



Fisheries New Zealand

Tini a Tangaroa

New Zealand Annual Report to the Extended Scientific Committee

New Zealand

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Introduction

BACKGROUND

This review report provides scientific information on the New Zealand southern bluefin tuna (SBT) fishery, including historical data and information but focusing on the 2020 calendar year and the most recent fishing year, which was from 1 October 2019 to 30 September 2020.

SUMMARY OF HISTORICAL DEVELOPMENTS IN THE FISHERY

Historically, juvenile and adult SBT have been widely distributed around New Zealand. During the 1960s and 1970s, juvenile SBT were encountered on both the east and west coasts of the North and South Islands during summer months. Domestically, several tonnes were taken in pole and line and troll fisheries.

In the early 1980s, a concerted effort to develop a domestic SBT fishery was undertaken to service the Japanese market. By 1982, a handline fishery was established with the catch frozen on board a former Japanese longline vessel. Following the high catches of the 1982 season (305 tonnes landed), the handline fishery continued into the late 1980s, albeit at a reduced level (below 100 tonnes until 1989). Around this time, longlining became the dominant fishing method for SBT, and remains so to this day.

In 1989, New Zealand implemented a national catch limit of 420 tonnes per year, which remained until 2008/09. In 2009, the 16th Commission Meeting of the Commission for the Conservation of Southern Bluefin Tuna (**CCSBT**) agreed to reduce the global total allowable catch (**TAC**) by 20% and apply revised national allocations for 2010 and 2011. New Zealand's national allocation increased to 1,088 tonnes for the 2018-2020 quota block, which was implemented domestically during the 2017/18 fishing year. In 2020 New Zealand's national allocation was increased to 1102.5 tonnes for the 2021-2023 quota block. On the few occasions when the New Zealand allocation has been exceeded, the domestic catch limit has been reduced in the following year by an equivalent amount.

Since 1 October 2004, SBT has been managed under the quota management system. The introduction to the quota management system saw a change from the "Olympic" race for fish, to fishing spread throughout the season, and was associated with a consolidation of the fleet.

In 2017, there was a significant increase in recreational fishing activity and catch rates on the east coast of the North Island. This has led to the establishment of a consistent winter recreational fishery, accessible by trailer boats, for southern bluefin tuna.

OVERVIEW OF THE MOST RECENT FISHING SEASON

For the 2019/20 fishing year, within New Zealand's national allocation of 1,088 tonnes, there were the following allowances: a total allowable commercial catch (**TACC**, which is the commercial allowance) of 1,046 tonnes; a recreational allowance of 20 tonnes; a customary non-commercial allowance of two tonnes; and an allowance for other sources of fishing-related mortality of 20 tonnes.

For the 2019/20 fishing year, commercial removals of SBT were 856.6 tonnes (**Table 1**). Given no foreign charter vessels have fished for southern bluefin tuna in New Zealand since 2015, the entire commercial catch was taken by the domestic fleet. Discard mortality for the domestic commercial fleet was estimated at 17.9 tonnes, although dead discards can only occur when authorised by Fisheries New Zealand observers so this scaled estimate should be treated with caution. Recreational removals were estimated at 48.9 tonnes, and there were no customary removals reported.

Catch and effort

Total catch for the New Zealand fishery is provided in **Table 1**, while catch and effort by fleet and region are provided in **Table 2**, **Table 3**, **Table 4**, and **Table 5**, **Figure 2** and **Figure 3**.

TRENDS BY GEAR TYPE

Prior to the early 1990s, small vessels handlining and trolling dominated the domestic SBT fishery. Since 1991, surface longlining has been the predominant method for both the domestic (ongoing) and foreign charter (ceased in 2016) fleets, while handlining and trolling have made up around 4% of the vessel days combined. Since 2008, there has only been a handful of days handlining and trolling for SBT. This represents a major change from the 1980s when most fishing was by handline.

TRENDS BY AREA AND SEASON

Total SBT catch has steadily increased since the early 1990s, reaching the highest level to date at 1,008 tonnes in 2018, and dropping to 903 tonnes in the 2020 calendar year (**Table 1 and Figure 1**). No foreign charter vessels have fished since 2016 so current catches are taken entirely by the domestic fleet. Total effort has fluctuated since the early 1990s, and was at its highest between 1999 and 2004, peaking in 2003 before declining back to similar levels as the 1990s (**Table 3 and Table 5**). Catch data shows most SBT are caught off the west coast of the South Island (CCSBT Region 6) and the east coast of the North Island (CCSBT Region 5) from April to July.

For the foreign charter fleet, catch fluctuated around 200 tonnes from the early 1990s to 2016 (**Table 2**). Effort gradually declined from the early 1990s to 2016 when, due to changes in legislation, the vessels left the fishery (**Figure 2**). Catch and effort predominantly occurred in Region 6, with under 10% of total charter catch and effort occurring in Region 5 (**Table 2**).

For the domestic fleet, catch has fluctuated, but generally remained below 300 tonnes up until 2011 when it began increasing year after year, peaking in 2018 at 1008 tonnes (**Table 4**). Effort increased dramatically in both regions from 1994 to 2003, which was followed by a decline to a low level in 2007 and 2008, particularly in Region 6 (**Table 5 and Figure 3**). This decline is associated with a substantial decrease in the number of vessels in the surface longline fleet (**Table 6**), and the removal from the fleet of a domestically-owned freezer vessel that fished in Region 6. Since 2008, domestic vessels have increased effort in Region 6, and this has been reflected in increased catch in Region 6, which reached 541 tonnes in 2019, exceeding the catch in Region 5 for the first time since 2012 (415 tonnes). In 2020, catch in Region 5 increased to 491 tonnes, and declined in Region 6 to 361 tonnes (**Table 4**).

Catch Per Unit of Effort (CPUE)

Nominal CPUE

TRENDS BY FLEET

From 2008 to 2015, the foreign charter fleet experienced an increase in CPUE, from around one fish per 1000 hooks to around seven fish per 1000 hooks, peaking in 2010 at nearer eight fish per 1,000 hooks (**Table 7 and Figure 4**).

For the domestic fleet, CPUE was calculated for effort from sets that either caught or targeted SBT. Due to the large changes in the structure of the domestic fleet and the nature of the “Olympic system” under which the New Zealand fishery operated prior to 2004, the trends in the CPUE for the domestic fishery may not provide reliable information on trends in vulnerable biomass, although the CPUE does exhibit similar trends to that of the charter fleet.

From 2009 to 2018, the domestic fleets operating in Regions 5 have experienced an increase in CPUE, from around three fish to 12 fish per 1000 hooks. The domestic fleets operating in Region 6 have also experienced an increase in CPUE from 2008 (six fish) to 2017 and 2018 (17 fish) (**Table 8 and Figure 4**). CPUE dropped in both areas in 2019 by about 50% and recovered in 2020 to about 11 fish per 1000 hooks in both Regions.

TRENDS BY AREA AND SEASON

Associated with a lack of new recruitment, CPUE declined dramatically for both charter and domestic fleets in 2003 and remained at these low levels (about one fish per 1000 hooks) for four to five years (**Figure 4**).

Nominal CPUE was calculated for the charter fleet in Region 6 for fish thought to be of spawning age (SBT greater than 10 years of age). This was done based on both approximate ageing from observer-derived lengths and on a smaller dataset of SBT that were directly aged. Both series agree closely with each other. CPUE of SBT greater than 10 years has varied around one fish per 1000 hooks, with an historical low of near-zero fish in 2003 to the highest level of just over two fish in 2015 (**Figure**).

Standardised CPUE

Due to the exit of the foreign charter fleet in 2016 and substantial changes in the relative amount of fishing effort in Areas 5 and 6, New Zealand conducted a standardised CPUE analysis for the first time in 2019 and has repeated it this year. Details of this analysis are reported in Appendix 3 and are summarised here.

The analysis conducted was a forward stepwise GLM assuming a negative binomial distribution using both the additional percent of deviance explained and AIC criteria to select or reject variables. Variables offered to the analysis were year (forced to be the first variable accepted), month, area, vessel, fleet, target, hooks set (as a polynomial distribution) and length of set (also polynomial).

The variables accepted were year, vessel, month, and area.

Figure 5 shows both the standardised and unstandardised CPUE as well as a three-year running average based on the standardised index. The unstandardised index shows a very small decline in CPUE in 2017 and 2018 with a marked decline in 2019 to a level that was sustained in 2020. The standardised index shows a more exaggerated decline beginning in 2017, one that is particularly large in 2019, and then a marked increase in 2020 to near 2018 levels.

Size composition

Length frequency distributions for the foreign charter and domestic fleets by year are provided in **Figure** and **Figure 8**. Proportions of catches under 120 and 140 centimetres for the foreign charter and domestic fleets are provided in **Figure 9** and **Figure 10**. Length frequency distributions for the foreign charter and domestic fleets for each 10-year period are provided in **Figure 1** and **Figure 2**. For the foreign charter fleet, length frequency distributions for each 10 centimetre interval are provided in **Table 9**, and proportion-at-age distributions, determined from direct aging, are provided in **Figure 13** (which includes information from the domestic fishery from 2016). Proportion-at-length information from the catch documentation scheme is provided in **Figure 6** and **Figure 7**.

TRENDS BY FLEET

Historically, observer coverage was low in the domestic fishery; therefore observer-reported length composition data are not as well estimated for this fleet relative to the foreign chartered fleet. Nevertheless, length composition data for both fleets show similar patterns (**Figure 7** and **Figure 88**). These distributions are now better described by data from the catch documentation system, which provides a complete census of fish lengths for the fishery since 2011 (**Figure 6** and **Figure 7**).

Since 1990, the proportion of the domestic fleet catch under 140 centimetres has varied from less than about 20% from 2003 to 2008 to over 60% from 2016 to 2020, suggesting that there are fewer spawning-age fish (with the proportion then declining since 2016, **Figure 10**).

From 1989 to 2015, the proportion of the charter fleet catch under 140 centimetres has varied from less than 10% in 2001–2004 to over 60% in 2010 (**Table 9** and **Figure 9**). In 2013, the proportion dropped to less than 30% as a result of growth (progression of the main length mode). Overall, the proportions

fluctuate in a manner consistent with periods of above and below average recruitment (for example, in two to three-year cycles).

TRENDS BY AREA AND SEASON

In the 2000s, there was a reduction in the range of sizes of SBT taken in the New Zealand fishery (**Figure 1** and **Figure 2**). There is evidence of growth (shown by progression of modes) over this period, but little evidence of recruitment of smaller fish to the New Zealand fishery (**Figure 11** and **Figure 12**). However, more recent data show a change, with smaller recruits appearing in the fishery (**Figure 7** and **Figure 8**), although this may have changed in the last two years.

Fleet size and distribution

Maps of historical catch and effort by gear type for the fishery are provided in **Figure 8**, **Figure 9**, **Figure 10** and **Figure 19**. The number of vessels catching SBT in New Zealand fisheries waters by year are provided in **Table 6**.

TRENDS BY SEASON

Up until 1991, foreign charter vessels dominated the New Zealand SBT fishery. In 1991, the first domestic longline vessel began fishing for SBT, and then throughout the 1990s and early 2000s the domestic fleet expanded. Since around the time that SBT was introduced into the quota management system (in 2004), the number of vessels operating in the New Zealand fishery has declined. Twenty eight vessels operated in the fishery during the 2019/20 fishing year, all of them domestic (**Table 6**).

TRENDS BY AREA

Historically, the charter fleet, which was primarily composed of the larger -60° freezer vessels, dominated the west coast South Island (Region 6) fishery; however, in 2016, changes in legislation resulted in the charter vessels leaving the fishery (**Figure 8** and **Figure 17**).

The domestic fleet is primarily composed of smaller vessels, which operate mainly in the longline fishery off east coast North Island (Region 5); however, in recent years, domestic vessels have increased effort off the west and east coast South Island (Region 6), replacing some of the effort previously made by the foreign charter fleet (**Figure 10** and **Figure 11**). The domestic vessels are typically at sea for only a few days, and land SBT both as a target and as a bycatch of bigeye target sets.

Research and monitoring to improve estimates of attributable catch

RELEASES AND/OR DISCARDS

Describe the various sources of information and data used in calculating the estimates

Southern bluefin tuna is listed on Schedule 6 of the Fisheries Act 1996, which enables a fish to be returned to the sea or other waters in accordance with the following requirement:

'A person who is a New Zealand national fishing against New Zealand's national allocation of southern bluefin tuna may return any southern bluefin tuna to the waters from which it was taken if—

- a) that southern bluefin tuna is likely to survive on return; and*
- b) the return takes place as soon as practicable after the southern bluefin tuna is taken'.*

Under the Fisheries Act 1996, dead southern bluefin tuna can only be discarded when authorised by an observer and are required to be reported against the annual catch entitlement (counted within the total allowable commercial catch). These SBT include those with shark or orca inflicted damage.

The Resolution on Reporting of all Sources of Mortality of Southern Bluefin Tuna requires that members report the fate of discards. New Zealand does not currently have a moribund category when reporting fate of captures. Moribund fish are included in the 'dead' category, reflecting the domestic requirements that only discarded fish that are 'likely to survive' can be considered 'alive'.

Estimates of non-retained catches are required for the CCSBT Data Exchange, and have been provided to the Commission for the charter and domestic fleets from 1989 to 2020 (**Table 3** and **Table 14**). Estimates of dead discards and live releases have been scaled from observed discards and releases to total effort, assuming a similar rate on unobserved vessels (noting that discarding dead SBT would not be in compliance with regulations if not authorised by an observer, and this scaling may therefore overestimate total dead discards).

Since 2004, fishers have also been required to report discards on their catch effort returns, providing another method to estimate non-retained catches. Schedule 6 (i.e. live) releases are also recorded on catch effort returns.

Describe the method applied for estimating the catch

Monitoring of compliance with these requirements is conducted by aerial flights, surface assets and in-port inspections. These procedures check fishing activity and include the use of seabird mitigation, at-sea inspections, hold checks and adherence to the catch documentation scheme. Other forms of monitoring include observer coverage, and electronic reporting/global position reporting (ER/GPR).

On average across the two areas, 16% of catch and 9% of effort was observed during the 2020 calendar year (**Table 5** and **Table 7**). There were five aerial flights during the same period that specifically covered areas where longline fishing activity targeting SBT occurs.

Discrepancy analysis between observer data and information reported by commercial fishers is done on a case by case basis when necessary. Fisheries Observer Supervisors also conduct observer briefings and debriefings prior to and after trips. During these discussions any compliance related issues are raised, in accordance with priorities and/or risk assessments. Routine debrief documentation is completed by the observer programme, and in the event of potential serious breaches, a formal debrief is carried out by a Fishery Officer.

Electronic catch and position reporting has allowed for increased visibility of vessel movements, processing practices, discards and has also expedited access to fishing reports. The ability to receive electronic catch and disposal reports within a 24-hour period allows for the early identification of any discrepancies between reports and has the additional benefit of highlighting areas of attention to be addressed by Fishery Compliance Officers.

Provide the resulting estimated catch

Estimated discards of SBT from the commercial fleet in 2020 is 17.9 tonnes.

RECREATIONAL FISHING

Reporting of recreational SBT catch is provided in **Table 9** and **Table 20**.

A recreational allowance for SBT was introduced when SBT entered New Zealand's Quota Management System on 1 October 2004. In the past, New Zealand based its national catch reporting and carry-forward calculations on the full recreational allowance even though estimates of actual recreational catch were consistently well below the levels set under that allowance.

Historically, a small summer recreational fishery has occurred out of Fiordland on the west coast of the South Island since the 1970s. A recreational fishery for Pacific bluefin tuna developed in 2005 out of Greymouth and Westport, on the west coast of the South Island, in which SBT are also occasionally taken as bycatch in August and September. At present, there are two distinct recreational fisheries; the west coast of the South Island from January to July, and the east coast of the North Island in June and July, primarily in the eastern Bay of Plenty. The North Island recreational fishery emerged rapidly in 2017, when SBT catches increased dramatically, and since then SBT catches from 2018 to 2020 have also been high (**Table 20**).

Describe the various sources of information and data used in calculating the estimates

A formal reporting regime for the recreational sector applies only to a proportion of the sector (recreational fishing from amateur charter vessels and commercial vessels). Other information sources are required to achieve an overall estimate of recreational catch, which can be particularly challenging for species such as SBT which are not caught frequently enough to result in reliable estimates of catch from national multi-species diary surveys.

Fisheries New Zealand monitors recreational catch of southern bluefin tuna in a variety of ways. These include amateur charter vessel records, reporting of recreational activity from commercial vessels, New Zealand sport fishing club records, boat ramp surveys, the New Zealand gamefish tagging programme, and social media. Further information on the different ways New Zealand monitors SBT recreational catch are outlined below.

Amateur charter vessel records

Amateur charter vessel records are an important source of information when estimating recreational catch of SBT. Anyone in New Zealand who takes someone fishing where payment is made for the vessel and guide services, is required to be registered as an amateur-fishing charter vessel operator under the Fisheries Act 1996. Fish caught on these types of fishing trips are not entitled to be sold or traded, and the catch is regarded as recreational catch.

Compulsory reporting for recreational charter vessel operators was introduced in November 2010 under the Fisheries (Amateur Fishing) Regulations 2013. This requires amateur charter vessel operators to report catch to Fisheries New Zealand on a number of shared species of interest, including compulsory reporting for southern bluefin tuna and Pacific bluefin tuna.

In 2020, 262 fish were recorded by amateur charter vessel records (**Table 19**) with 186 SBT retained and 76 released on those charter trips. The mean weight for fish retained by charter vessels in 2020 was 96.9 kg

New Zealand sport fishing club records

The New Zealand Sport Fishing Council has 57 affiliated clubs across New Zealand. Sport fishing club records provide an important source of information on tagging, landings and weights of highly migratory species caught by recreational fishers in New Zealand waters. Records of SBT landings from various sport fishing clubs are provided to Fisheries New Zealand.

In 2019, a total of 293 SBT were recorded landed by sport fishers in the North Island and estimated for South Island. Most of these fish were caught in the last week of June in the eastern Bay of Plenty. In 2020, 434 SBT were retained by sports fishers (**Table 20**).

In 2020, the average weight of SBT retained by sports fishers was 72.6 kg. In 2019 the average weight of SBT from North Island sport fishing clubs was 72.2 kg while in 2018 the average was 78.3 kg. In 2019 the proportion of SBT in the 40 and 60 kg size classes were higher, while the proportion in the 70 and 80 kg size classes were lower than in 2018. The weight distribution in 2020 was similar to that in 2019.

Section 111 reporting

Section 111 of the Fisheries Act 1996 stipulates that all fish that is on board, landed from, or transhipped from, any registered commercial fishing vessel or fish carrier is deemed to have been taken or possessed for the purpose of sale. However, commercial fishers can apply for an exemption to this provision that allows fish to be retained for recreational consumption subject to conditions requiring the use of recreational gear. Data on this type of recreational catch is captured as part of commercial reporting requirements.

In the 2020 fishing year, fish reported as Section 111 landings weighed 590 kg.

Over the past five fishing years, the highest catch weight reported under Section 111 was 1,038 kg in 2016/17 (**Table 21**).

Estimates of the recreational catch and size composition of SBT research project

Following the rapid development of a recreational fishery off the east coast of the North Island in 2017, Fisheries New Zealand approved a research project in 2018, with an overall objective to improve estimates of the recreational SBT catch and size composition in New Zealand.

Specific objectives of this research were to: design and implement an on-site creel survey to estimate recreational SBT harvest in the eastern Bay of Plenty; and estimate the recreational SBT harvest for the 2018 fishing year using a variety of inputs (the creel survey results, data from amateur charter vessel records, Section 111 landing reports and sport fishing club records). This survey was then repeated in the 2019 and 2020 fishing years.

Additionally, 32 otolith sets from SBT caught on recreational vessels fishing in the eastern Bay of Plenty in 2018 were collected to be part of New Zealand's otolith collection for the CCSBT. Most of the fish from which otoliths were taken were large, with a mode weight of 70 to 80 kg and a mode fork length of 160 to 165 cm.

In 2019, A total of 80 otolith sets were extracted from SBT intercepted during the creel survey at Waihou Bay. The weight of these fish ranged from 23.2 to 136.8 kg with a mode of 80 to 90 kg. The fork length of these fish ranged from 100.5 to 188 cm with a mode of 160 to 165 cm.

A total of 90 usable otolith sets were extracted from SBT intercepted during the creel survey at Waihou Bay in 2020. The weight of these fish ranged from 29.6 to 148.6 kg with a mode at 70 to 80 kg. The fork length of these fish ranged from 119 to 203 cm with a broad mode from 155 to 170 cm.

The New Zealand gamefish tagging programme

The New Zealand gamefish tagging programme is a cooperative project between Fisheries New Zealand, the New Zealand Sport Fishing Council, its affiliated clubs, and anglers. The New Zealand Gamefish Tagging Programme was introduced as a multi species gamefish tagging programme to study the seasonal and short-term movements of gamefish species of importance to recreational New Zealand fisheries. Recaptures from the programme provide information on distance and direction of movement, time at liberty, and in some circumstances the average migration rate of the fish involved.

The resulting report, 'Synthesis of New Zealand gamefish tagging data, 1975 to 2014' can be found at: <https://fs.fish.govt.nz/Doc/24040/FAR-2016-24-Gamefish-tagging-synthesis.pdf.ashx>. An updated assessment published in October 2019, 'New Zealand Billfish and Gamefish Tagging, 2016-17 to 2018-19' can be found at: <https://www.mpi.govt.nz/dmsdocument/37811/direct>.

Most southern bluefin tuna tagged under this programme are less than 30 kg and are tagged off the west coast of the South Island. Recaptures of SBT have been recorded in South Australia and Hokitika. Since the recent development of a recreational SBT fishery off the east coast North Island, where larger southern bluefin tuna have been landed (averaging 78 kg in 2018), the New Zealand Sport Fishing Council is encouraging tag and release of SBT. SBT tagged and released are not counted against the recreational allowance.

National Panel Survey of Marine Recreational Fishers

Nationwide panel surveys are conducted to generate harvest estimates of recreational catch in New Zealand waters. Features of the survey include meshblock-based face-to-face recruitment, a frequent and adaptable contact regime with a SMS texting option, and a structured questionnaire administered by telephone to record fishing details.

The most recent survey conducted included almost 7,000 fishers who reported their fishing activity throughout New Zealand during the fishing year from 1 October 2017 to 30 September 2018. The survey includes information on recreational harvest of highly migratory species, such as skipjack tuna and albacore tuna, but did not capture any information on SBT. The next iteration of the National Panel Survey is scheduled for the 2022/23 fishing year.

Management measures

Following a significant surge in recreational catch in 2017 on the east coast of the North Island, the national recreational SBT catch allowance was increased for the 2017/18 fishing year from eight to twenty tonnes. In 2018, Fisheries New Zealand undertook a public consultation to introduce new management measures for the recreational fishery.

In response to this consultation, a recreational bag limit of one SBT per person per day was put into effect for 2019. A SBT recreational management working group was also initiated, in order to monitor progression and changes in recreational fishing.

Social media

Social media provides a platform for New Zealand's commercial and recreational fishers alike to share information on SBT. Noted in the past few years, fishers have been seen to share information through "fishing forums" on SBT landings and locations, as well as sharing information about where SBT are congregating in New Zealand waters. A number of New Zealand's sport fishing clubs also share information on social media. Information from social media has been used to substantiate information received through official channels and can provide insight into the behaviour of the recreational sector.

Describe the method applied for estimating the catch

The total landed catch from on-site surveys and all other available data sources is 587 SBT for 2020. Allowing an additional 15% to 30% for unaccounted catch gives a range of 652 to 717 SBT and a point estimate of 685 SBT.

The mean weight for SBT recorded by North Island fishing clubs of 72.49 kg was multiplied by the estimate of North Island landed catch and the estimated number of SBT landed in the South Island was multiplied by the overall estimated mean weight of 72 kg. The reported weight of SBT retained under Section 111 was added to the recreational harvest estimates.

Provide the resulting estimated catch

The total harvest weight for recreational SBT in 2020 is estimated to be 48.9 tonnes.

CUSTOMARY AND/OR TRADITIONAL FISHING

Describe the various sources of information and data used in calculating the estimates

One of the allowances made under the New Zealand quota management system is to allow for the customary take of species. This customary allowance provides for catches of southern bluefin tuna that are governed by customary fishing regulations. There is no evidence to date that catches of southern bluefin tuna are made in this way. Most, if not all, non-commercial catches are taken subject to general

provisions for amateur fishing (rather than under the customary fishing regulations). However, in recognition that the introduction of recreational management constraints in 2019 could result in an increased use of customary provisions, the customary allowance was increased from 1 tonne to 2 tonnes.

Describe the method applied for estimating the catch

Fisheries New Zealand monitors customary permits; however, no permits have been used to take southern bluefin tuna to date. No additional research or consultation on customary catch was conducted in 2020.

Provide the resulting estimated catch

There were no customary permits issued for SBT, therefore the estimated catch is zero.

ARTISANAL

Describe the various sources of information and data used in calculating the estimates

New Zealand does not have an artisanal fleet, therefore, there are no sources of information and data used in calculating estimates.

Describe the method applied for estimating the catch

New Zealand does not have an artisanal fleet, therefore, there is no method applied for estimating catch.

Provide the resulting estimated catch

New Zealand does not have an artisanal fleet, therefore the estimated catch is zero.

Development and implementation of scientific observer programme

New Zealand's Observer Programme covers both domestic and foreign charter longline vessels. In 2016 to 2020, no foreign charter vessels targeting SBT fished in New Zealand's Exclusive Economic Zone, and increased coverage of the domestic fleet was attained. The target coverage level for fisheries targeting SBT is 10% of catch and effort, as specified in the CCSBT Scientific Observer Program Standards. Coverage is measured in two ways, proportion of catch (in numbers of fish) observed and proportion of hooks observed where relevant effort is hooks from sets that either targeted or caught SBT (unraised).

OBSERVER TRAINING

Overview of the training programme provided to scientific observers

Fisheries New Zealand's Observer Services Unit is responsible for the recruitment and training of Fisheries Observers. The recruitment process includes a half day assessment, online physiological testing, drug and alcohol testing, a criminal record check, seafarers medical, and referee checks. Successfully shortlisted candidates then undergo a comprehensive three-week training course which covers a mixture of New Zealand Qualification Authority (NZQA) unit standards, Fisheries New Zealand task specific units, other relevant government agency training modules, and industry representation. Candidates are assessed throughout the training course against the NZQA unit standards. Candidates must complete the entire three-week course and pass a written exam at the end. Those that

successfully pass the training course are deployed on at least one training trip at sea with an experienced observer to train and mentor the new observers. Regular audits are undertaken by the trainer to ensure competency is obtained. Training trips last between 3-7 weeks depending on the vessel type and fishery deployed. Additional SBT specific training is provided during briefing for relevant fishery deployments.

The three-week observer training course covers:

- State Services Code of conduct
- Maritime New Zealand training
- Data collection and report writing
- Safety at sea modules, including firefighting, emergency evacuations, communications, first aid
- De-escalation training
- Overview of NZ's Quota Management System
- Common parts of a vessel
- Commercial fishing methods
- Information display systems
- Catch quantification and species identification
- Biological sampling
- Protected species interaction and monitoring
- Computer training
- Vessel monitoring and compliance
- A day in the life of an observer role play

Number of observers trained

There are over 100 observers in Fisheries New Zealand's Observer Programme. One hundred percent of observers deployed by Fisheries New Zealand have successfully completed the full training programme. Eleven new observers were trained in 2020.

SCIENTIFIC OBSERVER PROGRAMME DESIGN AND COVERAGE

The fisheries Observer Programme is managed and coordinated by Fisheries New Zealand's Observer Services Unit. Fishing industry quota holders are levied or direct charged for observer coverage. Observer coverage for the incoming year is determined by consultation with industry and the requirements of fisheries managers and the Department of Conservation. Observer deployment is managed by shore-based staff in Wellington, New Zealand. Observers are deployed throughout New Zealand to cover vessels operating within New Zealand's Exclusive Economic Zone and in international waters as appropriate.

Which fleets, fleet components, or fishery components are covered by the programme:

In relation to CCSBT, Fisheries New Zealand observers were deployed to the surface longline targeting southern bluefin tuna, bigeye tuna, and swordfish.

How vessels were selected to carry observers within the above fleets or components:

Observer placements are prioritised based on vessel level of effort and catch, new entrants to the fishery, length of time since previous observation, and compliance risk assessment.

How was observer coverage stratified: By fleets, fisheries components, vessel types, vessel sizes, vessel ages, fishing areas and seasons.

The New Zealand domestic SBT fishery currently consists of a largely uniform fleet of smaller longline vessels. New Zealand has previously stratified its observer coverage reporting based on domestic vs foreign charter vessels however this stratification is no longer relevant with the exit of the large foreign vessels from the fishery.

Details of observer coverage of the above fleets:

During the 2020 calendar year, for those vessels targeting SBT, there were 267 sea days and 120 shore days.

On average across Region 5 and Region 6, 14% of the catch and 9.5% of the effort was observed during the 2020 calendar year (**Table 15 and Table 17**),

OBSERVER DATA COLLECTED

List of observer data collected against the agreed range of data set out in Appendix 1.

Catch data: Amount of catch observed of SBT and other species (if collected), by area and season, and % observed out of total estimated SBT catch by area and seasons

See **Tables 15 and Table 16**

Effort data: Amount of effort observed (vessel days, sets, hooks, etc), by area and season and % observed out of total by area and seasons

See **Table 7**

Length frequency data: Number of fish measured per species, by area and season.

See **Table 112**

Biological data: Type and quantity of other biological data or samples (otoliths, sex, maturity, Gonosomatic index, etc) collected per species.

See **Tables 11 and Table 12.**

TAG RETURN MONITORING

Six dart tags were recaptured during observed trips in 2015, none in 2016, two in 2017 and none in 2018. One tag was recovered in 2019 on the West Coast of the South Island. One tag was recaptured by an observer in 2020.

PROBLEMS EXPERIENCED

In 2020, there was one trip where observer coverage was cut short and this was due to the Covid-19 lockdown. There were three trips where health and safety concerns were reported by observers but none requiring the termination of the trip.

No harassment or bullying was reported by observers on board any SBT targeting vessels in 2020.

Other relevant information

New Zealand has implemented its Digital Monitoring Programme, which requires vessels to electronically report and use geospatial position reporting.

Acknowledgements

Fisheries New Zealand acknowledges Terese Kendrick for assistance with various parts of this report.

Appendix 1 – Tables

Table 1: Commercial catches of SBT in New Zealand fisheries waters (tonnes, whole weight) by calendar year and New Zealand fishing year (1 October to 30 September).

| Year | Calendar year catches | Fishing year Catches |
|------|-----------------------|----------------------|
| 1980 | 130.0 | 130.0 |
| 1981 | 173.0 | 173.0 |
| 1982 | 305.0 | 305.0 |
| 1983 | 132.0 | 132.0 |
| 1984 | 93.0 | 93.0 |
| 1985 | 94.0 | 94.0 |
| 1986 | 82.0 | 82.0 |
| 1987 | 59.0 | 59.0 |
| 1988 | 94.0 | 94.0 |
| 1989 | 437.2 | 437.1 |
| 1990 | 529.2 | 529.3 |
| 1991 | 164.5 | 164.5 |
| 1992 | 279.2 | 279.2 |
| 1993 | 216.6 | 216.3 |
| 1994 | 277.0 | 277.2 |
| 1995 | 436.4 | 434.7 |
| 1996 | 139.3 | 140.4 |
| 1997 | 333.7 | 333.4 |
| 1998 | 337.1 | 333.0 |
| 1999 | 460.6 | 457.5 |
| 2000 | 380.3 | 381.7 |
| 2001 | 358.5 | 359.2 |
| 2002 | 450.3 | 453.6 |
| 2003 | 389.6 | 391.7 |
| 2004 | 393.3 | 394.0 |
| 2005 | 264.4 | 264.0 |
| 2006 | 238.2 | 238.2 |
| 2007 | 382.6 | 383.1 |
| 2008 | 319.0 | 318.8 |
| 2009 | 418.5 | 417.3 |
| 2010 | 500.8 | 500.0 |
| 2011 | 547.1 | 547.2 |
| 2012 | 775.5 | 775.4 |
| 2013 | 756.4 | 758.2 |
| 2014 | 825.6 | 825.8 |
| 2015 | 922.3 | 922.2 |
| 2016 | 950.8 | 949.4 |
| 2017 | 913.3 | 913.5 |
| 2018 | 1008.0 | 1008.1 |
| 2019 | 959.4 | 956.9 |
| 2020 | 853.0 | 856.6 |

Table 2: Catch (tonnes) for the foreign charter fleet by year and CCSBT region. Based on raised catches. (No foreign charter vessels fished in 1996, nor since 2015).

| Calendar Year | Region 5 | Region 6 | Other* |
|---------------|----------|----------|--------|
| 1989 | | 296.3 | 0.3 |
| 1990 | 66.7 | 174.9 | |
| 1991 | 23.0 | 102.6 | |
| 1992 | 4.8 | 214.5 | 0.5 |
| 1993 | 20.2 | 120.5 | 9.5 |
| 1994 | | 234.1 | |
| 1995 | 1.6 | 228.7 | 0.2 |
| 1996 | | | |
| 1997 | 52.3 | 186.2 | |
| 1998 | 83.9 | 117.3 | |
| 1999 | 9.8 | 190.7 | |
| 2000 | 2.5 | 132.5 | |
| 2001 | | 139.3 | |
| 2002 | | 148.4 | |
| 2003 | | 82.1 | |
| 2004 | | 126.4 | |
| 2005 | 34.4 | 53.0 | |
| 2006 | 9.9 | 95.3 | |
| 2007 | 53.0 | 161.0 | |
| 2008 | | 200.0 | |
| 2009 | 17.0 | 201.2 | |
| 2010 | | 207.8 | |
| 2011 | | 199.1 | |
| 2012 | | 240.1 | 0.1 |
| 2013 | | 183.9 | |
| 2014 | | 223.9 | |
| 2015 | | 256.8 | |
| 2016 | | | |
| 2017 | | | |
| 2018 | | | |
| 2019 | | | |
| 2020 | | | |

*Most often erroneous position data

Table 3: Effort (1000s of hooks) for the foreign charter fleet by year and CCSBT region based on raised hooks. Note that this includes some non-SBT target effort in Region 5. (No foreign charter vessels fished in 1996, nor since 2015).

| Calendar Year | Region 5 | Region 6 | Other* |
|---------------|----------|----------|--------|
| 1989 | | 1596 | 3.5 |
| 1990 | 259 | 1490.6 | |
| 1991 | 306 | 1056.5 | |
| 1992 | 47.6 | 1386.8 | 3 |
| 1993 | 174.1 | 1125.7 | 101.4 |
| 1994 | | 799.1 | |
| 1995 | 27.1 | 1198.7 | 13.5 |
| 1996 | | | |
| 1997 | 135.2 | 1098.7 | |
| 1998 | 225 | 616 | |
| 1999 | 57.2 | 955.1 | |
| 2000 | 30.3 | 757.9 | |
| 2001 | | 639.4 | |
| 2002 | | 726.4 | |
| 2003 | 3 | 866.6 | |
| 2004 | | 1113.5 | |
| 2005 | 137 | 498.9 | |
| 2006 | 39.4 | 562.5 | |
| 2007 | 271.6 | 1136.1 | |
| 2008 | | 568.3 | |
| 2009 | 66.8 | 731.0 | |
| 2010 | | 484.9 | |
| 2011 | | 495.9 | |
| 2012 | | 548.4 | 3.4 |
| 2013 | 13.2 | 450.8 | |
| 2014 | | 655.8 | |
| 2015 | | 625.9 | |
| 2016 | | | |
| 2017 | | | |
| 2018 | | | |
| 2019 | | | |
| 2020 | | | |

*Most often erroneous position data

Table 4: Catch (tonnes) for the domestic commercial fleet by year and CCSBT region based on raised catches.

| Calendar Year | Region 5 | Region 6 | Other* |
|---------------|----------|----------|--------|
| 1980 | | | 130.0 |
| 1981 | | | 173.0 |
| 1982 | | | 305.0 |
| 1983 | | | 132.0 |
| 1984 | | | 93.0 |
| 1985 | | | 94.0 |
| 1986 | | | 82.0 |
| 1987 | | | 59.0 |
| 1988 | | | 94.0 |
| 1989 | 0.1 | 140.5 | |
| 1990 | 6.9 | 278.7 | 2.0 |
| 1991 | 0.9 | 37.8 | 0.1 |
| 1992 | 6.2 | 53.2 | |
| 1993 | 49.4 | 16.3 | 0.8 |
| 1994 | 6.5 | 35.6 | 0.8 |
| 1995 | 15.0 | 184.9 | 6.1 |
| 1996 | 34.2 | 103.8 | 1.3 |
| 1997 | 57.9 | 36.2 | 1.1 |
| 1998 | 83.4 | 52.2 | 0.4 |
| 1999 | 194.7 | 64.8 | 0.6 |
| 2000 | 184.0 | 60.9 | 0.4 |
| 2001 | 113.1 | 105.7 | 0.4 |
| 2002 | 135.7 | 162.9 | 3.2 |
| 2003 | 216.7 | 89.7 | 0.1 |
| 2004 | 101.0 | 165.9 | |
| 2005 | 165.2 | 11.6 | 0.3 |
| 2006 | 122.8 | 10.2 | |
| 2007 | 162.5 | 2.1 | |
| 2008 | 80.5 | 38.1 | |
| 2009 | 133.5 | 66.7 | 0.2 |
| 2010 | 204.8 | 88.2 | |
| 2011 | 237.2 | 110.8 | |
| 2012 | 249.1 | 285.8 | |
| 2013 | 344.1 | 227.2 | |
| 2014 | 334.0 | 267.6 | |
| 2015 | 406.1 | 259.3 | 0.1 |
| 2016 | 563.5 | 386.3 | 1.1 |
| 2017 | 483.6 | 428.6 | 1.1 |
| 2018 | 652.5 | 355.2 | 0.3 |
| 2019 | 414.7 | 544.7 | 0.0 |
| 2020 | 491.9 | 361.1 | |

* Includes erroneous position data and data without positions. 2018 numbers amended to include data from a vessel which was reporting incorrectly.

Table 5: Effort (1000s hooks that caught or targeted SBT) for the domestic commercial fleet by year and CCSBT region based on raised hooks.

| Calendar Year | Region 5 | Region 6 | Other* |
|---------------|----------|----------|--------|
| 1989 | | | |
| 1990 | 41.7 | | |
| 1991 | 31.5 | 49.2 | |
| 1992 | 71.7 | 12.1 | |
| 1993 | 644.0 | 108.1 | 7.7 |
| 1994 | 122.6 | 143.3 | 5.8 |
| 1995 | 221.5 | 760.4 | 26.7 |
| 1996 | 417.9 | 564.3 | 11.5 |
| 1997 | 736.4 | 8.9 | 17.3 |
| 1998 | 633.6 | 314.5 | 1.2 |
| 1999 | 1221.4 | 382.9 | 5.5 |
| 2000 | 1164.0 | 454.4 | 8.5 |
| 2001 | 1027.6 | 751.5 | 1.9 |
| 2002 | 1358.6 | 1246.8 | 13.5 |
| 2003 | 1868.7 | 1569.1 | 4.3 |
| 2004 | 1154.1 | 1431.9 | 1.2 |
| 2005 | 1133.0 | 153.6 | 2.4 |
| 2006 | 1036.4 | 122.4 | 0.9 |
| 2007 | 681.2 | 19.0 | |
| 2008 | 527.8 | 94.0 | |
| 2009 | 733.9 | 165.4 | 1.3 |
| 2010 | 1116.7 | 294.3 | |
| 2011 | 955.7 | 197.8 | |
| 2012 | 858.9 | 629.3 | |
| 2013 | 905.3 | 565.0 | 1.2 |
| 2014 | 595.0 | 540.2 | |
| 2015 | 716.0 | 524.1 | 0.7 |
| 2016 | 883.8 | 565.9 | 12.6 |
| 2017 | 867.1 | 589.6 | 7.9 |
| 2018 | 1203.9 | 485.0 | 3.7 |
| 2019 | 1356.5 | 1499.9 | 0.0 |
| 2020 | 779.4 | 705.1 | |

* Includes erroneous position data and data without positions. 2018 numbers amended to include data from a vessel which was reporting incorrectly.

Table 6: Number of commercial vessels catching SBT in New Zealand fisheries waters by calendar year and New Zealand fishing year (1 October to 30 September).

| Year | Calendar year vessel numbers | Fishing year vessel numbers |
|-------------|-------------------------------------|------------------------------------|
| 2001 | 132 | 132 |
| 2002 | 151 | 155 |
| 2003 | 132 | 132 |
| 2004 | 99 | 101 |
| 2005 | 57 | 58 |
| 2006 | 56 | 57 |
| 2007 | 44 | 45 |
| 2008 | 35 | 36 |
| 2009 | 40 | 39 |
| 2010 | 44 | 42 |
| 2011 | 42 | 42 |
| 2012 | 43 | 44 |
| 2013 | 39 | 39 |
| 2014 | 37 | 38 |
| 2015 | 34 | 33 |
| 2016 | 32 | 32 |
| 2017 | 32 | 32 |
| 2018 | 34 | 34 |
| 2019 | 28 | 30 |
| 2020 | 28 | 28 |

* 2018 number amended to include a vessel which was reporting incorrectly.

Table 7: CPUE (number of fish per 1000 target hooks) for the foreign charter fleet by year and Region, based on raised catches and effort. (No foreign charter vessels fished in 1996, nor since 2015.)

| Calendar Year | Region 5 | Region 6 | Other* |
|----------------------|-----------------|-----------------|---------------|
| 1989 | | 2.24 | 1 |
| 1990 | 2.98 | 1.61 | |
| 1991 | 0.91 | 1.43 | |
| 1992 | 1.32 | 2.48 | 2.52 |
| 1993 | 1.72 | 1.69 | 2.35 |
| 1994 | | 4.51 | |
| 1995 | 0.65 | 2.60 | 0.24 |
| 1996 | | | |
| 1997 | 4.68 | 2.25 | |
| 1998 | 5.48 | 2.94 | |
| 1999 | 2.50 | 2.78 | |
| 2000 | 1.04 | 2.78 | |
| 2001 | | 3.77 | |
| 2002 | | 3.33 | |
| 2003 | 0.00 | 1.34 | |
| 2004 | | 1.37 | |
| 2005 | 2.65 | 1.18 | |
| 2006 | 2.91 | 1.95 | |
| 2007 | 1.93 | 1.70 | |
| 2008 | | 4.88 | |
| 2009 | 2.42 | 4.55 | |
| 2010 | | 7.80 | |
| 2011 | | 6.39 | |
| 2012 | | 7.33 | 0.29 |
| 2013 | 0.08 | 6.49 | |
| 2014 | | 6.10 | |
| 2015 | | 6.74 | |
| 2016 | | | |
| 2017 | | | |
| 2018 | | | |
| 2019 | | | |
| 2020 | | | |

Table 8: CPUE (number of fish per 1000 target hooks) for the domestic commercial fleet by year and Region, based on raised catches and effort.

| Calendar Year | Region 5 | Region 6 | Other* |
|---------------|----------|----------|--------|
| 1989 | | | |
| 1990 | 1.32 | | |
| 1991 | 0.40 | 0.74 | |
| 1992 | 1.00 | 1.35 | |
| 1993 | 0.9 | 1.83 | 1.60 |
| 1994 | 0.69 | 3.62 | 2.38 |
| 1995 | 0.72 | 4.63 | 4.26 |
| 1996 | 1.17 | 2.68 | 2.37 |
| 1997 | 1.11 | 1.52 | 0.52 |
| 1998 | 2.22 | 1.82 | 7.00 |
| 1999 | 2.58 | 2.13 | 1.70 |
| 2000 | 2.37 | 1.99 | 0.75 |
| 2001 | 1.84 | 2.63 | 3.63 |
| 2002 | 1.55 | 2.20 | 3.53 |
| 2003 | 1.54 | 0.82 | 0.52 |
| 2004 | 1.16 | 1.46 | 0.0 |
| 2005 | 1.79 | 0.70 | 1.43 |
| 2006 | 1.44 | 0.88 | 0.0 |
| 2007 | 2.65 | 0.43 | |
| 2008 | 1.84 | 5.99 | |
| 2009 | 2.50 | 7.85 | 2.50 |
| 2010 | 2.75 | 7.29 | |
| 2011 | 3.98 | 11.12 | |
| 2012 | 4.84 | 9.78 | |
| 2013 | 6.15 | 8.11 | 2.00 |
| 2014 | 8.93 | 10.14 | |
| 2015 | 9.35 | 10.19 | 1.67 |
| 2016 | 12.34 | 16.48 | 1.83 |
| 2017 | 10.74 | 17.43 | 1.46 |
| 2018 | 11.08 | 16.81 | 1.17 |
| 2019 | 5.53 | 7.82 | |
| 2020 | 11.2 | 11.16 | |

* 2018 numbers amended to include data from a vessel which was reporting incorrectly.

Table 9: Frequency of catch from the foreign charter fleet under 110, 120, 130, and 140 centimeters (cm) for 1989 to 2020. (No charter vessels fished in 1996, nor since 2015.)

| Year | < 110 cm | < 120 cm | < 130 cm | < 140 cm |
|------|----------|----------|----------|----------|
| 1989 | 0.006 | 0.026 | 0.045 | 0.071 |
| 1990 | 0.041 | 0.101 | 0.131 | 0.164 |
| 1991 | 0.114 | 0.158 | 0.274 | 0.317 |
| 1992 | 0.052 | 0.237 | 0.392 | 0.556 |
| 1993 | 0.217 | 0.316 | 0.472 | 0.594 |
| 1994 | 0.028 | 0.122 | 0.229 | 0.380 |
| 1995 | 0.019 | 0.05 | 0.161 | 0.326 |
| 1996 | NA | NA | NA | NA |
| 1997 | 0.038 | 0.057 | 0.098 | 0.162 |
| 1998 | 0.094 | 0.209 | 0.247 | 0.321 |
| 1999 | 0.033 | 0.082 | 0.157 | 0.216 |
| 2000 | 0.067 | 0.194 | 0.279 | 0.370 |
| 2001 | 0.093 | 0.196 | 0.378 | 0.519 |
| 2002 | 0.037 | 0.135 | 0.245 | 0.398 |
| 2003 | 0.002 | 0.009 | 0.094 | 0.241 |
| 2004 | 0.001 | 0.001 | 0.004 | 0.042 |
| 2005 | 0.000 | 0.000 | 0.002 | 0.008 |
| 2006 | 0.035 | 0.041 | 0.051 | 0.059 |
| 2007 | 0.042 | 0.058 | 0.087 | 0.109 |
| 2008 | 0.080 | 0.181 | 0.230 | 0.289 |
| 2009 | 0.033 | 0.196 | 0.384 | 0.485 |
| 2010 | 0.062 | 0.106 | 0.366 | 0.633 |
| 2011 | 0.035 | 0.073 | 0.135 | 0.403 |
| 2012 | 0.062 | 0.142 | 0.212 | 0.328 |
| 2013 | 0.039 | 0.089 | 0.175 | 0.258 |
| 2014 | 0.050 | 0.177 | 0.321 | 0.438 |
| 2015 | 0.044 | 0.077 | 0.159 | 0.284 |
| 2016 | | | | |
| 2017 | | | | |
| 2018 | | | | |
| 2019 | | | | |
| 2020 | | | | |

Table 10: Frequency of catch from the domestic fleet under 110, 120, 130, and 140 centimeters (cm) for 1989 to 2020.

| Year | < 110 cm | < 120 cm | < 130 cm | < 140 cm |
|------|----------|----------|----------|----------|
| 1990 | 0.000 | 0.011 | 0.159 | 0.445 |
| 1991 | 0.000 | 0.264 | 0.264 | 0.264 |
| 1992 | 0.000 | 0.000 | 0.102 | 0.333 |
| 1993 | 0.108 | 0.160 | 0.183 | 0.301 |
| 1994 | 0.038 | 0.164 | 0.315 | 0.515 |
| 1995 | 0.056 | 0.205 | 0.406 | 0.667 |
| 1996 | 0.028 | 0.094 | 0.181 | 0.365 |
| 1997 | 0.028 | 0.029 | 0.066 | 0.257 |
| 1998 | 0.024 | 0.144 | 0.205 | 0.331 |
| 1999 | 0.018 | 0.060 | 0.140 | 0.322 |
| 2000 | 0.013 | 0.069 | 0.120 | 0.277 |
| 2001 | 0.022 | 0.086 | 0.187 | 0.396 |
| 2002 | 0.025 | 0.082 | 0.151 | 0.318 |
| 2003 | 0.000 | 0.020 | 0.099 | 0.186 |
| 2004 | 0.011 | 0.019 | 0.019 | 0.037 |
| 2005 | 0.000 | 0.006 | 0.006 | 0.006 |
| 2006 | 0.091 | 0.161 | 0.166 | 0.190 |
| 2007 | 0.004 | 0.004 | 0.004 | 0.007 |
| 2008 | 0.04 | 0.046 | 0.133 | 0.221 |
| 2009 | 0.005 | 0.031 | 0.129 | 0.289 |
| 2010 | 0.087 | 0.125 | 0.230 | 0.486 |
| 2011 | 0.028 | 0.098 | 0.161 | 0.328 |
| 2012 | 0.055 | 0.133 | 0.246 | 0.352 |
| 2013 | 0.002 | 0.006 | 0.036 | 0.084 |
| 2014 | 0.027 | 0.126 | 0.250 | 0.353 |
| 2015 | 0.011 | 0.040 | 0.131 | 0.266 |
| 2016 | 0.156 | 0.390 | 0.492 | 0.610 |
| 2017 | 0.072 | 0.307 | 0.525 | 0.625 |
| 2018 | 0.041 | 0.155 | 0.41 | 0.634 |
| 2019 | 0.089 | 0.177 | 0.349 | 0.603 |
| 2020 | 0.057 | 0.161 | 0.273 | 0.416 |

Table 101: Number of otoliths collected and aged by observers from the foreign charter and domestic fleet catch for the years 2000–2020, and by surveyors from the recreational catch from 2018– 2020. 2019, 2020 aging data is not yet available.

| Year | Foreign charter fleet | | Domestic fleet | | Recreational fleet | |
|------|-----------------------|-------------|----------------|-------------|--------------------|-------------|
| | Otoliths | Number aged | Otoliths | Number aged | Otoliths | Number aged |
| 2000 | 149 | 0 | | | | |
| 2001 | 777 | 198 | | | | |
| 2002 | 1199 | 197 | | | | |
| 2003 | 838 | 197 | | | | |
| 2004 | 1141 | 196 | 120 | 23 | | |
| 2005 | 417 | 252 | 3 | 3 | | |
| 2006 | 443 | 249 | | | | |
| 2007 | 714 | 254 | | | | |
| 2008 | 745 | 253 | | | | |
| 2009 | 1066 | 268 | | | | |
| 2010 | 875 | 258 | | | | |
| 2011 | 604 | 270 | | | | |
| 2012 | 1252 | 255 | | | | |
| 2013 | 1019 | 252 | | | | |
| 2014 | 1241 | 257 | | | | |
| 2015 | 1231 | 380 | | | | |
| 2016 | | | 101 | 89 | | |
| 2017 | | | 119 | 108 | | |
| 2018 | | | 6 | 5 | 32 | 32 |
| 2019 | | | | | 80 | |
| 2020 | | | 26 | | 90 | |

Table 112: Biological specimens taken by observers.

| Calendar year | 2017 | | 2018 | | 2019 | | 2020 | |
|--------------------------------|------|------|------|-----|------|------|------|------|
| | 5 | 6 | 5 | 6 | 5 | 6 | 5 | 6 |
| Region | | | | | | | | |
| LF # | 2003 | 2051 | 2434 | 851 | 530 | 1163 | 1077 | 1041 |
| Sexed | 1806 | 1416 | 2314 | 835 | 449 | 1008 | 974 | 986 |
| Head | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Viscera | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Stomach (stomach log) | 1696 | 1731 | 2043 | 739 | 402 | 753 | 955 | 942 |
| Otolith | 54 | 69 | 0 | 6 | 0 | 0 | 25 | 1 |
| Tail | 10 | 0 | 0 | 0 | 2 | 0 | 0 | 0 |
| Anal fin | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Entire specimen | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| White muscle | 452 | 701 | 1043 | 222 | 320 | 576 | 450 | 824 |
| Photo | 30 | 23 | 45 | 3 | 11 | 31 | 40 | 4 |
| Gillraker | 1 | 19 | 0 | 0 | 0 | 0 | 121 | 0 |
| Stomach contents - kept | 0 | 13 | 8 | 0 | 38 | 0 | 0 | 0 |
| Gonads | 0 | 0 | 10 | 0 | 0 | 0 | 0 | 0 |
| Tag retained | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| Eye | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

Table 13: Number of releases and discards observed and the estimated total number of discards (separated by life status¹ - alive and dead) based on observer coverage and the life status of the observed discards for the foreign charter fleet. Note that numbers are rounded to the nearest whole fish. (No foreign charter vessels fishing in 1996, 2016, or 2017).

| Year | Observed numbers | | Scaled estimate | | |
|------|------------------|--|------------------|------|-------|
| | Alive | Dead | Alive (released) | Dead | Total |
| 1989 | 0 | 0 | 0 | 0 | 0 |
| 1990 | 0 | 0 | 0 | 0 | 0 |
| 1991 | 0 | 0 | 0 | 0 | 0 |
| 1992 | 0 | 0 | 0 | 0 | |
| 1993 | 18 | 4 | 55 | 13 | 68 |
| 1994 | 27 | 9 | 40 | 13 | 53 |
| 1995 | 2 | 3 | 4 | 9 | 13 |
| 1996 | 0 | 0 | | | |
| 1997 | 0 | 23 | 0 | 38 | 38 |
| 1998 | 0 | 20 | 0 | 20 | 20 |
| 1999 | 18 | 15 | 18 | 15 | 33 |
| 2000 | 0 | 3 | 0 | 4 | 4 |
| 2001 | 3 | 3 | 3 | 4 | 6 |
| 2002 | 2 | 3 | 2 | 3 | 5 |
| 2003 | 0 | 2 | 0 | 2 | 2 |
| 2004 | 0 | 2 | 0 | 2 | 2 |
| 2005 | 0 | 0 | 0 | 0 | 0 |
| 2006 | 2 | 2 | 2 | 2 | 5 |
| 2007 | 2 | 1 | 4 | 2 | 5 |
| 2008 | 0 | 0 | 0 | 0 | 0 |
| 2009 | 5 | 0 | 6 | 0 | 6 |
| 2010 | 10 | 2 | 12 | 3 | 15 |
| 2011 | 10 | 0 | 14 | 0 | 14 |
| 2012 | 36 | 0 | 43 | 0 | 43 |
| 2013 | 64 | 4 | 82 | 5 | 87 |
| 2014 | 65 | 0 | 78 | 0 | 78 |
| 2015 | 16 | 0 | 20 | 0 | 20 |
| 2016 | | No charter vessels fishing in New Zealand waters this year | | | |
| 2017 | | No charter vessels fishing in New Zealand waters this year | | | |
| 2018 | | No charter vessels fishing in New Zealand waters this year | | | |
| 2019 | | No charter vessels fishing in New Zealand waters this year | | | |
| 2020 | | No charter vessels fishing in New Zealand waters this year | | | |

¹ The Resolution on Reporting all Sources of Mortality of Southern Bluefin Tuna requires that members report the fate of discards. New Zealand does not currently use the moribund category when reporting fate of captures. Moribund fish are included within the "dead" category reflecting the domestic requirement that only discarded fish which are "likely to survive" can be considered "alive".

Table 14: Actual number of releases and discards observed and the estimated total number of discards (separated by life status - alive and dead) based on observer coverage and the life status of the observed discards for the domestic commercial fleet. Note that numbers are rounded to the nearest whole fish.

| Year | Observed numbers | | Scaled estimate | | |
|------|------------------|------|------------------|-------|-------|
| | Alive | Dead | Alive (released) | Dead* | Total |
| 1989 | 0 | 0 | | | |
| 1990 | 0 | 0 | | | |
| 1991 | 0 | 0 | | | |
| 1992 | 0 | 0 | 0 | 0 | 0 |
| 1993 | 0 | 0 | | | |
| 1994 | 0 | 0 | 0 | 0 | 0 |
| 1995 | 1 | 3 | 10 | 20 | 30 |
| 1996 | 4 | 1 | 25 | 6 | 31 |
| 1997 | 0 | 1 | 0 | 4 | 4 |
| 1998 | 0 | 0 | 0 | 0 | 0 |
| 1999 | 0 | 0 | 0 | 0 | 0 |
| 2000 | 0 | 0 | 0 | 0 | 0 |
| 2001 | 2 | 3 | 8 | 10 | 18 |
| 2002 | 2 | 2 | 24 | 30 | 53 |
| 2003 | 0 | 0 | 0 | 0 | 0 |
| 2004 | 0 | 1 | 0 | 7 | 7 |
| 2005 | 4 | 1 | 33 | 8 | 42 |
| 2006 | 1 | 0 | 16 | 0 | 16 |
| 2007 | 1 | 1 | 8 | 8 | 15 |
| 2008 | 2 | 0 | 13 | 0 | 13 |
| 2009 | 1 | 1 | 12 | 12 | 24 |
| 2010 | 24 | 2 | 282 | 25 | 307 |
| 2011 | 37 | 7 | 442 | 84 | 526 |
| 2012 | 61 | 5 | 745 | 65 | 810 |
| 2013 | 50 | 0 | 1180 | 0 | 1180 |
| 2014 | 48 | 19 | 710 | 276 | 986 |
| 2015 | 62 | 15 | 913 | 214 | 1127 |
| 2016 | 534 | 66 | 2770 | 342 | 3113 |
| 2017 | 193 | 31 | 975 | 159 | 1133 |
| 2018 | 70 | 48 | 404 | 280 | 684 |
| 2019 | 47 | 9 | 512 | 98 | 610 |
| 2020 | 244 | 37 | 2486 | 381 | 2858 |

*Dead discards can only occur when authorised by Fisheries New Zealand observers, so the scaled estimates should be treated with caution.

Table 15: Observer coverage in terms of catch (proportion of individual SBT observed) for the domestic surface longline commercial fleet for 2019 and 2020 calendar years.

| Country/ Fishing Entity | Calendar Year | Fishery | | CCSBT statistical area | Total SBT catch numbers | Observed SBT catch numbers | Observer coverage (%) |
|-------------------------------|------------------|--------------|---------------|------------------------------|----------------------------|-------------------------------|-----------------------------|
| | | Gear Code | Fleet Code | | | | |
| NZ | 2019 | SLL | NZD | 5 | 4,206 | 546 | 13% |
| | | | | 6 | 6,073 | 1,209 | 20% |
| NZ | 2020 | SLL | NZD | 5 | 9,177 | 1,250 | 14% |
| | | | | 6 | 8,091 | 1,161 | 14% |

Table 16: Observer coverage in terms of estimated catch (proportion of total estimated weight) for the domestic surface longline commercial fleet for 2019 and 2020 calendar years.

| Country/ Fishing Entity | Calendar Year | Fishery | | CCSBT statistical area | Total SBT Catch (kg) | Observed SBT Catch (kg) | Observer coverage (%) |
|-------------------------------|------------------|--------------|---------------|------------------------------|-------------------------|----------------------------|-----------------------------|
| | | Gear Code | Fleet Code | | | | |
| NZ | 2019 | SLL | NZD | 5 | 199,109 | 29,789 | 15% |
| | | | | 6 | 240,157 | 58,510 | 24% |
| NZ | 2020 | SLL | NZD | 5 | 432,204 | 63,932 | 15% |
| | | | | 6 | 317,191 | 54,517 | 17% |

Table 17: Observer coverage in terms of effort (proportion of hooks observed) for the domestic commercial fleet for 2019 and 2020 calendar years.

| Country/ Fishing Entity | Calendar year | Fishery | | CCSBT statistical area | Total Effort (no. of hooks) | Observed Effort (no. of hooks) | Observer coverage (%) |
|-------------------------------|------------------|--------------|---------------|------------------------------|--------------------------------|-----------------------------------|-----------------------------|
| | | Gear code | Fleet code | | | | |
| NZ | 2019 | SLL | NZD | 5 | 772,489 | 55,020 | 7% |
| | | | | 6 | 727,470 | 82,928 | 11% |
| NZ | 2020 | SLL | NZD | 5 | 787,667 | 67,591 | 9% |
| | | | | 6 | 712,744 | 69,828 | 10% |

Table 18: Observer coverage in terms of days for the domestic commercial fleet for the 2019 and 2020 calendar years.

| Country/ Fishing Entity | Calendar Year | Fishery | | CCSBT statistical area | Total Effort (vessel days) | Observed Effort (vessel days) | Observer coverage (%) |
|-------------------------------|------------------|--------------|---------------|------------------------------|-------------------------------|----------------------------------|-----------------------------|
| | | Gear Code | Fleet Code | | | | |
| NZ | 2019 | SLL | NZD | 5 | 875 | 77 | 9% |
| | | | | 6 | 757 | 88 | 12% |
| NZ | 2020 | SLL | NZD | 5 | 896 | 89 | 10% |
| | | | | 6 | 755 | 64 | 8% |

Table 19: Number of landed SBT recorded through amateur charter vessel reporting for 2013-2020 calendar years.

| Calendar year | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|--|------|------|------|------|------|------|------|------|
| Amateur charter vessel reporting SBT landed (number) | 12 | 0 | 5 | 36 | 47 | 12 | 42 | 186 |

Table 20: Number of landed SBT reported through New Zealand sport fishing clubs for 2013-2020 calendar years.

| Calendar year | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|------|------|------|------|------|------|------|------|
| New Zealand sport fishing clubs landed SBT (number) | 0 | 2 | 1 | 7 | 266 | 171 | 293 | 434 |

Table 21: Recreational catch (greenweight, kg) retained by fishers on commercial vessels under a Section 111 approval.

| Fishing year | 2014/15 | 2015/16 | 2016/17 | 2017/18 | 2018/19 | 2019/20 |
|--------------------------------------|---------|---------|---------|---------|---------|---------|
| Section 111 landed green weight (kg) | 672 | 661 | 1038 | 507 | 454 | 671 |

Appendix 2 – Figures

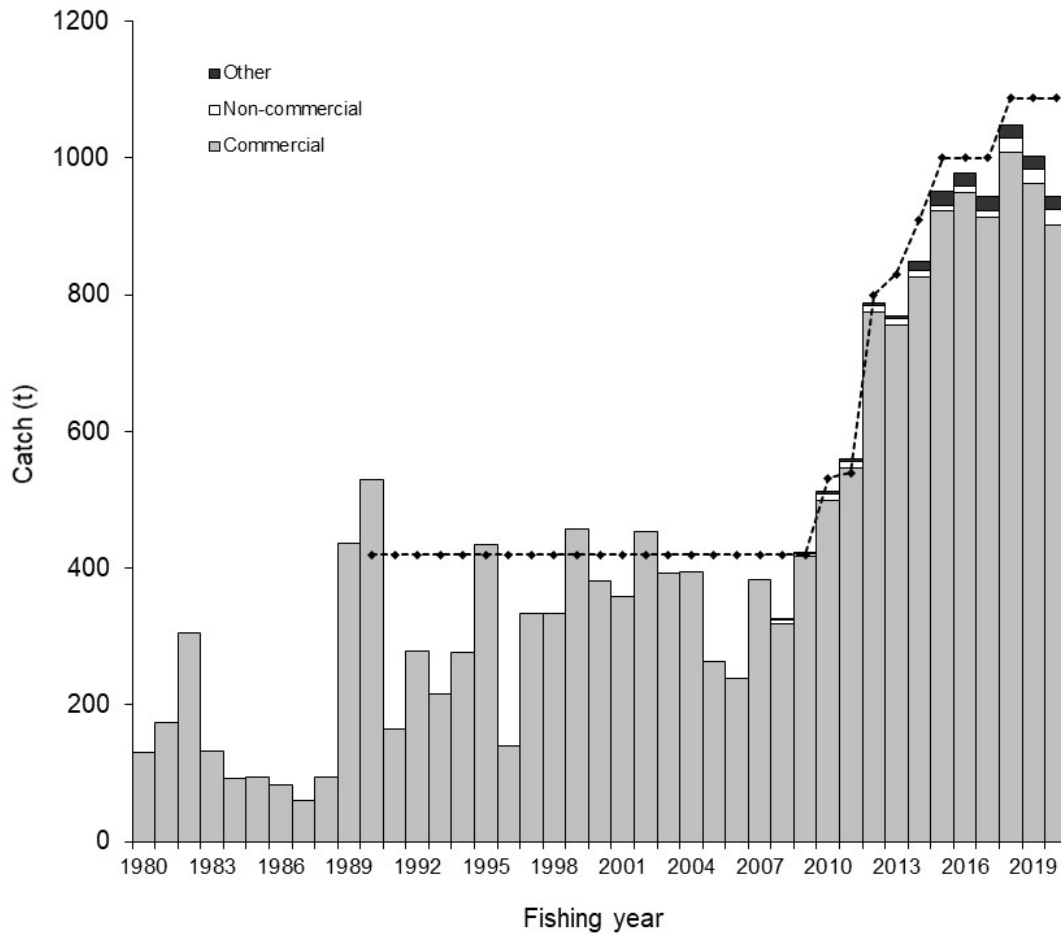


Figure 1: Commercial catches of SBT (tonnes, whole weight) by New Zealand fishing year. From 1998/99 to 2000/01, commercial catch information is from Licensed Fish Receivers, and from 2001/02, commercial catch information is from Monthly Harvest Returns from permit holders. The dashed horizontal line refers to the catch limit for New Zealand. From the 2007/08 fishing year, estimates of non-commercial catch and discard mortality (included as 'other') are provided.

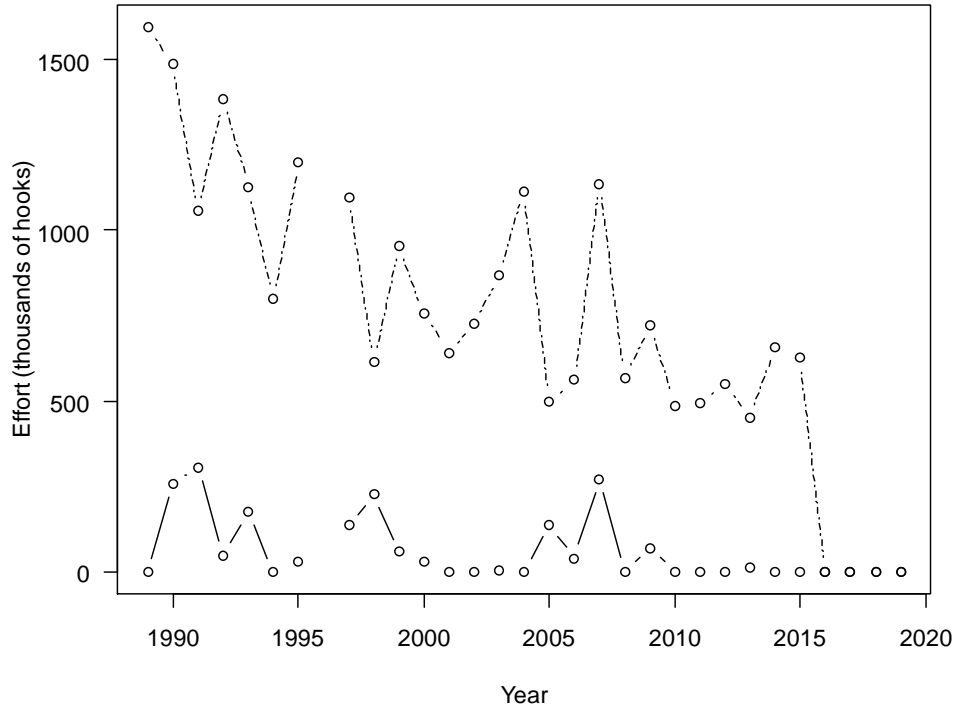


Figure 2: Effort (1000s of hooks) for the foreign charter fleet in Region 5 (solid line) and Region 6 (dashed line). Note that this includes some non-SBT target effort in Region 5 and that no foreign charter vessels fished in 1996, and from 2016 onwards.

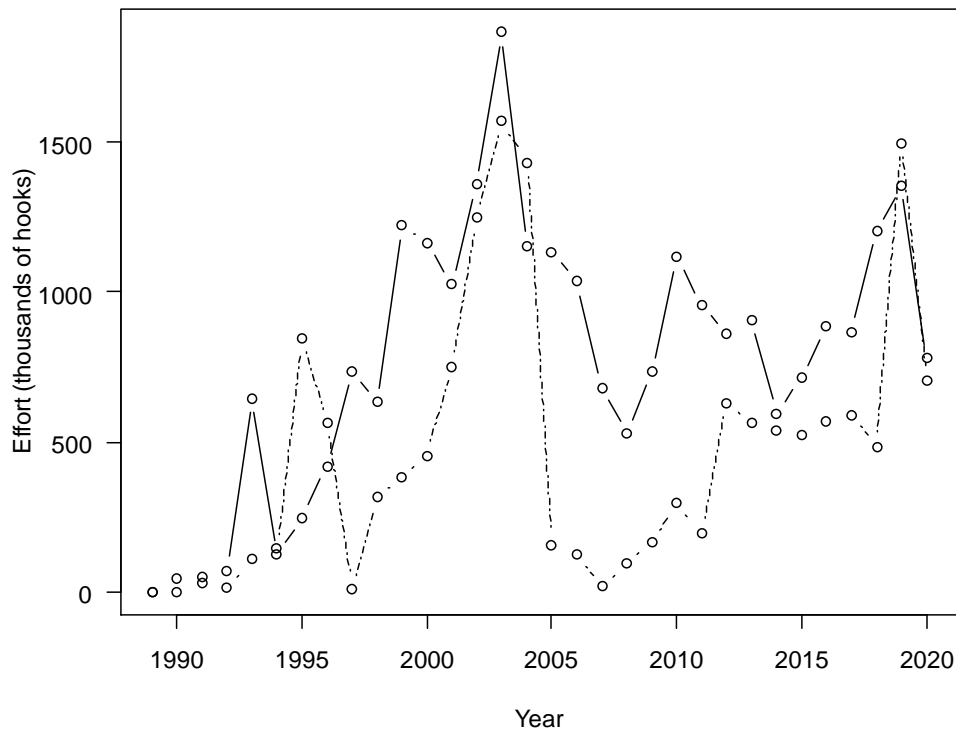


Figure 3: Target effort (1000s of hooks, hooks from sets that either targeted or caught SBT) by the domestic commercial fleet for Region 5 (solid line) and Region 6 (dashed line).

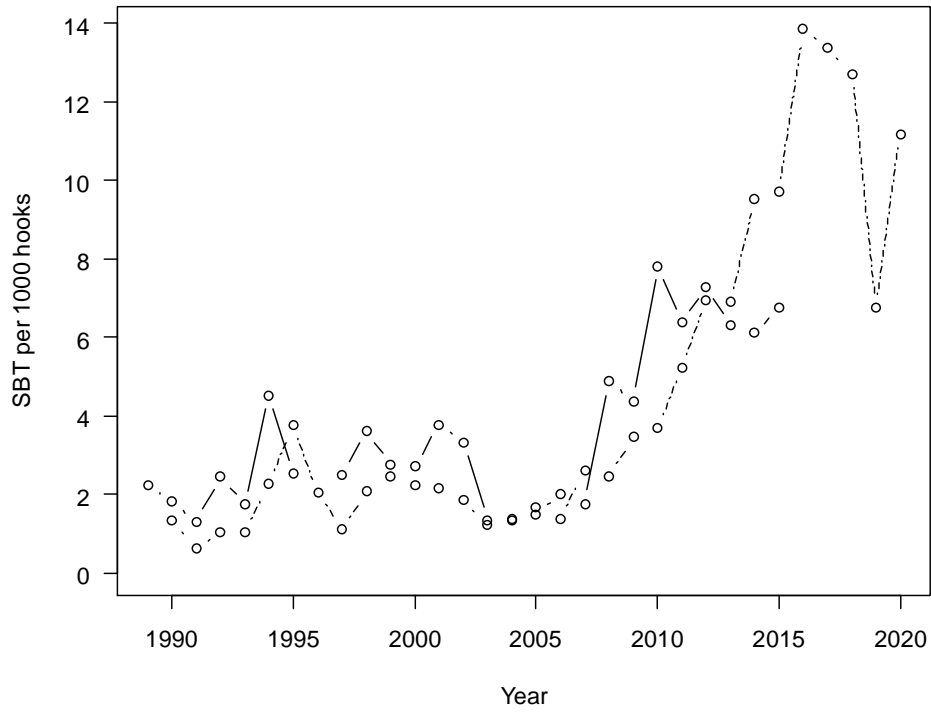


Figure 4: CPUE (number of SBT per 1000 hooks) by calendar year for the charter (solid line) and domestic (dashed line) longline fleets based only on effort from sets that either targeted or caught SBT. Note that no charter vessels fished in 1996, and from 2016 onwards.

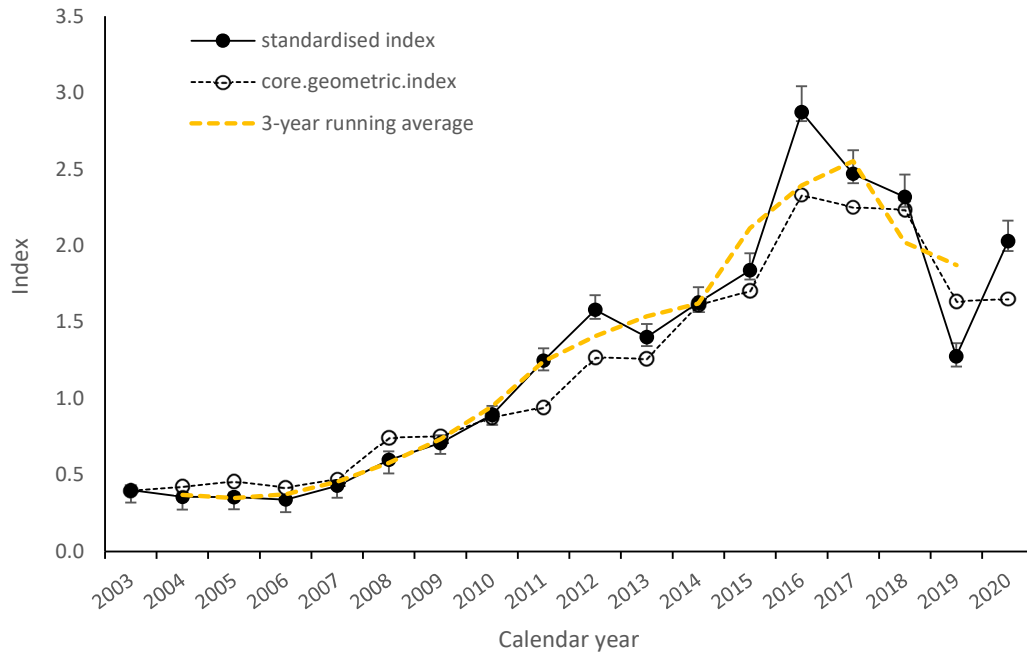


Figure 5: Standardised and unstandardised CPUE indices from unraised catch and effort reported on TLCERs for 2003 to 2020, and a three-year moving average based on the standardised index. Catch per unit of effort for the period 2003 to 2020 was standardised for changes in the core fleet, month and area of fishing, assuming a negative binomial error structure. The index was the number of fish per longline set with year, vessel month and area included in the GLM and the number of hooks and length of longline not being accepted into the model. The three-year running average is plotted at the midpoint of the year range.

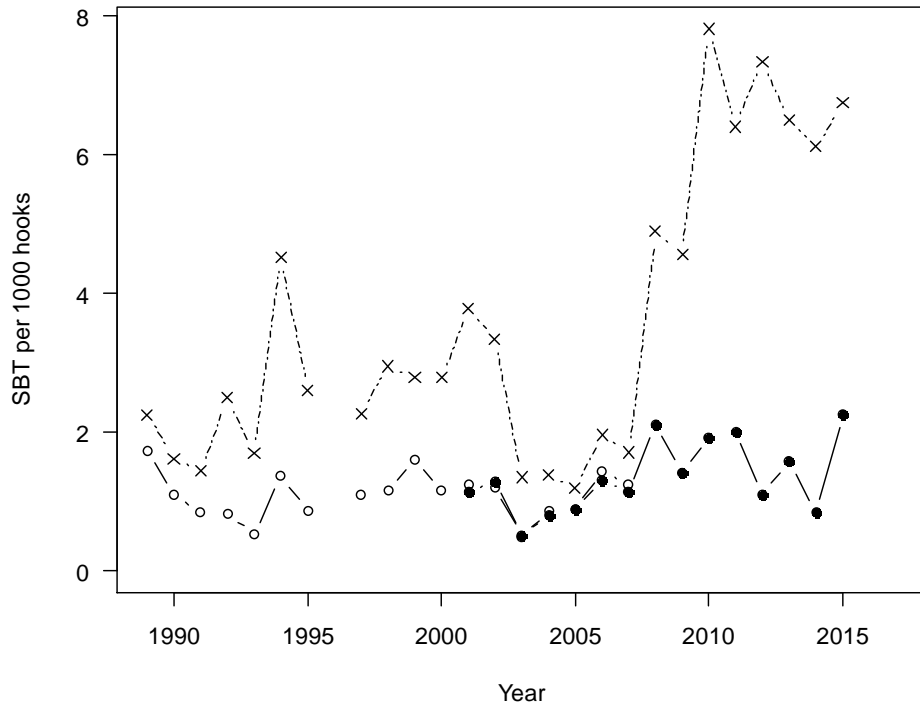


Figure 6: CPUE (number of SBT per 1000 hooks) from the foreign charter fleet in Region 6 (west coast South Island) for all southern bluefin tuna (dashed line) and for fish greater than 10 years of age based on approximate ageing from length frequency data (solid line, open symbols) and based on direct ageing data (solid line, solid symbols). Note that no foreign charter vessels fished in 1996, nor since 2015.

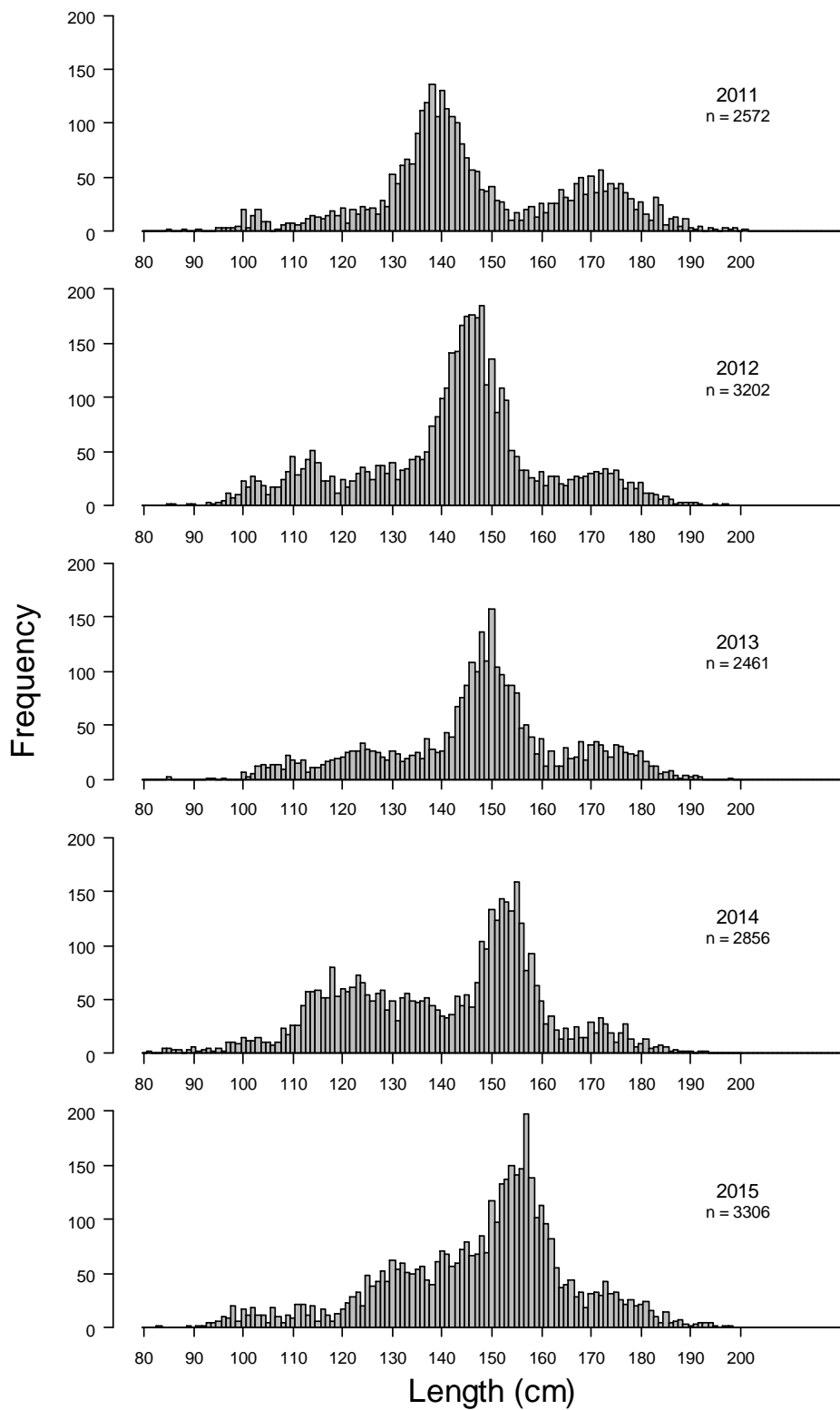


Figure 7: Length frequency of SBT catch (raised) by the foreign charter fleet for the most recent five calendar years (no foreign charter vessels have fished since 2015).

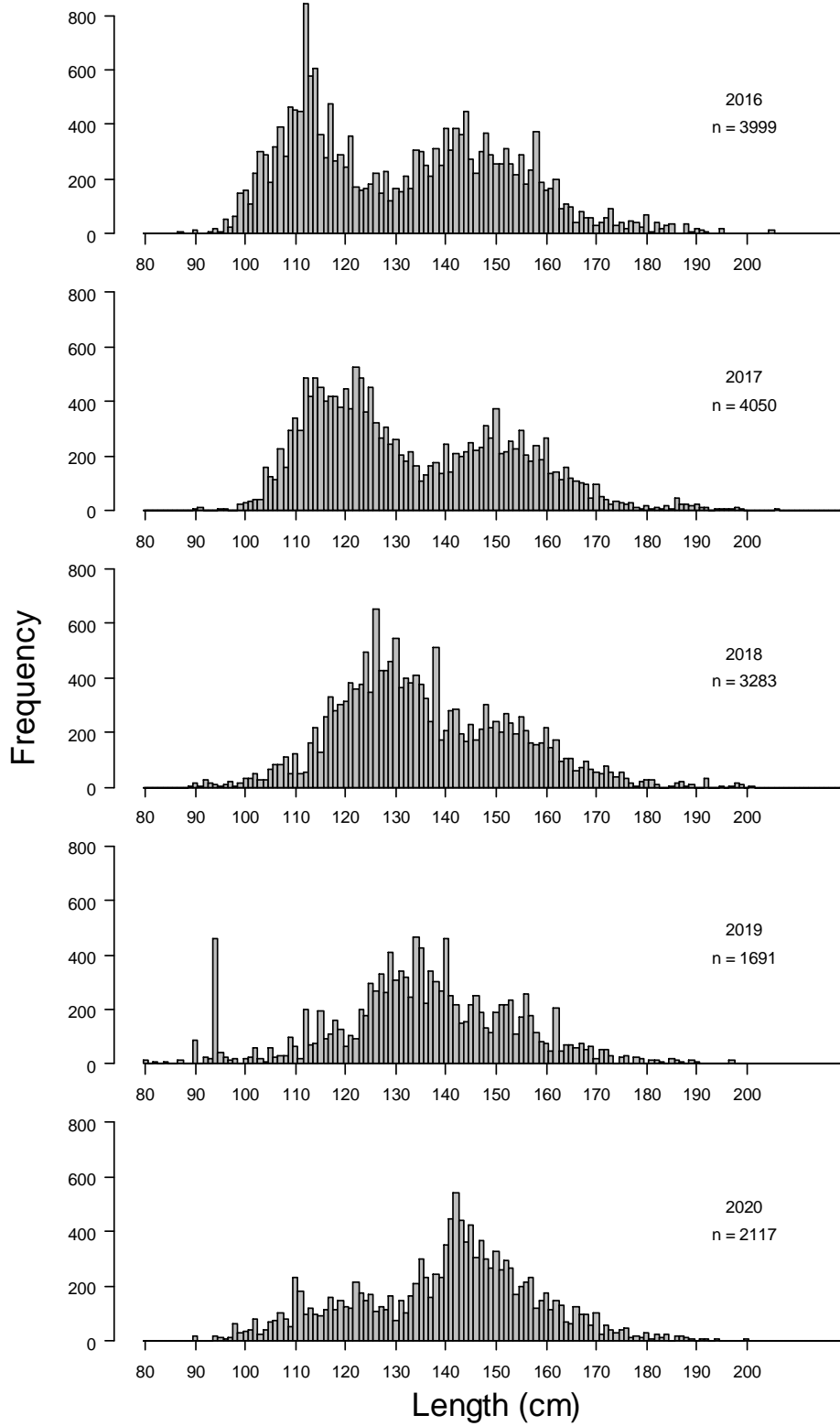


Figure 8: Length frequency of SBT catch by the domestic commercial fleet for the five most recent calendar years.

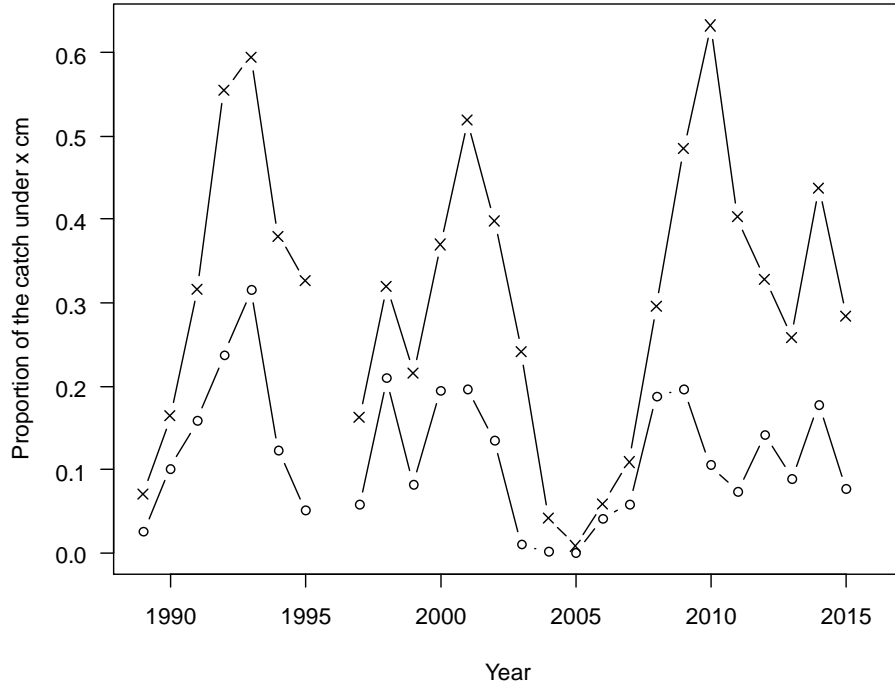


Figure 9: Proportion of the catch from the foreign charter fleet under 120 cm (o) and 140 cm (x) since 1989 (no foreign charter vessels fishing in 1996, nor since 2015).

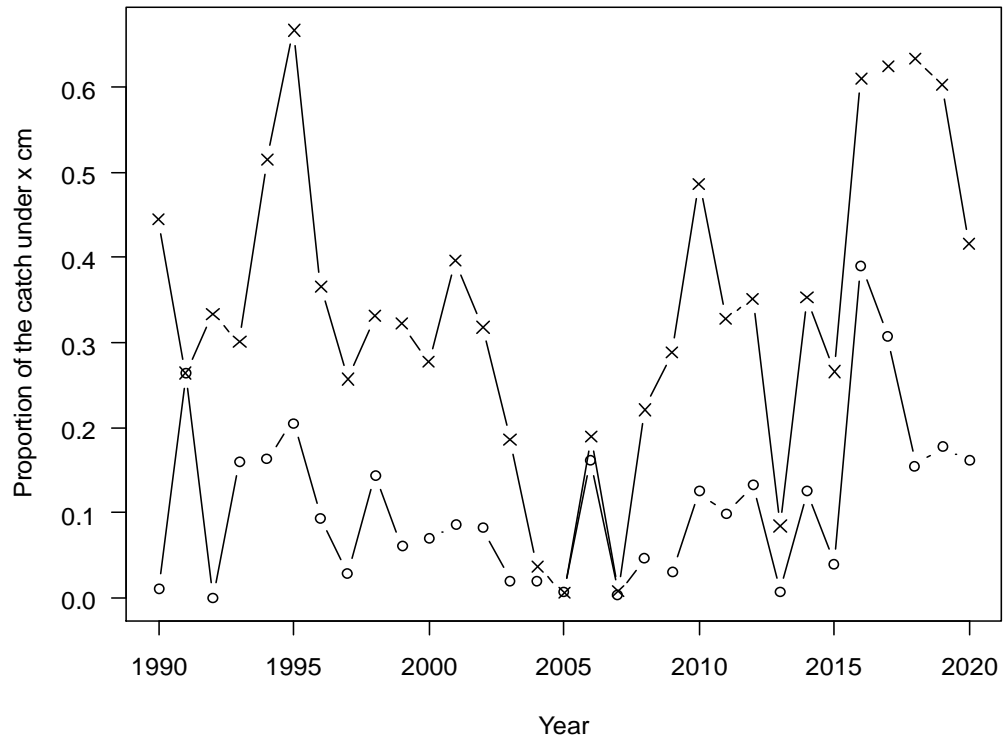


Figure 10: Proportion of the catch from the domestic commercial fleet under 120 cm (o) and 140 cm (x) for 1989 to 2020.

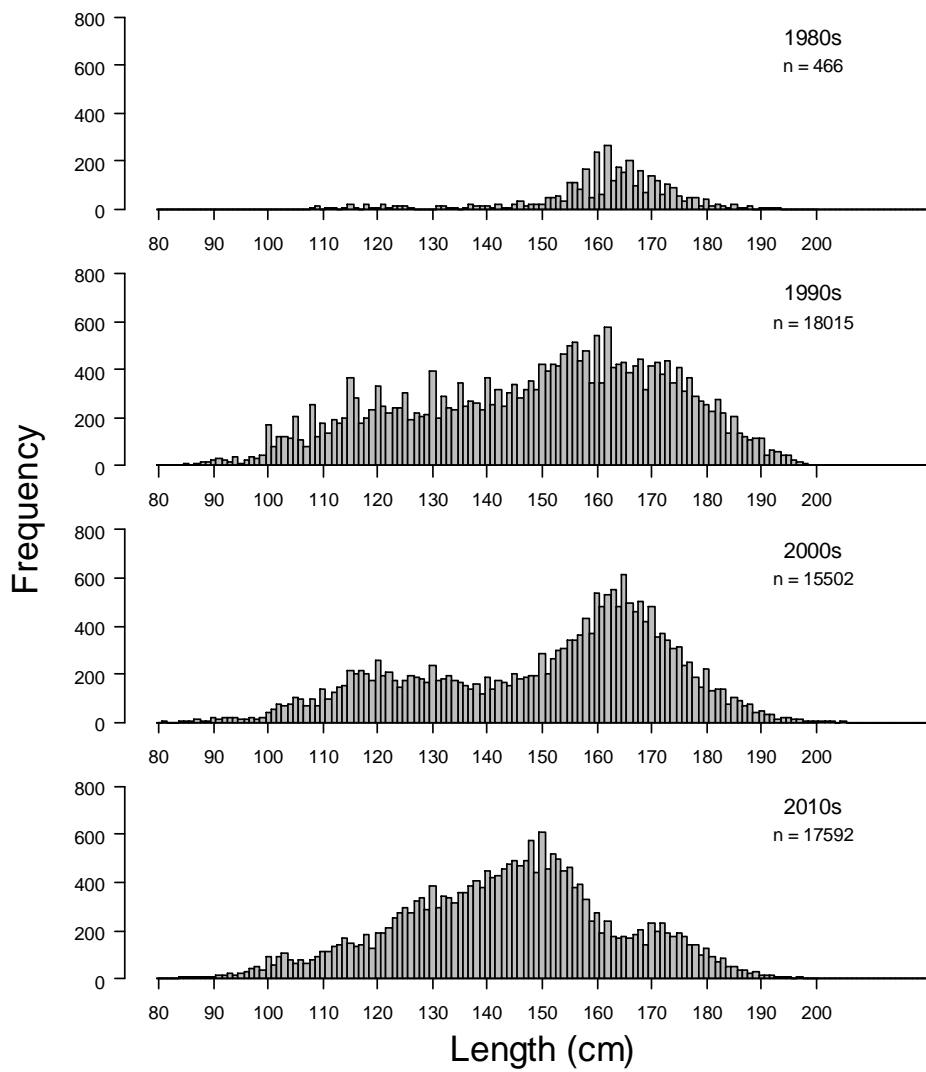


Figure 11: Length frequencies (raised) for the foreign charter fleet in the 10 year periods 1990-99, 2000-09, and 2010-present. (No foreign charter vessel fished in 2016, nor since 2015.) n= number of fish measured

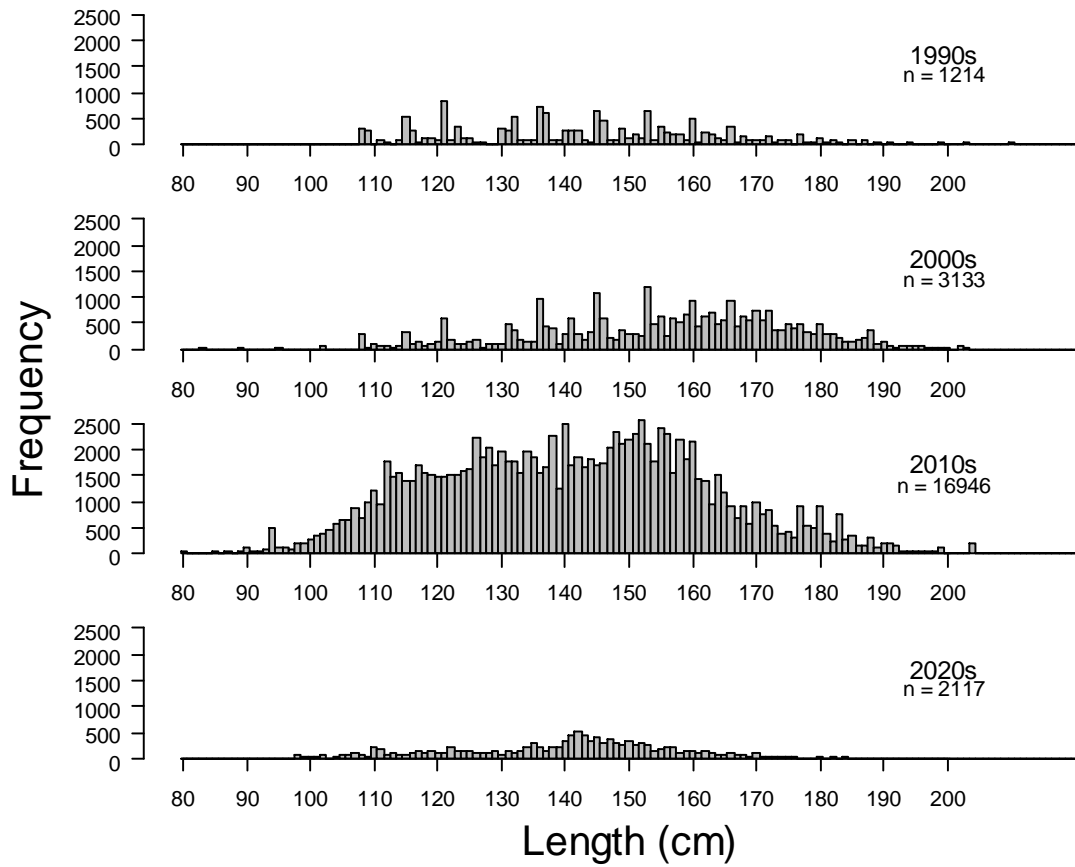


Figure 12: Length frequencies (raised) for the domestic commercial fleet in the 10 year periods 1990-99, 2000-09, 2010-2019, and 2020 -present n= number of fish measured

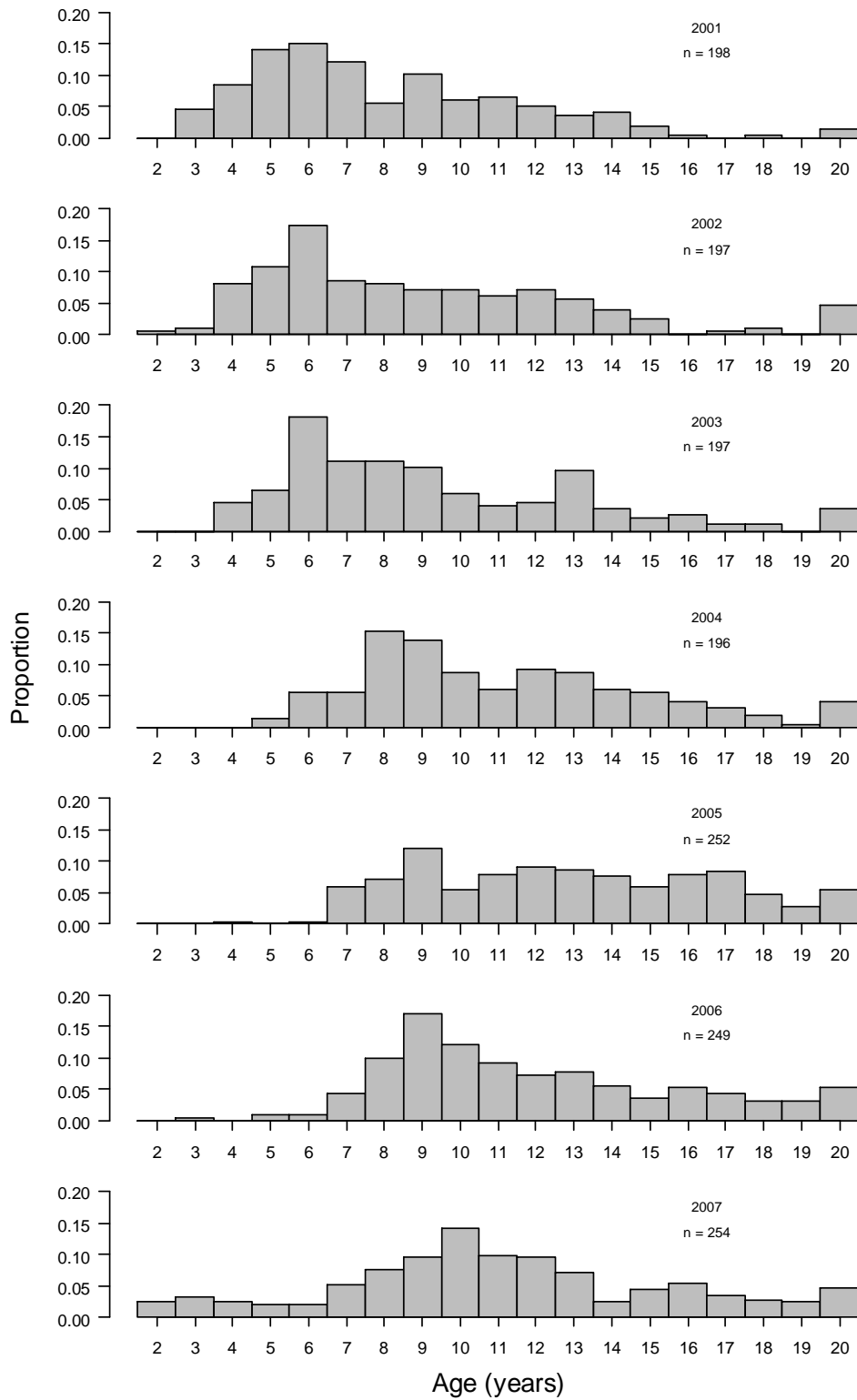


Figure 13: Proportion-at-age for the foreign charter fleet for 2001 to 2015, and for the domestic commercial fleet for 2016 to 2018, based on direct ageing. Age 20 is a plus group. 2019, 2020 length data not available at the time of reporting.

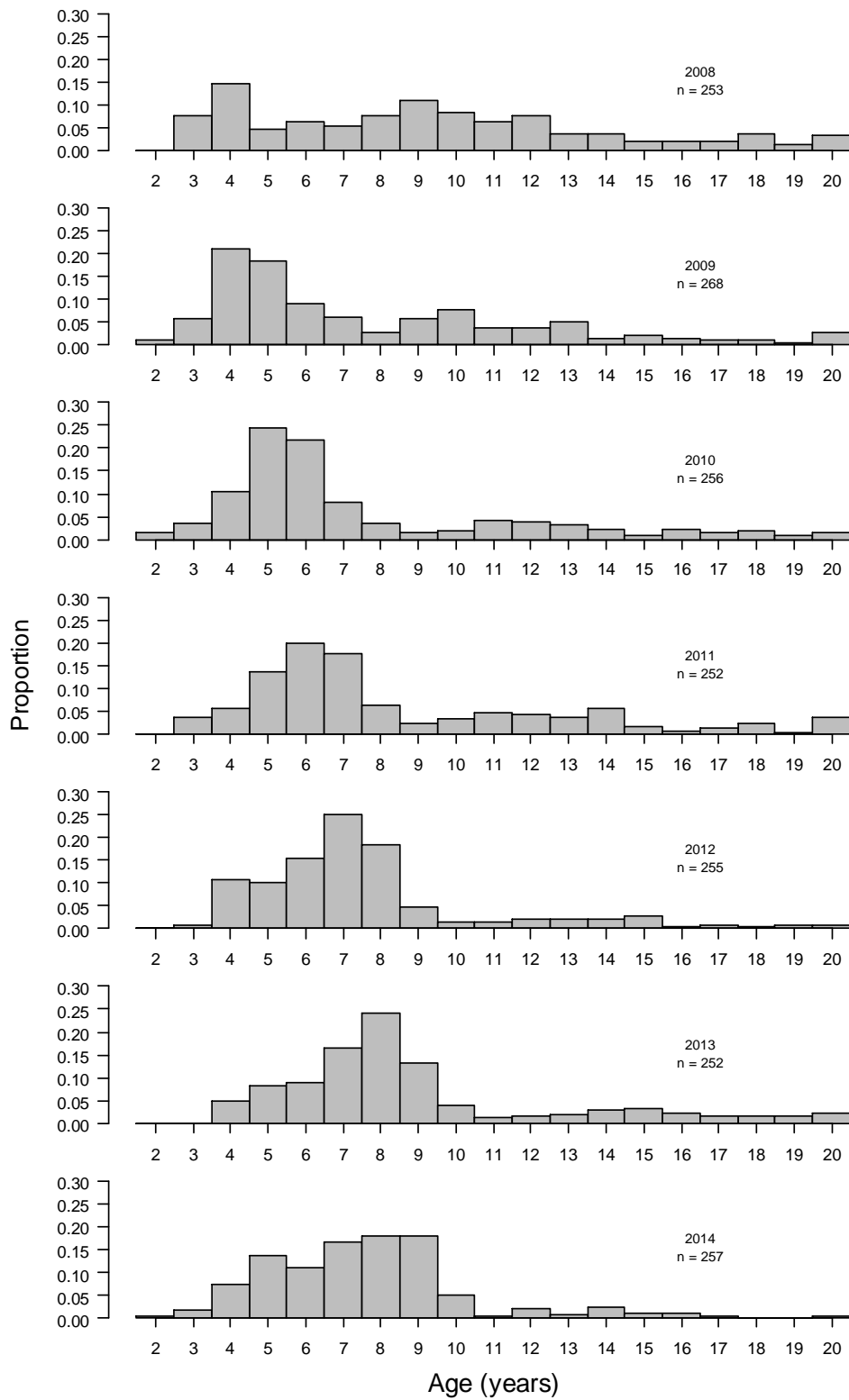


Figure 5 (continued): Proportion-at-age for foreign charter fleet for 2001 to 2015, and for the domestic commercial fleet for 2016 to 2018, based on direct ageing. Age 20 is a plus group. 2019, 2020 length data not available at the time of reporting.

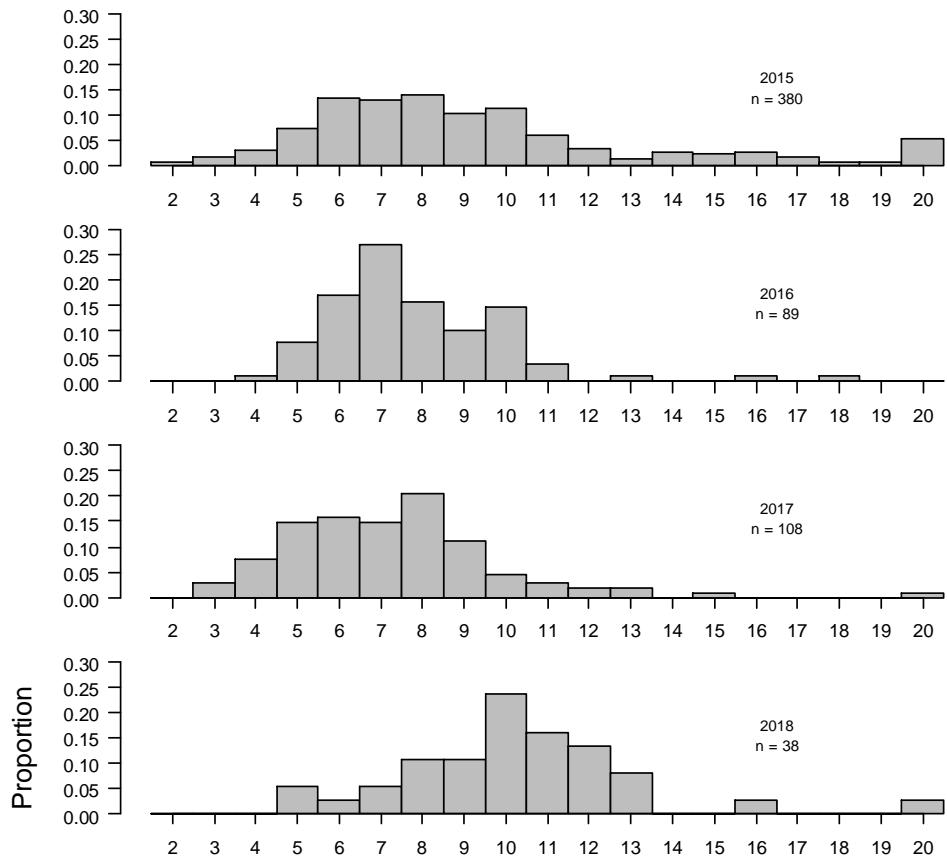


Figure 13 (continued): Proportion-at-age for the foreign charter fleet for 2001 to 2015, and for the domestic commercial fleet for 2016 to 2018 based on direct ageing. Age 20 is a plus group. 2019, 2020 age data not available at the time of reporting.

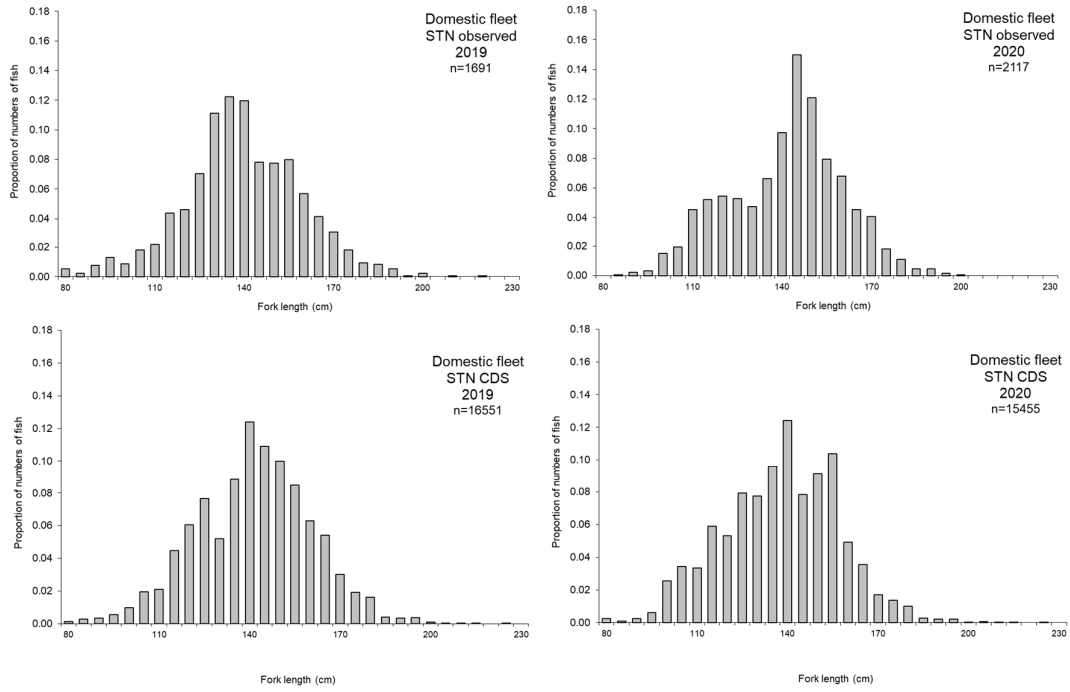


Figure 6: Proportion-at-length for SBT catches from 2019, and 2020 for the domestic commercial fleet measured by observers (upper), and reported on CDS forms (lower).

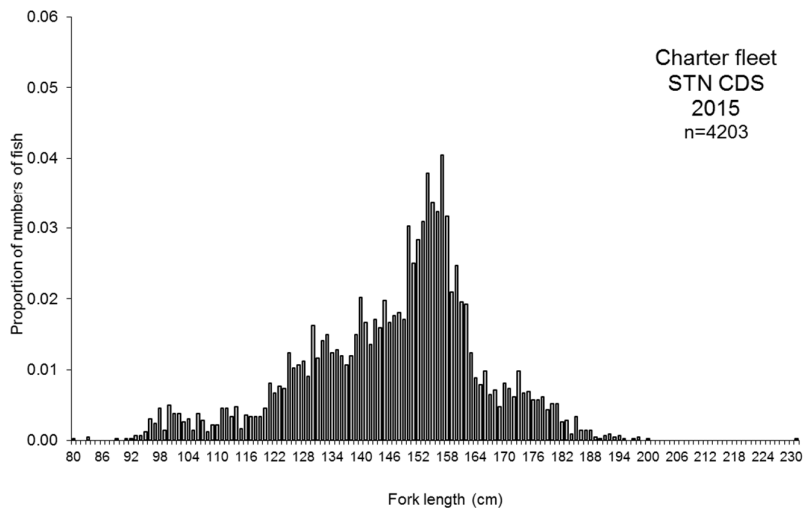
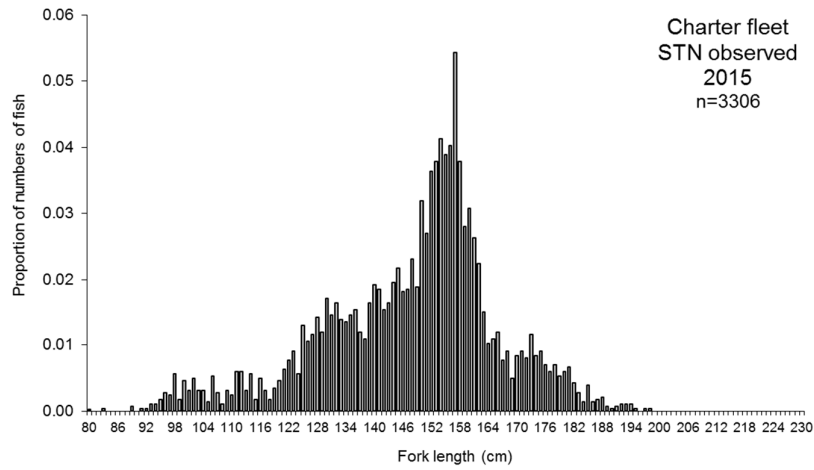


Figure 7: Proportion-at-length for the SBT catches from 2015 for the foreign charter fleet measured by observers and reported on CDS forms.

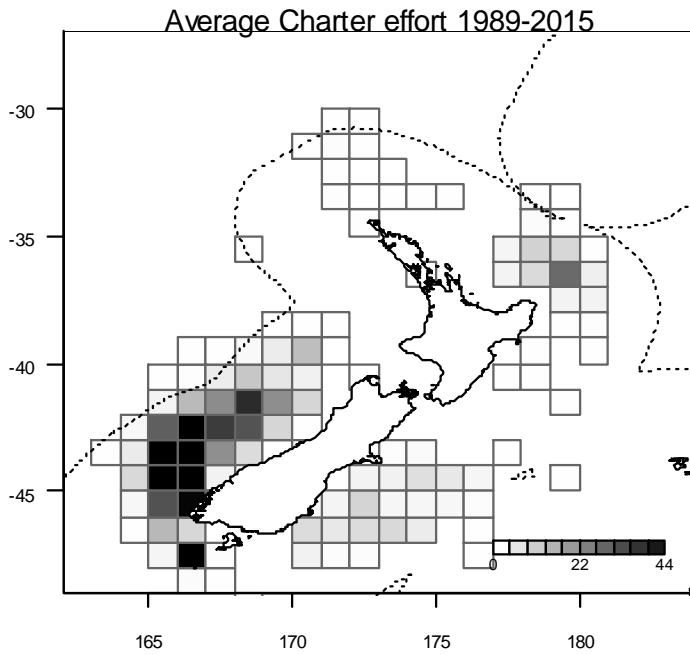


Figure 8: Distribution of longline effort (1,000s of hooks per one degree square) for the foreign charter fleet: average for the time series (1989 to 2015). No foreign charter vessels fished 2016 to 2020.

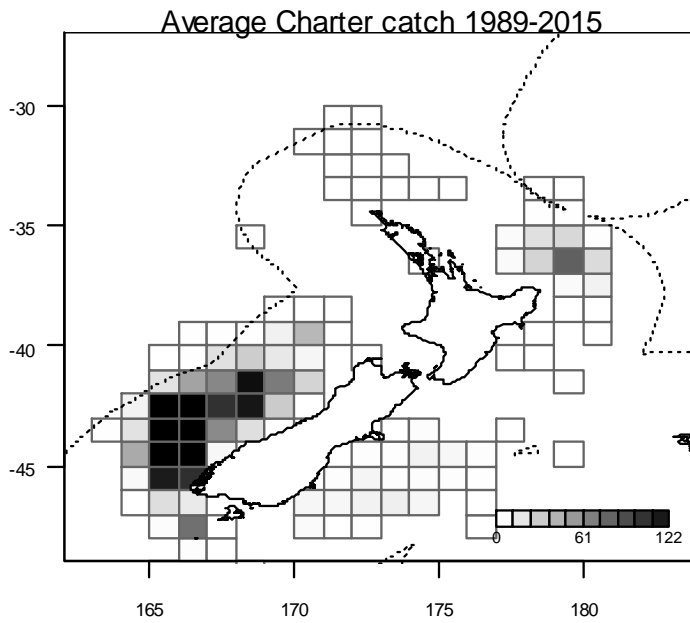


Figure 9: Distribution of longline catches (number of fish per one degree square) for the foreign charter fleet: average for the time series (1989 to 2015). (No foreign charter vessels fishing 2016 to 2020.)

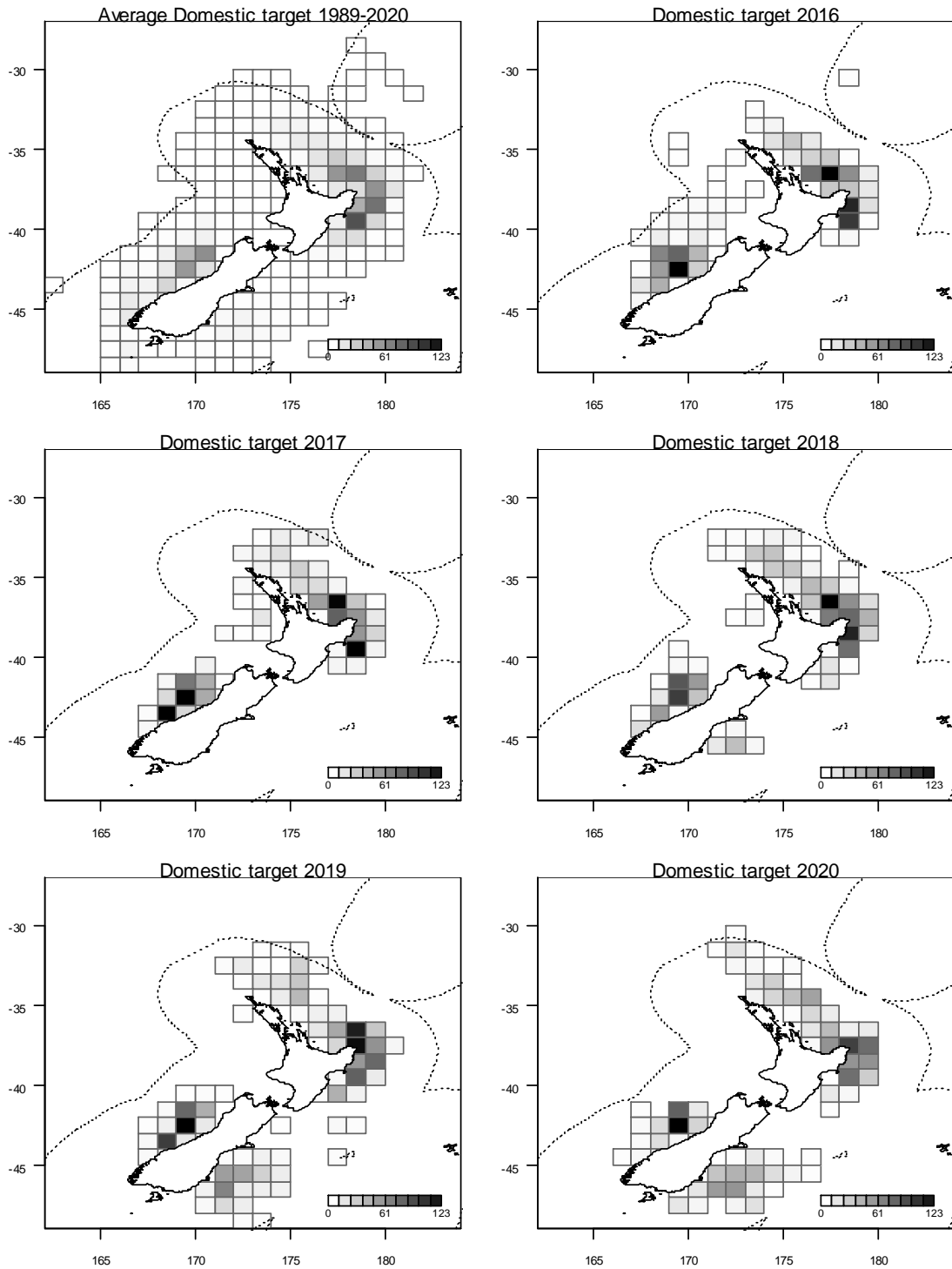


Figure 10: Distribution of longline effort (1,000s of hooks per one degree square) for the domestic commercial fleet that was targeted at SBT: average for the time series (1989 to 2020), and annually for 2016 to 2020.

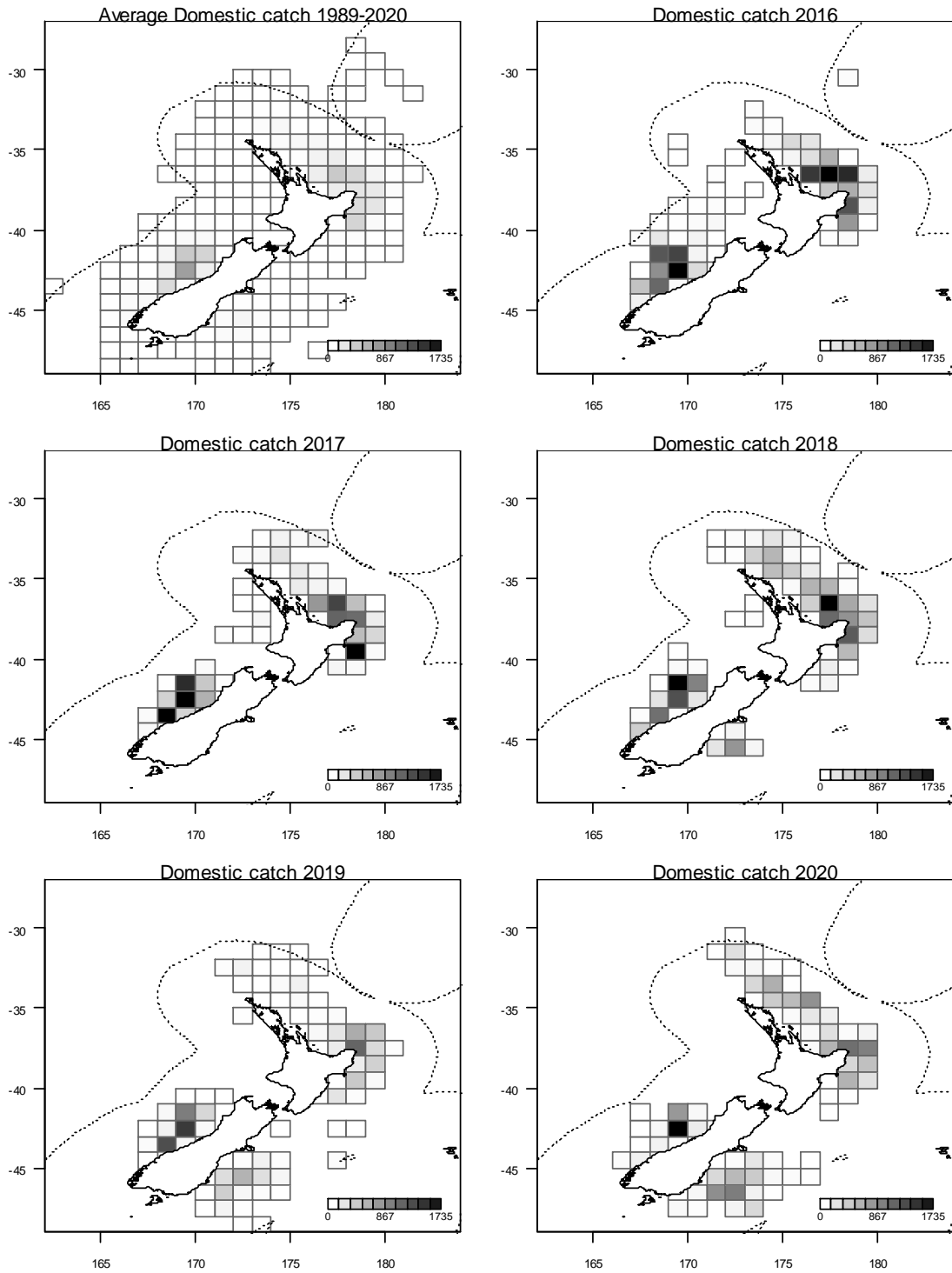


Figure 11: Distribution of longline catches (number of fish per one degree square) for the domestic commercial fleet: average for the time series (1989 to 2020), and annually for 2016 to 2020.

Appendix 3 – Standardised CPUE for southern bluefin tuna in New Zealand

Terese Kendrick

25 June 2021

1. Data subsetting and processing

Tuna Longline Effort Return (TLCER) data as submitted to CCSBT. These data include sets that targeted or that caught southern bluefin tuna.

Table 1: Summary of data available by calendar year.

| Year | Vessels | Sets | Effort (hooks) | Catch (t) | Sets with catch (landed,%) |
|------|---------|-------|-------------------|-----------|-------------------------------|
| 2003 | 120 | 2 721 | 3 959 495 | 4.9 | 53.47 |
| 2004 | 89 | 2 085 | 3 362 763 | 4.6 | 62.01 |
| 2005 | 50 | 1 195 | 1 764 341 | 2.8 | 63.60 |
| 2006 | 49 | 1 070 | 1 586 188 | 2.6 | 67.48 |
| 2007 | 37 | 991 | 1 978 741 | 4.0 | 81.53 |
| 2008 | 33 | 775 | 1 152 575 | 4.3 | 72.52 |
| 2009 | 38 | 1 082 | 1 645 274 | 6.5 | 86.97 |
| 2010 | 39 | 1 445 | 1 724 815 | 8.5 | 78.89 |
| 2011 | 39 | 1 253 | 1 584 735 | 9.2 | 86.27 |
| 2012 | 43 | 1 526 | 1 887 204 | 14.2 | 92.14 |
| 2013 | 38 | 1 455 | 1 706 112 | 12.1 | 92.78 |
| 2014 | 34 | 1 317 | 1 656 421 | 14.0 | 90.51 |
| 2015 | 33 | 1 392 | 1 721 229 | 15.3 | 93.89 |
| 2016 | 32 | 1 567 | 1 393 552 | 20.7 | 94.89 |
| 2017 | 32 | 1 563 | 1 402 499 | 19.3 | 94.75 |
| 2018 | 33 | 1 674 | 1 557 266 | 20.0 | 86.44 |
| 2019 | 28 | 1 762 | 1 629 829 | 10.8 | 59.36 |
| 2020 | 28 | 1 651 | 1 500 411 | 17.3 | 90.61 |

2. Core vessel selection

Alternative core vessel selection criteria were investigated by considering the reduction in the number of vessels and percentage of catch ([Figure 1](#)). The most appropriate combination of criteria was considered to be to define the core fleet as those vessels that had fished for at least 10 trips in each of at least 4 years. To qualify, trips were required to have recorded at least 0kg of catch. These criteria resulted in a core fleet size of 60 vessels which took 89% of the catch ([Figure 1](#)). A plot of the degree of overlap of data among core vessels is provided ([Figure 2](#)). A comparison between all vessels and core vessels for key indicators of catch rates is also given ([Figure 3](#)). Trips in this dataset actually means sets.

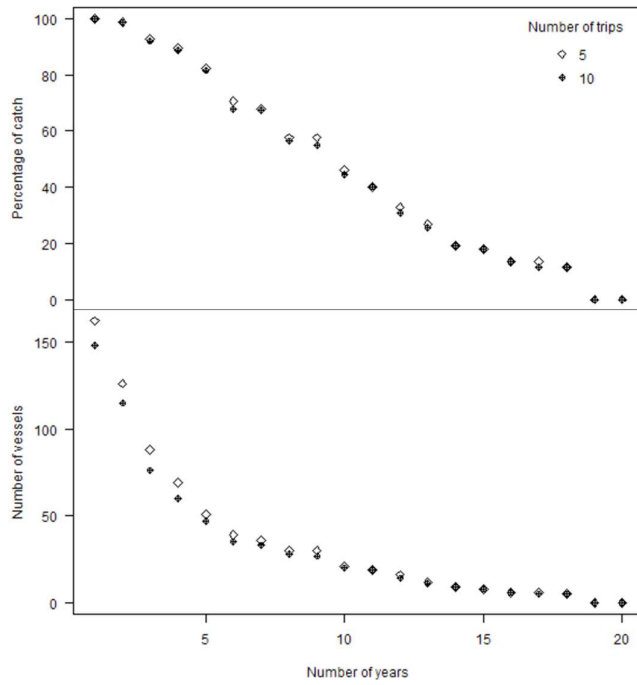


Figure 1: Examination of parameters for defining core vessels. The upper panel indicates how the percentage of catch represented by core vessels changes with alternative criteria. The lower panel indicates how the number of vessels changes with alternative criteria. Trips means sets.

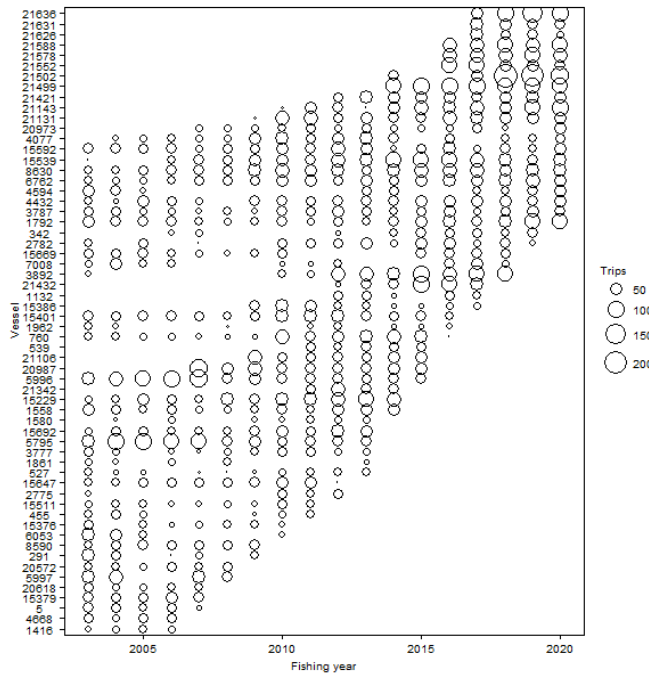


Figure 2: Number of sets by year for core vessels. The area of circles is proportional to the number of sets for a vessel in a year.

Table 2: Summary of core vessel data by year.

| Year | Vessels | Sets | Effort (hooks) | Catch (t) | Sets with catch (%) |
|------|---------|-------|----------------|-----------|---------------------|
| 2003 | 38 | 1 193 | 1 883 879 | 2.6 | 57.42 |
| 2004 | 35 | 1 048 | 1 789 604 | 2.9 | 68.03 |
| 2005 | 31 | 972 | 1 530 983 | 2.5 | 64.20 |
| 2006 | 32 | 920 | 1 451 473 | 2.4 | 69.02 |
| 2007 | 32 | 959 | 1 948 041 | 3.9 | 81.65 |
| 2008 | 27 | 671 | 1 046 550 | 4.1 | 74.22 |
| 2009 | 30 | 944 | 1 505 725 | 6.2 | 87.29 |
| 2010 | 34 | 1 347 | 1 641 543 | 8.3 | 79.88 |
| 2011 | 34 | 1 182 | 1 516 741 | 9.0 | 86.13 |
| 2012 | 36 | 1 399 | 1 766 944 | 13.5 | 92.14 |
| 2013 | 33 | 1 319 | 1 575 352 | 11.3 | 92.87 |
| 2014 | 31 | 1 266 | 1 493 836 | 13.1 | 90.13 |
| 2015 | 25 | 1 259 | 1 508 909 | 14.0 | 93.80 |
| 2016 | 27 | 1 432 | 1 279 657 | 19.1 | 94.55 |
| 2017 | 28 | 1 432 | 1 293 479 | 18.1 | 94.83 |
| 2018 | 26 | 1 467 | 1 365 064 | 17.6 | 85.62 |
| 2019 | 22 | 1 433 | 1 297 679 | 8.5 | 60.08 |
| 2020 | 21 | 1 283 | 1 145 065 | 12.6 | 91.19 |

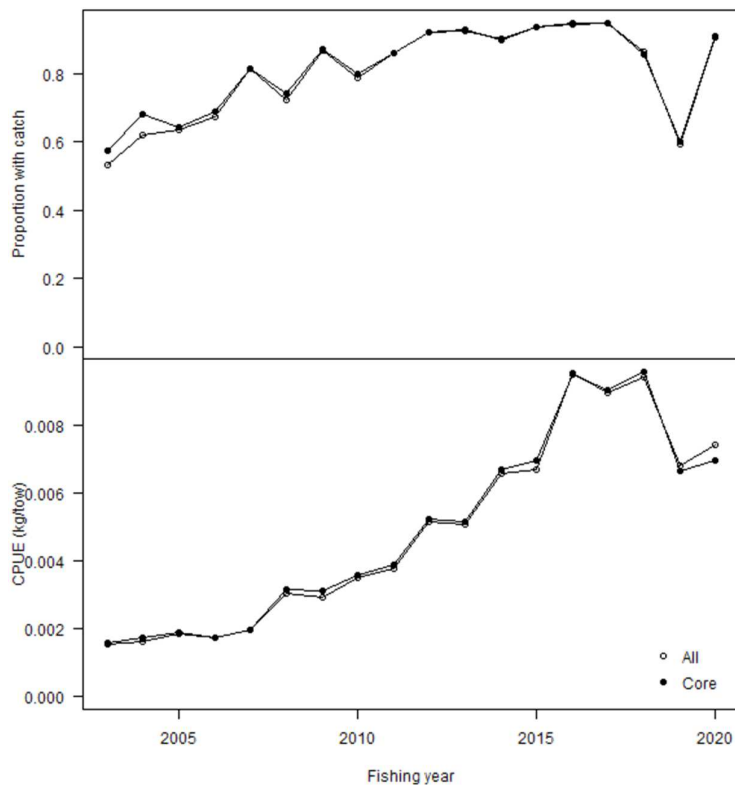


Figure 3: Comparison of the proportion of sets with positive catch (upper) and unstandardised CPUE (geometric mean of catch divided by effort where catch was positive; lower) for the all and core vessels.

3. Stepwise selection of model terms

A negative binomial distribution was used. Forward stepwise selection of model terms was done on the basis of the Akaike Information Criterion (AIC). The maximal set of model terms offered to the stepwise selection algorithm was $\sim . \text{year} + \text{month} + \text{area} + \text{vessel} + \text{fleet} + \text{target} + \text{poly}(\log(\text{hooks}), 3) + \text{poly}(\log(\text{length}), 3)$ with the term *year* forced into the model. Terms were only added to the model if they increased the percent deviance explained by 1 %. [Table 3](#) provides a summary of the changes in the deviance explained and in AIC as each term was added to the model. The final model formula was $\sim \text{fyear} + \text{vessel} + \text{month} + \text{area}$.

Table 3: Summary of stepwise selection. Model terms are listed in the order of acceptance to the model. AIC: Akaike Information Criterion; *: Term included in final model.

| Term | DF | Log likelihood | AIC | Nagelkerke pseudo-R2 (%) | Final Model |
|----------------------|-----|----------------|---------|--------------------------|-------------|
| year | 18 | -64 358 | 128 751 | 15.45 | * |
| vessel | 77 | -62 244 | 124 641 | 30.57 | * |
| month | 88 | -61 316 | 122 807 | 36.32 | * |
| area | 89 | -61 092 | 122 363 | 37.63 | * |
| target | 97 | -60 976 | 122 146 | 38.31 | |
| poly(log(hooks), 3) | 100 | -60 937 | 122 075 | 38.53 | |
| poly(log(length), 3) | 103 | -60 930 | 122 065 | 38.57 | |

4. Influence of model terms on annual CPUE indices

Table 4: Summary of the explanatory power and influence of each term in the standardisation model. Coefficients is the number of coefficients associated with the term added. Log likelihood and AIC values are for the fit as each term is successively added. Coefficient of determination (R2) values represent the change in R2 from the previous model. R2: square of the correlation coefficient between log(observed) and log(fitted).

| Term | Coefficients | Log likelihood | AIC | Nagelkerke pseudo-R2 (%) | Overall influence (%) |
|-----------|--------------|----------------|---------|--------------------------|-----------------------|
| intercept | 1 | -66 160 | 132 322 | - | - |
| year | 17 | -64 358 | 128 751 | 15.45 | - |
| vessel | 59 | -62 244 | 124 641 | 15.12 | 9.70 |
| month | 11 | -61 316 | 122 807 | 5.75 | 7.89 |
| area | 1 | -61 092 | 122 363 | 1.31 | 4.39 |

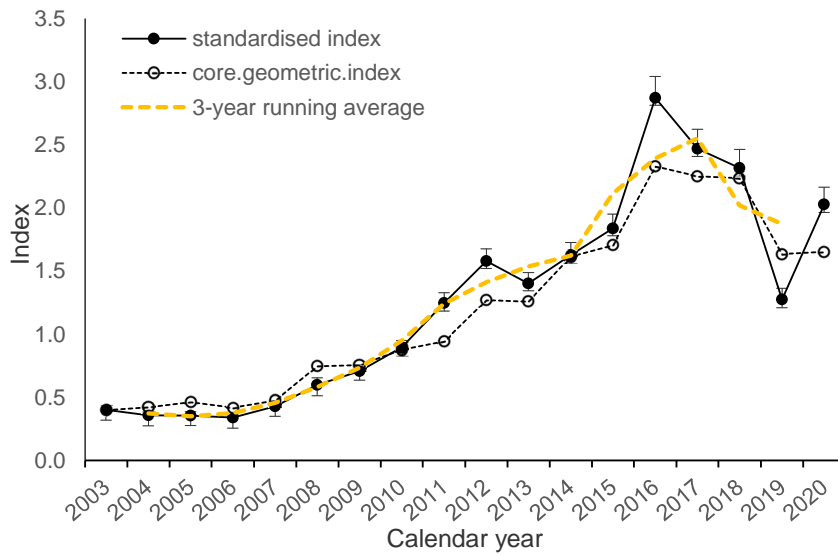


Figure 4: Overall standardisation effect of the model. The unstandardised index is based on the geometric mean of the catch per set and is not adjusted for effort. A 3-year running average smoother is calculated from the standardised index and plotted in the middle year of the 3-year range.

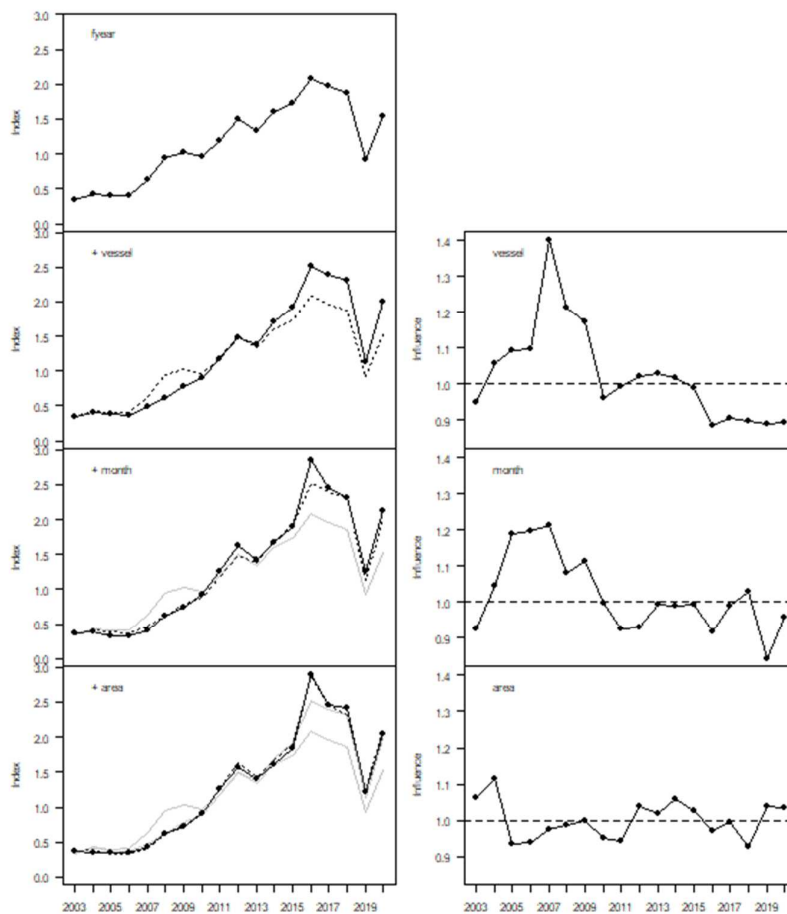


Figure 5: Step and influence plot. The new variable being added is a solid black line, the immediately previous line is dashed, and older lines are in grey.

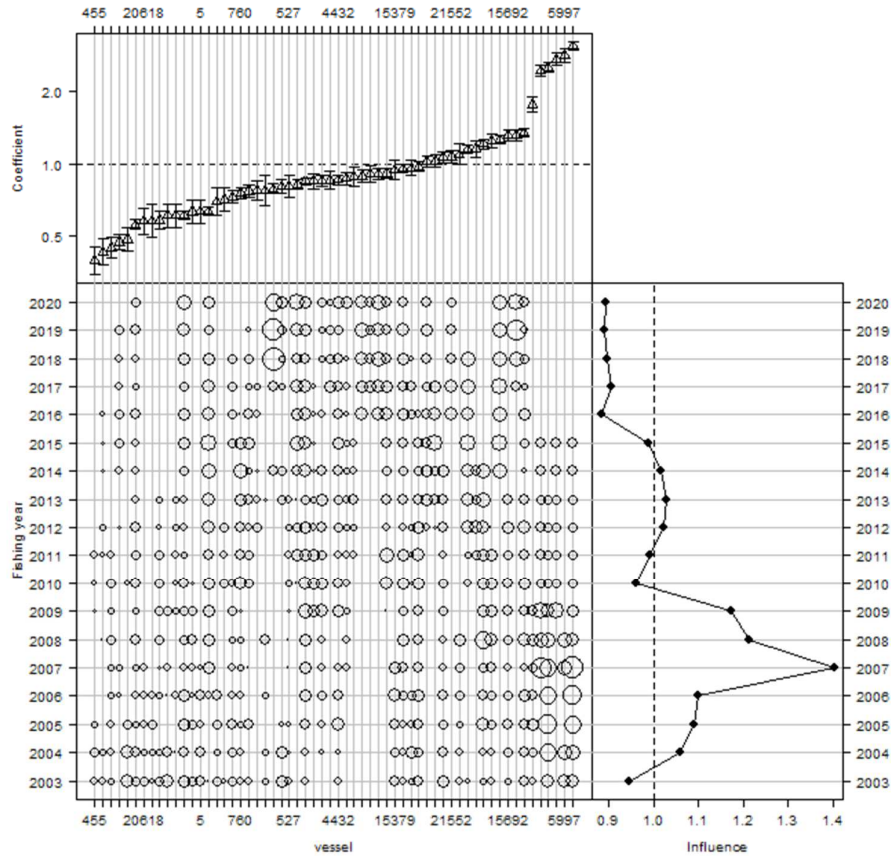


Figure 6: Coefficient-distribution-influence plot for vessel.

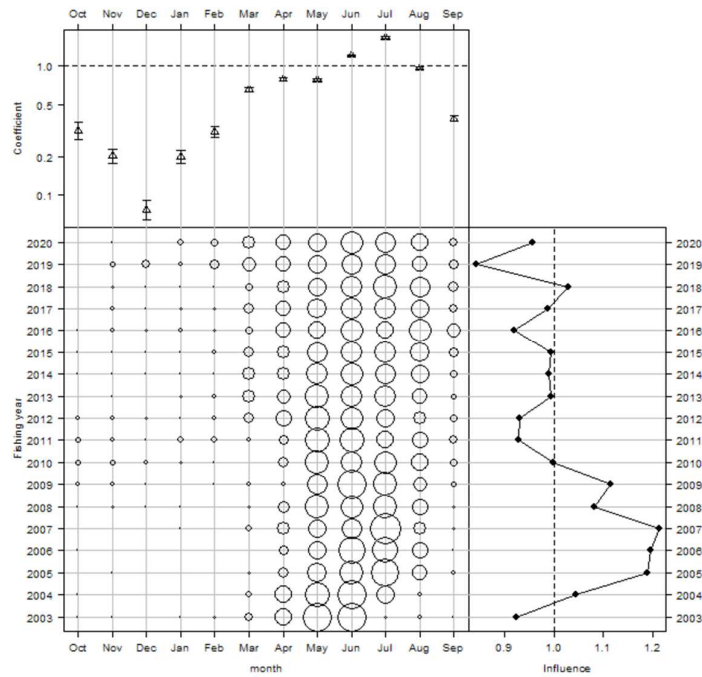


Figure 7: Coefficient-distribution-influence plot for month.

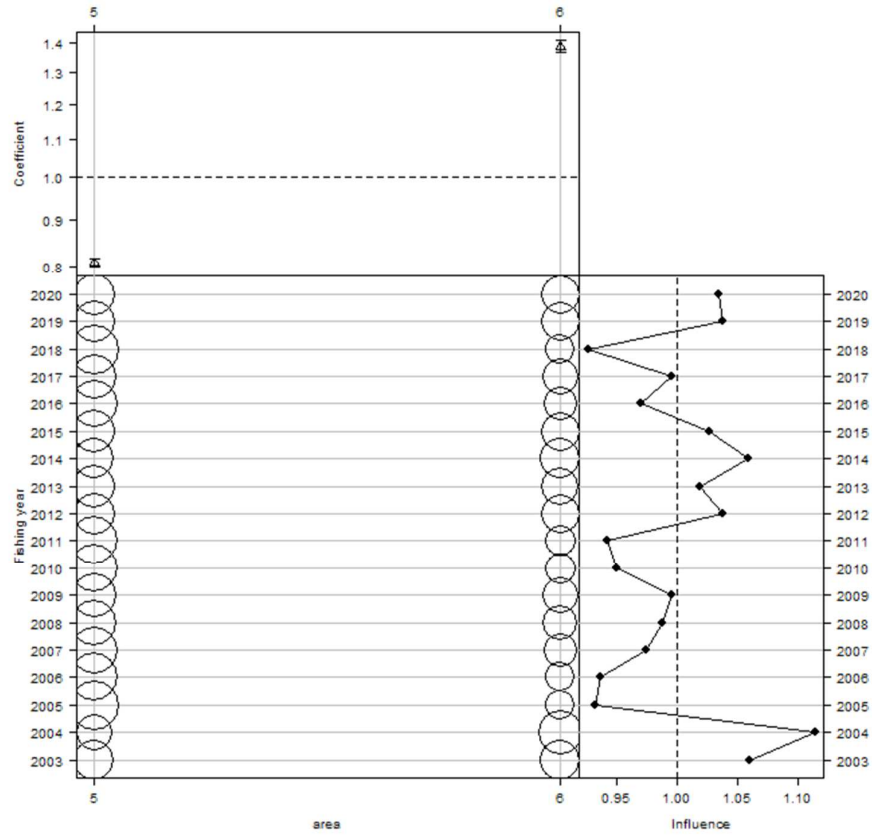


Figure 8: Coefficient-distribution-influence plot for area.

5. Residual diagnostics

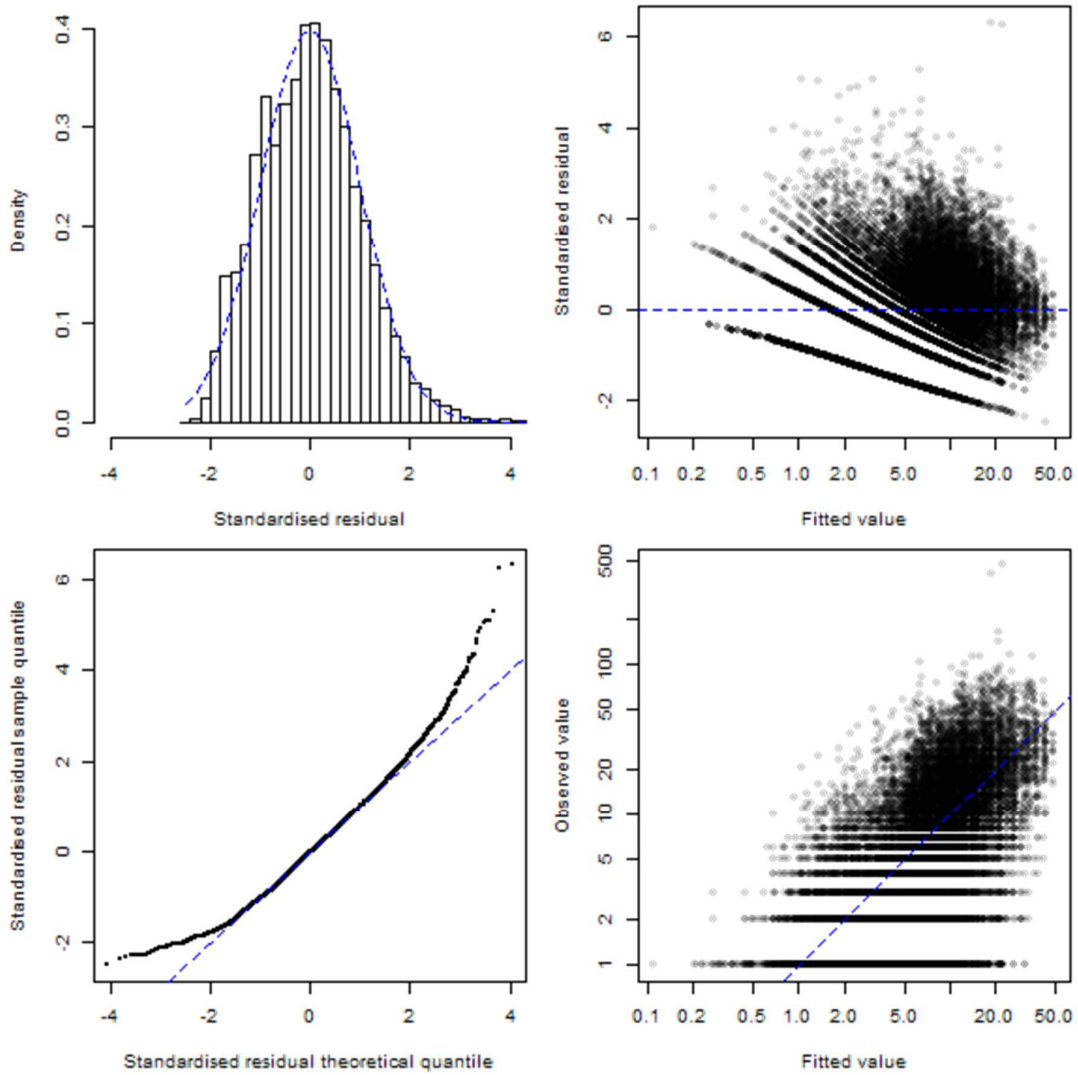


Figure 9: Residual diagnostics. Top left: histogram of standardised residuals compared to standard normal distribution. Bottom left: quantile-quantile plot of standardised residuals. Top right: fitted values versus standardised residuals. Bottom right: observed values versus fitted values.

5.1. Area x year diagnostics

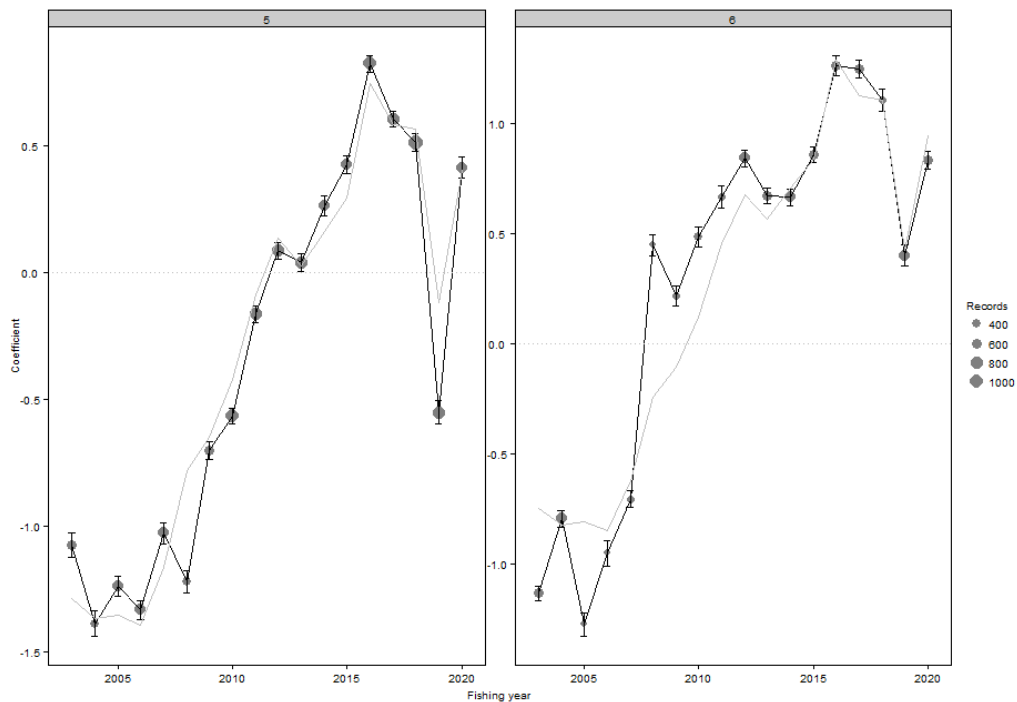


Figure 10: Residual implied coefficients (in log space) for area x fishing year interactions. Implied coefficients (points) are calculated as the normalised fishing year coefficient (grey line) plus the mean of the standardised residuals in each fishing year and area. These values approximate the coefficients obtained when an area x year interaction term is fitted, particularly for those area x year combinations which have a substantial proportion of the records. The error bars indicate one standard error of the standardised residuals. Combinations with less than 10 records are not shown.

5.2. Area x month diagnostics

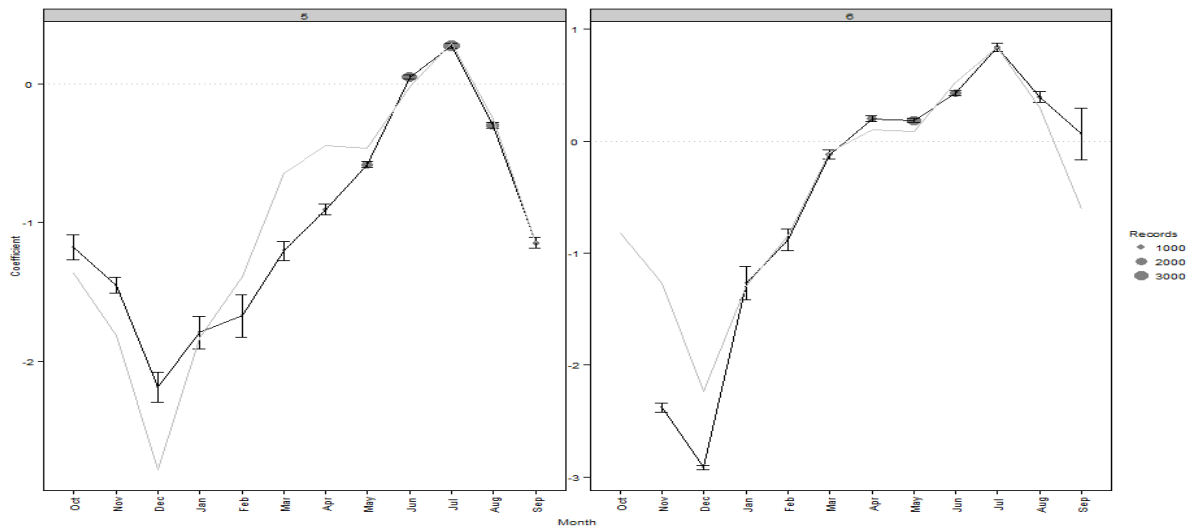


Figure 11: Residual implied coefficients (in log space) for area x month interactions. Implied coefficients (black points) are calculated as the normalised month coefficients (grey line) plus the mean of the standardised residuals in each month and area. These values approximate the coefficients obtained when an area x month interaction term is fitted, particularly for those area x month combinations which have a substantial proportion of the records. The error bars indicate one standard error of standardised residuals. Combinations with less than 10 records are not shown.

6. Summary of CPUE indices

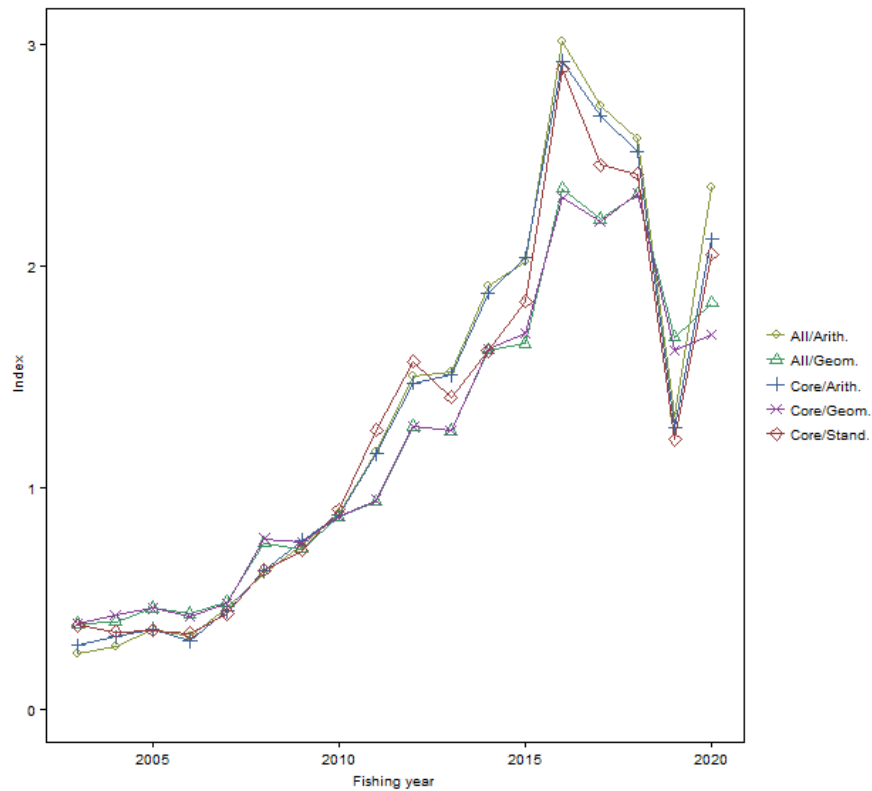


Figure 12: Standardised and unstandardised CPUE indices. All: all vessels, Core: core vessels, Geom.: geometric mean, Arith: arithmetic mean, Stand.: standardised using GLM.

Table 5: Standardised and unstandardised CPUE indices. All: all vessels, Core: core vessels, Geom.: geometric mean, Arith: arithmetic mean, Stand.: standardised using GLM, SE: standard error.

| Year | All/Arith. | Core/Arith. | Core/Geom. | Core/Stand. | Core/Stand. SE |
|------|------------|-------------|------------|-------------|----------------|
| 2003 | 0.2468 | 0.2857 | 0.3846 | 0.3788 | 0.03755 |
| 2004 | 0.2795 | 0.3249 | 0.4237 | 0.3500 | 0.03834 |
| 2005 | 0.3597 | 0.3621 | 0.4541 | 0.3553 | 0.03892 |
| 2006 | 0.3261 | 0.3077 | 0.4166 | 0.3416 | 0.03992 |
| 2007 | 0.4569 | 0.4418 | 0.4736 | 0.4292 | 0.03743 |
| 2008 | 0.6143 | 0.6231 | 0.7692 | 0.6279 | 0.04235 |
| 2009 | 0.7398 | 0.7632 | 0.7554 | 0.7180 | 0.03561 |
| 2010 | 0.8803 | 0.8775 | 0.8692 | 0.9003 | 0.03028 |
| 2011 | 1.1592 | 1.1524 | 0.9434 | 1.2598 | 0.03152 |
| 2012 | 1.5047 | 1.4727 | 1.2748 | 1.5705 | 0.02866 |
| 2013 | 1.5246 | 1.5097 | 1.2592 | 1.4076 | 0.02920 |
| 2014 | 1.9102 | 1.8811 | 1.6252 | 1.6187 | 0.02956 |
| 2015 | 2.0198 | 2.0391 | 1.6983 | 1.8416 | 0.02996 |
| 2016 | 3.0141 | 2.9265 | 2.3097 | 2.8935 | 0.02884 |
| 2017 | 2.7241 | 2.6817 | 2.2013 | 2.4581 | 0.02923 |
| 2018 | 2.5751 | 2.5185 | 2.3277 | 2.4152 | 0.02971 |
| 2019 | 1.3209 | 1.2728 | 1.6197 | 1.2181 | 0.03180 |
| 2020 | 2.3584 | 2.1212 | 1.6922 | 2.0538 | 0.03104 |