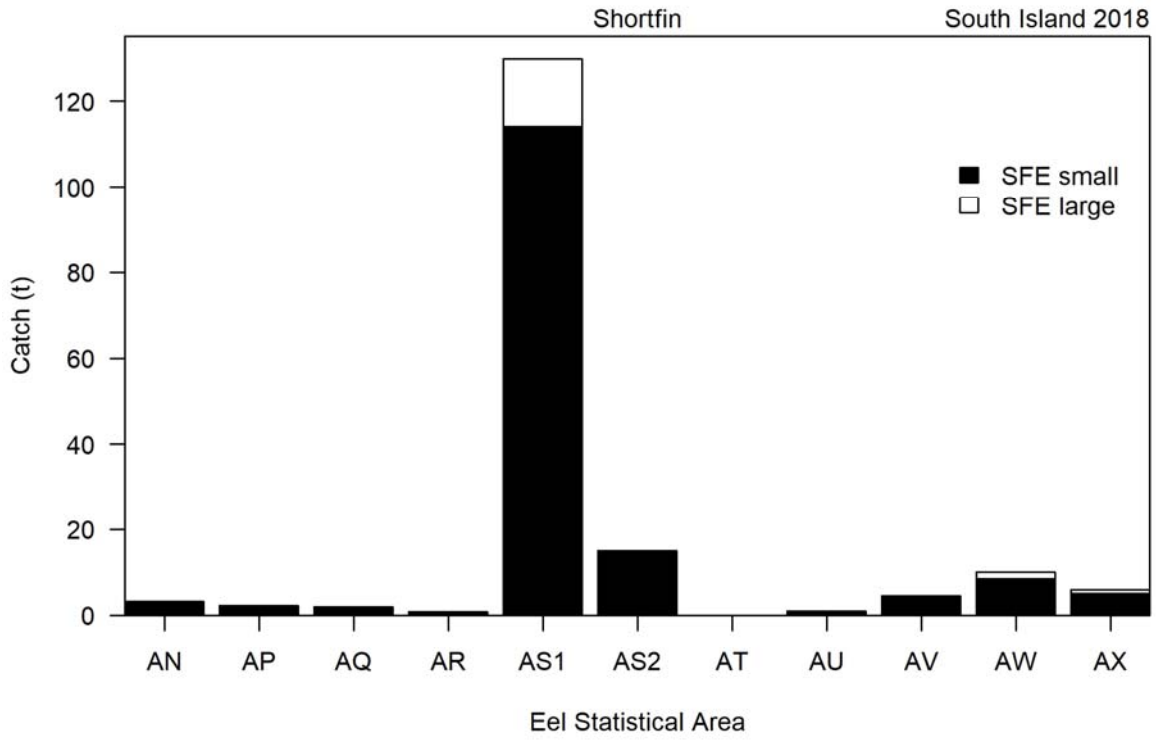


Figure 30: Catch of South Island shortfin (SFE) by weight grade by Eel Statistical Area for 2015–16 (2016), 2016–17 (2017), and 2017–18 (2018).



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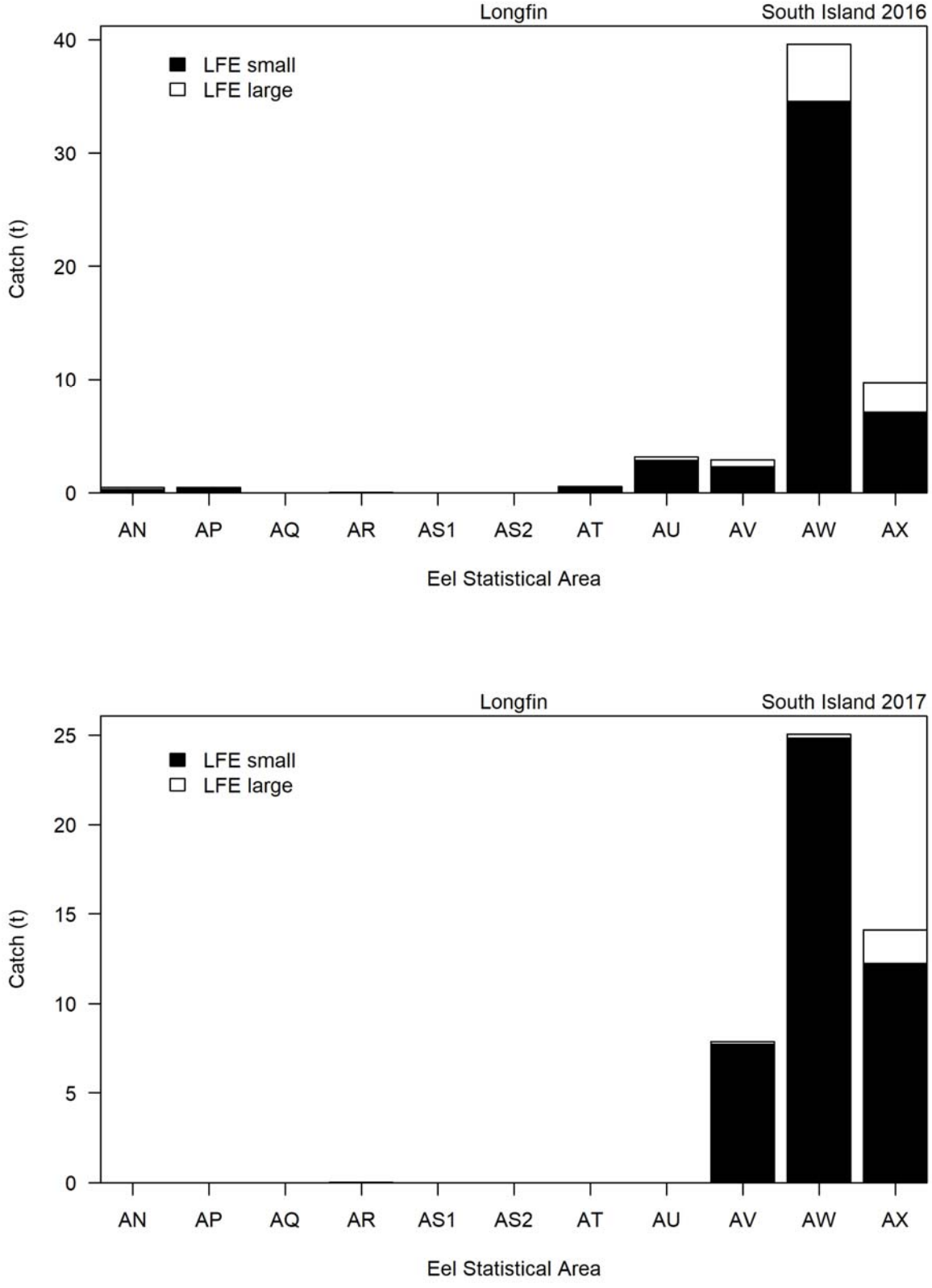
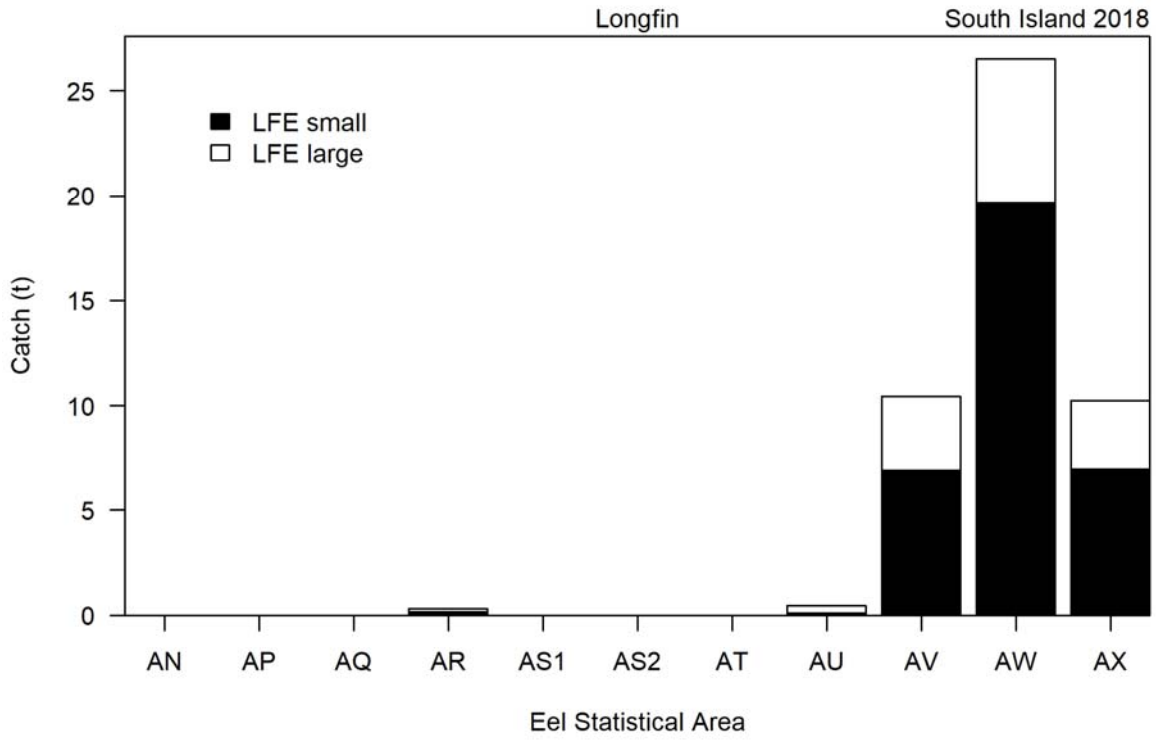


Figure 31: Catch of South Island longfin (LFE) by weight grade by Eel Statistical Area for 2015–16 (2016), 2016–17 (2017), and 2017–18 (2018).



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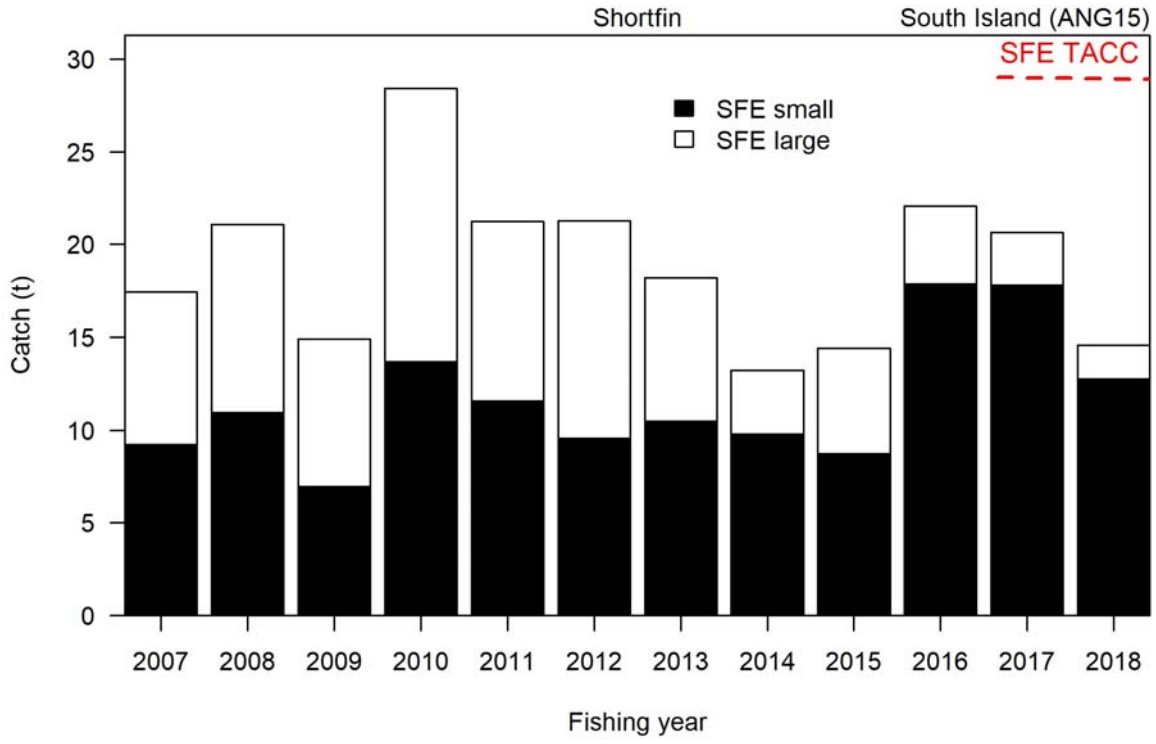

Figure 32: ANG 15 shortfin eel (SFE) catch by weight (t) by weight grade from 2006–07 to 2017–18.

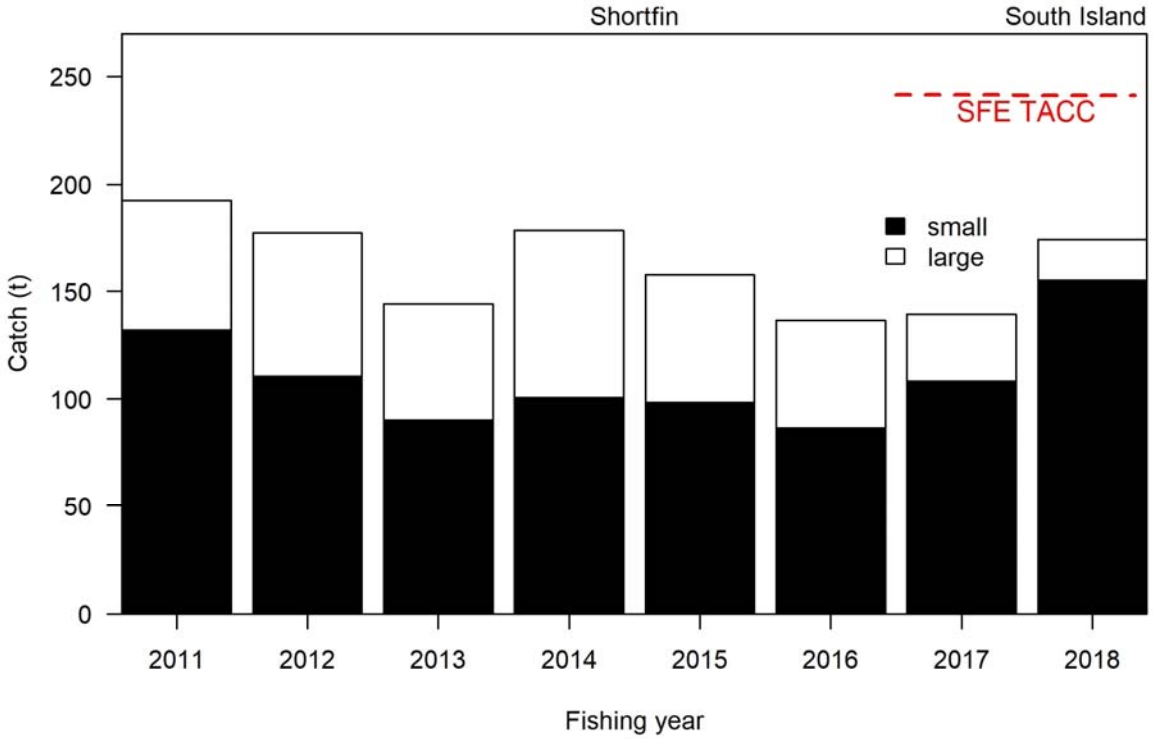

Figure 33: South Island shortfin eel (SFE) catch by weight (t) by weight grade from 2010–11 to 2017–18.

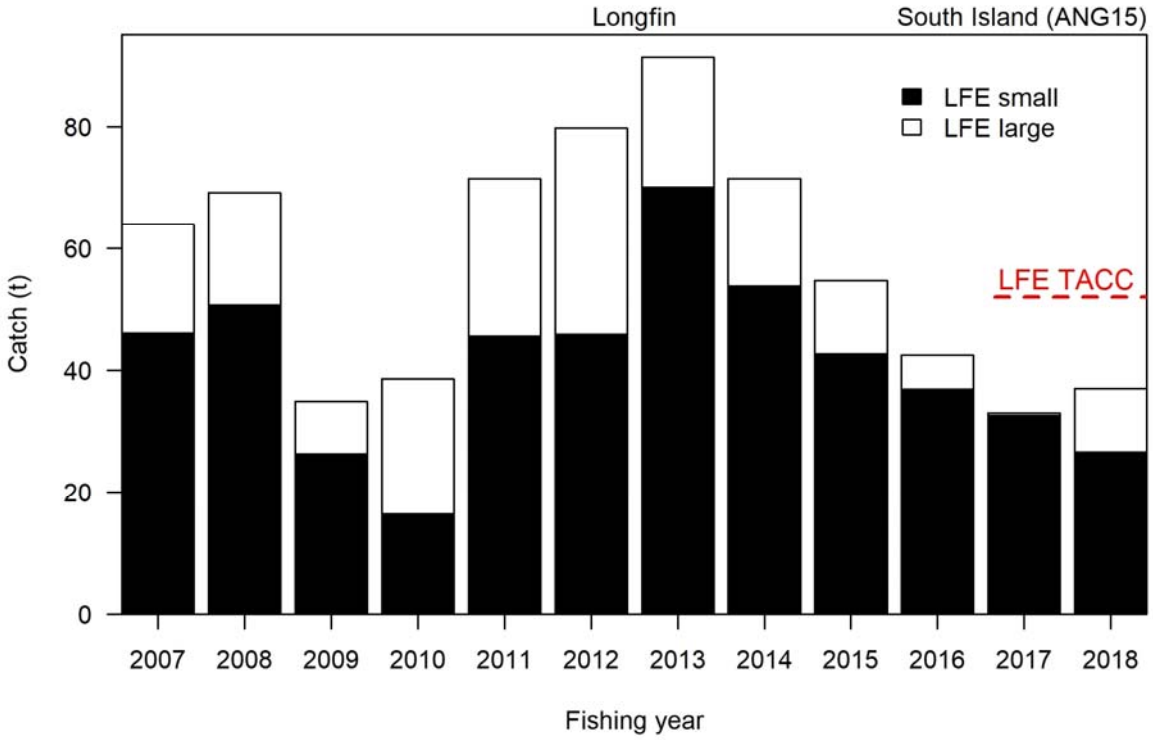

Figure 34: ANG 15 longfin eel (LFE) catch by weight (t) by weight grade from 2006–07 to 2017–18.

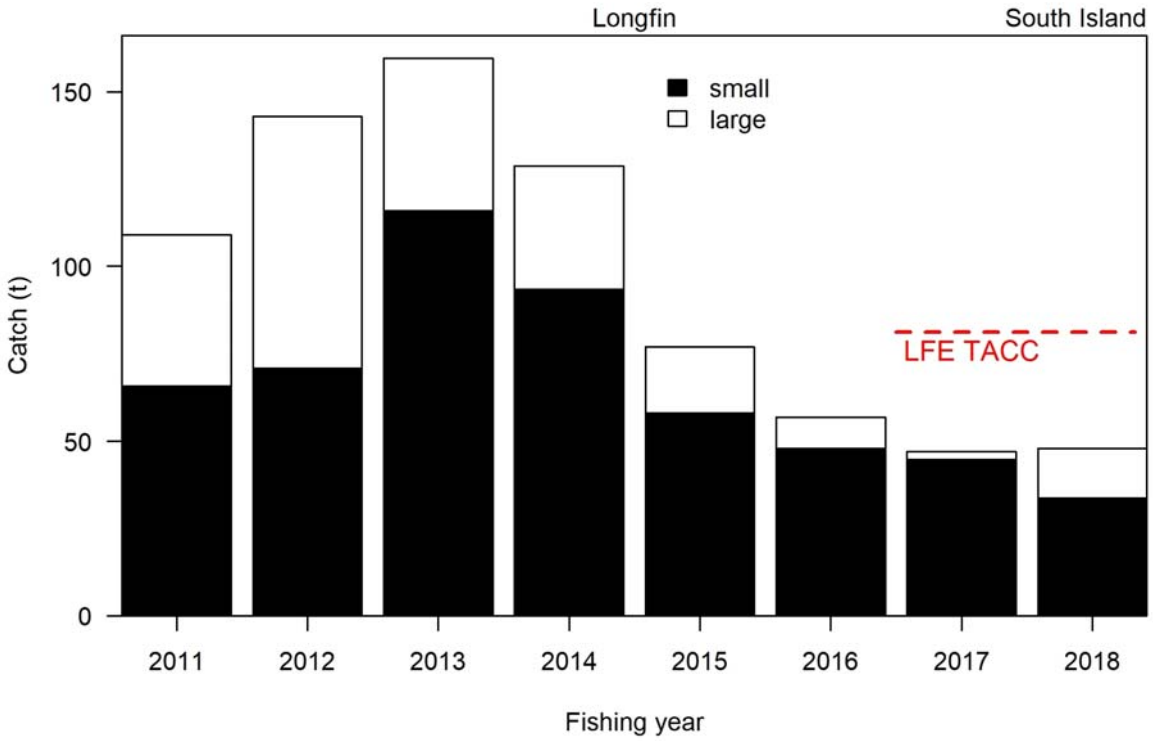

Figure 35: South Island longfin eel (LFE) catch by weight (t) by weight grade from 2010–11 to 2017–18.

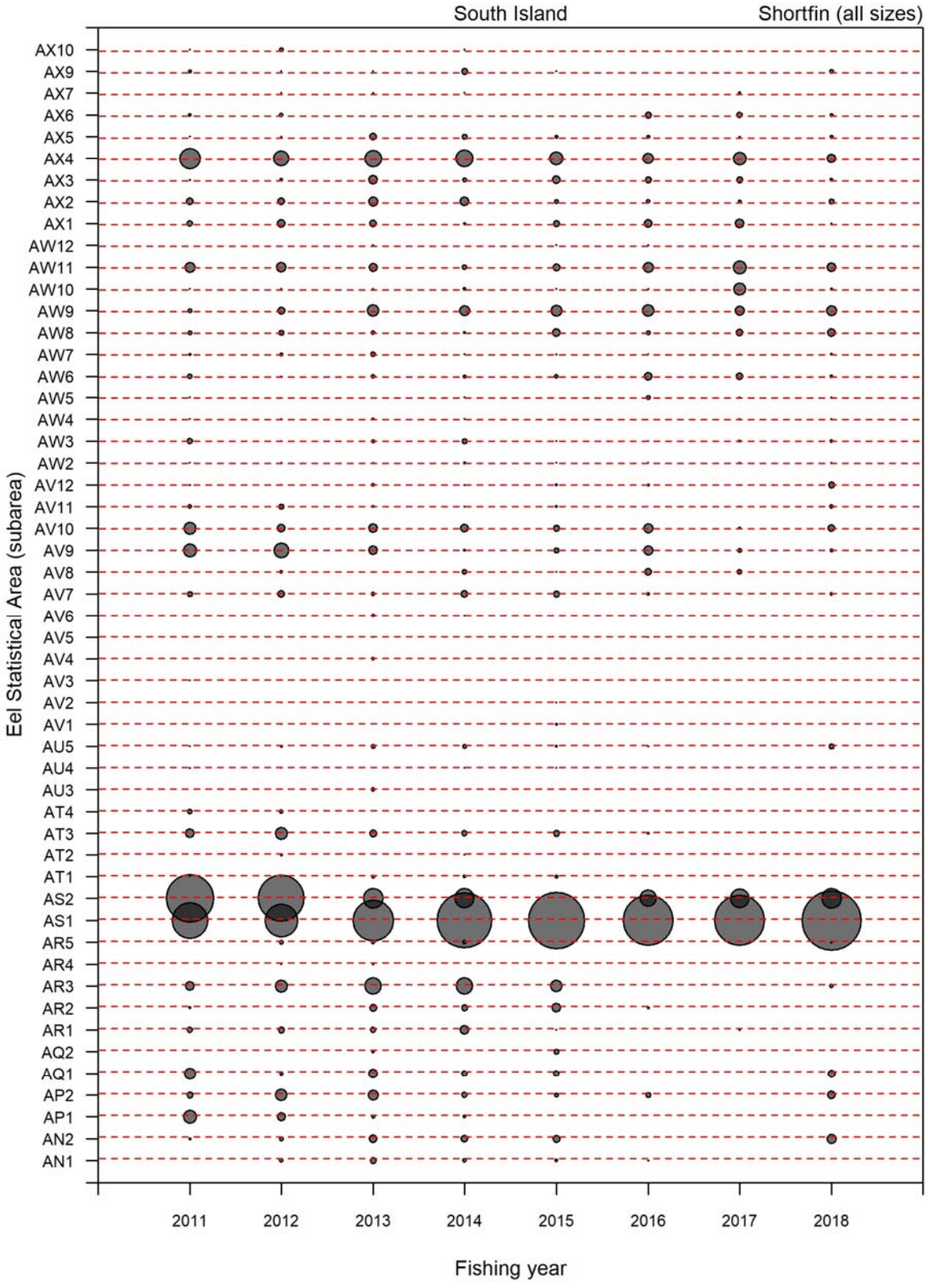

Figure 36: South Island shortfin catch by Eel Statistical Area subarea from 2010–11 to 2017–18. Maximum = 117 t.

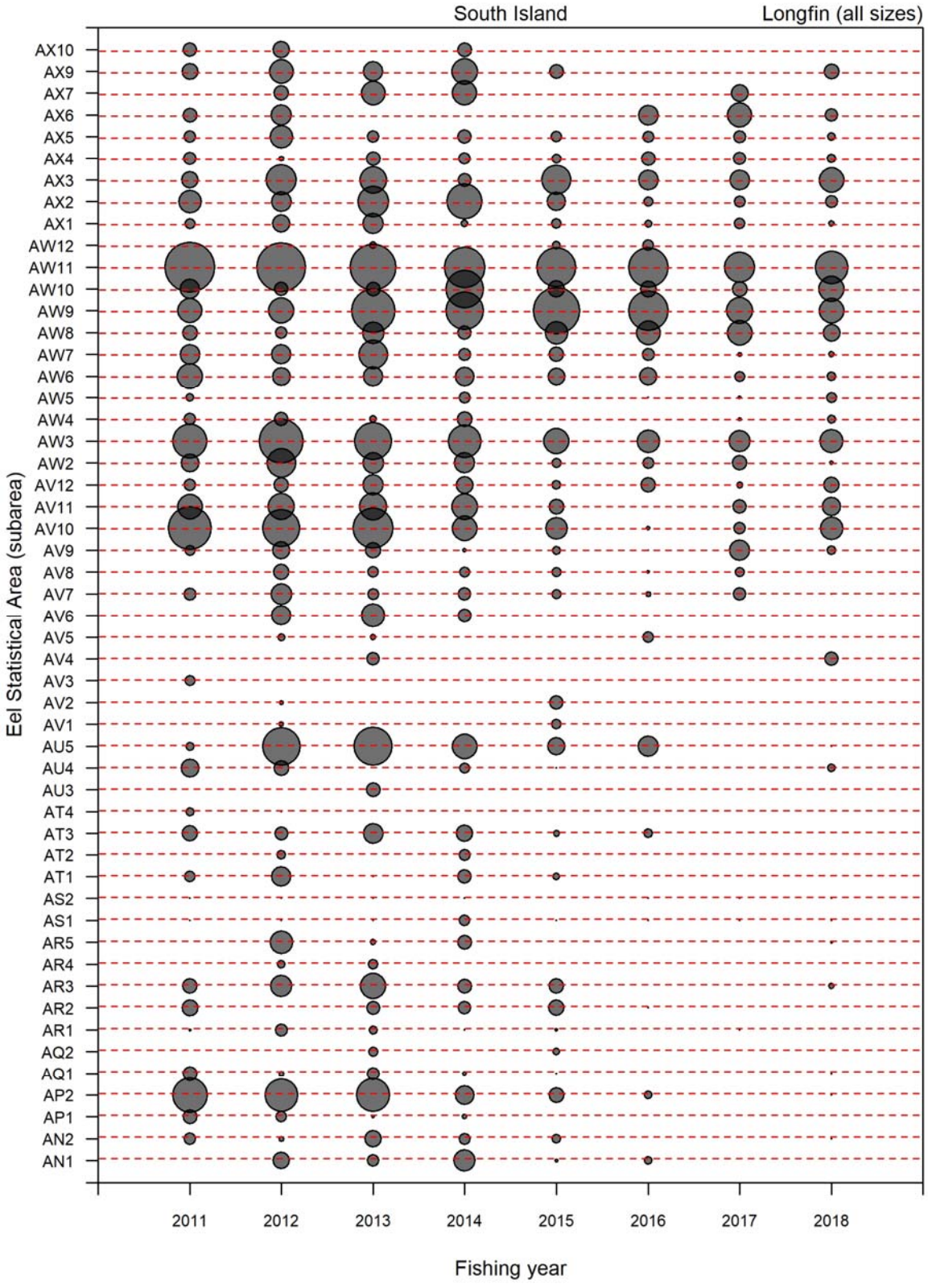

Figure 37: South Island longfin catch by Eel Statistical Area subarea from 2010–11 to 2017–18. Maximum = 19 t.

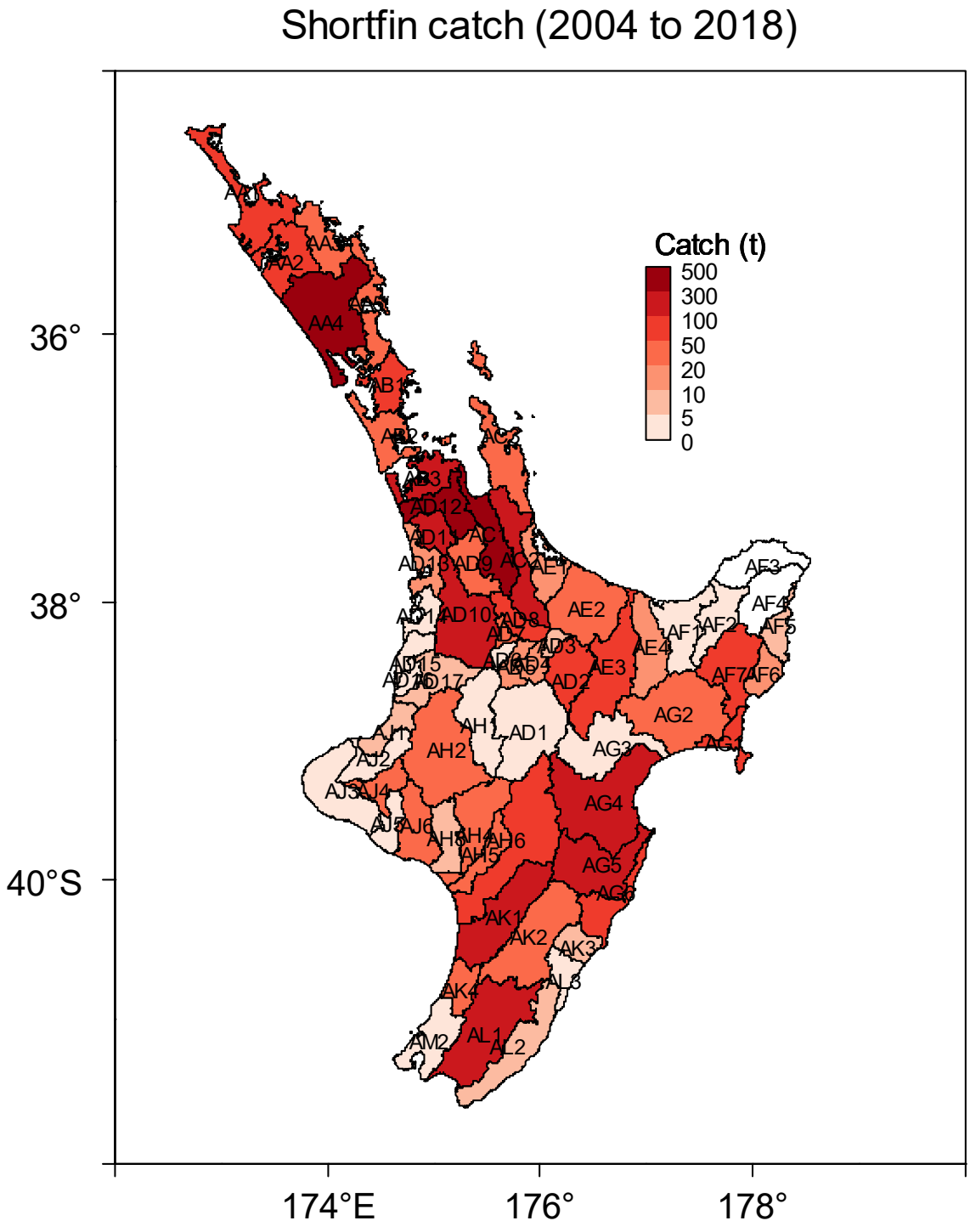

Figure 38: Catch of North Island shortfin plotted by subarea aggregated for the fishing years 2003–04 to 2017–18. Zero catch is white, the lightest red colour represents 0 to 5 t and the darkest red colour 300 to 510 t of shortfin catch. The maximum catch is 509 t in subarea AA4.

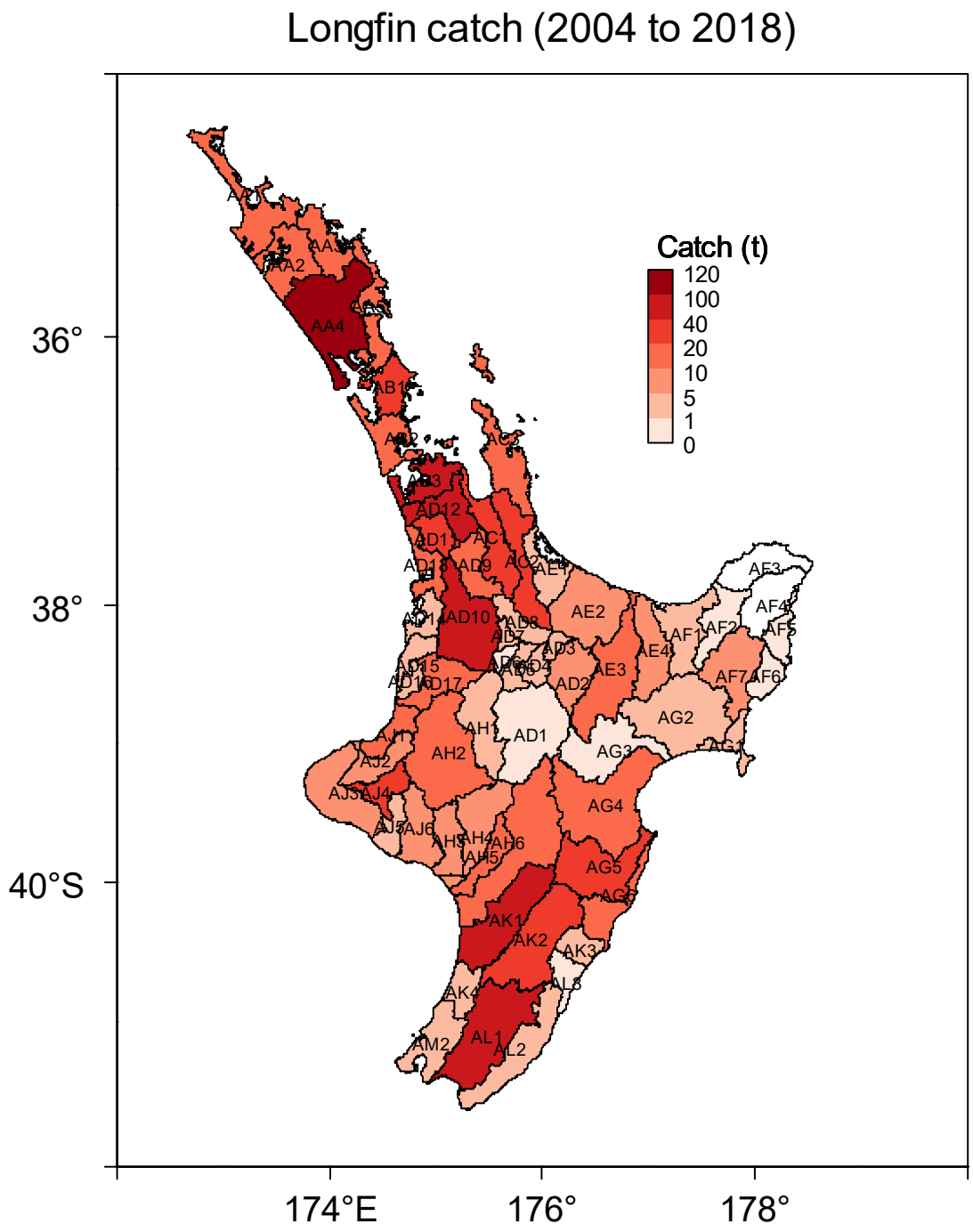

Figure 39: Catch of North Island longfin plotted by subarea aggregated for the fishing years 2003–04 to 2017–18. Zero catch is white, the lightest red colour represents 0 to 1 t and the darkest red colour 100 to 120 t of longfin catch. The maximum catch is 117 t in subarea AA4.

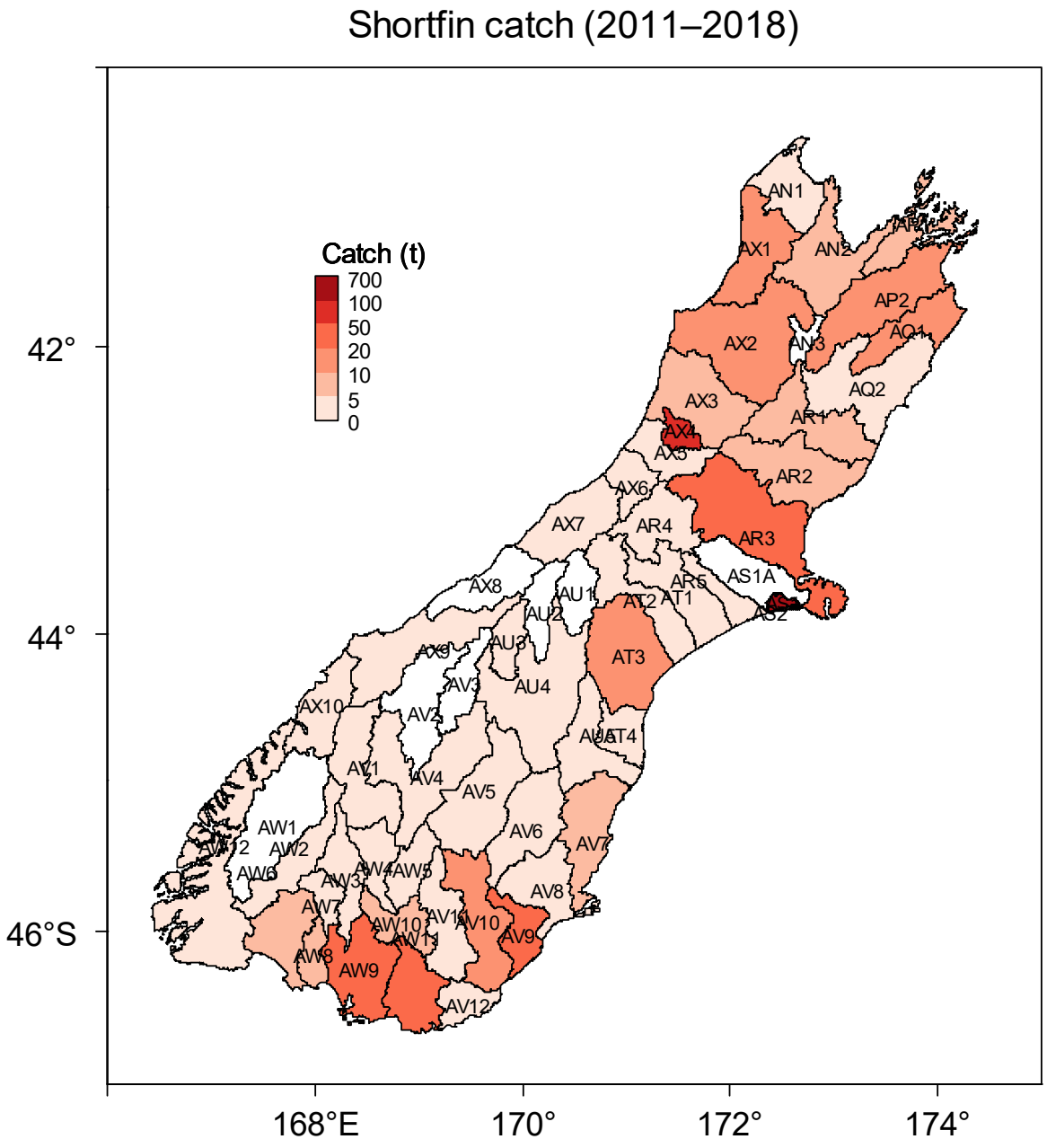

Figure 40: Catch of South Island shortfin plotted by subarea aggregated for the fishing years 2010–11 to 2017–18. Zero catch is white, the lightest red colour represents 0 to 5 t and the darkest red colour 100 to 700 t of shortfin catch. The maximum catch is 689 t in subarea AS1.

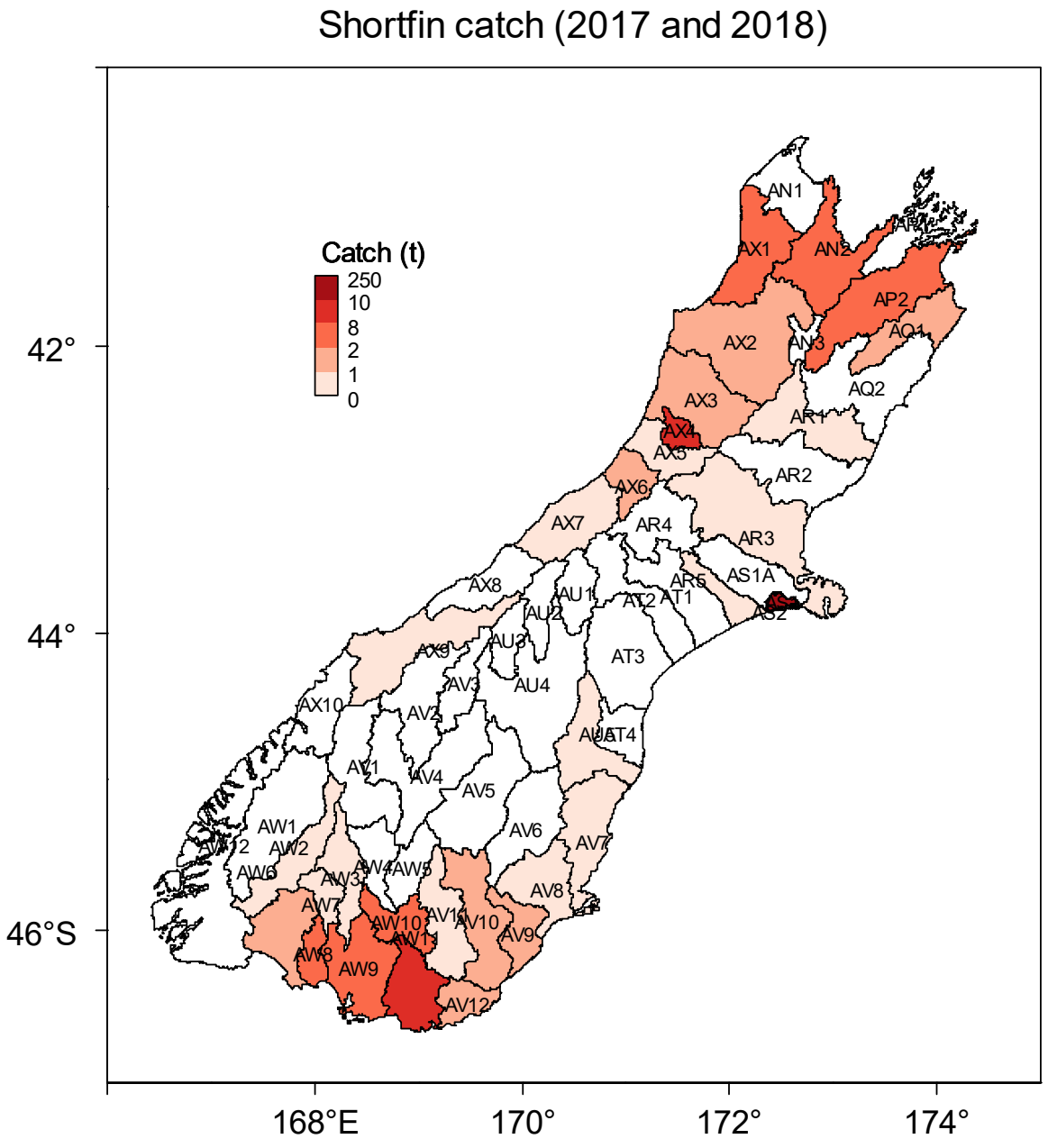

Figure 41: Catch of South Island shortfin plotted by subarea aggregated for the fishing years 2016–17 to 2017–18. TACCs in LFE 11 to LFE 14 were set at a nominal 1 tonne in 2016–17 when ANG was split into shortfin and longfin stocks. Zero catch is white, the lightest red colour represents 0 to 1 t and the darkest red colour 10 to 250 t of shortfin catch. The maximum catch is 222 t in subarea AS1.

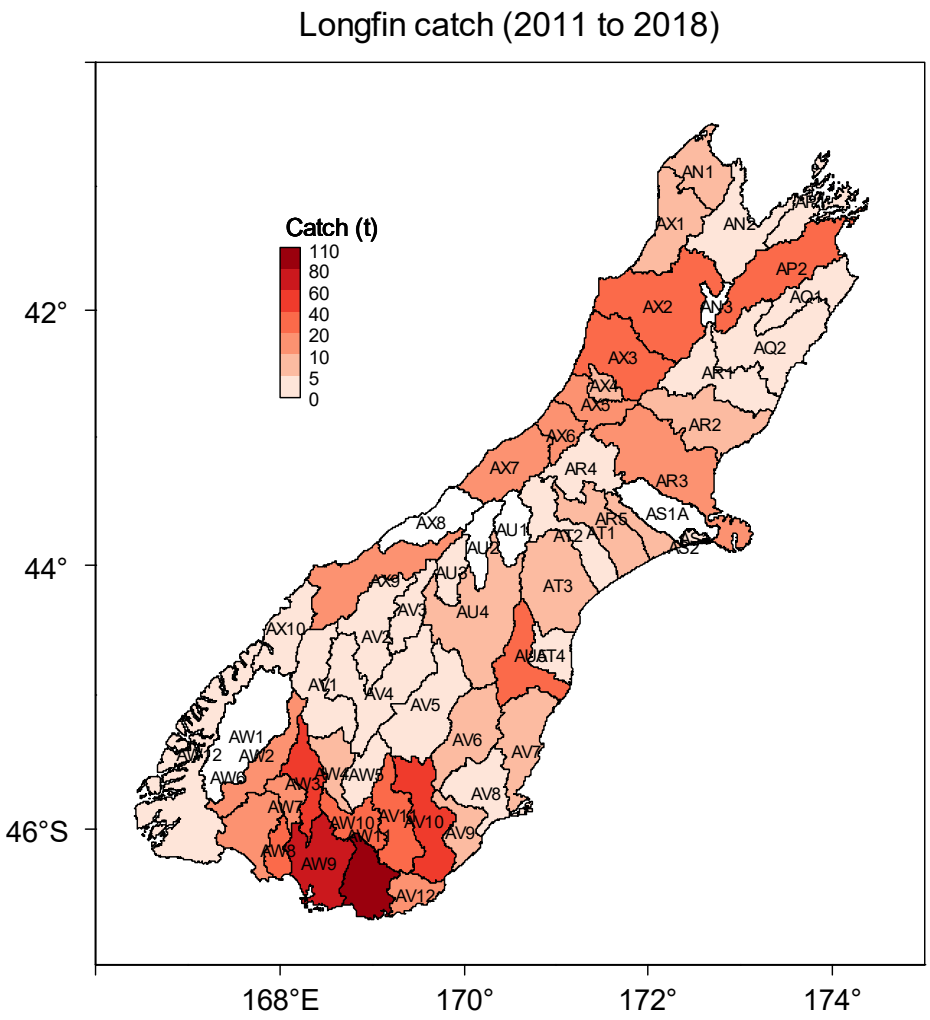

Figure 42: Catch of South Island longfin plotted by subarea aggregated for the fishing years 2010–11 to 2017–18. Zero catch is white, the lightest red colour represents 0 to 5 t and the darkest red colour 80 to 110 t of longfin catch. The maximum catch is 104 t in subarea AW11.

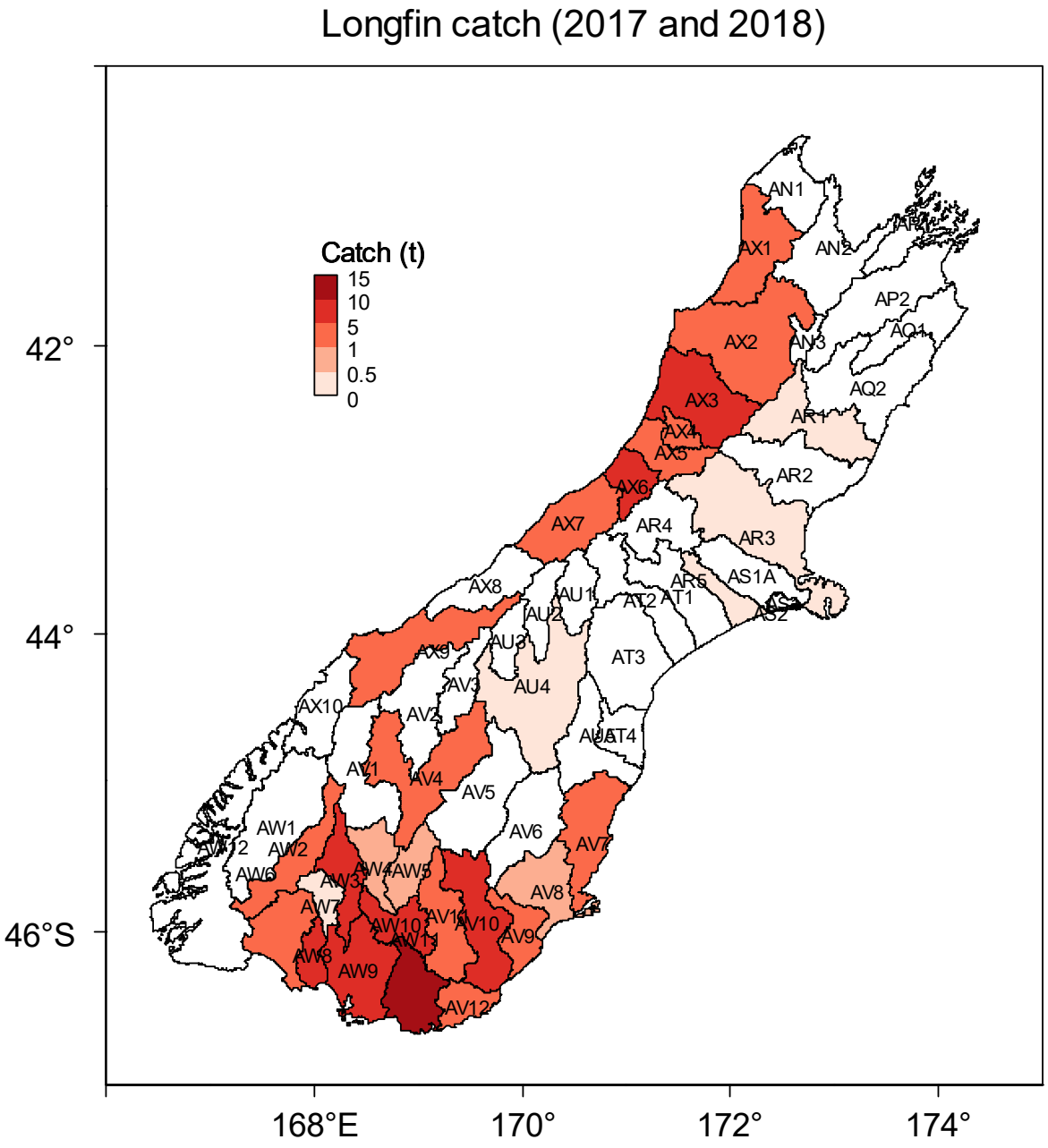

Figure 43: Catch of South Island longfin plotted by subarea aggregated for the fishing years 2016–17 and 2017–18. TACCs in LFE 11 to LFE 14 were set at a nominal 1 tonne in 2016–17 when ANG was split into shortfin and longfin stocks. Zero catch is white, the lightest red colour represents 0 to 0.5 t and the darkest red colour 10 to 15 t of longfin catch. The maximum catch is 15 t in subarea AW1.

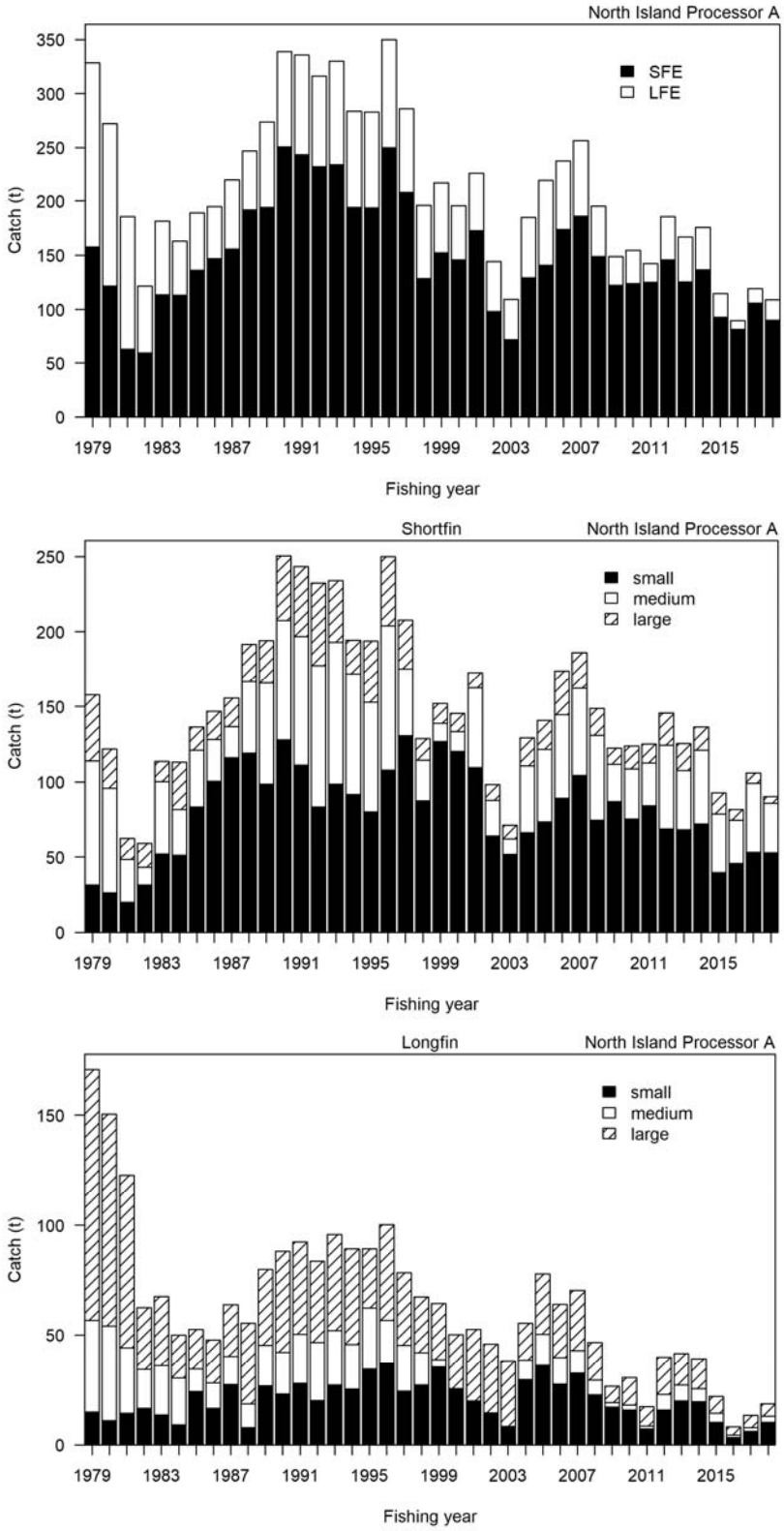

Figure 44: Landed eel catch from North Island eel processor A from 1979 to 2017–18. Top panel: shortfin and longfin landed catch. Middle panel: Shortfin landed catch by weight grade. Bottom Panel: Longfin landed catch by weight grade. Data before 2003–04 were provided to NIWA by Processor A and subsequent data are from the commercial eel monitoring programme.

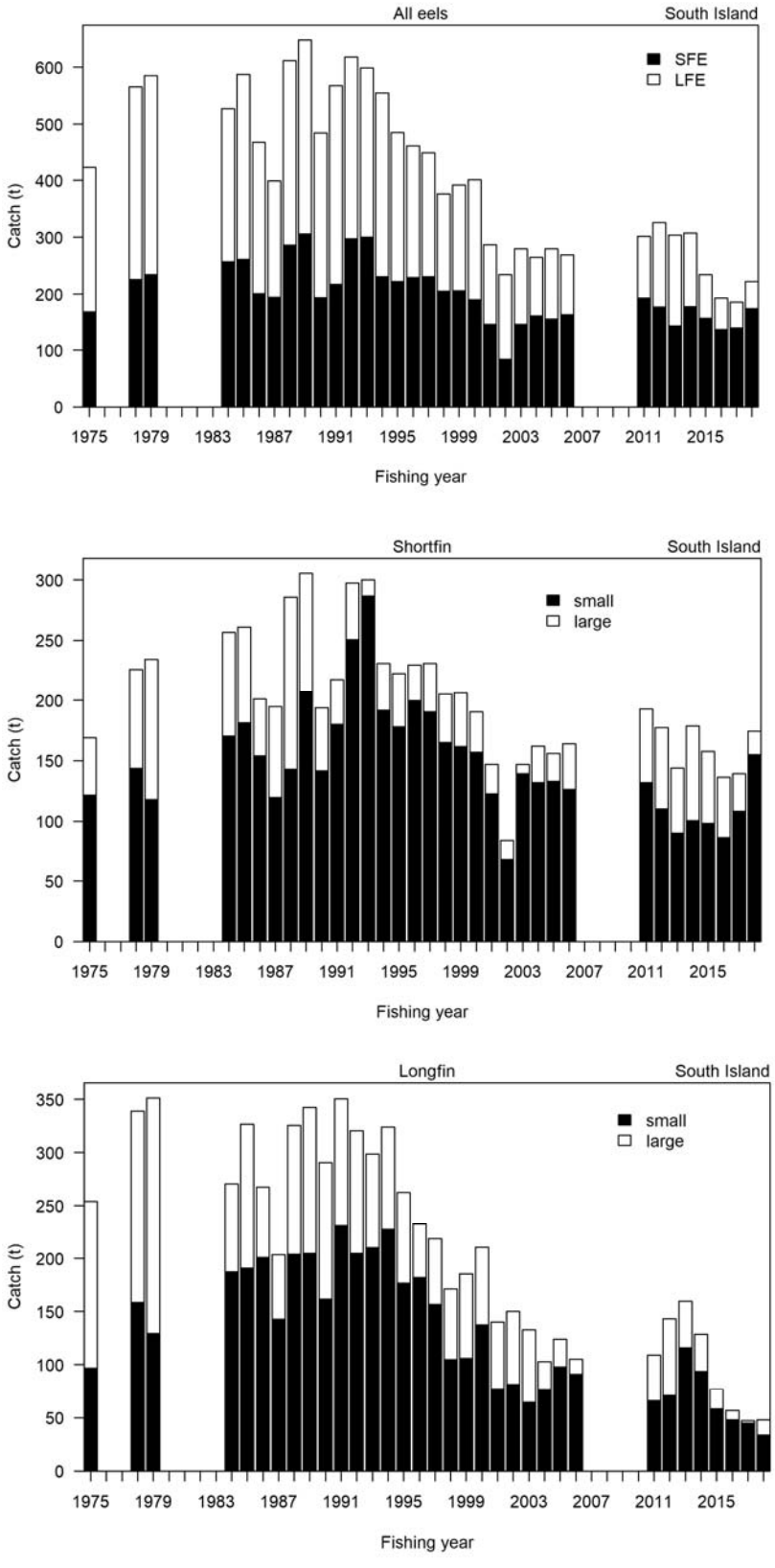

Figure 45: Landed eel catch from the South Island from 1975 to 2017–18. Top panel: shortfin and longfin landed catch. Middle panel: Shortfin landed catch by weight grade. Bottom Panel: Longfin landed catch by weight grade. Data before 2003–04 were provided to NIWA by a South Island Processor and subsequent data are from the commercial eel monitoring programme.

9. APPENDICES

Appendix 1: Summary of data collection from 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	Species size, landing weight, location	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	Kaitaia	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	Waiapu River	North	AF	LFE 21	SFE 21
6E	AF5	Tolaga Bay	North	AF	LFE 21	SFE 21
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

Subarea	Subarea2	Subarea location	Island	ESA	QMA (LFE)	QMS (SFE)
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	ANG 13	ANG 13
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 Middlemarch	South	AV	ANG 15	ANG 15
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

Subarea	Subarea2	Subarea location	Island	ESA	QMA (LFE)	QMS (SFE)
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