Fisheries New Zealand
Tini a Tangaroa

Catches, size, and age structure of the 2017–18 hoki fishery, and a summary of input data used for the 2019 stock assessment

New Zealand Fisheries Assessment Report 2019/48

S.L. Ballara,
R.L. O'Driscoll

ISSN 1179-5352 (online)
ISBN 978-1-99-000844-3 (online)

September 2019

New Zealand Government

Requests for further copies should be directed to:

Publications Logistics Officer
Ministry for Primary Industries
PO Box 2526
WELLINGTON 6140

Email: brand@mpi.govt.nz
Telephone: 0800 00 83 33
Facsimile: 04-894 0300

This publication is also available on the Ministry for Primary Industries websites at:
http://www.mpi.govt.nz/news-and-resources/publications
http://fs.fish.govt.nz go to Document library/Research reports

CONTENTS

EXECUTIVE SUMMARY

Ballara, S.L.; O'Driscoll, R.L. (2019). Catches, size, and age structure of the 2017–18 hoki fishery, and a summary of input data used for the 2019 stock assessment.

New Zealand Fisheries Assessment Report 2019/48. **140 p.**

This report summarises catches by area and presents the length and age structure of hoki caught commercially during the 2017–18 fishing year. Length frequency and catch-at-age data from spawning and non-spawning fisheries are compared with those from previous years. Biomass indices from research surveys and results from other research on hoki in the last year are also briefly described. Data in this report were incorporated in the hoki stock assessment in 2019.

The total reported hoki catch in 2017–18 of 135 383 t was about 6200 t lower than the catch in 2016–17, and about 14 600 t lower than the TACC. Catches in 2017–18 decreased on the west coast South Island (WCSI), Chatham Rise, and east coast South Island (ECSI), and increased in Cook Strait and Sub-Antarctic. The spawning fishery catch on the WCSI decreased by 10 500 t to 55 400 t, but was the largest hoki fishery for the eighth consecutive season. Most of the decrease in total catch was driven by the reduction in the midwater trawl fishery on the WCSI in August. The non-spawning fishery on the Chatham Rise was the second largest fishery, with 37 200 t taken in 2017–18, about 2700 t less than in 2016–17. The spawning fishery catch from Cook Strait increased by 5300 t to 21 500 t. The non-spawning catch from the Sub-Antarctic fishery increased by 2200 t to 14 500 t in 2017–18. Catches from Puysegur, east coast North Island (ECNI), and ECSI in 2017–18 were similar to those in 2016–17 at 1133 t, 1140 t, and 3570 t respectively. Overall, about 72 000 t of the total catch in 2017–18 was taken from western stock areas, well below the industry-agreed catch limit of 90 000 t. About 63 400 t came from the eastern stock areas.

Recent trends in standardised CPUE have varied by area but are all at or above the long-term average. Indices have been relatively stable on the Chatham Rise for the last 10 years; increased by 29% over the last three years in Cook Strait; declined by 43% over the last three years on the WCSI; and declined by 27% since 2012 in the Sub-Antarctic.

Length and age frequency distributions from the commercial fishery show that most of the catch in 2017–18 was of fish 45–90 cm. The 2015 year-class (45–55 cm) was important in all areas at age 2+ on the Chatham Rise and Sub-Antarctic, and at age 3 in Cook Strait and on the WCSI. The 2014 year-class (56–70 cm) was also important in all areas at age 3+ on the Chatham Rise and Sub-Antarctic, and at age 4 in Cook Strait, WCSI and Puysegur. The 2016-year class appeared low in all the main fishery areas. Large female hoki (over 100 cm) were proportionately more abundant in Cook Strait, WCSI, and the Sub-Antarctic, and rarely caught on the Chatham Rise. There were few male hoki over 90 cm in any area.

Two fishery independent research surveys for hoki have been carried out since the 2018 stock assessment. Two acoustic snapshots of spawning hoki on the WCSI were carried out in conjunction with a random trawl survey in July–August 2018. The acoustic estimate of hoki abundance in 2018 was about half the equivalent index from 2013, and the lowest estimate in the time-series, going back to 1988, but the coefficient of variation (CV) was relatively high (46%). Hoki abundance in the Sub-Antarctic trawl survey in November-December 2018 was down 18% from November-December 2016, and is now the lowest in the time-series since 2007.

1. INTRODUCTION

This report provides biological data relevant to the 2019 hoki stock assessment. Catch statistics and data from commercial sampling carried out during the 2017–18 fishing year are presented, and results from other research programmes carried out since March 2018 are summarised, including results of an acoustic and trawl survey of the WCSI in July-August 2018, and a trawl survey of the Sub-Antarctic in November-December 2018. Details of model structure, results, and yield estimates for the hoki stock assessment carried out in 2019 are published separately.

1.1 Project objectives

This report fulfils the final reporting requirement for objectives in research projects HOK2018-01 and MID2018-03.

HOK2018-01 Objective 1: To complete a descriptive analysis of the commercial catch and effort data, trawl survey data, and observer data for hoki in New Zealand.

MID2018-03: To determine catch-at-age for commercial catches and resource surveys of specified middle depth and deepwater fishstocks. Specific Objective 1 includes:

- Estimate the catch-at-age for hoki in the winter Cook Strait and WCSI spawning fisheries;
- Estimate the catch-at-age for the non-spawning hoki fisheries on the Chatham Rise and Sub-Antarctic.

1.2 Stock structure

The hoki catch is currently managed under a single TACC which can be caught in all areas of the EEZ excluding QMA 10 (Fishstock HOK 1). However, since 1990 the Hoki Working Group has assessed hoki as two stocks, "eastern" and "western" (Annala (1990) and subsequent Plenary Reports). Hoki on the west coast of the North and South Islands and in the area south of New Zealand, including Puysegur Bank, Snares Shelf, and Campbell Plateau, are assumed to be one stock unit, the "western stock". The east coast of the South Island, Mernoo Bank, Chatham Rise, Cook Strait, and the east coast of the North Island up to North Cape are assumed to contain the "eastern stock". Immature hoki (2–4 years old) from both "stocks" occur together on the Chatham Rise.

Livingston (1997) reviewed the two-stock hypothesis originally adopted in 1990 (Livingston 1990) with respect to data collected in 1990–97, and concluded that this hypothesis was still a valid interpretation for hoki. Morphometric and ageing studies (Horn & Sullivan 1996, Livingston & Schofield 1996) found consistent differences between adult hoki from the two main dispersed areas (Chatham Rise and Southern Plateau), and from the two main spawning grounds in Cook Strait and west coast South Island (WCSI), which suggested that there were two sub-populations of hoki. It is not known if differences between the two sub-populations are the result of genetic, environmental, or some other factors. The chemistry of otoliths from the WCSI and Cook Strait stocks was similar (Kalish et al. 1996), and no genetic differences were detected between spawning stocks (Smith et al. 1981, 1996).

The hoki stock assessment model from 2006 to 2007 (Francis 2007, 2008) had two variants which were associated with different stock structure hypotheses. The 'base case' hypothesis assumed natal fidelity: a fish that was spawned in one area will grow up to spawn in the same area (i.e., a fish is 'eastern' or 'western' from birth). The alternative hypothesis does not assume natal fidelity, so fish spawned in one area can spawn in another area (i.e., a fish chooses to be 'eastern' or 'western' when it matures). Under both hypotheses, it was assumed that once a fish has spawned it shows site fidelity – it cannot later change spawning grounds. All model runs from 2008–11 assumed natal fidelity because of technical problems concerning the definition of unfished biomass without this assumption (Francis 2009,

McKenzie 2013). These problems were resolved and model runs which do not assume natal fidelity were included as sensitivity runs from 2012 to 2018 (McKenzie 2013, 2015a, 2015b, 2016, 2017, 2018, 2019).

Francis et al. (2011) described a pilot study, aimed at determining whether analyses of stable isotopes and trace elements in otoliths could be used to test the stock structure hypothesis and the question of natal fidelity. However, none of the six trace elements or two stable isotopes considered, unambiguously differentiated the two hoki stocks. Two earlier pilot studies appeared to provide weak support for the hypothesis of natal fidelity for the western and eastern spawning stocks. Smith et al. (2001) found significant differences in gill raker counts, and Hicks & Gilbert (2002) found significant differences in measurements of otolith zones between samples of 3 year-old hoki from the 1997 year-class caught on the WCSI and in Cook Strait. However, when additional year-classes were sampled, differences were not always detected (Hicks et al. 2003).

Horn (2011) reviewed the published literature on natal fidelity in relationship to management of hoki. He concluded that, because hoki are an off-shore species, widely dispersed in the non-spawning season, with multiple diffuse spawning areas, it is unlikely that hoki exhibit 100% natal fidelity. Even if natal fidelity is the preferred option for hoki from an evolutionary perspective, it is likely that some proportion of the population would stray routinely. An independent review of the hoki assessment model, commissioned by Ministry for Primary Industries in February 2014, noted that "the extents of natal fidelity are important to identify", and recommended exploration of a range of model structures (Butterworth et al. 2017).

Issues associated with stock structure assumptions were again investigated in the 2019 assessment (Roberts 2019). A simplified western stock only model was constructed to assess the impact of the two stock model data and assumptions. In this model the eastern areas and data were dropped. Instead of young juvenile western fish being on the Chatham Rise, where some are caught and some die, they directly recruit to the Sub-Antarctic, and henceforth spawn on the WCSI. While this model neglects western catch on the Chatham Rise and processes between newly spawned fish and their arrival at the Sub-Antarctic, it removes conflicts between eastern data and western biomass indices when western biomass is estimated in the model.

1.3 Description of the hoki fishery

Since the 1980s the main fishery for hoki has operated from late June to late August on the WCSI, where hoki aggregate to spawn. The spawning aggregations begin to concentrate at depths of 300–700 m around the Hokitika Canyon from late June, and further north off Westport later in the season. Fishing in these areas continues into September in some years. In 1988 another fishery developed on large spawning aggregations of hoki in Cook Strait. The spawning season in Cook Strait runs from late June to mid-September, peaking in July and August. Small catches of spawning hoki are taken from other grounds off the East Coast South Island (ECSI), and late in the season at Puysegur Bank. There are also anecdotal reports of spawning hoki being caught near the Snares Islands, Chatham Islands, and several other locations off the east coast of North Island (ECNI).

Outside the spawning season, when hoki disperse to their feeding grounds, substantial fisheries have developed since the early 1990s on the Chatham Rise and in the Sub-Antarctic. These fisheries usually operate at depths of 300–800 m. The Chatham Rise fishery generally has similar catches over all months except in July–September, when catches are lower due to the fishery moving to the spawning grounds. In the Sub-Antarctic, catches have typically peaked in April–June. Out-of-season catches are also taken from Cook Strait and ECNI, but these are small compared to spawning season catches.

From 1986 to 1990 surimi vessels dominated the catches and took about 60% of the annual WCSI catch. However, since 1991, the surimi component of catches has decreased and processing to head

and gut or to fillet product has increased, as has "fresher" catch for shore processing. The hoki fishery now operates throughout the year, producing high quality fillet product from both spawning and non-spawning fisheries. Twin-trawl rigs have been used in some hoki fisheries since 1998, and trawls made of spectra twine (a high strength twine with reduced diameter resulting in reduced drag and improved fuel efficiencies) were introduced to some vessels in 2007–08.

Between 2012–13 and 2017, Precision Seafood Harvest (PSH) technology was tested in the hoki fishery. This included a prototype trawl system called a Modular Harvest System (MHS) that aimed to target specific species and fish size, as well as enabling fish to be landed in much better condition than traditional trawls. Approval to use MHS gear in the hoki, hake and ling fisheries was granted in 2018. During the 2017–18 fishing year, seven vessels subsequently used the gear to target hoki. To date, the proportion of catch taken by this gear method is still relatively small with 9724 t taken (7% of the total catch) in 2017–18.

The fishing industry introduced a Code of Practice (COP) for hoki target trawling in 2001 with the aim of protecting small fish (less than 60 cm). The main components of this COP were to restrict fishing in waters shallower than 450 m; a rule requiring vessels to 'move on' if there were more than 10% small hoki in the catch; and seasonal and area closures in spawning fisheries. The COP was superseded by Operational Procedures for Hoki Fisheries, also introduced by the fishing industry, from 1 October 2009. The Operational Procedures aim to manage and monitor fishing effort within four industry Hoki Management areas, where there are thought to be high abundances of juvenile hoki (Narrows Basin of Cook Strait, Canterbury Banks, Mernoo, and Puysegur). These areas are closed to trawlers over 28 m targeting hoki, with increased monitoring when targeting species other than hoki. There is also a general recommendation that vessels move from areas where catches of juvenile hoki (now defined as less than 55 cm total length) comprise more than 20% of the hoki catch by number.

Concerns about the reduced availability of hoki in the WCSI fishery during recent spawning seasons has prompted agreement from industry to: a) shelve 20 000 tonnes of HOK 1W Annual catch entitlement (ACE) (along with any HOK 1W ACE carried forward from 2017–18) for the 2018–19 year; and b) close certain fishing grounds to target fishing for hoki to allow spawning to occur undisturbed at peak times (Operational Procedures version 18). Seasonal spawning closures in place for 2018–19 are:

- WCSI inside the 25 n. mile line: between 0000 hrs 18 July and 2400 hrs 24 July
- WCSI outside of the 25 n. mile closure, shallower than 800 m, between Kahurangi Point in the north and the boundary between FMAs 5 and 7 in the south: between 0000 hrs 25 July and 2400 hrs 31 July
- Cook Strait: Entire fishery between 0000 hrs 1 August and 2400 hrs 7 August
- Pegasus: between 0000 hrs 1 September and 2400 hrs 7 September.

1.4 Recent hoki research

McKenzie (2019) reported the stock assessment carried out in 2018, using the Bayesian model developed in 2002 (Francis et al. 2003) and implemented in the general-purpose stock-assessment program CASAL (Bull et al. 2012). As in 2017 (McKenzie 2018), the Deepwater Fisheries Assessment Working Group (DWWG) agreed on a single base model run. In this base model, the problem of the lack of old fish in both fishery-based and survey-based observations was dealt with by allowing natural mortality to be age dependent. A single catchability was used for the Sub-Antarctic summer trawl surveys, with process error estimated. The western stock was estimated to be 44–86% B_0 and the eastern stock 39–79% B_0 (values are 95% CIs for the base case). In the base-case run, where process error was estimated for trawl surveys, the November-December 2014 and 2016 Sub-Antarctic trawl surveys were interpreted by the model as being low due to observation and process error. The DWWG noted that the risk is that if the Sub-Antarctic trawl survey was reflecting an actual change in biomass, then the western stock status would be lower than estimated in the base case.

Following the 2018 assessment, Dunn & Langley (2018) independently reviewed the hoki stock assessment, with a focus on evaluating the assumptions and observational data sets that were determining the estimates of stock size and status. They concluded that the most informative observational data sets were the catch-at-age estimates, which suggested a large and less depleted stock, and the Sub-Antarctic trawl survey, which suggested a smaller and more depleted stock. The prior assumptions (Bayesian priors) were also important in determining stock size and status. Overall, the stock assessment model estimates of stock size and status seemed to be robust to many changes in model assumptions. Dunn & Langley (2018) recommended a range of future work, some of which was carried out during the 2019 assessment. One key area of work was to investigate consistency of input data, especially age composition data, which is described in this report. Another was to investigate data weighting in the model with an emphasis on better fitting biomass indices. These results are described in the 2019 assessment report.

An updated analysis of catch and discards in the hoki, hake, ling, silver warehou, and white warehou fishery from 1990–91 to 2016–17 was provided by Anderson et al. (2019). The calculation of bycatch and discard estimates was based on a statistical model, using Bayesian estimation and incorporating fishing year, standardised areas, net type, and vessel class as model covariates. Hoki accounted for about 73% of the total estimated catch from all observed tows in the target fishery for the five species since 2002–03. Total annual bycatch was 17 500–49 000 t between 1990–91 and 2016–17, varying over time approximately relative to total fishing effort throughout the period. Annual bycatch was an approximately even mixture of QMS species and non-QMS species, although QMS species catch increased over time while non-QMS species catch decreased. Discard estimates were low but highly variable. The discard fraction (kg of discards/kg of target species catch) varied from 0.03 in 2015–16 to 0.17 in 2008–09 with an overall value for the 27-year period of 0.06 and little trend over time.

Marsh et al. (2018) investigated the potential impact of the reduction in the frequency of the Chatham Rise and Sub-Antarctic trawl surveys from annual to biennial using three types of computer simulation: (a) generic simulations, (b) retrospective analyses, and (c) forward projection simulations. The retrospective analyses and forward projection simulations were conducted for the hoki, hake, and ling stock assessments in the Chatham Rise and Sub-Antarctic. The generic simulations demonstrated that, under very simple scenarios, when moving from annual to biennial surveys we expect to get less precision, but no bias, in estimated biomass changes. For the retrospective simulations, there were small differences in current biomass estimates ($\%B_0$) between annual and biennial survey scenarios (both accuracy and precision). The size of the differences between annual and biennial scenario in forward projections varied between stocks and population trajectories, but were small, with the annual scenario having greater accuracy and slightly higher precision than the biennial scenarios.

Two new fisheries-independent estimates of hoki abundance are available since the 2018 hoki assessment, a WCSI acoustic and trawl survey carried out in July-August 2018 (O'Driscoll & Ballara 2019), and a trawl survey of the Sub-Antarctic in November-December 2018. Results from these surveys are summarised in Section 3.1.

Links between climate, oceanographic conditions and hoki recruitment are still unknown, but are thought to exist (e.g., Dunn et al. 2009, Bradford-Grieve & Livingston 2011). Recent research by Sutton & Bowen (2019) has indicated surface warming in sub-tropical waters around New Zealand since 1981, extending down to depths of 850 m in the eastern Tasman Sea. Any effects of recent warmer temperatures (e.g., such as the high surface temperatures on the WCSI during the 2016 and 2017 hoki spawning seasons, Sutton & Bowen 2019) on fish distribution, growth, or spawning success have yet to be determined.

Castillo-Jordán et al. (2019) modelled the effects of a recruitment shift on a closely related species, the Patagonian grenadier (*Macruronus magellanicus*), off South America. This stock declined in abundance off Chile, which has been attributed to a major change in recruitment strength after 1999. The change in recruitment was modelled as a shift in the stock-recruitment relationship, and management strategy

evaluation was used to examine the consequences of a mismatch between recruitment assumptions in the assessment used to set the annual total allowable catch, and those in the operating model. The authors concluded that a management strategy ignoring the shift in recruitment would lead to unsustainable catches, with major impacts on the ecosystem as well as the industry and coastal communities reliant on the fishery, if there was an actual shift in recruitment.

2. HOKI FISHERY

2.1 Catch and effort information

2.1.1 Methods

Catch-effort, daily processed, and landings data were extracted from the Fisheries New Zealand catch-effort database Enterprise Data Warehouse (EDW) as extract 12063A on 7 December 2018 and consist of all fishing and landing events associated with a set of fishing trips that reported a positive catch or landing of hoki, hake, or ling from fishing years 1989–90 to 2017–18. This included all fishing recorded on Trawl Catch, Effort and Processing Returns (TCEPRs); Trawl Catch Effort Returns (TCERs); Catch, Effort and Landing Returns (CELRs); Lining Catch Effort Returns (LCERs); Lining Trip Catch Effort Returns (LTCERs); Netting Catch Effort Landing Return (NCELRs); and ERS–trawl (digital monitoring of trawl commercial fishing); and high seas versions of these forms. Catch and effort data for hoki from the Fisheries New Zealand Observer sampling programme (hosted by NIWA in the *cod* database) were also extracted on 4 December 2018. Data are analysed by fishing year (1 October to 30 September), referred to as, for example, 1990 for the 1989–1990 fishing year.

As part of Digital Monitoring of Commercial Fishing, ER (Electronic Reporting) is being introduced to replace paper-based catch and effort reporting. On 1 October 2017 trawl vessels over 28 metres started supplying fishing and related event data such as catch, effort and landing data via new ER systems, and data is now available from the Fisheries New Zealand EDW database. As the ER was beginning in 2017–18, there were still a few trawl vessels over 28 metres that reported on the legacy TCEPR form type.

TCEPR and TCER forms record tow-by-tow data with the estimated catch (by weight) of the top five species (TCEPRs) or the top eight species (TCERs) in each individual tow. The new ERS-trawl form reports the top five QMS species and top three non-QMS species and consequently should produce data closely comparable to that from the TCEPR and TCER paper forms for deepwater vessels. CELR forms record estimated daily catches for the top five species, which are further stratified by statistical area, method of capture, and target species. Greenweight data associated with landing events are reported on the bottom part of the CELR forms, or on CLR forms for fishing reported on TCEPRs and TCERs. Information on total harvest levels are provided via the Quota Management Report/Monthly Harvest Return (QMR/MHR) system, but only at the resolution of Quota Management Area.

Data were checked for errors, using simple checking and imputation algorithms similar to those used by Ballara & O'Driscoll (2018). Data were also groomed for errors using simple checking and imputation algorithms developed in the statistical software package 'R' (R Development Core Team 2018). Individual tows were investigated and errors were corrected using median imputation for start/finish latitude or longitude, fishing method, target species, tow speed, net depth, bottom depth, wingspread, duration, and headline height for each fishing day for a vessel. Range checks were defined for the remaining attributes to identify outliers in the data. The outliers were checked and corrected if possible with mean imputation on larger ranges of data such as vessel, target species and fishing method for a year or month, or the record was removed from the data set. Statistical areas were calculated from positions where these were available. Transposition of some data was carried out (e.g., bottom depth and depth of net).

Deepwater commercial vessels were classified by fleet using data provided by Fisheries New Zealand. Vessel classifications are not recorded in either commercial or observer databases, it is a set of

classifications Fisheries New Zealand uses to differentiate the deepwater fleet based upon target species, areas fished etc, rather than referring to nationality given that all vessels are now legally required to be New Zealand flagged. Classifications included:

- BATM: All Ukranian/Russian crewed vessels (regardless of ownership) are referred to as BATMs, which is the specific class of factory trawler with a meal plant on board.
- FOV: All Korean/Japanese vessels are lumped together under the term FOV which is defined as 'all foreign owned vessels excluding BATMs'. These vessels do not have a meal plant on board.
- Domestic: All NZ owned vessels except BATMs and FOVs. The domestic fleet includes vessels that vary in length, presence of meal plants, and on board processing (fillet producing vessels vs ice boats etc.). The domestic category was then further subdivided according to whether meal plants were on board or not.

The classification system is useful when categorizing the fleet back to 2007–08. Further back in time the classification system breaks down due to the presence of vessels that do not fit neatly into one of these three categories.

2.1.2 Total Allowable Commercial Catch (TACC)

In the 2017–18 fishing year, the TACC for HOK 1 was 150 000 t. This TACC applied to all areas of the EEZ (except the Kermadec FMA which had a TACC of 10 t). There was an agreement with the Minister that 90 000 t of the TACC should be taken from western stock areas and 60 000 t from the eastern stock areas. With the allowance for other mortality at 1500 t, and 20 t allowances each for customary and recreational catch, the 2017–18 TACC was 151 540 t. The TACC for the 2018–19 fishing year remains at 150 000 t with a catch limit arrangement for 60 000 t to be taken from the eastern fisheries and 90 000 t from the western fisheries, but with shelving of 20 000 t of catch from the western spawning stock and spawning area closures (see Section 1.3). Industry representatives (George Clement, Deepwater Group, pers. comm.) indicated that the total catch taken for 2018–19 would be likely to be 135 500 t with 64 000 t taken from the eastern fisheries and 71 500 t from the western fisheries.

Vessels larger than 46 m in overall length may not fish inside the 12-mile Territorial Sea, and there are other various vessel size restrictions around some parts of the coast. On the WCSI, a 25-mile line closes much of the hoki spawning area in the Hokitika Canyon, and most of the area south to the Cook Canyon, to vessels larger than 46 m overall length. In Cook Strait, the whole spawning area is closed to vessels over 46 m overall length. In November 2007 the Government closed 17 Benthic Protection Areas (BPAs) to bottom trawling and dredging, representing about 30% of the EEZ but including depths that are outside the depth range of hoki.

2.1.3 Catch history

The total annual catches of hoki within the EEZ from 1969 to 2017–18 are given in Tables 1 and 2. The hoki fishery was developed by Japanese and Soviet vessels in the early 1970s (Table 1). Catches increased to 100 000 t in 1977, but dropped to less than 10 000 t in 1978 when the 200 n. mile Exclusive Economic Zone (EEZ) was declared and a quota limit of 60 000 t was introduced (Figure 1). Hoki remained a relatively small fishery of up to 50 000 t a year until 1986, when the TACC was increased. Reported annual catches ranged between 175 000 and 255 000 t from 1987–88 to 1996–97, and peaked at 269 000 t in 1997–98, when the TACC was over-caught by 19 000 t (Table 2). The TACC was reduced to 90 000 t by 2007–08 as catches declined. The TACC was increased in five steps from 2009–10, reaching 160 000 t in 2014–15. The TACC was then reduced to 150 000 t in 2015–16, and catches in the past three years have been below this (Table 2).

Catches by area since 1988–89 are given in Table 3 and Figure 2. The pattern of fishing has changed markedly since 1988–89 when over 90% of the total catch was taken in the WCSI spawning fishery. This was due to a combination of TACC changes and redistribution of fishing effort. The WCSI fishery

accounted for about 41% of the total hoki catch in 2017–18, and has been the largest hoki fishery in New Zealand since 2010–11 (Table 3). Cook Strait catches peaked at 67 000 t in 1995–96, but have been relatively stable in the range from 15 000 to 20 000 t in the past 11 years. The Chatham Rise was the largest hoki fishery from 2006–07 to 2009–10, and contributed about 27% of the total catch in 2017–18. Catches from the Sub-Antarctic peaked at over 30 000 t from 1999–2000 to 2001–02, but have been variable since, ranging between 6 000 and 20 000 t over the past 11 years (Table 3). Catches from other areas remained at relatively low levels (Table 3).

From 1999–2000 to 2001–02, there was a redistribution in catch from eastern stock areas (Chatham Rise, ECSI, ECNI, and Cook Strait) to western stock areas (WCSI, Puysegur, and Sub-Antarctic) (Figure 2). This was initially due to industry initiatives to reduce the catch of small fish in the area of the Mernoo Bank, but from 1 October 2001 became part of an informal agreement with the Minister of Fisheries that 65% of the catch should be taken from the western fisheries to reduce pressure on the eastern stock. This agreement was removed in 2002–03 following the 2003 hoki assessment, which indicated that the eastern hoki stock was by then less depleted than the western stock, and effort was shifted back into eastern areas, particularly Cook Strait. From 2004–05 to 2006–07 there was a further agreement with the Minister that only 40% of the catch should be taken from western fisheries. From 1 October 2007 the target catch from the western fishing grounds was further reduced to 25 000 t within the overall TACC of 90 000 t. This target was exceeded in both 2007–08 and 2008–09, with about 30 000 t taken from western areas. In 2009–10, the target catch from the western fishing grounds was increased to 50 000 t within the overall TACC of 110 000 t, and catches were at about the industry-agreed catch split. Since then the target eastern catch has remained at 60 000 t, and the target western catch has further increased with changes in the overall TACC, up to a maximum of 100 000 t in 2014–15 (within the overall TACC 160 000 t). The western target catch from 2015–16 to 2017–18 was 90 000 t. The split between eastern and western catches has been within 2 000 t of the management targets since 2011–12, except in 2014–15 where the eastern catch was 4 600 t over the target, and in 2015–16, 2016–17 and 2017–18 where the western catches were lower than the target total by 13 400 t, 9 600 t, and 18 000 t respectively.

2.1.4 Catch in 2017–18

Overall catches

The overall 2017–18 catch of 135 383 t was about 6200 t lower than the catch in 2016–17, and about 14 600 t lower than the TACC (see Table 2). The total estimated catch from all reporting form types was 131 477 t. A small amount of data may not have been entered into the database as the data extraction was done in mid-December 2018. Estimated catches were scaled up to the total monthly harvest return MHR catch of 135 383 t because estimated catches did not match the (MHR) catch.

Nearly 87% of the hoki catch was recorded on the ERS-trawl form, with only 3% of the catch from the TCEPR form (Figure 3). WCSI and Cook Strait were the only areas where a substantial amount of catch was recorded on the TCER form (Figures 4–9). Most hoki catch on the WCSI and in Cook Strait was taken by midwater trawling, whereas most catch on the Chatham Rise and Sub-Antarctic was taken by bottom trawling (Figures 4–7).

Relative to 2016–17, catches in 2017–18 decreased in WCSI, Chatham Rise and ECSI and increased in Cook Strait and Sub-Antarctic (Figure 2, Table 3). Most of the decrease in total catch was driven by the decline in the midwater spawning fishery on the WCSI in August (Figure 4). A high proportion of the hoki catch in 2017–18 was taken during the spawning season from June to September (Figure 10). Overall, about 72 006 t of the total catch in 2017–18 was taken from western stock areas, with 63 336 t from the eastern stock areas (Figure 2). The western catch was well below the industry-agreed western catch limit of 90 000 t.

Up until 2003–04 almost all of the hoki catch was from target hoki tows. Hoki targeting then decreased on

the Sub-Antarctic, WCSI and Chatham Rise until 2008–09, when only 86% of the overall hoki catch was from tows targeting hoki (Figures 3–7). With the increases in TACC from 2009–10, hoki targeting has again increased, and in 2017–18 96% of the overall catch was taken from hoki target tows. Note that the target species reported for any tow may not be the true target; it may be that some fishers decide what to record only after the trawl is retrieved and the main component of the catch becomes apparent.

WCSI

The WCSI was the largest fishery for the eighth consecutive year, but catches decreased by 10 500 t from 2016–17, to 55 400 t in 2017–18. Catches from inside the 25 n. mile line made up 30% of the total WCSI catch in 2017–18, an increase in proportion from 2016–17, but still lower than the peak of 41% of the catch taken inside-the-line in 2003–04 (Figure 11). Twin trawls accounted for 16% of the WCSI catch in 2017–18 (Figure 4). The WCSI fishing season is now longer – there was fishing in May in the last 8 seasons, with most pre-June catch from inside the 25 n. mile line (Figure 4). Peak catches on the WCSI spawning grounds were in July and August, as in previous years. The 2018 season (i.e., 2017–18 fishing year) ended in early September, as it did in the 2015 to 2017 seasons (Figure 10b). Target hoki trawls made up 99% of the hoki catch on the WCSI in 2018 (Figure 4). Since the 2008 season, the WCSI fleet has been made up of BATM, domestic vessels with meal plants on board, and FOV vessels, and inside the 25 n. mile line mainly domestic vessels without meal plants on board (Figure 12).

Cook Strait

The catch from Cook Strait in 2017–18 of 21 500 t increased by about 5300 t from that in 2016–17, and was the highest from this area since 2006–07 (Table 3, Figure 2). Peak catches were from mid-July to mid-September, with about 3400 t caught outside the spawning season, and MHS trawls accounting for 2574 t (Figure 5). The seasonal pattern of fishing in Cook Strait was similar to that in previous years, but catches were higher in July 2018 compared to those in the 2017 season (Figures 5 and 10). Cook Strait has remained almost exclusively a hoki target midwater trawl fishery, with mainly domestic vessels without meal plants on board (Figures 5 and 12).

Chatham Rise

The Chatham Rise fishery was the second largest hoki fishery and took 37 200 t in 2017–18, a decrease of 2700 t from 2016–17 (Table 3, Figure 2). Over 87% of the 2017–18 Chatham Rise catch was taken in bottom trawls, with twin trawl (17 000 t) and MHS (4300 t) accounted for 46% and 11% of the total catch respectively (Figure 6). Most of the catch was taken from October 2017 to June 2018, and target hoki trawls accounted for 95% of the hoki catch (Figures 6 and 10). Since the 2008 season, the Chatham Rise fleet has mainly been made up of domestic vessels with meal plants on board (Figure 12).

Sub-Antarctic

The catch from the Sub-Antarctic of 14 500 t in 2017–18 was 2200 t higher than that in 2016–17 (Table 3). Most (88%) of the Sub-Antarctic 2017–18 catch came from hoki target tows, and 41% of the catch came from twin trawl tows. MHS contributed only 2.6% of the catch. The 2017–18 catch was taken in all months except July 2018, and target hoki trawls made up 88% of the hoki catch on the Sub-Antarctic (Figures 7 and 10). Since 2007–08, the Sub-Antarctic fleet has been mainly made up of domestic vessels with meal plants on board (Figure 12).

Other areas

Catches from ECSI decreased by 800 t to 3600 t in 2017–18, while catches from Puysegur and ECNI in 2017–18 (1100 t in each area) were similar to those in 2016–17 (Table 3, Figures 2, 8 and 9). Fishing during the spawning season on the ECSI occurred mainly in August and September, with fishing at Puysegur mainly in June and August (Figure 10). Small catches were taken year-round from the ECNI, with very little catch taken from the WCNI. Catches in the ECSI and Puysegur in recent years were taken mainly by domestic vessels with meal plants, whereas ECNI catches were taken mainly by domestic vessels without meal plants (Figure 12).

2.1.5 CPUE analysis

Unstandardised catch and effort from ERS-trawl and TCEPR data for the six largest hoki fisheries (WCSI, Cook Strait, Chatham Rise, ECSI, Sub-Antarctic, and Puysegur) are summarised in Appendix A1. Standardised CPUE analyses on tow-by-tow target hoki catches reported on TCEPR or ERS-trawl for the WCSI, Cook Strait, Chatham Rise, and Sub-Antarctic were also carried out (Appendix A2–A5 and Figure 13). Catch rate analysis did not include data from CELR forms (which account for up to a third of the catch in some years in Cook Strait and some catch from the WCSI), as they do not provide tow-by-tow effort data. The analyses also excluded data from TCER forms (which have been in use for the last eleven years, as catches do not fall into core vessel definitions, see details in the 'Model' section below) and from the LCER, LTCER, TLCER or NCELR forms. Standardised CPUE analyses using observer tow-by-tow target hoki catches for the WCSI, Cook Strait, Chatham Rise, and Sub-Antarctic were also carried out.

Standardised CPUE analyses were carried out only to explore trends in catch rate. CPUE indices are not believed to provide reliable estimates of hoki abundance and were not used in the 2019 hoki stock assessment. Changes in fishing methods (e.g., use of twin trawls), fishing practices (e.g., target fishing, use of escapement panels on smaller boats, incorrect recording of tow duration as some vessels leave the catch in the water until ready to process, changes in target bag size to reflect the processing capacity of the vessel and improve the quality of fish product), and the reliability of gear parameters recorded on the fishing returns are problems for CPUE analyses. There are also other effects on catching ability that cannot be quantified, such as improvements or changes in net and bottom rig design, and electronic equipment. MHS trawls were identified in ERS-trawl, TCEPR and observer data based on information from the MPI and were excluded from unstandardised and standardised analyses.

Model

A lognormal linear model was used for all standardised analysis models, following Dunn (2002). A forward stepwise Generalised Linear Model (Chambers & Hastie 1991) implemented in R code (R Development Core Team 2018) was used to select variables in the model. *Fishing year* was forced into the model as the first term, and the algorithm added variables based on changes in residual deviance. The explanatory power of a particular model is described by the reduction in residual deviance relative to the null deviance defined by a simple intercept model. Variables were added to the model until an improvement of less than 1% of residual deviance explained was seen following inclusion of an additional variable. Variables were either categorical or continuous. Categorical variables offered to the model included *vessel key*, *primary method*, *month*, *vessel experience* (number of years vessel participated in the fishery*)*, *twin vessel* (true/false variable for a vessel that has used a twin trawl), and *statistical area*. Continuous variables included *fishing duration*, *fishing distance* (calculated from positions at start and end of tow), *distance 2* (calculated as *fishing duration* × *speed*), *start latitude*, *start longitude*, *start time*, *mid time* (mid time of tow), *depth of bottom*, *effort depth (*depth of net*)*, *depth above bottom* (*depth of bottom* minus *effort depth*), *effort width (*wing spread*)*, *day of season*, and *effort height* (headline height). Model fits to most continuous variables were made as third-order polynomials, but a fourth-order polynomial was also offered to the models for duration. As the WCSI dataset included both midwater and bottom tows, nested effects between *method* and *effort duration*, *effort depth*, *effort height*, *effort speed*, *depth above bottom* and *effort width* were investigated. The dependent variable was the log-transformed estimated catch per tow, with positive catches retained and zero hoki catches excluded. *Grid number*, defined as the 0.5° latitude/longitude square where the catch was taken (V. McGregor, NIWA, pers. comm.) was included in all runs to allow for differences in fishing area. Model runs with *grid number* included all cells, top cell (cell with the highest overall catch), the top 4–6 cells (i.e., 4–6 cells with the highest catches), and the complement of the top cells (all cells not included in the top cells model run).

A vessel variable was incorporated into the CPUE standardisation to allow for differences in fishing power between vessels. A subset of "core" vessels was chosen for each analysis, with vessels not involved in the fishery for a minimum number of years (varied by analysis) and with a minimum level of annual effort excluded because they provided little information for the standardisations. Inclusion of these vessels could result in model over-fitting (Francis 2001b). Data were investigated for level of catch and effort for different years of vessel participation in the fishery, and "core" vessels were defined as those which reported approximately 80% of hoki catches in the defined fishery.

The standardised indices were calculated using GLM, with associated standard errors. Indices were presented using the canonical form (Francis 1999) so that the year effects for an area were standardised to have a geometric mean of 1. The CVs represent the ratio of the standard error to the index. The 95% confidence intervals were also calculated for each index.

The influence of each variable accepted into the lognormal models was described by influence plots (Bentley et al. 2012). They show the combined effect of (a) the expected log catch for each level of the variable (model coefficients) and (b) the distribution of the levels of the variable in each year, and therefore describe the influence that the variable has on the unstandardised CPUE and which is accounted for by the standardisation.

Fits to the model were investigated using standard residual diagnostics. For each model, a plot of residuals against fitted values and a plot of residuals against quantiles of the standard normal distribution were produced to check for departures from the regression assumptions of homoscedasticity and normality of errors in log-space (i.e., log-normal errors).

The data used for each CPUE analysis consisted of all records from core vessels that targeted hoki with further constraints listed in Table A2. Selected explanatory variables for target hoki runs are listed in Table A3.

WCSI

Unstandardised catch rates are presented for both midwater and bottom trawls (Table A1). Midwater trawl catches accounted for 64% of the total spawning season catch in 2018, with almost all bottom trawl tows from outside the 25 n. mile line. Unstandardised midwater catch rates on the WCSI in 2017–18 decreased from 2016–17, with a median catch rate in all midwater tows targeting hoki of 4.9 t per hour, and a median tow duration of 2.0 hours. As most of the midwater catch and tows were from target hoki tows, catch rates and median tow duration from all tows were the same as those for target hoki tows. Catch rates in bottom trawls were lower than those in midwater trawls, with median catch rates of 0.9 t per hour for all non-zero hoki bottom trawl catches. Catch rates were marginally higher for target hoki bottom tows at 1.1 t per hour. Median tow duration of bottom trawls increased in 2018, to 5.3 hours for both all target species and target hoki tows. Standardised CPUE indices show a similar pattern to unstandardised catch rates, with a decline from 2000 to 2003, an increase to 2013, then a decline by 43% over the last three years (now at 0.98, i.e. close to the long-term average of 1) (Tables A4–A5, Figure 13a). Commercial (TCEPR and ERS-trawl data) and observer data tow-by-tow showed similar overall trends. Standardised CPUE analyses also showed similar trends for data subsets including by fleet, fishing method, outside 25 n. mile line, exclude twin trawl tows, and cell subsets (Ballara 2019a, 2019b).

Cook Strait

Midwater trawl catches accounted for 98% of the spawning season catch of 12 955 t reported on TCEPR and ERS-trawl forms in 2018, with 198 t (1.5%) coming from MHS tows. During the non-spawning season, 29% (983 t) of the catch came from midwater tows using standard gear whereas 70% (2375 t) came from MHS tows. A catch of 4831 t was reported on TCER forms of which 4811 t came from the spawning season (Figure 5). Non-standardised catch rates continued to be high. Median catch rates in non-zero mid-water tows targeting hoki increased from 17.5 in 2017 to 21.7 t per hour in 2018, with a slight decrease in median tow duration from 0.9 to 0.8 hours. Overall, the non-standardised catch rates showed a slight increase from 1990 to 2002 and have been flat since, and standardised catch rates showed no trend, but increased by 29% over the last three years (now at 1.2) (Table A4–A5, Figure 13b). Catch rates appear to reflect a fishing strategy where vessels limit the size of catches to maintain

fish quality. TCEPR and ERS-trawl commercial data and observer data tow-by-tow showed similar overall trends.

Chatham Rise

Over 87% of the catch in 2017–18 was taken in bottom trawls, with most of the catch reported on the ERS-trawl form (Figure 6). MHS tows accounted for another 11% of the catch. There was a general increase in tow duration since the 1990s, with a median tow duration of 4.5 hours in 2017–18. The median non-standardised catch rate in bottom trawls in 2017–18 of 1.1 t per hour was similar to that in the previous ten years. The catch rate in hoki target trawls increased from 0.6 t per hour in 2002–03 to 1.7 t per hour in 2008–09, and has levelled off to 1.4–1.6 t per hour since 2009–10. Standardised CPUE indices show a similar pattern to unstandardized catch rates with indices relatively stable for the last 10 years (1.24–1.42) (Table A4–A5, Figure 13c). TCEPR and ERS-trawl standardised CPUE analyses showed similar trends for data subsets (Ballara 2019a, 2019b).

Sub-Antarctic

Bottom trawl catches reported on ERS-trawl and TCEPR forms accounted for 92% of the catch taken in 2017–18, with MHS accounting for 2.6%, and midwater trawling accounting for the balance (Figure 7). Median tow duration in 2017–18 increased slightly to 5.8 hours, and non-standardised catch rates in bottom trawls decreased to 0.3 t per hour. Catch rates for hoki target bottom trawls (1.0 t per hour in 2017–18) were higher than those for all target trawls, and only slightly lower than those on the Chatham Rise. Standardised CPUE generally decreased from 1996–97 to 2003–04, increased to much higher levels in 2010–11 to 2014–15, but has now again declined (to 1.2 in 2017–18) (Table A4–A5, Figure 13d). TCEPR and ERS-trawl standardised CPUE analyses showed similar trends for data, although a CPUE run using only catches from October to December showed an increase in the most recent year (Ballara 2019a, 2019b). Observed vessels had lower CPUE indices from 2011–12 to 2013–14, but showed an increase in CPUE from 2016–17 to 2017–18 (Figure 13d).

Other fisheries

Spawning season catches from the ECSI were mainly reported on ERS-trawl forms (Figure 8). Midwater trawl target hoki catch rates in 2017–18 decreased slightly to 6.2 t per hour, and bottom trawl catch rates decreased to 1.4 t per hour. Spawning season catches from Puysegur were also mainly reported on ERS-trawl (Figure 9), and midwater and bottom trawl target hoki catch rates in 2017–18 decreased to 1.8 t and 1.9 t per hour respectively.

CPUE trends

Standardised CPUE indices for WCSI, Chatham Rise, and Sub-Antarctic all decreased from 1991–92 to 2003–04 and have since increased (Figure 14). Recent trends in standardised CPUE have varied by area but are all at or above their long-term average. CPUE indices from the WCSI, Chatham Rise, and Sub-Antarctic all decreased from 2016–17 to 2017–18, whereas the index from Cook Strait increased. Observer CPUE indices for WCSI, Chatham Rise, and Sub-Antarctic showed overall trends similar to the 'all data' series, but were spiky due to there being less data.

2.1.6 Bycatch

Estimates of bycatch in the hoki fishery were determined from data collected by Fisheries New Zealand observers. For target hoki trawls, the observer data in 2017–18 represented about 69% of vessels, 13% of tows, and 18% of the total hoki catch (Table 4). The bycatch rate (defined as the percentage of the hoki catch) was estimated for the main bycatch species by fishery in Table 5. Other bycatch species were also taken, particularly in the non-spawning fisheries, but bycatch rates for these species were usually less than 1%. Some of the apparent changes in bycatch rates may have been related to changes in observer coverage between years (e.g., Livingston et al. 2002), so the data should be treated with caution. There were changes in the proportion of catches reported as target hoki (Figure 15), so caution also needs to be exercised when interpreting the definition of the hoki target fishery. A more comprehensive analysis of catch and discards

in the hoki, hake, and ling fishery from 1990–91 to 2016–17 was provided by Anderson et al. (2019).

Overall bycatch rates in the spawning areas in 2017–18 were generally low (less than 2%) for most species (Table 5, Figure 15). On the WCSI, bottom trawl fishery bycatch rates in 2017–18 were similar to those in 2016–17, although hake (8.9%) decreased and javelinfish increased (1.4%). WCSI midwater trawl bycatch rates increased for most main species, especially for hake (4.8%), and ling (2.8%). As in the past, there was very little bycatch in the midwater Cook Strait fishery, and ling had the largest observed bycatch rates (0.6%).

In the non-spawning fisheries, bycatch rates were generally higher than those for spawning fisheries (Table 5, Figure 15). In the Chatham Rise bottom trawl fishery, bycatch rates for hake (1.8%), ling (4.7%), and silver warehou (4.4%), javelinfish (9.7%), and spiny dogfish (3.1%) increased from 2016–17, whereas bycatch of rattails (7.8%) decreased. Of the main Sub-Antarctic bottom trawl bycatch species, bycatch rates increased for hake (2.4%), javelinfish (7.2%), rattails (4.8%), and silver warehou (5.9%), and decreased for spiny dogfish (4.3%), and white warehou (1.7%).

2.2 Size and age composition of commercial catches

Data to estimate length frequency distributions in 2017–18 were available from the at-sea Fisheries New Zealand Observer Programme (OP). Land-based ('market') sampling of landed hoki from Cook Strait and WCSI (inside the 25 n. mile line) was also carried out in 2017–18 for Ministry for Primary Industries research project HOK2018-02. The fishing industry observer programme formerly run by the Hoki Fishery Management Company (HMC) was discontinued and no data have been provided since 2004–05.

Density plots of all commercial ERS-trawl, TCEPR, and TCER trawls in which hoki was caught in 2017–18 are shown in Figure 16. Positions of all tows sampled for hoki length frequency by the Observer Programme are provided in the TCEPR plot. Hoki were measured by Observer Programme observers from 2019 tows (more than in 2016–17), of which 891 came from the WCSI, 81 from Cook Strait, 346 from the Chatham Rise, 669 from the Sub-Antarctic, 38 from the ECSI (June–September), 26 from Puysegur (June–September), and 32 from ECNI. In Cook Strait and WCSI, 34 and 12 land-based samples respectively were collected by NIWA scientists. Table 6 describes timing of sampling in the main areas.

Spawning fisheries catch-at-age methods

Length frequency distributions were estimated for each of the major fisheries as the weighted (by catch weight) average of individual length samples. Length frequency data from each area were post-stratified. Data from the WCSI were stratified by area (inside or outside 25 n. miles) and time. Length frequency data from outside and inside the line from May to September were split into weekly or fortnightly time periods and scaled, respectively, to the outside or inside the line catch in each period (Table 7a). Adjacent strata were combined if there were few length samples available, e.g., strata 1, 8, 9 and 22 (Table 7a). Alternative strata for WCSI outside the line were investigated by fleet and fishing method (Table 7b and c). Length frequency data from Cook Strait are normally stratified by month and vessel size, although in 2018, Cook Strait samples from June and July were combined for vessels less than 40 m (Table 7d).

Catch-at-age from spawning fisheries was estimated using age-length keys derived from otolith ageing. Otoliths were available from the Observer Programme and land-based samples. A subsample of 750 otoliths from WCSI (613 from OP samples, and 137 from land-based samples), and 750 otoliths from Cook Strait (194 from Observer Programme samples, and 556 from land-based samples) were selected, prepared, and read using the validated technique of Horn & Sullivan (1996) as modified by Cordue et al. (2000), and described by Horn & Sutton (2017). The sub-sample was derived by randomly selecting a set number of otoliths from each of a series of 1 cm length/sex bins covering the bulk of the catch and then systematically selecting additional otoliths to ensure that the tails of the length distribution were represented. The chosen sample sizes approximated those necessary to produce mean weighted CVs of less than 20% across all age classes, in each of the spawning fisheries.

Age-length keys were constructed for each spawning fishery and applied to the total length frequency distribution to produce an age frequency distribution for the catch of each sex separately. Catch-at-age estimates were determined using the 'catch.at.age' software (Bull & Dunn 2002). This software also incorporates data from otolith zone measurements using the consistency scoring method of Francis (2001a) in the age-length key.

Non-spawning fisheries direct ageing methods

Catch-at-age in both the Chatham Rise and Sub-Antarctic fisheries was estimated by sampling directly for age. This continued the approach used since 1998–99 for the Chatham Rise (Francis 2002) and since 2000–01 for the Sub-Antarctic (Ballara et al. 2003). Sampling directly for age is necessary because a single age-length key is not appropriate in non-spawning fisheries. The fisheries are spread over much of the year and there will be substantial fish growth. This means that for any given length the proportions-at-age will change through the fishery. To sample directly for age, observer coverage must be sufficient to provide a random sample of otoliths from the fishery. Francis (2002) suggested that even a sample size of 1200 otoliths may not be sufficient to achieve a target CV of 0.20 in some years.

Criteria for otolith selection involves choosing about 1200 otoliths for each area (1200–1250, depending on criteria), with more otoliths from larger catches and fewer from smaller catches, but most importantly covering all tows with catches greater than 1 tonne. Otoliths categorised by observers as 'non random' are not used. The proportion of catch by fishing method from the previous year is used to apportion otoliths between methods. The previous year's data is used because delaying otolith selection until details of the catch from the analysed year are available would result in the age data not being ready for the stock assessment.

In the 2017–18 Chatham Rise non-spawning season, 3128 otoliths were collected from 380 tows, of which 2418 were identified as 'random'. In the 2016–17 season 97.4% of the catch was from bottom tows, 1.5% of the catch from midwater tows, and 1.1% of the catch from MHS tows. Hence 1200 'random' otoliths tows were selected at random for age estimation using the following rules:

1. Rejected all otoliths from tows that caught less than 1 t of hoki.
2. For tows that caught 1–3 t of hoki, 1 otolith from each tow.
3. For tows that caught 3–5 t of hoki, 3 otoliths from each tow.
4. For tows that caught 5–10 t of hoki, 5 otoliths from each tow.
5. For tows that caught more than 10 t of hoki, 7 otoliths from each tow.

This selected 1181 otoliths from bottom trawls and 19 otoliths from midwater tows.

A further 25 otoliths were selected from observed MHS tows based on the following rules:

1. Rejected all otoliths from tows that caught less than 1 t of hoki.
2. For tows that caught 1–7 t of hoki, 1 otolith from each tow.
3. For tows that caught 7–10 t of hoki, 2 otoliths from each tow.
4. For tows that caught 10–15 t of hoki, 3 otoliths from each tow.
5. For tows that caught more than 15 t of hoki, 4 otoliths from each tow.

In the 2017–18 Sub-Antarctic non-spawning season, 5912 otoliths were collected from 669 tows, of which 4138 were identified as 'random'. In 2016–17 98% of the catch was from bottom tows, 1.5% of the catch from midwater tows, and no catch from MHS tows. In 2017–18, the decision was made to apportion the selection of otoliths as 2% from MHS tows, 2% from midwater tows and the rest from bottom tows. Otoliths from MHS tows were included because there were some observed tows from this method in 2017–18. Hence 1181 'random' otoliths from bottom tows were selected at random for age estimation as follows:

1. Rejected all otoliths from tows that caught less than 1 t of hoki.
2. For tows that caught 1–3 t of hoki, 1 otolith from each tow.
3. For tows that caught 3–7 t of hoki, 2 otoliths from each tow.
4. For tows that caught 7–15 t of hoki, 4 otoliths from each tow.
5. For tows that caught more than 15 t of hoki, 5 otoliths from each tow.

A further 38 otoliths were selected from observed Sub-Antarctic midwater tows based on the selection:

1. Rejected all otoliths from tows that caught less than 1 t of hoki.
2. For tows that caught 1–10 t of hoki, 1 otolith from each tow.
3. For tows that caught 10–15 t of hoki, 1 otolith from each tow.
4. For tows that caught 15–22 t of hoki, 2 otoliths from each tow.
5. For tows that caught more than 22 t of hoki, 4 otoliths from each tow.

A further 31 otoliths were selected from observed Sub-Antarctic MHS tows based on the selection:

1. Rejected all otoliths from tows that caught less than 1 t of hoki.
2. For tows that caught 1–10 t of hoki, 1 otolith from each tow.
3. For tows that caught 10–20 t of hoki, 2 otoliths from each tow.
4. For tows that caught 20–24 t of hoki, 4 otoliths from each tow.
5. For tows that caught more than 24 t of hoki, 5 otoliths from each tow.

The criteria used to select otoliths based on catch size came under scrutiny from the DWWG during the 2019 assessment as it potentially introduces bias. This is discussed further in Section 2.2.2 below.

The method to estimate catch-at-age for the Chatham Rise and Sub-Antarctic followed that of Francis (2002) as modified by Smith (2005). First, the regression tree method (Breiman et al. 1984) was used to stratify the two fishing areas by minimising the weighted least squares of the mean lengths (as a proxy for age) of fish in the observed tows (see Smith (2005) for details). Next, the estimated age frequencies by sex for the observed tows within each stratum were obtained by scaling the otolith ages and sexes up by the estimated numbers of hoki of each sex caught in the tow and averaging over all tows in the stratum. Finally, the number of fish caught in each stratum was estimated from ERS-trawl and TCEPR data, and catch-at-age frequencies were calculated as the weighted average, over the strata, of the estimated age frequencies by sex. Tows that caught at least 150 kg of hoki were used to calculate strata. Numbers of fish were estimated from catch weights using the length-weight relationship of Francis (2003). Alternative tree-based stratification was used to investigate stratification by fleet for Chatham Rise and for target only otoliths for the Sub-Antarctic (Table 8).

Estimates of catch-at-age before 1999–2000 in the Sub-Antarctic and up to 1997–98 on the Chatham Rise were based on an optimised length frequency model (OLF) described in detail by Hicks et al. (2002).

2.2.1 Size and age composition in spawning fisheries

West coast South Island

The WCSI catch in 2018 was dominated by fish from 55 to 110 cm from the 2008–15 year-classes (ages 3–10) (Figures 17 and 18). The length distribution of hoki had three modes, the smaller mode made up mainly of fish from the 2015 year class (age 3), and the middle mode made up of fish from the 2014 year class (age 4). The right-hand mode centred at 90 cm, which comprised mainly older fish from the 2007–11 year classes (ages 7–11), was large for the females but much smaller for males (Figures 17 and 18). There were very few fish from the 2016 year class (age 2, less than 55 cm). There was a relatively high proportion of males from the 2015 year class (age 3), and 14% of hoki caught on the WCSI were less than 65 cm (Figures 17 and 18).

From 1999–00 to 2003–04, the sex ratio of the WCSI catch was highly skewed, with many more females caught than males (Figure 19a). In 2004–05 to 2010–11, as the catch of younger fish increased, the sex ratio reversed with more males than females caught. The sex ratio of the WCSI catch was about even in 2018, with 57% females. The percentage of hoki aged 7 and older in the catch declined steeply from 68% in 2003–04 to 16% in 2005–06, increased again to 47–49% in 2013 and 2014, but decreased to 43% in 2015 owing to the abundance of the 2011 year-class (Figure 19a). In 2016 the percentage of fish aged 7 and older increased substantially to 62%, but this dropped to 49% in 2018. Conversely, the

percentage of small fish (less than 65 cm, which is approximately equivalent to ages 3 years and younger) by number in the catch increased from 20% in 2006–07 to 31% in 2008–09, then decreased to 7–14% in 2013–18 (Figure 19b).

Some of these small fish outside the 25 n. mile line were spawning: 11% of the female fish less than 55 cm (i.e., mostly 2 year-olds) were in active spawning condition (ripe and running ripe) in 2018, compared to 36% of all fish (Table 9). Inside the line most (90%) observed female hoki over 55 cm were actively spawning, whereas only 45% of females from the land-based data were ripe and running ripe. This difference will be in part due to timing and number of samples (see Table 7a). The spawning state of male hoki is not recorded by observers, but observations from research tows in other areas suggest that a higher proportion of small males than females would be mature.

Previous comparisons showed that in most years there were differences in the length frequency distributions from land-based samples of hoki caught inside the 25 n. mile line and at-sea samples of fish outside this area, with a higher proportion of larger fish (greater than 70 cm) from samples taken inside the line (Ballara & O'Driscoll 2014, 2015, 2016, 2017, 2018). In 2018, the observer and land-based sampling data from inside the line in May–September had very few fish less than 80 cm, and many fish smaller than 80 cm were caught outside the 25 n. mile line, especially males (Figure 20).

The overall mean length of both female and male hoki decreased as the 2018 spawning season progressed (Figure 21). This pattern of declining mean length over the spawning season used to be a common feature of the fishery, but was not observed between 1999 and 2006. The mean length-at-age for hoki aged from 3–10 years on the WCSI increased from the start of the fishery to the mid-2000s, but has since decreased, although fish in 2018 were larger at age compared to recent years (Figure 22).

The Observer Programme data used to estimate catch-at-age was representative of the overall spatial, depth, and temporal distribution of the catch in the 2018 season, although domestic vessels with meal plants on board from 60–70 m were not as well sampled (Figure 23).

Investigation of fish size by fleet or fishing method showed that fleet or fishing method does not make a big difference to age frequency distributions, as boats fishing in similar places at similar time catch similar size fish (Figure 24). There was weak evidence that domestic meal vessels have caught smaller fish in the past two years (Figure 25), but there was very little impact on the overall length frequency in 2018 (Figure 26a). Female age frequency distributions were similar for all fishing methods, but a higher proportion of large (i.e., older) males were caught in midwater tows, compared to bottom tows, in the 2018 season (Figure 26b).

Cook Strait

Fish from a broad range of ages contributed to the Cook Strait fishery, with the main mode at ages 3–11 (2009 to 2015 year-classes) for females and ages 3–4 (2014 and 2015 year classes) for males (Figures 27 and 28). Length frequency distributions by strata showed that the size distribution of the catch was broadly similar in each month, by each sampling method, and by vessel size category (Figure 29), although more males were caught by smaller vessels, and most large females were caught from June to August. The sex ratio of the Cook Strait catch has fluctuated over time; females dominated from 2001–05, but the fishery has been mostly male-dominated since then (Figure 19a). The apparent change in sex ratio may be related to a sampling bias, as there is some evidence that larger vessels catch a higher proportion of female hoki in Cook Strait (O'Driscoll et al. 2015). Males comprised 57% of the catch in 2017–18 (Figure 19a), and only 28% of the catch was fish less than 65 cm (Figure 19b).

There was a slight decreasing trend in the mean length of hoki during the season (Figure 21). As on the WCSI, the mean length-at-age in the Cook Strait fishery increased to the mid-2000s, but has subsequently declined (Figure 30), although fish in 2018 were larger at age compared to recent years (Figure 31).

In 2018, the Observer Programme data used to estimate catch-at-age was poorly representative of the

overall spatial and depth and temporal distribution of the catch for large vessels (Figure 32, see Table 7d). However, land-based samples were well spread throughout the spawning season.

Catch-at-age distributions for spawning seasons from 1990–1998 were re-calculated in a consistent way in 2019 (Ballara, 2019c). Re-calculation included: 'Warehou' data extract rep log 11384; land-based sampling data extract in December 2018; consistent stratification by months; out of spawning season land-based samples removed; and use of latest "official" age data (some otoliths from 1993–1998 had been re-aged). Recalculation of 1988 and 1989 catch-at-age was not done as no tow-by-tow catches were available. Catch-at-age from 1999 onwards was already consistently calculated. The revised age frequency distributions appeared to reduce the contribution of the weak 1989 year class, and were used in the 2019 hoki stock assessment model runs.

The catch-at-age data for 2011–13 were not used in the 2015 hoki stock assessment model as they were not considered representative of the commercial catch due to poor observer coverage and the rapidly changing sex ratio. The catch-at-age data for 2014–18 were included in the 2019 assessment model because of improved coverage due to reinstatement of the land-based sampling programme for Cook Strait hoki.

Puysegur
In 2017–18, 26 Observer Programme samples were collected during the spawning season, and these were mainly fish of 45–80 cm (Figure 33).

East coast South Island
Thirty-eight samples were collected during the 2018 spawning season (Figure 34). Fish from this area were smaller than those observed in the non-spawning fishery on the Chatham Rise, with a large mode of fish at about 57 cm, probably from the 2015 year class.

2.2.2 Size and age composition in non-spawning fisheries

Chatham Rise
About 95% of the commercial catch, 78% of length frequency data, and 89% of the available otoliths came from the hoki target fishery in 2017–18 (Figure 35). The tree-based regression split the Observer Programme data into four strata based on depth of net, with mean length of hoki smaller in shallower water (Table 8a).

The length frequency distributions for both males and female hoki had modes at 50–60 cm from the 2015 year-class (age 2+), and at 60–68 cm from the 2014 year-class (ages 3+), with fewer larger, older fish (Figure 36 and 37). The 2016 year class appears in low numbers. Females comprised 60% of the catch (Figure 19a). There was a lower proportion of large old fish (males and females) than in other areas, with only 9% of the catch aged 7 years or older, and only 23% of these were male (Figure 19a). About 58% of the catch by number was less than 65 cm in 2017–18 which is similar to the percentage in 2016–17 (60%) (Figure 19b).

The Observer Programme data used to estimate catch-at-age was representative of the overall spatial and temporal distribution of the catch in 2017–18, although coverage was lower than ideal from January to March, and in Statistical Areas 018, 023, and 407–410 (Figure 38). There was a suggestion of under-sampling of domestic vessels with meal plants on board, and of vessels less than 46 m (Figure 38).

Most Chatham Rise hoki was caught by domestic vessels with meal plants on board, and most length frequency distributions were from this fleet (Figure 38). Investigation of fish size by fleet showed that fleet does not influence age frequency distributions, as boats fishing in similar places at similar time catch similar size fish (Figure 39). The DWWG concluded that using the 'original' age frequency (Figure 37), which did not include fleet stratification, was appropriate. There was weak evidence that

vessels catching smaller fish on average were processing a higher proportion to meal (Figure 40).

Sub-Antarctic

About 88% of the commercial catch, 65% of length frequency data, and 95% of the available otoliths came from the hoki target fishery in 2017–18 (Figure 41). The remainder of the otoliths were from tows that targeted hake, ling, squid, silver warehou, or white warehou. The tree-based regression on hoki target tows split the Observer Programme data into three strata based on depth and latitude (Table 8c). Smaller fish tended to occur on the Snares Shelf, especially in shallower water, and in deeper tows in the west.

The 2017–18 observed catch was bimodal for females and unimodal for males. The catch included hoki of 45–60 cm from the 2015 year-class (age 2+), fish of 60–68 cm from the 2014 year class (age 3+), and fish of 68–90 cm primarily from ages 4–10 (Figures 42 and 43). There was a higher proportion of old fish caught in the Sub-Antarctic than on the Chatham Rise (Figure 19a). About 15% of the Sub-Antarctic catch was fish less than 65 cm, and about 45% of the catch were females (Figure 19).

Length frequency distributions including only target hoki tows showed more small hoki at the 60 cm peak than when using all target tows (Figures 44 and 45), but this did not make a big difference to the overall age frequency distribution (Figure 46). The DWWG concluded that using the original age frequency (Figure 43) was appropriate in the hoki model in 2019.

Problems with estimation of catch-at-age in non-spawning fisheries

A key issue is whether Observer Programme coverage is representative of the catch. In 2017–18, coverage was relatively good in both the Chatham Rise and in the Sub-Antarctic. The DWWG has suggested using consistent stratification across all years to estimate age frequencies, instead of annual stratification using tree-based methods. This approach will be investigated, but may be limited by available data.

Previously there has been an issue with biased selection of otoliths by observers (e.g., Ballara & O'Driscoll 2018). Observers collect otoliths from 10 fish out of the 50–150 sampled per tow for length measurement (and three otoliths per tow in the spawning fisheries), and in some previous years there was evidence that there had been preferential selection of larger fish. In 2017–18, a rank sums test showed that otolith selection from both the Chatham Rise and Sub-Antarctic appeared unbiased (Figure 47).

Our criteria used to select otoliths for ageing based on catch size may also introduce bias, if otoliths are not selected in proportion to the catch, and if there is a relationship between catch size and fish size. An investigation concluded that there is not a major issue with Chatham Rise in 2017–18 as the cumulative plot of selected otoliths was close to the cumulative plot of catches (Figure 48), and there was no clear relationship between mean length and catch size (Figure 49. However, there may be an issue for the Sub-Antarctic. There was more of a difference in the cumulative plot of selected otoliths compared to cumulative catch from the Sub-Antarctic in 2017–18 than for the Chatham Rise (Figure 48), and larger catches (which were oversampled) caught more fish over 100 cm (Figures 49 and 50). This indicates a potential bias which may oversample large fish. Further investigation will be carried out before the 2020 hoki assessment.

2.2.3 Comparison of size and age composition between the main fisheries

Length distributions from the main fisheries in 2017–18 are compared in Figure 51. The catch in all areas was mainly fish from 45–90 cm. The 2015 year-class (45–55 cm) was important in all areas at age 2+ on the Chatham Rise and Sub-Antarctic, and at age 3 in Cook Strait and on the WCSI. The 2014 year-class (56–70 cm) was also important in all areas at age 3+ on the Chatham Rise and Sub-Antarctic, and at age 4 in Cook Strait, WCSI and Puysegur. The 2016-year class appeared low in all the main

fishery areas. Large female hoki (over 100 cm) were proportionately more abundant in Cook Strait, WCSI, and the Sub-Antarctic, and rarely caught on the Chatham Rise. There were few male hoki over 90 cm.

3. HOKI RESEARCH

3.1 Resource surveys

3.1.1 Trawl surveys

Chatham Rise
No Chatham Rise trawl survey was carried out in January 2019. Results from the 2018 survey are described by Stevens et al. (2018).

WCSI
A fifth *Tangaroa* trawl survey of the WCSI was carried out from 24 July to 16 August 2018 (O'Driscoll & Ballara 2019), with previous surveys in 2000, 2012, 2013, and 2016. Hoki was not a target species for the 2018 survey, as the survey is not thought to adequately monitor the abundance of that species (O'Driscoll et al. 2015). A total of 57 successful random tows were completed in 11 strata north of Hokitika Canyon.

Although the random trawl survey is not thought to be a good index of hoki abundance, the biomass estimate from the core strata in 2018 was only a third of what it was in 2016, and less than 10% of that in 2012 (Table 10).

A high proportion of the hoki were 3-year old fish (2015 year-class) about 60 cm long, with other length modes at about 50 cm and 70–75 cm corresponding to ages 2 (2016 year-class) and 4 (2014 year-class) respectively (Figure 52). Most small hoki were in pre-spawning or spawning condition, but a few large spent female hoki were caught in deeper water (greater than 650 m).

Sub-Antarctic
The eighteenth *Tangaroa* trawl survey of the Sub-Antarctic summer series was conducted from 23 November to 22 December 2018, with previous surveys in 1991–1993, 2000–2009, 2011, 2012, 2014, and 2016. All 81 phase one trawl stations were carried out successfully. There was insufficient time to carry out any phase two stations.

The abundance index for hoki from core strata was 31 188 t (CV 11.1%), down 18% from the 2016 (scaled) estimate, and similar to the 2014 estimate. This was the lowest estimate in the series since 2006 (Table 11). Several modes were present in the hoki scaled length frequency, with the main mode at age 3+ (2015 year-class), especially for males (Figures 53 and 54).

3.1.2 Acoustic surveys

Cook Strait
No Cook Strait acoustic survey was carried out in winter 2018. Results from the 2017 survey are described by O'Driscoll & Escobar-Flores (2018).

WCSI
NIWA received Ministry of Business, Innovation and Employment (MBIE) funding to add four days to the 2018 WCSI trawl survey for testing of a new acoustic-optical system (AOS). An outcome of having additional time and staff onboard for this testing was to produce an acoustic abundance estimate of spawning hoki on the WCSI. Two acoustic snapshots were carried out between 26 July and 14 August

(O'Driscoll & Ballara 2019). This is the eleventh in a series of acoustic surveys of WCSI hoki spawning areas, with previous surveys in 1988–2013.

The two acoustic snapshots both covered the entire acoustic survey area, with 9 targeted tows to identify acoustic marks and collect biological samples. Acoustic estimates of hoki abundance were calculated using the same methods as for previous surveys in the time series, and gave a 2018 survey abundance index averaged over the two snapshots of 123 000 t. This was about half the comparable acoustic index from 2013 (233 000 t) and the lowest estimate in the time-series going back to 1988 (Table 12). The 2018 acoustic survey weighting (expressed as a coefficient of variation, CV), which includes uncertainty associated with survey timing, sampling precision, mark identification, calibration, and target strength, was 46%. Spawning hoki aggregations were detected in the inner Hokitika Canyon with weaker aggregations also observed on the slope south of Hokitika Canyon and in Cook Canyon. Only about 36% of the estimated hoki abundance was from hoki schools, where marks were assumed to contain 100% hoki. Remaining abundance came from mixed species 'fuzz' marks. Unlike in previous acoustic surveys, no hoki aggregations were detected in the northern area and only about 20% of the hoki from the WCSI in 2018 was from the area north of the Hokitika Canyon (O'Driscoll & Ballara 2019).

4. CONCLUSIONS

The total reported hoki catch in 2017–18 of 135 383 t was about 6200 t lower than the catch in 2016–17, and about 14 600 t lower than the TACC. Catches in 2017–18 decreased in WCSI, Chatham Rise and ECSI and increased in Cook Strait and Sub-Antarctic. Most of the decrease in total catch was driven by the decline in the midwater trawl spawning fishery on the WCSI in August. The WCSI was the largest hoki fishery for the eighth consecutive season, followed by the non-spawning fishery on the Chatham Rise.

Length and age frequency distributions from the commercial fishery show that most of the catch in 2017–18 was of fish 45–90 cm. The 2015 year-class (45–60 cm) was important in all areas at age 2+ on the Chatham Rise and Sub-Antarctic, and at age 3 in Cook Strait and on the WCSI. The 2014 year-class (56–70 cm) was also important in all areas at age 3+ on the Chatham Rise and Sub-Antarctic, and at age 4 in Cook Strait, WCSI and Puysegur. The 2016-year class appeared low in all the main fishery areas. Large female hoki (over 100 cm) were proportionately more abundant in Cook Strait, WCSI, and the Sub-Antarctic than on the Chatham Rise. There were few male hoki over 90 cm in all areas.

CPUE in the major fisheries have exhibited a mix of changes over the past few years: standardised indices have been relatively stable on the Chatham Rise for the last 10 years; increased by 29% over the last three years in Cook Strait; declined by 43% over the last three years on the WCSI; and declined by 27% since 2012 on the Sub-Antarctic. CPUE is not used in the stock assessment because it does not accurately index abundance over the long term.

Recent trends (by fishing year) in survey abundance indices have been mostly declining. The Sub-Antarctic trawl survey estimate in Nov-Dec 2018 was down 18% from 2016, was similar to that in 2014, and is now the lowest in the series since the four low points from 2003 to 2006. The acoustic survey biomass in Cook Strait in 2017 was half that in 2015 and the lowest since 2008 (O'Driscoll & Escobar-Flores 2018). The 2018 WCSI acoustic survey was down 47% on 2013 and is the lowest in the time series, going back to 1988. The Chatham Rise 2018 trawl survey biomass was the only recent survey to show a slight increase, up by 6% from 2016 (Stevens et al. 2018). This increase was largely driven by the biomass estimates for 1+ and 2+ hoki. The relative biomass of recruited hoki (ages 3+ years and older) on the Chatham Rise in 2018 declined by 26% from that in 2016.

5. ACKNOWLEDGMENTS

This work was funded by Ministry for Primary Industries Research Projects HOK2018-01, HOK2018-02, and MID2018-03. It also incorporated trawl survey results from Ministry for Primary Industries Research Projects MID2018-01 and MID2018-02. Thanks to the many scientific and industry staff who contributed to the collection and analysis of data used in this report. We especially thank Colin Sutton for otolith preparation, and Peter Horn and Debbie Hulston for their ageing work. We also thank Peter Horn for reviewing this report.

6. REFERENCES

Anderson, O.F.; Edwards, C.T.T.; Ballara (2019). Fish and invertebrate bycatch and discards in New Zealand hoki, hake, ling, silver warehou, and white warehou trawl fisheries from 1990–91 to 2016–17. *New Zealand Aquatic Environment and Biodiversity Report No. 220*. 117 p.

Annala, J.H. (comp.) (1990). Report from the Fishery Assessment Plenary, April–May 1990: stock assessments and yield estimates. 165 p. (Unpublished report held in NIWA library, Wellington.)

Ballara, S.L. (2019a). 2017-18 hoki fishery catches. Document DWWG-2019-04. Fisheries New Zealand Deepwater Working Group, NIWA, Wellington, 7 February, 2019.

Ballara, S.L. (2019b). Size and age structure of the 2017-18 hoki fishery. Document DWWG-2019-22. Fisheries New Zealand Deepwater Working Group, NIWA, Wellington, 21 February, 2019.

Ballara, S.L. (2019c). Re-calculation of Cook Strait catch at age 1990-1998. Word document DWWG-2019-52. Fisheries New Zealand Deepwater Working Group, NIWA, Wellington, 21 March, 2019.

Ballara, S.L.; O'Driscoll, R.L. (2014). Catches, size, and age structure of the 2011–12 hoki fishery, and a summary of input data used for the 2013 stock assessment. *New Zealand Fisheries Assessment Report 2014/05*. 117 p.

Ballara, S.L.; O'Driscoll, R.L. (2015). Catches, size, and age structure of the 2013–14 hoki fishery, and a summary of input data used for the 2015 stock assessment. *New Zealand Fisheries Assessment Report 2015/57*. 122 p.

Ballara, S.L.; O'Driscoll, R.L. (2016). Catches, size, and age structure of the 2014–15 hoki fishery, and a summary of input data used for the 2016 stock assessment. *New Zealand Fisheries Assessment Report 2016/40*. 122 p.

Ballara, S.L.; O'Driscoll, R.L. (2017). Catches, size, and age structure of the 2015–16 hoki fishery, and a summary of input data used for the 2017 stock assessment. *New Zealand Fisheries Assessment Report 2017/31*. 119 p.

Ballara, S.L.; O'Driscoll, R.L. (2018). Catches, size, and age structure of the 2016–17 hoki fishery, and a summary of input data used for the 2018 stock assessment. *New Zealand Fisheries Assessment Report 2018/38*. 125 p.

Ballara, S.L.; O'Driscoll, R.L.; Phillips, N.L.; Livingston, M.E.; Smith, M.H.; Kim, S.W. (2003). Catches, size, and age structure of the 2001–02 hoki fishery, and a summary of input data used for the 2003 stock assessment. *New Zealand Fisheries Assessment Report 2003/42*. 77 p.

Bentley, N.; Kendrick, T.H.; Starr, P.J.; Breen, P.A. (2012). Influence plots and metrics: tools for better understanding fisheries catch-per-unit-effort standardizations. *ICES Journal of Marine Science* 69(1): 84–88.

Bradford-Grieve, J.M.; Livingston, M.E. (Eds.) (2011) Spawning fisheries and the productivity of the marine environment off the west coast of the South Island, New Zealand. *New Zealand Aquatic Environment and Biodiversity Report No. 84.* 136 p.

Breiman, L.; Friedman, J.H.; Olshen, R.A.; Stone, C.J. (1984). Classification and regression trees. Wadsworth, Belmont, California. 358 p.

Bull, B.; Dunn, A. (2002). Catch-at-age user manual v1.06.2002/09/12. NIWA Internal Report 114. 23 p. (Unpublished report held in NIWA library, Wellington.)

Bull, B.; Francis, R.I.C.C.; Dunn, A.; McKenzie, A.; Gilbert, D.J.; Smith, M.H.; Bian, R. (2012). CASAL (C++ algorithmic stock assessment laboratory): CASAL User Manual v2.30-2012/03/21. *NIWA Technical Report 135*. 280 p.

Butterworth, D.; Hilary, R.; Ianelli, J. (2014). Report on the review of the New Zealand hoki stock assessment model. *New Zealand Fisheries Science Review 2017/1*. 17 p.

Castillo-Jordán, C.; Wayte, S.E.; Tuck, G.N.; Tracey, S.; Frusher, S.D.; Punt, A.E. (2019). Implications

of a climate-induced recruitment shift in the stock assessment of Patagonian grenadier (*Macruronus magellanicus*) in Chile. *Fisheries Research 212*: 114–122.

Chambers, J.M.; Hastie, T.J. (1991). Statistical models in S. Wadsworth & Brooks-Cole, Pacific Grove, CA. 608 p.

Cordue, P.L.; Ballara, S.L.; Horn P.L. (2000). Hoki ageing: recommendation of which data to routinely record for hoki otoliths. Final Research Report for Ministry of Fisheries Research Project MOF1999/01. (Unpublished report held by Fisheries New Zealand, Wellington.)

Dunn, A. (2002). Updated catch-per-unit-effort indices for hoki (*Macruronus novaezelandiae*) on the west coast South Island, Cook Strait, Chatham Rise, and sub-Antarctic for the years 1990 to 2001. *New Zealand Fisheries Assessment Report 2002/47*. 51 p.

Dunn, M.; Hurst, R.; Renwick, J.; Francis, R.I.C.C; Devine, J.; McKenzie, A. (2009) Fish abundance and climate trends in New Zealand. *New Zealand Aquatic Environment and Biodiversity Report 31*.

Dunn, M.R.; Langley, A. (2018). A review of the hoki stock assessment for 2018. *New Zealand Fisheries Assessment Report 2018/42*. 55 p.

Francis, R.I.C.C. (1999). The impact of correlations in standardised CPUE indices. New Zealand Fisheries Assessment Research Document 99/42. 30 p. (Unpublished report held in NIWA library, Wellington.)

Francis, R.I.C.C. (2001a). Improving the consistency of hoki age estimation. *New Zealand Fisheries Assessment Report 2001/12*. 18 p.

Francis, R.I.C.C. (2001b). Orange roughy CPUE on the South and East Chatham Rise. *New Zealand Fisheries Assessment Report 2001/26.* 30 p.

Francis, R.I.C.C. (2002). Estimating catch at age in the Chatham Rise hoki fishery. *New Zealand Fisheries Assessment Report 2002/9*. 22 p.

Francis, R.I.C.C. (2003). Analyses supporting the 2002 stock assessment of hoki. *New Zealand Fisheries Assessment Report 2003/5*. 34 p.

Francis, R.I.C.C. (2007). Assessment of hoki (*Macruronus novaezelandiae*) in 2006. *New Zealand Fisheries Assessment Report 2007/15*. 99 p.

Francis, R.I.C.C. (2008). Assessment of hoki (*Macruronus novaezelandiae*) in 2007. *New Zealand Fisheries Assessment Report 2008/4.* 109 p.

Francis R.IC.C. (2009). Assessment of hoki (*Macruronus novaezelandiae*) in 2008. *New Zealand Fisheries Assessment Report 2009/7*. 80 p.

Francis, R.I.C.C.; Haist, V.; Bull, B. (2003). Assessment of hoki (*Macruronus novaezelandiae*) in 2002 using a new model. *New Zealand Fisheries Assessment Report 2003/6.* 69 p.

Francis, R.I.C.C.; Neil, H.L.; Horn, P.L.; Gillanders, B.; Marriott, P.; Vorster, J. (2011). A pilot study to evaluate the utility of otolith microchemistry for determining natal fidelity in New Zealand hoki. Final Research Report for Ministry of Fisheries Research Project HOK2006/05 Objective 1. 24 p. (Unpublished report held by Fisheries New Zealand, Wellington.)

Hicks, A.C.; Cordue, P.L.; Bull, B. (2002). Estimating proportion at age and sex in the commercial catch of hoki (*Macruronus novaezelandiae*) using length frequency data. *New Zealand Fisheries Assessment Report 2002/43*. 51 p.

Hicks, A.C.; Gilbert, D.J. (2002). Stock discrimination of hoki (*Macruronus novaezelandiae*) based on otolith ring measurements. *New Zealand Fisheries Assessment Report 2002/2*. 31 p.

Hicks, A.C.; Smith, P.J.; Horn, P.L.; Gilbert, D.J. (2003). Differences in otolith measurements and gill raker counts between the two major spawning stocks of hoki (*Macruronus novaezelandiae*) in New Zealand. *New Zealand Fisheries Assessment Report 2003/7.* 23 p.

Horn, P.L. (2011). Natal fidelity: a literature review in relation to the management of the New Zealand hoki (*Macruronus novaezelandiae*) stocks. *New Zealand Fisheries Assessment Report 2011/34*. 18 p.

Horn, P.L.; Sullivan, K.J. (1996). Validated ageing methodology using otoliths, and growth parameters for hoki (*Macruronus novaezelandiae*) in New Zealand waters. *New Zealand Journal of Marine and Freshwater Research 30*: 161–174.

Horn, P.L.; Sutton, C.P. (2017). Age determination protocol for hoki (*Macruronus novaezelandiae*). *New Zealand Fisheries Assessment Report 2017/13*. 22 p.

Kalish, J.M.; Livingston, M.E.; Schofield, K.A. (1996). Trace elements in the otoliths of New Zealand blue grenadier (*Macruronus novaezelandiae*) as an aid to stock discrimination. *Marine and*

Freshwater Research 47: 537–542.
Livingston, M.E. (1990). Stock structure of New Zealand hoki (*Macruronus novaezelandiae*) New Zealand Fisheries Assessment Research Document 90/8. 21 p. (Unpublished report held in NIWA library, Wellington.)
Livingston, M.E. (1997). The stock structure of hoki: hypotheses and assumptions revised. (Unpublished report presented to the Hoki Working Group 1997, held by Fisheries New Zealand, Wellington.)
Livingston. M.E.; Clark, M.R.; Baird, S-J. (2002). Trends in bycatch of major fisheries in depths over 200 m on the Chatham Rise, for fishing years 1989/90 to 1998/99. Final Research Report for Ministry of Fisheries Research Project ENV1999/05. (Unpublished report held by Fisheries New Zealand, Wellington.)
Livingston, M.E.; Schofield, K.A. (1996). Stock discrimination of hoki (*Macruronus novaezelandiae*, Merluccidae) in New Zealand waters using morphometrics. *New Zealand Journal of Marine and Freshwater Research 30*: 197–208.
Marsh, C.; McKenzie, A.; Francis, R.I.C.C.; Doonan, I. (2018). Evaluating the effects of changes in the frequency of research abundance trawl surveys and age frequency sampling on the hoki, hake, and ling stock assessments. *New Zealand Fisheries Assessment Report 2018/43.* 60 p.
McKenzie, A. (2013). Assessment of hoki (*Macruronus novaezelandiae*) in 2012. *New Zealand Fisheries Assessment Report 2013/27*. 65 p.
McKenzie, A. (2015a). Assessment of hoki (*Macruronus novaezelandiae*) in 2013. *New Zealand Fisheries Assessment Report 2015/08*. 73 p.
McKenzie, A. (2015b). Assessment of hoki (*Macruronus novaezelandiae*) in 2014. *New Zealand Fisheries Assessment Report 2015/09*. 68 p.
McKenzie, A. (2016). Assessment of hoki (*Macruronus novaezelandiae*) in 2015. *New Zealand Fisheries Assessment Report 2016/01*. 88 p.
McKenzie, A. (2017). Assessment of hoki (*Macruronus novaezelandiae*) in 2016. *New Zealand Fisheries Assessment Report 2017/11*. 80 p.
McKenzie, A. (2018). Assessment of hoki (*Macruronus novaezelandiae*) in 2017. *New Zealand Fisheries Assessment Report 2018/40.* 101 p.
McKenzie, A. (2019). Assessment of hoki (*Macruronus novaezelandiae*) in 2018. *New Zealand Fisheries Assessment Report 2019/nn.* xx p.
O'Driscoll, R.L.; Ballara, S.L. (2019). Trawl and acoustic survey of hoki and middle depth fish abundance on the west coast South Island, July–August 2018 (TAN1807). *New Zealand Fisheries Assessment Report 2019/19*. 120 p.
O'Driscoll, R.L.; Ballara, S.L.; Bagley, N.W. (2015). Review of performance of west coast South Island trawl/acoustic survey of deepwater stocks. Final Research Report for Ministry for Primary Industries Research Project SEA2014/10. 86 p. (Unpublished report held by Fisheries New Zealand.)
O'Driscoll, R.L.; Escobar-Flores, P. (2018). Acoustic survey of spawning hoki in Cook Strait during winter 2017. *New Zealand Fisheries Assessment Report 2018/12.* 39 p.
R Development Core Team (2018). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna. http://www.R-project.org.
Roberts, J. (2019). Exploration of hoki life history to inform migration/ maturation in the stock assessment model. Deepwater Fisheries Assessment Working Group document 2019_32, 7 March 2019. (Unpublished report held by Fisheries New Zealand, Wellington.)
Smith, M.H. (2005). Direct estimation of year class frequencies for the non-spawning hoki fisheries with estimates of the coefficients of variation. *New Zealand Fisheries Assessment Report 2005/14*. 26 p.
Smith, P.J.; Bull, B.; McVeagh, S.M. (2001). Evaluation of meristics characters for determining hoki stock relationships. Final Research Report for Ministry of Fisheries Research Project HOK1999/05 Objective 1. (Unpublished report held by Fisheries New Zealand, Wellington.)
Smith, P.J.; McVeagh, S.M.; Ede, A. (1996). Genetically isolated stocks of orange roughy *(Hoplostethus atlanticus*), but not of hoki (*Macruronus novaezelandiae*), in the Tasman Sea and southwest Pacific Ocean around New Zealand. *Marine Biology 125*: 783–793.
Smith, P.J.; Patchell, G.; Benson, P.G. (1981). Genetic tags in the New Zealand hoki *Macruronus novaezelandiae*. *Animal Blood Groups and Biochemical Genetics 12*: 37–45.

Stevens, D.W.; O'Driscoll, R.L.; Ballara, S.L.; Schimel, A.C.G. (2018). Trawl survey of hoki and middle depth species on the Chatham Rise, January 2018 (TAN1801). *New Zealand Fisheries Assessment Report 2018/41*. 111 p.

Sutton, P.J.H.; Bowen, M. (2019). Ocean temperature change around New Zealand over the last 36 years. *New Zealand Journal of Marine & Freshwater Research*, DOI: 10.1080/0028830.2018.1562945

TABLES

Table 1: Reported trawl catches (t) from 1969 to 1987–88; 1969–83 by calendar year, 1983–84 to 1987–88 by fishing year (1 October to 30 September). Source, FSU data.

				New Zealand		
Year	U.S.S.R.	Japan	South Korea	Domestic	Chartered	Total
1969		95				95
1970		414				414
1971		411				411
1972	7 300	1 636				8 936
1973	3 900	4 758				8 658
1974	13 700	2 160		125		15 985
1975	36 300	4 748		62		41 110
1976	41 800	24 830		142		66 772
1977	33 500	54 168	9 865	217		97 750
1978*	2 028 +	1 296	4 580	678		8 581
1979	4 007	8 550	1 178	2 395	7 970	24 100
1980	2 516	6 554		2 658	16 042	27 770
1981	2 718	9 141	2	5 284	15 657	32 802
1982	2 251	7 591		6 982	15 192	32 018
1983	3 853	7 748	137	7 706	20 697	40 141
1983–84	4 520	7 897	93	9 229	28 668	50 407
1984–85	1 547	6 807	35	7 213	28 068	43 670
1985–86	4 056	6 413	499	8 280	80 375	99 623
1986–87	1 845	4 107	6	8 091	153 222	167 271
1987–88	2 412	4 159	10	7 078	216 680	230 339

* Catches for foreign licensed and New Zealand chartered vessels from 1978 to 1984 were based on estimated catches from vessel logbooks. Few data were available for the first 3 months of 1978 because these vessels did not begin completing these logbooks until 1 April 1978.

\+ Soviet hoki catches were taken from the estimated catch records and differ from official Fisheries New Zealand statistics. Estimated catches were used because of the large amount of hoki converted to meal and not recorded as processed fish.

Table 2: Reported catch (t) from QMS[1], estimated catch (t) from Monthly Harvest Return (MHR) data, and TACC (t) for HOK 1 from 1986–87 to 2017–18. Estimated catches included TCEPR and CELR data (from 1989–90), LCER data (from 2003–04), NCELR data (from 2006–07), TCER and LTCER data (from 2007–08), and 'ERS-trawl' (from 2017–18).

Year	Reported catch	Estimated catch (MHR)		TACC
		Exclude HOK ET	Include HOK ET	
1986–87	158 171		175 000	250 000
1987–88	216 206		255 000	250 000
1988–89	208 500		210 000	250 000
1989–90	210 000		210 000	251 884
1990–91	215 000		210 000	201 897
1991–92	215 000		215 000	201 897
1992–93	195 000		215 000	202 155
1993–94	191 000		195 000	202 155
1994–95	174 000		190 000	220 350
1995–96	210 000		168 000	240 000
1996–97	246 000		194 000	250 000
1997–98	269 000		230 000	250 000
1998–99	244 500		234 000	250 000
1999–00	242 000		237 000	250 000
2000–01	230 625	229 858	229 862	250 000
2001–02	200 054	195 492	195 506	200 000
2002–03	182 560	184 659	184 668	200 000
2003–04	133 764	135 784	135 787	180 000
2004–05	102 885	104 364	106 189	100 000
2005-06	101 984	104 385	105 965	100 000
2006–07	97 790	101 009	102 861	100 000
2007–08	87 815	89 318	91 045	90 000
2008–09	87 598	88 805	89 475	90 000
2009–10	105 105	107 209	107 209	110 000
2010–11	115 782	118 805	118 805	120 000
2011–12	126 184	130 108	130 108	130 000
2012–13	127 962	131575	132 618	130 000
2013–14	143 705	146 344	146 344	150 000
2014–15	156 471	161 528	161 528	160 000
2015–16	136 087	136 719	136 722	150 000
2016–17	138 553	141 567	141 571	150 000
2017–18	131 477	135 383	135 384	150 000

1. Discrepancies between QMS data and estimated catches from 1986 to 1990 arose from incorrect surimi conversion factors. The estimated catch in those years was corrected from conversion factors measured each year by Ministry observers on the WCSI fishery. Since 1990 the current conversion factor of 5.8 was used, and the total catch reported to the QMS is considered to be more representative of the true level of catch. From 2000–01 MHR catches were shown including and excluding HOK ET catches (catches outside the EEZ).

Table 3: Estimated total catch (t) of hoki by area[1], 1988–89 to 2017–18. Estimated (TCEPR, CELR) catches were scaled to reported (QMR or MHR) catch totals (excluding HOK ET catches). Data also includes LCER (from 2003–04), and NCELR estimated data (from 2006–07), TCER and LTCER data (from 2007–08), and "ERS – Trawl" data (from 2017–18). Estimated catches by area from TCEPR, CELR, LCER, NCELR, and TCER adjusted pro rata to the total reported (QMR or MHR) catches (excluding HOK ET catches) in Table 2. Area undefined (other) because of missing positions or statistical areas. - No catches

Fishing	Spawning fisheries				Non-spawning fisheries					Total
year	WCSI	PUYS	CSTR	ECSI	SUBA	CHAT	ECNI	WCNI	Other	catch
1988–89	188 000	3 500	7 000	-	5 000	5 000	-	-	-	208 500
1989–90	165 000	8 000	14 000	-	10 000	13 000	-	-	-	210 000
1990–91	154 000	4 000	26 500	1 000	18 000	11 500	-	-	-	215 000
1991–92	105 000	5 000	25 000	500	34 000	45 500	-	-	-	215 000
1992–93	98 000	2 000	21 000	-	26 000	43 000	2 000	-	3 000	195 000
1993–94	113 000	2 000	37 000	-	12 000	24 000	2 000	-	1 000	191 000
1994–95	80 000	1 000	40 000	-	13 000	39 000	1 000	-	-	174 000
1995–96	73 000	3 000	67 000	1 000	12 000	49 000	3 000	-	2 000	210 000
1996–97	91 000	5 000	61 000	1 500	25 000	56 500	5 000	-	1 000	246 000
1997–98	107 000	2 000	53 000	1 000	24 000	75 000	4 000	-	3 000	269 000
1998–99	94 546	2 874	45 252	1 977	23 778	73 589	2 315	62	134	244 527
1999–00	102 721	2 880	43 192	2 351	33 772	56 014	1 387	98	4	242 419
2000–01	102 235	6 798	36 298	2 411	30 076	49 847	2 035	147	-	229 847
2001–02	92 719	5 322	23 976	2 971	30 175	39 151	1 147	39	-	195 500
2002–03	73 856	5 948	36 713	7 382	20 199	39 091	929	532	8	184 658
2003–04	45 112	1 158	41 034	2 140	11 635	33 650	880	126	-	135 735
2004–05	33 111	5 548	24 833	3 244	6 244	30 673	522	37	-	104 212
2005–06	38 989	1 437	21 803	665	6 732	34 058	686	8	-	104 378
2006–07	33 328	408	20 113	1 006	7 661	37 813	667	8	-	101 004
2007–08	20 931	308	18 470	2 323	8 708	37 920	640	17	-	89 317
2008–09	20 548	233	17 535	1 054	9 807	39 011	588	25	-	88 801
2009–10	36 349	272	17 880	669	12 275	39 138	618	7	0	107 208
2010–11	48 373	1 176	14 937	1 625	12 655	38 447	1 588	2	-	118 803
2011–12	54 532	1 308	15 859	2 531	15 743	39 246	858	31	-	130 108
2012–13	56 218	955	19 396	3 311	14 098	36 536	1 051	9	-	131 574
2013–14	69 400	778	18 400	2 750	19 927	33 752	1 326	9	-	146 342
2014–15	78 700	1 875	20 100	3 624	16 378	40 071	766	11	5	161 530
2015–16	68 869	1 056	18 378	4 126	6 639	36 714	888	20	-	136 690
2016–17	65 953	1 209	16 084	4 405	13 157	39 919	826	6	-	141 559
2017–18	55 437	1 133	21 474	3 570	15 434	37 182	1 140	10	-	135 380

Table 4: Observer coverage in 2017–18 by area, for combined trawl methods. WCSI, Cook Strait and ECSI are for June to September only.

(a) All target species tows

	Number of vessels			Number of tows			Catch (t)		
Area	**All**	**Observed**	**Percent**	**All**	**Observed**	**Percent**	**All**	**Observed**	**Percent**
Chatham Rise	54	22	40.7	6 136	346	5.6	37 091	3 143	8.5
Cook Strait	22	7	31.8	1 243	81	6.5	18 033	1 050	5.8
ECNI	45	6	13.3	2 250	32	1.4	1 135	30	2.7
ECSI	21	6	28.6	217	38	17.5	3 646	1 080	29.6
Puysegur	15	8	53.3	159	40	25.2	1 133	355	31.3
Sub–Antarctic	36	23	63.9	3 672	669	18.2	15 434	5 075	32.9
WCNI	13	1	7.7	103	1	1.0	10	-	-
WCSI	42	28	66.7	5 400	891	16.5	54 694	12 965	23.7
All areas combined	96	48	50.0	19 180	2 097	10.9	131 175	23 698	18.1

(b) Target hoki tows

	Number of vessels			Number of tows			Catch (t)		
Area	**All**	**Observed**	**Percent**	**All**	**Observed**	**Percent**	**All**	**Observed**	**Percent**
Chatham Rise	24	14	58.3	4 159	269	6.5	35 313	2 715	7.7
Cook Strait	18	7	38.9	1 198	81	6.8	18 026	1 050	5.8
ECNI	15	4	26.7	433	19	4.4	755	16	2.1
ECSI	16	6	37.5	181	38	21.0	3 643	1 080	29.7
Puysegur	7	5	71.4	98	18	18.4	884	198	22.4
Sub–Antarctic	21	17	81.0	1 830	436	23.8	13 584	4 459	32.8
WCNI	3	1	33.3	3	1	33.3	6	-	-
WCSI	34	28	82.4	5 088	874	17.2	54 334	12 874	23.7
All areas combined	62	43	69.4	12 990	1 735	13.4	126 546	22 393	17.7

Table 5: Bycatch rates (in parentheses) on vessels with Observer Programme observers in the hoki fishery for tows that targeted hoki from 1990–91 to 2017–18. The WCSI (bottom and midwater trawls), Cook Strait, and ECSI data covered the spawning season (June–September) only. -, less than 0.1 t (except for Cook Strait 1994–95 and 1996–97, Puysegur 1997–98 to 2008–09, and ECSI 2006–07, for which there were no observer data). Bycatch rates were not calculated where observed hoki catch was less than 100 t. Species chosen were the top eight by observed catch in an area. Species include: BAR, barracouta; CSQ, leafscale gulper shark; FRO, frostfish; GSP, pale ghost shark; HAK, hake; HOK, hoki; JAV, javelinfish; JMA, jack mackerels; LIN, ling; RAT, rattails; RCO, red cod; SND, shovelnose dogfish; SPD, spiny dogfish; SPO, rig; SQU, arrow squid; SWA, silver warehou; and WWA, white warehou.

(a) WCSI (bottom trawl)

Catch in t (% of hoki catch)

Year	HOK	HAK	JAV	LIN	RAT	SPD	SQU	SWA	Other
1990–91	1 046	25 (2.4)	1 (0.1)	56 (5.3)	2 (0.2)	1 (0.1)	8 (0.8)	67 (6.4)	48 (4.6)
1991–92	516	7 (1.4)	1 (0.2)	44 (8.5)	2 (0.4)	1 (0.2)	5 (1)	9 (1.7)	56 (10.8)
1992–93	3 375	82 (2.4)	1 (0)	79 (2.3)	6 (0.2)	7 (0.2)	30 (0.9)	78 (2.3)	57 (1.7)
1993–94	1 503	52 (3.5)	4 (0.3)	56 (3.7)	4 (0.3)	2 (0.1)	28 (1.9)	23 (1.5)	73 (4.9)
1994–95	179	24 (13.4)	1 (0.6)	30 (16.8)	3 (1.7)	- (-)	7 (3.9)	9 (5)	33 (18.4)
1995–96	360	48 (13.3)	- (-)	31 (8.6)	2 (0.6)	1 (0.3)	43 (11.9)	26 (7.2)	28 (7.8)
1996–97	1	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)
1997–98	673	69 (10.2)	3 (0.4)	45 (6.7)	5 (0.7)	- (-)	15 (2.2)	19 (2.8)	31 (4.6)
1998–99	2 660	244 (9.2)	19 (0.7)	159 (6)	24 (0.9)	- (-)	67 (2.5)	85 (3.2)	111 (4.2)
1999–00	3 033	438 (14.4)	17 (0.6)	122 (4)	26 (0.9)	1 (0)	35 (1.1)	84 (2.8)	179 (5.9)
2000–01	1 462	54 (3.7)	4 (0.3)	66 (4.5)	6 (0.4)	1 (0.1)	13 (0.9)	57 (3.9)	42 (2.9)
2001–02	7 493	592 (7.9)	33 (0.4)	306 (4.1)	51 (0.7)	8 (0.1)	80 (1.1)	60 (0.8)	307 (4.1)
2002–03	2 609	213 (8.2)	17 (0.6)	139 (5.3)	19 (0.7)	16 (0.6)	28 (1.1)	49 (1.9)	147 (5.6)
2003–04	2 034	335 (16.5)	32 (1.6)	270 (13.3)	20 (1)	60 (3)	28 (1.4)	182 (8.9)	268 (13.2)
2004–05	1 507	74 (4.9)	5 (0.3)	126 (8.4)	5 (0.3)	42 (2.8)	23 (1.5)	74 (4.9)	86 (5.7)
2005–06	2 242	102 (4.5)	26 (1.2)	141 (6.3)	17 (0.8)	27 (1.2)	50 (2.2)	70 (3.1)	135 (6)
2006–07	1 375	71 (5.2)	12 (0.9)	38 (2.8)	11 (0.8)	2 (0.2)	7 (0.5)	42 (3)	71 (5.2)
2007–08	1 297	23 (1.8)	8 (0.6)	43 (3.3)	6 (0.5)	1 (0.1)	28 (2.2)	36 (2.8)	36 (2.8)
2008–09	61	31 (50.8)	2 (3.3)	4 (6.6)	- (-)	1 (1.6)	4 (6.6)	1 (1.6)	9 (14.8)
2009–10	3 888	67 (1.7)	14 (0.4)	132 (3.4)	9 (0.2)	3 (0.1)	73 (1.9)	41 (1.1)	63 (1.6)
2010–11	2 961	194 (6.5)	18 (0.6)	154 (5.2)	21 (0.7)	20 (0.7)	49 (1.6)	75 (2.5)	112 (3.8)
2011–12	5 284	169 (3.2)	21 (0.4)	217 (4.1)	16 (0.3)	3 (0.1)	136 (2.6)	61 (1.1)	95 (1.8)
2012–13	6 874	865 (12.6)	98 (1.4)	449 (6.5)	82 (1.2)	9 (0.1)	158 (2.3)	102 (1.5)	399 (5.8)
2013–14	4 996	554 (11.1)	67 (1.3)	278 (5.6)	50 (1.0)	33 (0.7)	55 (1.1)	96 (1.9)	324 (6.5)
2014–15	4 761	389 (8.2)	72 (1.5)	281 (5.9)	65 (1.4)	27 (0.6)	48 (1)	58 (1.2)	281 (5.9)
2015–16	6 751	184 (2.7)	58 (0.9)	266 (3.9)	64 (1)	23 (0.3)	56 (0.8)	198 (2.9)	257 (3.8)
2016–17	8 340	760 (9.1)	51 (0.6)	376 (4.5)	85 (1)	67 (0.8)	80 (1)	60 (0.7)	384 (4.6)
2017–18	9 159	812 (8.9)	133 (1.4)	395 (4.3)	115 (1.3)	87 (1)	84 (0.9)	66 (0.7)	563 (6.2)

Table 5: continued.

(b) WCSI (midwater trawls)

Catch in t (% of hoki catch)

Year	HOK	BAR	FRO	HAK	JMA	LIN	SPD	SWA	Other
1990–91	27 606	36 (0.1)	285 (1)	1 548 (5.6)	197 (0.7)	187 (0.7)	35 (0.1)	397 (1.4)	397(0.6)
1991–92	18 157	57 (0.3)	174 (1)	145 (0.8)	83 (0.5)	97 (0.5)	94 (0.5)	147 (0.8)	147(0.8)
1992–93	15 720	67 (0.4)	82 (0.5)	289 (1.8)	16 (0.1)	104 (0.7)	27 (0.2)	61 (0.4)	61(0.4)
1993–94	31 065	29 (0.1)	253 (0.8)	166 (0.5)	128 (0.4)	111 (0.4)	187 (0.6)	591 (1.9)	591(0.8)
1994–95	25 541	30 (0.1)	188 (0.7)	817 (3.2)	261 (1)	191 (0.8)	186 (0.7)	152 (0.6)	152(0.7)
1995–96	17 346	85 (0.5)	111 (0.6)	1 361 (7.8)	157 (0.9)	247 (1.4)	272 (1.6)	446 (2.6)	446(1.8)
1996–97	14 270	10 (0.1)	192 (1.4)	647 (4.5)	89 (0.6)	131 (0.9)	59 (0.4)	422 (3)	422(0.6)
1997–98	17 981	15 (0.1)	84 (0.5)	1 008 (5.6)	20 (0.1)	281 (1.6)	230 (1.3)	427 (2.4)	427(1.4)
1998–99	14 768	12 (0.1)	203 (1.4)	781 (5.3)	21 (0.1)	130 (0.9)	151 (1)	136 (0.9)	136(0.9)
1999–00	15 729	2 (0)	155 (1)	643 (4.1)	6 (0)	169 (1.1)	76 (0.5)	299 (1.9)	299 (1)
2000–01	14 971	90 (0.6)	270 (1.8)	460 (3.1)	3 (0)	196 (1.3)	69 (0.5)	238 (1.6)	238(1.1)
2001–02	9 175	38 (0.4)	215 (2.3)	868 (9.5)	1 (0)	206 (2.2)	39 (0.4)	65 (0.7)	65(2.8)
2002–03	7 582	73 (1)	166 (2.2)	315 (4.2)	2 (0)	52 (0.7)	13 (0.2)	47 (0.6)	47(1.1)
2003–04	6 396	63 (1)	213 (3.3)	482 (7.5)	63 (1)	237 (3.7)	22 (0.3)	87 (1.4)	87(2.9)
2004–05	5 671	221 (3.9)	262 (4.6)	271 (4.8)	8 (0.1)	155 (2.7)	15 (0.3)	25 (0.4)	25(3.2)
2005–06	7 283	35 (0.5)	152 (2.1)	302 (4.2)	3 (0)	91 (1.2)	12 (0.2)	26 (0.4)	26(0.9)
2006–07	8 445	26 (0.3)	176 (2.1)	41 (0.5)	1 (0)	41 (0.5)	23 (0.3)	39 (0.5)	39(0.8)
2007–08	6 478	6 (0.1)	158 (2.4)	24 (0.4)	1 (0)	29 (0.4)	20 (0.3)	17 (0.3)	17(1.2)
2008–09	8 733	3 (0)	106 (1.2)	37 (0.4)	24 (0.3)	64 (0.7)	21 (0.2)	58 (0.7)	58(1.8)
2009–10	7 731	- (-)	17 (0.2)	18 (0.2)	- (-)	30 (0.4)	6 (0.1)	24 (0.3)	24(0.6)
2010–11	6 595	25 (0.4)	15 (0.2)	37 (0.6)	- (-)	35 (0.5)	13 (0.2)	23 (0.4)	23(0.7)
2011–12	13 150	2 (0)	43 (0.3)	132 (1.0)	1 (0)	117 (0.9)	108 (0.8)	29 (0.2)	29(0.6)
2012–13	24 970	3 (0)	162 (0.6)	647 (2.6)	18 (0.1)	372 (1.5)	91 (0.4)	44 (0.2)	44(0.9)
2013–14	26 989	7 (0)	295 (1.1)	476 (1.8)	1 (-)	331 (1.2)	89 (0.3)	50 (0.2)	50 (1)
2014–15	33 042	164 (0.5)	312 (0.9)	435 (1.3)	62 (0.2)	388 (1.2)	98 (0.3)	75 (0.2)	75(0.9)
2015–16	21 974	10 (0)	292 (1.3)	486 (2.2)	20 (0.1)	435 (2)	58 (0.3)	51 (0.2)	51(1.1)
2016–17	13 230	95 (0.7)	94 (0.7)	224 (1.7)	4 (0)	211 (1.6)	51 (0.4)	15 (0.1)	15(1.2)
2017–18	15 756	221 (1.4)	338 (2.1)	751 (4.8)	130 (0.8)	442 (2.8)	96 (0.6)	9 (0.1)	9(2.4)

(c) Cook Strait (midwater trawls)

Catch in t (% of hoki catch)

Year	HOK	CSQ	LIN	RAT	RCO	SPD	SPO	SWA	Other
1992–93	107	- (-)	- (-)	- (-)	- (-)	- (-)	1 (0.9)	- (-)	- (-)
1993–94	495	- (-)	6 (1.2)	- (-)	- (-)	- (-)	1 (0.2)	- (-)	-(0.2)
1995–96	734	- (-)	2 (0.3)	- (-)	- (-)	- (-)	13 (1.8)	- (-)	- (-)
1997–98	3 435	- (-)	7 (0.2)	- (-)	- (-)	- (-)	55 (1.6)	- (-)	-(0.4)
1998–99	3 513	- (-)	16 (0.5)	- (-)	- (-)	2 (0.1)	76 (2.2)	- (-)	-(0.1)
1999–00	3 017	- (-)	9 (0.3)	- (-)	- (-)	- (-)	103 (3.4)	- (-)	-(0.1)
2000–01	4 089	- (-)	15 (0.4)	- (-)	- (-)	1 (0)	84 (2)	1 (0)	1(0.2)
2001–02	1 991	- (-)	6 (0.3)	- (-)	- (-)	- (-)	44 (2.2)	- (-)	-(0.1)
2002–03	2 416	- (-)	5 (0.2)	- (-)	- (-)	- (-)	104 (4.3)	- (-)	-(0.1)
2003–04	2 482	- (-)	4 (0.2)	- (-)	- (-)	- (-)	39 (1.6)	- (-)	-(0.2)
2004–05	2 176	- (-)	4 (0.2)	- (-)	- (-)	1 (0)	38 (1.8)	2 (0.1)	2(0.3)
2005–06	1 080	- (-)	2 (0.2)	- (-)	- (-)	- (-)	15 (1.4)	- (-)	-(0.2)
2006–07	2 102	- (-)	10 (0.5)	- (-)	2 (0.1)	- (-)	84 (4.0)	2 (0.1)	2(0.2)
2007–08	3 437	3 (0.1)	8 (0.2)	2 (0.1)	1 (0)	- (-)	63 (1.8)	1 (0)	1(0.1)
2008–09	2 290	- (-)	3 (0.1)	1 (0)	- (-)	- (-)	27 (1.2)	- (-)	-(0.1)
2009–10	3 353	- (-)	4 (0.1)	3 (0.1)	- (-)	- (-)	27 (0.8)	- (-)	-(0.2)
2010–11	1 590	1 (0.1)	- (-)	- (-)	- (-)	- (-)	13 (0.8)	2 (0.1)	2(0.1)
2011–12	1 551	1 (0.1)	4 (0.3)	3 (0.2)	1 (0.1)	- (-)	27 (1.7)	7 (0.4)	7(0.3)
2012–13	956	- (-)	3 (0.3)	- (-)	- (-)	- (-)	6 (0.6)	- (-)	-(0.1)
2013–14	2 537	6 (0.2)	7 (0.3)	3 (0.1)	1 (0)	1 (0)	24 (1)	6 (0.2)	6(0.5)
2014–15	320	- (-)	1 (0.3)	- (-)	- (-)	- (-)	2 (0.6)	- (-)	- (-)
2015–16	2 139	- (-)	9 (0.4)	1 (0)	- (-)	- (-)	9 (0.4)	- (-)	-(0.1)
2016–17	2 054	- (-)	3 (0.2)	- (-)	- (-)	- (-)	9 (0.4)	- (-)	- (0)
2017–18	2 291	1 (0)	13 (0.6)	1 (0)	- (-)	- (-)	14 (0.6)	- (-)	-(0.2)

Table 5: continued.

(d) ECSI, June–September.

		Catch in t (% of hoki catch)							
Year	**HOK**	**HAK**	**JAV**	**LIN**	**RAT**	**SPD**	**SWA**	**WWA**	**Other**
2000–01	5	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)
2001–02	97	- (-)	- (-)	1 (1)	1 (1)	- (-)	- (-)	- (-)	- (1)
2002–03	914	22 (2.4)	6 (0.7)	8 (0.9)	18 (2)	5 (0.6)	20 (2.2)	2 (0.2)	2 (2.7)
2003–04	939	2 (0.2)	4 (0.4)	4 (0.4)	6 (0.6)	1 (0.1)	1 (0.1)	2 (0.2)	2 (0.8)
2004–05	280	- (-)	1 (0.4)	1 (0.4)	2 (0.7)	- (-)	- (-)	- (-)	- (0.4)
2005–06	505	5 (1)	1 (0.2)	- (-)	3 (0.6)	1 (0.2)	35 (6.9)	- (-)	- (0.6)
2007–08	72	2 (2.8)	2 (2.8)	1 (1.4)	9 (12.5)	- (-)	2 (2.8)	2 (2.8)	2 (4.2)
2008–09	311	- (-)	- (-)	- (-)	1 (0.3)	- (-)	- (-)	- (-)	- (-)
2009–10	41	- (-)	1 (2.4)	1 (2.4)	18 (43.9)	- (-)	- (-)	2 (4.9)	2 (4.9)
2010–11	413	2 (0.5)	- (-)	1 (0.2)	4 (1)	- (-)	- (-)	2 (0.5)	2 (0.2)
2011–12	355	1 (0.3)	2 (0.6)	1 (0.3)	15 (4.2)	- (-)	10 (2.8)	3 (0.8)	3 (0.6)
2012–13	1 451	7 (0.5)	3 (0.2)	4 (0.3)	17 (1.2)	4 (0.3)	99 (6.8)	- (-)	- (0.2)
2013–14	43	3 (7)	1 (2.3)	1 (2.3)	2 (4.7)	- (-)	- (-)	- (-)	- (4.7)
2014–15	627	7 (1.1)	1 (0.2)	2 (0.3)	- (-)	2 (0.3)	5 (0.8)	- (-)	- (0.5)
2015–16	249	2 (0.8)	8 (3.2)	5 (2)	17 (6.8)	7 (2.8)	6 (2.4)	5 (2)	5 (6.8)
2016–17	582	3 (0.5)	1 (0.2)	3 (0.5)	4 (0.7)	1 (0.2)	30 (5.2)	1 (0.2)	1 (0.9)
2017–18	2 561	22 (0.9)	9 (0.4)	12 (0.5)	29 (1.1)	5 (0.2)	11 (0.4)	- (-)	- (0.8)

(e) Chatham Rise and ECSI (excludes ECSI from June–September) (bottom trawl).

		Catch in t (% of hoki catch)							
Year	**HOK**	**GSP**	**HAK**	**JAV**	**LIN**	**RAT**	**SPD**	**SWA**	**Other**
1990–91	3 323	33 (1)	132 (4)	142 (4.3)	157 (4.7)	100 (3)	24 (0.7)	210 (6.3)	210(15.9)
1991–92	4 853	24 (0.5)	59 (1.2)	70 (1.4)	144 (3)	129 (2.7)	5 (0.1)	28 (0.6)	28 (7.1)
1992–93	455	- (-)	46 (10.1)	13 (2.9)	8 (1.8)	7 (1.5)	- (-)	9 (2)	9 (11)
1993–94	3 526	6 (0.2)	50 (1.4)	76 (2.2)	112 (3.2)	108 (3.1)	16 (0.4)	15 (0.4)	15 (7.5)
1994–95	1 463	- (-)	23 (1.6)	58 (4)	51 (3.5)	38 (2.6)	7 (0.5)	6 (0.4)	6 (6)
1995–96	3 477	- (-)	112 (3.2)	103 (3)	131 (3.8)	190 (5.5)	47 (1.4)	128 (3.7)	128 (5.6)
1996–97	1 027	- (-)	86 (8.4)	38 (3.7)	49 (4.8)	90 (8.8)	6 (0.6)	116 (11.3)	116(10.4)
1997–98	5 388	- (-)	107 (2)	291 (5.4)	184 (3.4)	297 (5.5)	67 (1.2)	90 (1.7)	90(10.5)
1998–99	7 745	61 (0.8)	90 (1.2)	339 (4.4)	267 (3.5)	313 (4)	131 (1.7)	84 (1.1)	84 (7)
1999–00	3 457	68 (2)	62 (1.8)	217 (6.3)	103 (3)	156 (4.5)	135 (3.9)	126 (3.6)	126(11.7)
2000–01	4 262	117 (2.8)	125 (2.9)	344 (8.1)	214 (5)	291 (6.8)	91 (2.1)	214 (5)	214(14.2)
2001–02	4 643	117 (2.5)	95 (2)	385 (8.3)	223 (4.8)	385 (8.3)	121 (2.6)	50 (1.1)	50(13.1)
2002–03	2 260	104 (4.6)	67 (3)	429 (19)	199 (8.8)	330 (14.6)	48 (2.1)	139 (6.2)	139(21.1)
2003–04	2 384	69 (2.9)	52 (2.2)	250 (10.5)	157 (6.6)	265 (11.1)	58 (2.4)	245 (10.3)	245(16.4)
2004–05	4 768	104 (2.2)	52 (1.1)	528 (11.1)	177 (3.7)	338 (7.1)	106 (2.2)	134 (2.8)	134(11.6)
2005–06	5 182	99 (1.9)	49 (1)	396 (7.6)	132 (2.5)	316 (6.1)	93 (1.8)	260 (5)	260 (9.3)
2006–07	5 533	69 (1.2)	80 (1.4)	500 (9)	155 (2.8)	165 (3)	39 (0.7)	195 (3.5)	195 (7)
2007–08	5 695	62 (1.1)	77 (1.4)	408 (7.2)	121 (2.1)	323 (5.7)	73 (1.3)	153 (2.7)	153 (9.1)
2008–09	4 427	28 (0.6)	50 (1.1)	355 (8)	96 (2.2)	289 (6.5)	45 (1)	71 (1.6)	71 (4.9)
2009–10	4 208	31 (0.7)	58 (1.4)	431 (10.2)	105 (2.5)	382 (9.1)	35 (0.8)	238 (5.7)	238 (6.8)
2010–11	6 012	51 (0.8)	52 (0.9)	385 (6.4)	143 (2.4)	317 (5.3)	46 (0.8)	222 (3.7)	222 (6)
2011–12	7 868	69 (0.9)	42 (0.5)	329 (4.2)	185 (2.4)	350 (4.5)	107 (1.4)	237 (3)	237 (5.8)
2012–13	10 254	116 (1.1)	106 (1)	754 (7.3)	390 (3.8)	822 (8)	96 (0.9)	321 (3.1)	321 (9.8)
2013–14	8 808	83 (0.9)	88 (1.0)	444 (5)	350 (4)	462 (5.2)	229 (2.6)	389 (4.4)	389 (9.8)
2014–15	5 025	75 (1.5)	116 (2.3)	581 (11.6)	262 (5.2)	415 (8.3)	94 (1.9)	242 (4.8)	242(11.2)
2015–16	7 303	74 (1)	85 (1.2)	650 (8.9)	290 (4)	550 (7.5)	129 (1.8)	217 (3)	217 (8.1)
2016–17	8 100	81 (1.0)	82 (1)	787 (9.7)	295 (3.6)	679 (8.4)	198 (2.4)	50 (0.6)	50 (8.8)
2017–18	6 267	68 (1.1)	115 (1.8)	939 (15)	296 (4.7)	490 (7.8)	194 (3.1)	276 (4.4)	276 (9.2)

Table 5: continued.

(f) Puysegur (Bottom and midwater trawls)

Catch in t (% of hoki catch)

Year	HOK	CSQ	HAK	LIN	RCO	SND	SPD	SWA	Other
1990–91	986	- (-)	3 (0.3)	25 (2.5)	2 (0.2)	2 (0.2)	1 (0.1)	1 (0.1)	1 (1.4)
1991–92	1 028	1 (0.1)	27 (2.6)	431 (41.9)	16 (1.6)	4 (0.4)	4 (0.4)	2 (0.2)	2 (5.3)
1992–93	530	3 (0.6)	3 (0.6)	80 (15.1)	2 (0.4)	1 (0.2)	- (-)	1 (0.2)	1 (3)
1993–94	959	- (-)	- (-)	8 (0.8)	5 (0.5)	- (-)	6 (0.6)	7 (0.7)	7 (1)
1994–95	226	- (-)	- (-)	8 (3.5)	- (-)	- (-)	- (-)	- (-)	- (0.4)
1995–96	719	- (-)	2 (0.3)	33 (4.6)	3 (0.4)	- (-)	2 (0.3)	3 (0.4)	3 (0.7)
1996–97	455	1 (0.2)	- (-)	6 (1.3)	- (-)	- (-)	3 (0.7)	3 (0.7)	3 (2)
1998–99	226	- (-)	4 (1.8)	25 (11.1)	6 (2.6)	1 (0.4)	9 (4)	6 (2.6)	6 (6.2)
1999–00	370	- (-)	- (-)	25 (6.8)	- (-)	2 (0.5)	7 (1.9)	17 (4.6)	17 (4)
2000–01	823	- (-)	6 (0.7)	30 (3.6)	4 (0.5)	5 (0.6)	16 (1.9)	221 (26.9)	221 (6.3)
2001–02	561	- (-)	- (-)	20 (3.6)	1 (0.2)	- (-)	1 (0.2)	34 (6.1)	34 (1.2)
2002–03	678	2 (0.3)	2 (0.3)	52 (7.7)	- (-)	1 (0.2)	2 (0.3)	25 (3.7)	25 (3.8)
2003–04	549	- (-)	- (-)	32 (5.8)	1 (0.2)	2 (0.4)	2 (0.4)	14 (2.5)	14 (3.1)
2004–05	1 237	- (-)	1 (0.1)	20 (1.6)	1 (0.1)	- (-)	11 (0.9)	1 (0.1)	1 (1.4)
2005–06	478	5 (1.1)	3 (0.6)	105 (22)	1 (0.2)	10 (2.1)	1 (0.2)	26 (5.4)	26 (7.7)
2006–07	10	- (-)	- (-)	4 (40.0)	- (-)	- (-)	- (-)	- (-)	-(20.0)
2009–10	31	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	1 (3.2)	1 (-)
2010–11	1	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)
2011–12	381	6 (1.6)	6 (1.6)	19 (5)	- (-)	2 (0.5)	- (-)	5 (1.3)	5 (2.6)
2012–13	444	13 (2.9)	12 (2.7)	22 (5)	- (-)	12 (2.7)	1 (0.2)	30 (6.8)	30 (7.7)
2013–14	69	3 (4.3)	1 (1.4)	6 (8.7)	- (-)	1 (1.4)	- (-)	- (-)	- (5.8)
2014–15	8	- (-)	- (-)	5 (62.5)	- (-)	- (-)	- (-)	1 (12.5)	1 (-)
2015–16	163	7 (4.3)	1 (0.6)	7 (4.3)	- (-)	15 (9.2)	- (-)	1 (0.6)	1 (4.9)
2016–17	5	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)
2017–18	353	25 (7.1)	4 (1.1)	103 (29.2)	- (-)	17 (4.8)	- (-)	1 (0.3)	1 (6.8)

(g) Sub-Antarctic (bottom trawls)

Catch in t (% of hoki catch)

Year	HOK	HAK	JAV	LIN	RAT	SPD	SWA	WWA	Other
1990–91	1 974	204 (10.3)	17 (0.9)	91 (4.6)	14 (0.7)	3 (0.2)	- (-)	3 (0.2)	3(10.9)
1991–92	3 452	332 (9.6)	47 (1.4)	248 (7.2)	39 (1.1)	15 (0.4)	9 (0.3)	35 (1)	35 (5.9)
1992–93	2 566	509 (19.8)	30 (1.2)	224 (8.7)	21 (0.8)	8 (0.3)	5 (0.2)	22 (0.9)	22 (4.4)
1993–94	1 118	31 (2.8)	11 (1)	98 (8.8)	10 (0.9)	12 (1.1)	11 (1)	5 (0.4)	5 (5.5)
1994–95	877	22 (2.5)	14 (1.6)	57 (6.5)	12 (1.4)	15 (1.7)	- (-)	8 (0.9)	8 (6.2)
1995–96	742	27 (3.6)	9 (1.2)	95 (12.8)	15 (2)	5 (0.7)	8 (1.1)	22 (3)	22 (6.7)
1996–97	66	8 (12.1)	4 (6.1)	3 (4.5)	3 (4.5)	- (-)	- (-)	- (-)	-(30.3)
1997–98	1 893	127 (6.7)	66 (3.5)	190 (10)	59 (3.1)	20 (1.1)	3 (0.2)	28 (1.5)	28 (6)
1998–99	4 727	133 (2.8)	74 (1.6)	256 (5.4)	77 (1.6)	20 (0.4)	26 (0.6)	18 (0.4)	18 (4.8)
1999–00	5 020	212 (4.2)	186 (3.7)	336 (6.7)	65 (1.3)	47 (0.9)	158 (3.1)	25 (0.5)	25 (6.7)
2000–01	2 739	87 (3.2)	76 (2.8)	369 (13.5)	50 (1.8)	58 (2.1)	159 (5.8)	26 (1)	26 (7.7)
2001–02	3 889	154 (4)	308 (7.9)	193 (5)	94 (2.4)	97 (2.5)	35 (0.9)	27 (0.7)	27 (7.7)
2002–03	2 003	81 (4)	99 (4.9)	363 (18.1)	47 (2.4)	80 (4)	21 (1.1)	20 (1.0)	20(10.3)
2003–04	548	37 (6.8)	36 (6.6)	309 (56.4)	16 (2.9)	171 (31.2)	54 (9.8)	13 (2.4)	13(15.7)
2004–05	391	24 (6.1)	71 (18.2)	189 (48.3)	15 (3.8)	6 (1.5)	5 (1.3)	10 (2.6)	10(11.5)
2005–06	1 170	14 (1.2)	29 (2.5)	118 (10.1)	14 (1.2)	63 (5.4)	68 (5.8)	70 (6)	70 (4)
2006–07	1 225	16 (1.3)	50 (4.1)	225 (18.4)	18 (1.5)	85 (6.9)	82 (6.7)	85 (6.9)	85 (7.3)
2007–08	2 670	100 (3.8)	176 (6.6)	1 002 (37.5)	28 (1.1)	30 (1.1)	9 (0.3)	76 (2.8)	76(10.8)
2008–09	2 890	93 (3.2)	127 (4.4)	359 (12.4)	40 (1.4)	83 (2.9)	52 (1.8)	39 (1.4)	39 (6.6)
2009–10	635	16 (2.5)	37 (5.8)	122 (19.2)	25 (3.9)	13 (2)	2 (0.3)	15 (2.4)	15 (3.1)
2010–11	2 014	34 (1.7)	61 (3)	208 (10.3)	58 (2.9)	105 (5.2)	58 (2.9)	56 (2.8)	56 (8.3)
2011–12	2 141	46 (2.1)	64 (3)	404 (18.9)	48 (2.2)	46 (2.1)	1 (0)	30 (1.4)	30 (5.4)
2012–13	6 059	58 (1)	197 (3.2)	647 (10.7)	129 (2.1)	132 (2.2)	226 (3.7)	39 (0.6)	39 (4.7)
2013–14	5 327	81 (1.5)	225 (4.2)	593 (11.1)	149 (2.8)	240 (4.5)	58 (1.1)	74 (1.4)	74 (7.3)
2014–15	2 463	27 (1.1)	131 (5.3)	299 (12.1)	120 (4.9)	185 (7.5)	115 (4.7)	6 (0.2)	6 (9.5)
2015–16	1 739	87 (5.0)	105 (6)	470 (27)	41 (2.4)	53 (3)	16 (0.9)	16 (0.9)	16(13.3)
2016–17	1 236	26 (2.1)	52 (4.2)	211 (17.1)	38 (3.1)	130 (10.5)	49 (4)	84 (6.8)	84(13.4)
2017–18	7 741	188 (2.4)	558 (7.2)	1 335 (17.2)	368 (4.8)	337 (4.3)	460 (5.9)	131 (1.7)	131(10.1)

Table 6: Number of 2017–18 hoki length frequency samples and otoliths by observer trip and land-based sampling programme, target species, and monthly timing. Length frequency samples with errors, missing data or outside the sample period (e.g. non-spawning season in a spawning area) were removed. Four observer programme length frequency samples were excluded as these were from large vessels inside the 25 n. mile line, which may have position errors. – no data.

(a) WCSI observer samples

				Number of
Trip	**Month**	**Target species**	**Length frequency samples**	**Otoliths**
1	Jun	HOK	24	47
2	Jun	HAK/HOK	21	26
3	Jun/Jul	HOK	42	38
4	May/Jun	HOK/JMA	11	15
5	Jun	HOK	16	12
6	Jun/Jul	HOK	19	20
7	Jun/Jul	HOK	18	18
8	Jun	HOK	1	-
9	Jul	HOK	4	-
10	Jun/Jul	HOK	28	17
11	Jun/Jul/Aug	HOK	75	81
12	Jun/Jul/Aug	HOK	32	29
13	JunJulAugSep	HAK/HOK	44	-
14	Jul	HOK	6	12
15	Jul	HOK	2	-
16	Jul/Aug	HOK	72	-
17	Jul	HOK	15	14
18	Jul/Aug	HOK	27	41
19	Jul	HOK	1	-
20	Jul	HOK	5	8
21	Jul	HOK	32	31
22	Jul/Aug	HOK	15	19
23	Jul/Aug	HOK	39	45
24	Jul/Aug	HOK	31	23
25	Jul	HOK	25	30
26	Jul/Aug	HOK	17	14
27	Jul/Aug	HOK	24	15
28	Jul/Aug	HOK	24	9
29	Jul/Aug	HOK	17	-
30	Jul/Aug	HOK	33	28
31	Aug	HOK	6	-
32	Aug	HOK	13	10
33	Jul/Aug	HOK	20	-
34	Aug	HOK	8	11
35	Aug/Sep	HAK/HOK	28	-
36	Aug	HOK	20	-
37	Aug	HOK	12	-
38	Aug	HOK	2	-
39	Aug	HAK/HOK	11	-
40	Aug	HOK	10	-
41	Aug	HOK	9	-
42	Aug/Sep	HAK	5	-
43	Aug	HOK	3	-
44	Aug/Sep	HOK	15	-
Total	-	-	882	613
		HAK (15), HOK (866), JMA (1)	(773 outside, 109 inside)	
Market Jun	Jun	HOK	4	47
Market Jul	Jul	HOK	4	45
Market Aug	Aug	HOK	4	45
Market Sep			0	0
Total market	-	-	12	137
Total	-	-	894	750

Table 6: continued.

(b) Cook Strait observer and land-based samples.

Trip	Month	Target species	Number of Length frequency samples	Number of Otoliths
1	Jun	HOK	9	22
2	Jul/Aug	HOK	11	33
3	Jul	HOK	12	46
4	Jul/Aug	HOK	24	67
5	Aug	HOK	5	9
6	Aug	HOK	5	17
7	Aug/Sep	HOK	15	-
Total observer	-	-	81	194
Land-based	Jun	HOK	3	48
Land-based	Jul	HOK	12	214
Land-based	Aug	HOK	12	183
Land-based	Sep	HOK	7	111
Land-based	Total	-	34	556
Total	-	-	115	750

Table 6: continued.

(c) Chatham Rise and ECSI observer data; Chatham Rise includes ECSI non-spawning data. – no data.

			Number of samples		
Trip	**Month**	**Target species**	**Chatham Rise**	**ECSI spawning**	**Number of otoliths**
1	Oct	HOK/LIN/SWA	5	-	25
2	Oct	HOK/LIN	5	-	6
3	Oct	HOK/SWA	21	-	98
4	Oct/Nov	HOK/LIN/SWA	11	-	58
5	Oct	HOK/SWA	6	-	22
6	Oct/Nov	HOK/LIN/SWA	10	-	-
7	Nov/Dec	HOK	8	-	39
8	Nov	HOK	2	-	14
9	Nov/Dec	HOK	33	-	193
10	Nov/Dec	HOK/SWA	25	-	104
11	Nov	HOK	5	-	26
12	Dec/Jan	SCI	9	-	-
13	Dec	HOK/SWA	7	-	33
14	Dec/Jan	SCI	11	-	-
15	Dec/Jan	BAR	5	-	-
16	Apr	SQU	1	-	-
17	Feb	BAR/HOK/SWA	4	-	8
18	Mar	BAR	1	-	-
19	Feb	BAR/JMA	3	-	-
20	Mar	BAR/JMA	2	-	-
21	Mar	BAR	1	-	-
22	Mar/Apr	HOK/SWA	52	-	143
23	May/Jun	HOK/SQU	7	-	31
24	May	SWA	1	-	7
25	May/Jun	HOK	23	-	139
26	May/Jun	HOK	35	-	141
27	May	HOK/SWA	6	-	36
28	Jun	ORH	1	-	-
29	Jun	HOK	3	-	19
30	Jun	HOK	1	-	-
31	Jul	HOK	2	-	8
32	Aug	ORH	4	-	-
33	Sep	HOK	3	6	19
34	Aug	HOK	-	3	-
35	Aug/Sep	HOK	-	7	-
36	Sep	HOK	15	8	-
37	Sep	HOK	-	8	-
38	Aug/Sep	HOK	-	4	-
39	Sep	HOK	14	-	53
40	Sep	HOK	-	2	-
Total	-	-	342	38	1222

(d) Sub-Antarctic observer data

				Number of
Trip	**Month**	**Target species**	**Length frequency samples**	**Otoliths**
1	Oct	HOK/LIN	3	9
2	Oct	LIN	1	-
3	Oct	HOK	3	-
4	Oct/Nov	HOK/SWA	18	46
5	Oct	HOK	3	2
6	Oct/Nov	HAK/LIN/SQU/WWA	20	2
7	Nov	HOK/SWA	8	-
8	Oct/Nov	HOK/LIN	11	13
9	Nov/Dec	HOK	30	92
10	Nov	HOK	15	51
11	Nov	HOK/SWA	2	-
12	Nov/Dec/Jan	HOK/LIN	43	125

Table 6: Sub-Antarctic observer data, continued.

Trip	Month	Target species	Number of Length frequency samples	Number of Otoliths
13	Dec/Jan	HOK/LIN	41	44
14	Nov/Dec	HAK/LIN/WWA	13	4
15	Dec/Jan	HOK/SWA	13	11
16	Dec/Jan	HOK	19	7
17	Jan	SQU	3	-
18	Dec	HOK/LIN/SWA	5	10
19	Dec/Jan	HOK/LIN/SWA	4	9
20	Jan	SQU	4	-
21	Jan/Feb	SQU	3	-
22	Jan/Feb	HOK/SQU/SWA	13	2
23	Jan	SQU	1	-
24	Feb	SQU	1	-
25	Jan/Feb	HOK/SQU/SWA	3	10
26	Jan/Feb	SQU	5	-
27	Feb	SQU	3	-
28	Feb/Mar	SQU	6	-
29	Feb/Mar	SQU	11	-
30	Mar	HOK/NOS	5	4
31	Feb	HOK	4	14
32	Feb/Mar	HOK/SQU	3	-
33	Mar/Apr	BAR/HOK/SQU	6	-
34	Feb/Mar	HOK/SQU	50	181
35	Feb/Mar/Apr	BOE/SQU	3	-
36	Mar	SQU	5	-
37	Mar	SWA	1	-
38	Mar/Apr	SQU/SWA	10	8
39	Mar/Apr	HOK	33	100
40	Mar/Apr	HOK/SQU/SWA	6	6
41	Mar	SWA	1	2
42	Mar	SQU	4	-
43	Mar/Apr	SWA	2	-
44	Apr/May	SQU	5	-
45	Apr/May	SQU	3	-
46	Apr/May	HOK	52	141
47	Apr/May	SQU/SWA	5	-
48	May/Jun	HOK	15	48
49	May	HOK	26	87
50	May/Jun	HOK/SWA	22	75
51	May	SQU	2	-
52	Sep	HOK	15	30
53	Jul/Aug	HOK/LIN/WWA	8	2
54	Jul	HOK	1	5
55	Aug	HOK	14	51
56	Sep	HOK/LIN	3	-
57	Aug/Sep	HOK	4	14
58	Aug	SBW	1	-
59	Sep	HOK	1	-
60	Sep	HOK/LIN	8	-
61	Sep	HOK	2	-
62	Sep	SBW	7	-
63	Sep	HOK/LIN/SBW	12	10
64	Sep	HOK/LIN	17	4
65	Sep	SBW	7	-
66	Sep	HOK	1	2
Total	-	-	669	1221

Table 7: Stratification for the 2018 WCSI and Cook Strait length samples.

(a) WCSI. Strata inside and outside 25 n. mile line by time

		Length samples			Catch	
Stratum	25 n. mile line	Date	Number of Observer	Number of Land-based	Date	Tonnes
1	Inside	6-17 Jun	2	2	1 May - 17 Jun	2 507.7
2	Inside	18 Jun-1 Jul	15	2	18 Jun-1 Jul	2 297.7
3	Inside	3-15 Jul	17	2	2-15 Jul	2 080.1
4	Inside	16-22 Jul	27	-	16-22 Jul	1 349.3
5	Inside	23-29 Jul	24	2	23-29 Jul	1 344.6
6	Inside	30 Jul-12 Aug	6	2	30 Jul-12 Aug	2 518.8
7	Inside	13 Aug-2 Sep	8	2	13 Aug-2 Sep	3 693.6
8	Inside	3-12 Sep	10	-	3-30 Sep	1 276.6
9	Outside	29 May-3 Jun	10	-	1 May-3 Jun	721.5
10	Outside	4-10 Jun	16	-	4-10 Jun	483.4
11	Outside	11-16 Jun	11	-	11-17 Jun	533.0
12	Outside	18-24 Jun	30	-	18-24 Jun	1 267.0
13	Outside	25 Jun-1 Jul	47	-	25 Jun-1 Jul	1 753.3
14	Outside	2-8 Jul	43	-	2-8 Jul	2 722.1
15	Outside	9-15 Jul	65	-	9-15 Jul	4 295.4
16	Outside	16-22 Jul	62	-	16-22 Jul	4 678.7
17	Outside	23-29 Jul	92	-	23-29 Jul	3 991.6
18	Outside	30 Jul-5 Aug	116	-	30 Jul-5 Aug	5 431.4
19	Outside	6-12 Aug	112	-	6-12 Aug	5 846.9
20	Outside	13-19 Aug	79	-	13-19 Aug	3 736.3
21	Outside	20-26 Aug	61	-	20-26 Aug	2 309.6
22	Outside	27 Aug - 14 Sep	29	-	27 Aug - 30 Sep	581.5

(b) WCSI stratification outside 25 n. mile line by time and fleet. Strata inside 25 n. mile line as for (a).

		Length samples			Catch (t)		
Stratum	Date	BATM	FOV	Domestic meal	BATM	FOV	Domestic meal
9	1 May-24 Jun	13	22	32	1 200.5	209.3	1 572.0
10	25 Jun-1 Jul	10	21	16	326.8	433.8	992.2
11	2-8 Jul	13	20	10	1 208.7	301.6	1 211.3
12	9-15 Jul	35	21	9	2 183.7	537.2	1 555.9
13	16-22 Jul	24	22	16	1 771.4	698.5	2 072.9
14	23-29 Jul	48	24	20	1 441.9	532.9	1 915.5
15	30 Jul-5 Aug	60	24	32	2 604.5	608.5	2 062.4
16	6-12 Aug	51	22	39	2 210.9	676.4	2 841.6
17	13-19 Aug	29	22	28	1 753.4	449.7	1 438.8
18	20 Aug - 30 Sep	31	32	27	1 070.2	289.7	1 520.6

Table 7: continued.

(c) WCSI stratification outside 25 n. mile line by time and fishing method outside the 25 n. mile line. Strata inside 25 n. mile line as for (a).

		Length samples			Catch
Stratum	Fishing method	Week range	Number	Week range	Tonnes
9	BT	22:25	31	18:25	363.81
10	BT	26	36	26	832.46
11	BT	27	30	27	695.45
12	BT	28	29	28	979.82
13	BT	29	27	29	1710.31
14	BT	30	24	30	1186.20
15	BT	31	37	31	1203.47
16	BT	32	43	32	1691.69
17	BT	33	38	33	908.66
18	BT	34	24	34	434.75
19	BT	35	12	35	233.71
20	BT	36:37	9	36:40	73.11
21	BT twin	22:26	23	18:26	1691.57
22	BT twin	27:31	14	27:31	4320.17
23	BT twin	32	12	32	1401.14
24	BT twin	33:37	11	33:40	1332.28
25	MW	22:25	13	18:25	1200.47
26	MW	26	10	26	328.03
27	MW	27	13	27	1273.35
28	MW	28	34	28	2325.03
29	MW	29	24	29	1834.64
30	MW	30	48	30	1667.87
31	MW	31	62	31	3084.79
32	MW	32	51	32	2465.05
33	MW	33	29	33	1841.75
34	MW	34:37	35	34:40	1512.35
35	PRB	22:29	12	18:29	653.67
36	PRB	30	14	30	339.45
37	PRB	31	11	31	186.76
38	PRB	32:37	17	32:40	579.71

(d) Cook Strait. Strata by vessel overall length and time.

			Stratum	Number of samples	
Stratum	Vessel size	Date range	Catch (t)	Market	Observer
1	< 40 m	Jun–Jul	2 661.3	10	34
2	< 40 m	Aug	3 091.3	8	29
3	< 40 m	Sep	962.2	3	9
4	≥ 40m	Jun	2 086.4	2	9
5	≥ 40m	Jul	3 585.6	3	-
6	≥ 40m	Aug	3 685.3	4	-
7	≥ 40m	Sep	1 988.8	4	-

Table 8: Strata for the 2017–18 non spawning fisheries based on the tree regression of all data (Observer Programme only), with comparison of the TCEPR, Observer Programme (OP), tows and otolith data sampled by stratum. The catch for Observer Programme is the total catch for the observed tows.

(a) Chatham Rise all target species. Original method (stratification without fleet).

	Splitting variable	Mean length	Hoki catch (t)		No. of tows			No. of otoliths	No. of fish measured
Stratum	Depth of net (m)	(cm)	TCEPR	OP	TCEPR	OP	Otolith		
1	< 489.75	61.3	8 445.1	882.3	1 750	111	52	278	8 575
2	489.75–610.25	66.0	24 611.4	2 093.8	2 866	206	169	865	21 378
3	> 610.25	76.7	4 028.4	166.4	1 281	25	18	67	2 446

(b) Chatham Rise all target species. Stratification with fleet.

	Splitting variables		Mean length	Hoki catch (t)		No. of tows			No. of otoliths	No. of fish measured
Stratum	Fleet	Depth of net (m)	(cm)	TCEPR	OP	TCEPR	OP	Otoliths		
1	No meal	-	60.5	1 852.5	843.0	1 628	110	65	328	8 833
2	Meal	< 610.25	66.2	31 311.0	2 133.4	3 624	211	156	815	21 200
3	Meal	> 610.25	77.4	3 922.0	166.1	645	21	18	67	2 366

Nb: No meal = FOV and Domestic.no.meal; Meal =BATM and Domestic.meal

(c) Sub-Antarctic all target species

	Splitting variables			Mean length	Hoki catch (t)		No. of tows		No. of otoliths	No. of fish measured
Stratum	Depth of net (m)	Latitude	Longitude	(cm)	TCEPR	OP	TCEPR	OP		
1	< 597.75	≤ 52.62° S	-	66.0	6 334.3	2 625.5	2 197	444	591	28 897
2	< 597.75	> 52.62° S	-	95.6	173.7	237.4	20	13	37	1 212
3	≥ 597.75	-	< 168.4°	74.4	2 017.6	443.8	601	74	139	5 792
4	≥ 597.75	-	≥ 168.4°	87.7	6 901.3	1 768.5	820	135	434	13 735

(d) Sub-Antarctic target hoki

	Splitting variables			Mean length	Hoki catch (t)		No. of tows		No. of otoliths	No. of fish measured
Stratum	Depth of net (m)	Latitude	Longitude	(cm)	TCEPR	OP	TCEPR	OP		
1	< 597.75	≤ 51.5° S	-	65.6	6 254.7	2 032.2	2 122	231	524	21 335
2	< 597.75	> 51.5° S	-	92.2	253.3	250.6	95	16	40	1 524
3	≥ 597.75	-	< 168.4°	74.9	1 984.6	408.2	599	52	138	5 181
4	≥ 597.75	-	≥ 168.4°	87.6	6 934.3	1 768.4	822	134	434	13 727

Table 9: Percentage of female hoki by gonad stages on the WCSI for female fish less than or equal to 55 cm and female fish greater than 55 cm for the 2018 spawning season inside and outside the 25 n. mile line.

(a) Observer data outside 25 n. mile line

		Females ≤ 55 cm		Females > 55 cm	
Stage		Number	Percent	Number	Percent
1	Immature and resting	373	51.9	2 312	5.0
2	Maturing	263	33.3	23 586	450.7
3	Mature/Ripe	62	8.6	13 120	28.2
4	Running ripe	18	2.5	3 695	17.8
5	Spent	3	0.4	3 823	8.2
Total		719	-	46 536	-

(b) Observer data inside 25 n. mile line

		Females ≤ 55 cm		Females > 55 cm	
Stage		Number	Percent	Number	Percent
1	Immature and resting	-	0	43	0.9
2	Maturing	-	0	259	5.7
3	Mature/Ripe	1	50	1 999	43.7
4	Running ripe	1	50	2 125	46.5
5	Spent	-	0	148	3.2
Total		2	-	4 574	-

(c) Land-based data inside 25 n. mile line

		Females ≤ 55 cm		Females > 55 cm	
Stage		Number	Percent	Number	Percent
1	Immature and resting	-	-	-	-
2	Maturing	1	50	480	38.5
3	Mature/Ripe	1	50	494	39.6
4	Running ripe	-	-	65	5.2
5	Spent	-	-	207	16.6
Total		2	-	1 246	-

Table 10: Relative biomass estimates (t) of hoki from the July WCSI *Tangaroa* trawl surveys for the core strata (300–650 m), all strata (200–800 m), and deep strata (200–1000 m) from the 2000, 2012, 2013, 2016, and 2018 WCSI *Tangaroa* trawl surveys. The 2000 survey abundance estimates were re-calculated using 2012–13 stratum areas. (CV, coefficient of variation.)

	Core		All		Deep	
year	Biomass	CV	Biomass	CV	Biomass	CV
2000	5 385	(20.6)	-	-	-	-
2012	32 495	(24.2)	32 602	(24.1)	-	-
2013	14 184	(26.9)	14 356	(26.5)	-	-
2016	7 734	(35.7)	7 797	(35.4)	7 830	(35.3)
2018	2 484	(14.2)	2 636	(13.6)	2 661	(13.5)

Table 11: Relative biomass estimates (t in thousands) of hoki for the core strata (300–800 m) from the November–December Sub-Antarctic *Tangaroa* 1991–1993, 2000–2009, 2011, 2012, 2014, 2016, and 2018 trawl surveys. The CV is the coefficient of variation as % (in parentheses). 3++ all hoki aged 3 years and older.

Survey	1+ hoki			2+ hoki			3 ++ hoki		Total hoki	
	1+ year	t	CV	2+ year	t	CV	t	CV	t	CV
1991	1990	0.7	(87)	1989	0.2	(56)	79.4	(7)	80.3	(7)
1992	1991	0.2	(66)	1990	0.2	(90)	86.9	(6)	87.4	(6)
1993	1992	1.1	(98)	1991	3.7	(49)	94.9	(9)	99.7	(9)
2000	1999	0.1	(99)	1998	0.03	(51)	55.6	(13)	55.7	(13)
2001	2000	0.2	(49)	1999	0.1	(46)	37.8	(16)	38.2	(16)
2002	2001	0.01	(53)	2000	2.5	(51)	37.4	(14)	39.9	(14)
2003	2002	1.8	(28)	2001	0.1	(26)	12.4	(14)	14.3	(13)
2004	2003	1.1	(58)	2002	3.3	(57)	13.2	(9.4)	17.6	(12)
2005	2004	0.4	(50)	2003	1.6	(25)	18.5	(14)	20.4	(13)
2006	2005	0.5	(48)	2004	0.7	(25)	13.1	(11)	14.3	(11)
2007	2006	1.0	(54)	2005	1.9	(42)	43.0	(17)	45.9	(16)
2008	2007	1.0	(48)	2006	1.6	(37)	44.4	(15)	47.0	(14)
2009	2008	0.5	(54)	2007	11.1	(64)	53.4	(12)	65.0	(16)
2011	2010	0.01	(100)	2009	2.3	(21)	43.8	(15)	46.1	(15)
2012	2011	0.90	(44)	2010	0.2	(60)	54.6	(15)	55.7	(15)
2014	2013	0.25	(67)	2012	1.7	(48)	29.0	(13)	31.3	(13)
2016	2015	-	(-)	2014	-	(-)	-	(-)	37.9	(17)
2018	2017	0.05	(44)	2016	1.0	(35)	30.1	(11)	31.1	(11)

Table 12: Acoustic abundance indices for WCSI acoustic surveys. From O'Driscoll & Ballara (2019).

Year	Abundance ('000 t)	CV
1988	266	0.60
1989	165	0.38
1990	169	0.40
1991	227	0.73
1992	229	0.49
1993	380	0.38
1997	445	0.60
2000	263	0.28
2012	283	0.34
2013	233	0.35
2018	123	0.46

FIGURES

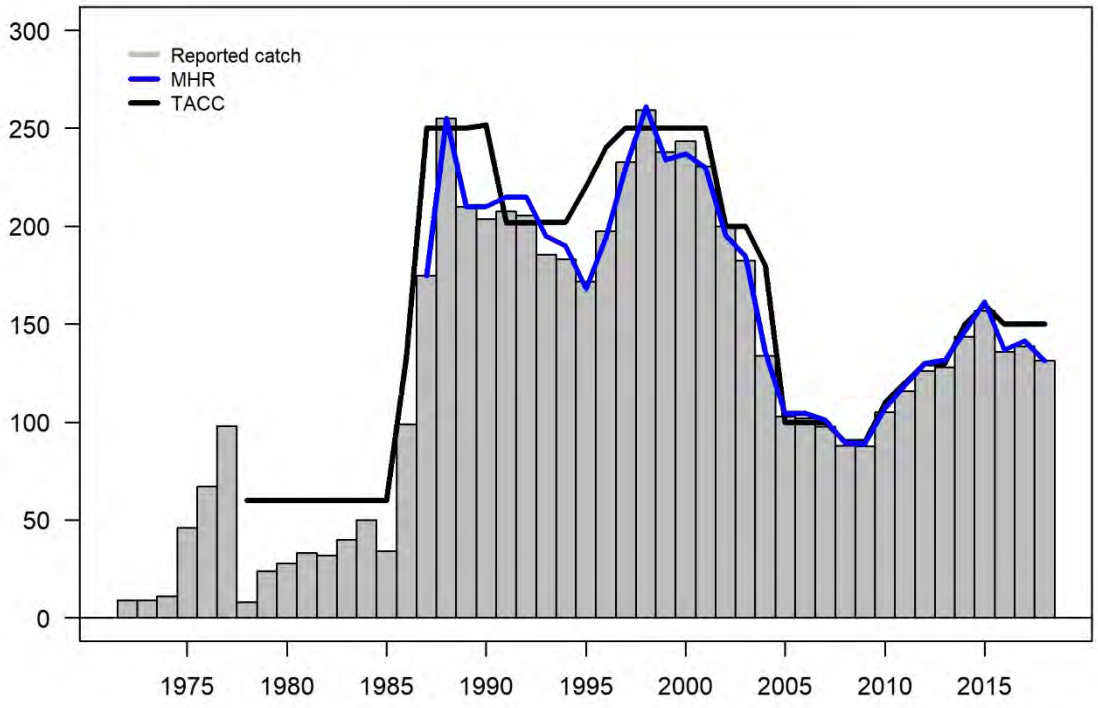


Figure 1: Total New Zealand hoki catch (thousands of tonnes) estimated from reported landings for calendar years 1972 to 1983 and fishing years 1983–84 (1984) to 2017–18.

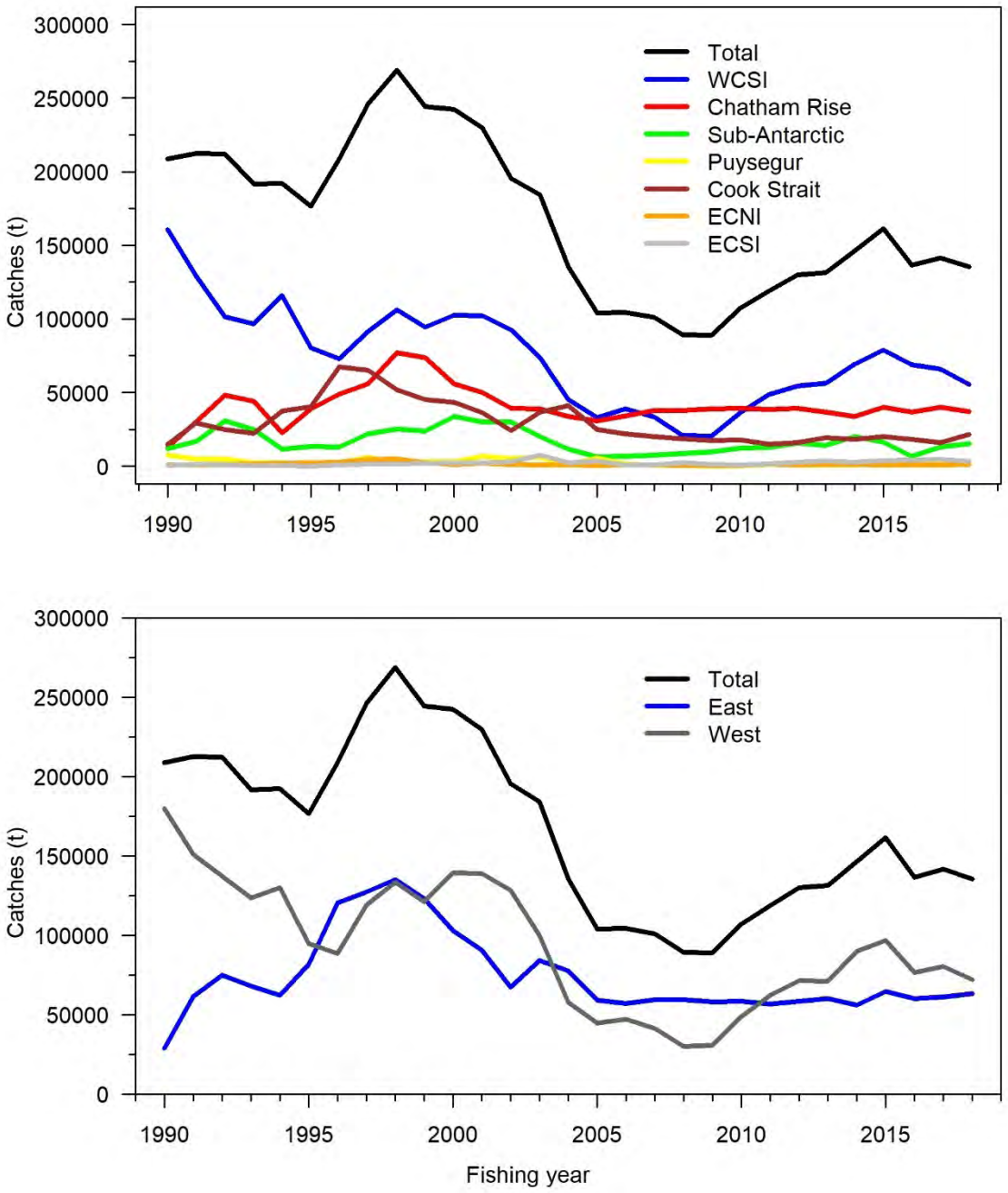


Figure 2: Estimated total catch (t) of hoki by 'stock' area (upper panel) and fishing area (lower panel) from 1988–89 (1989) to 2017–18 (2018). "Eastern" areas include Chatham Rise, east coast South Island (ECSI), Cook Strait, and east coast North Island (ECNI). "Western" areas include west coast South Island (WCSI), Sub-Antarctic, and Puysegur.

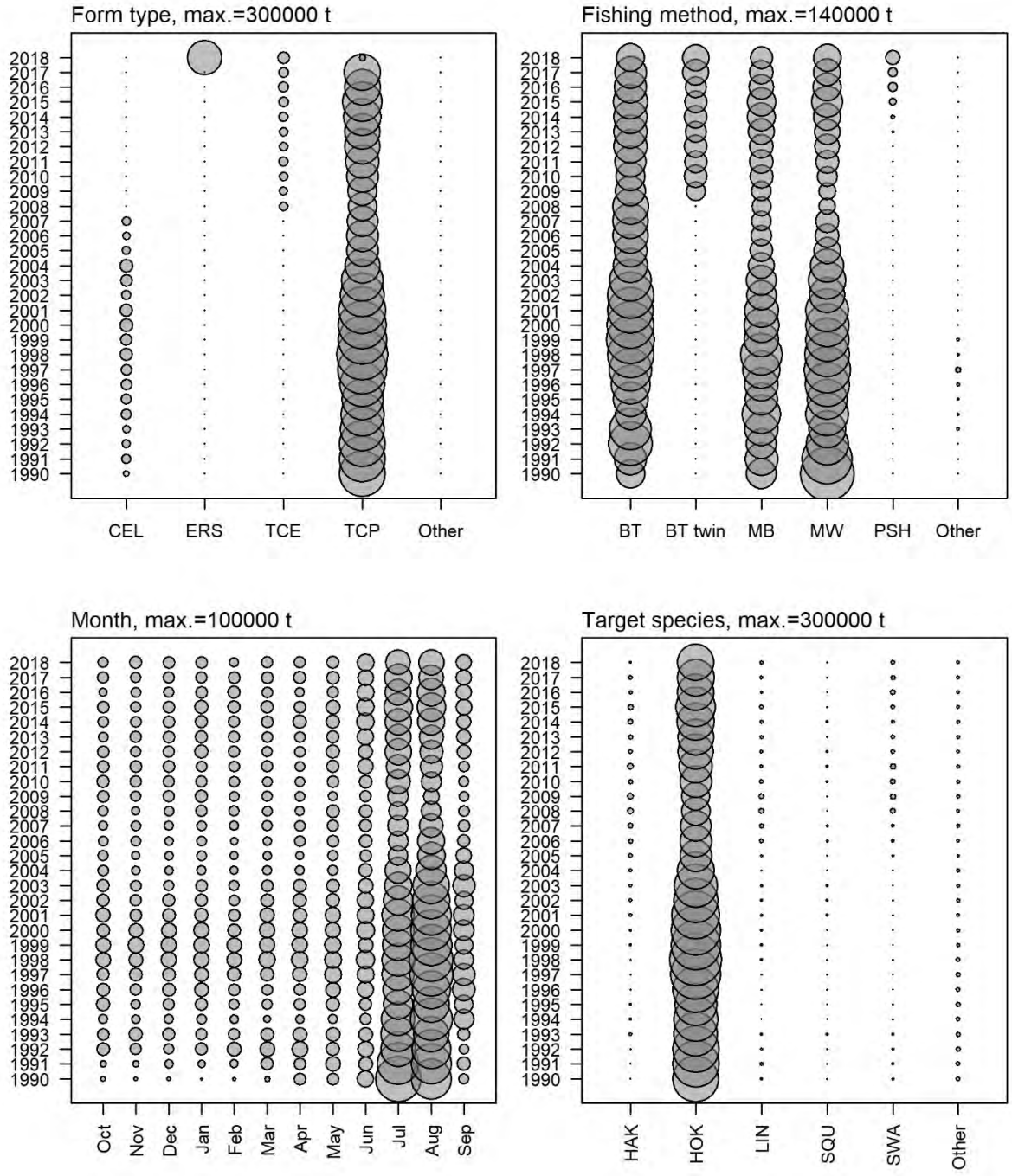


Figure 3: Distribution of hoki catch by form type, fishing method, month and target species for the 1989–90 to 2017–18 fishing years.

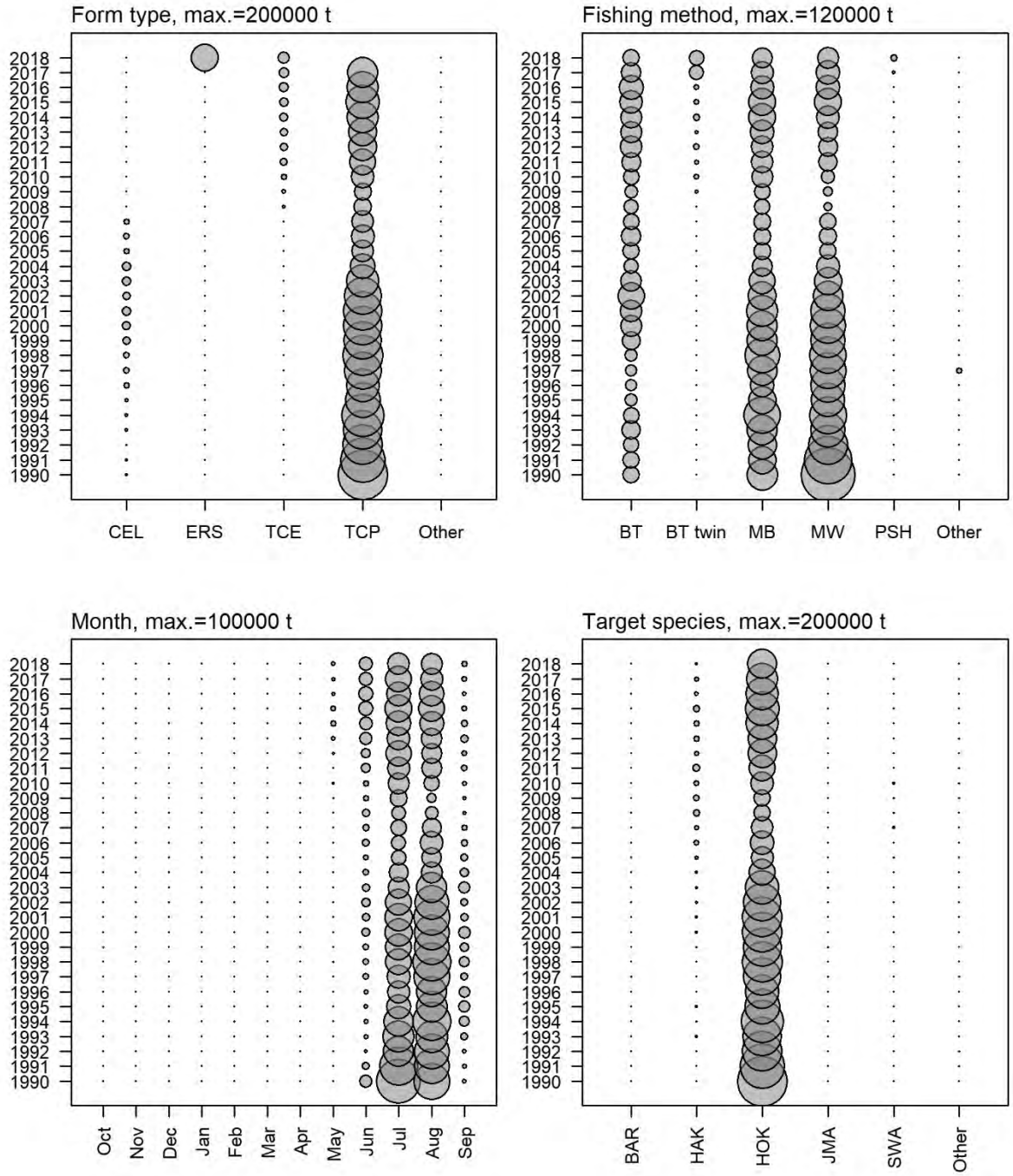


Figure 4: Distribution of WCSI hoki catch by form type, fishing method, month and target species for the 1989–90 to 2017–18 fishing years.

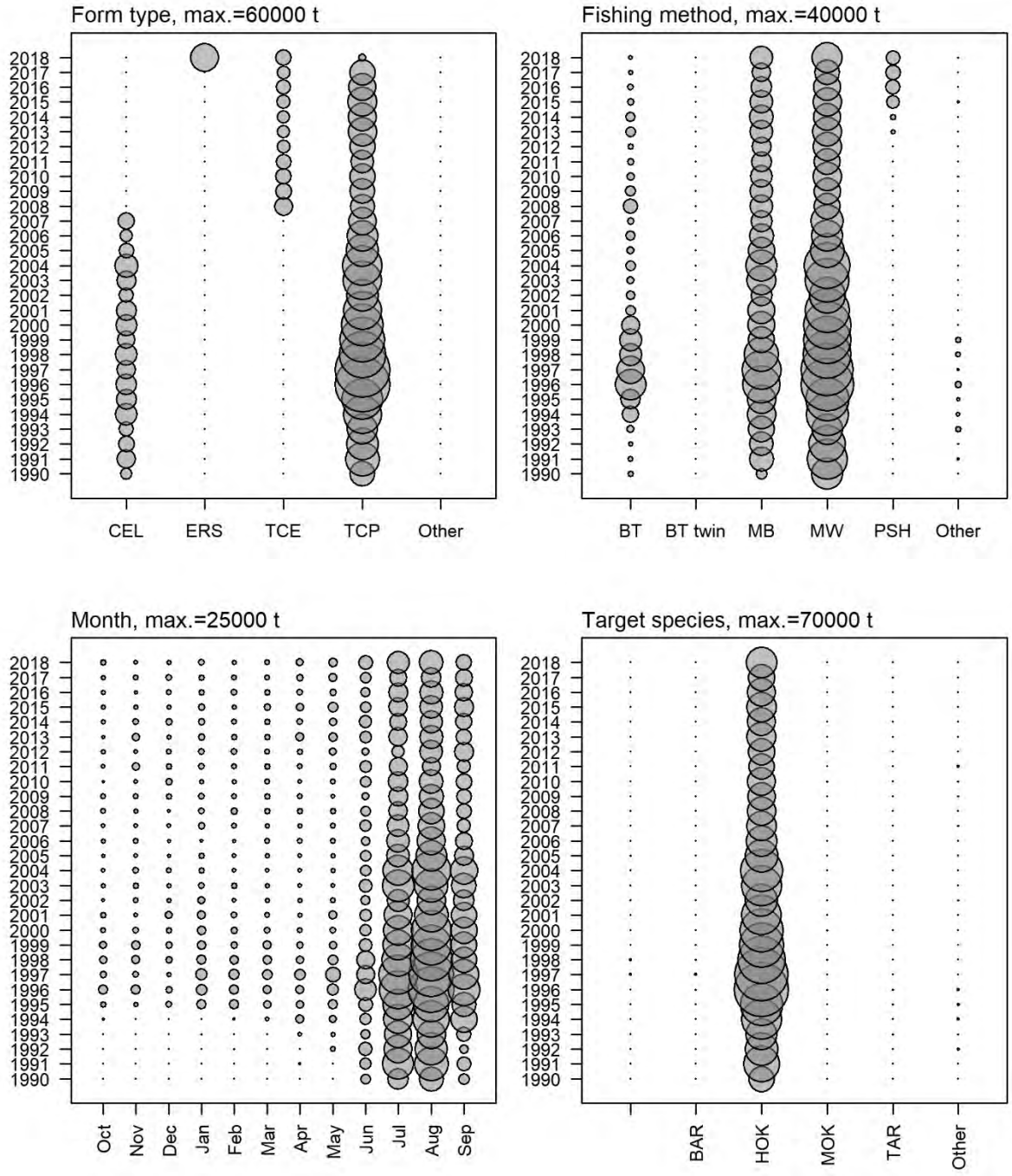


Figure 5: Distribution of Cook Strait hoki catch by form type, fishing method, month and target species for the 1989–90 to 2017–18 fishing years.

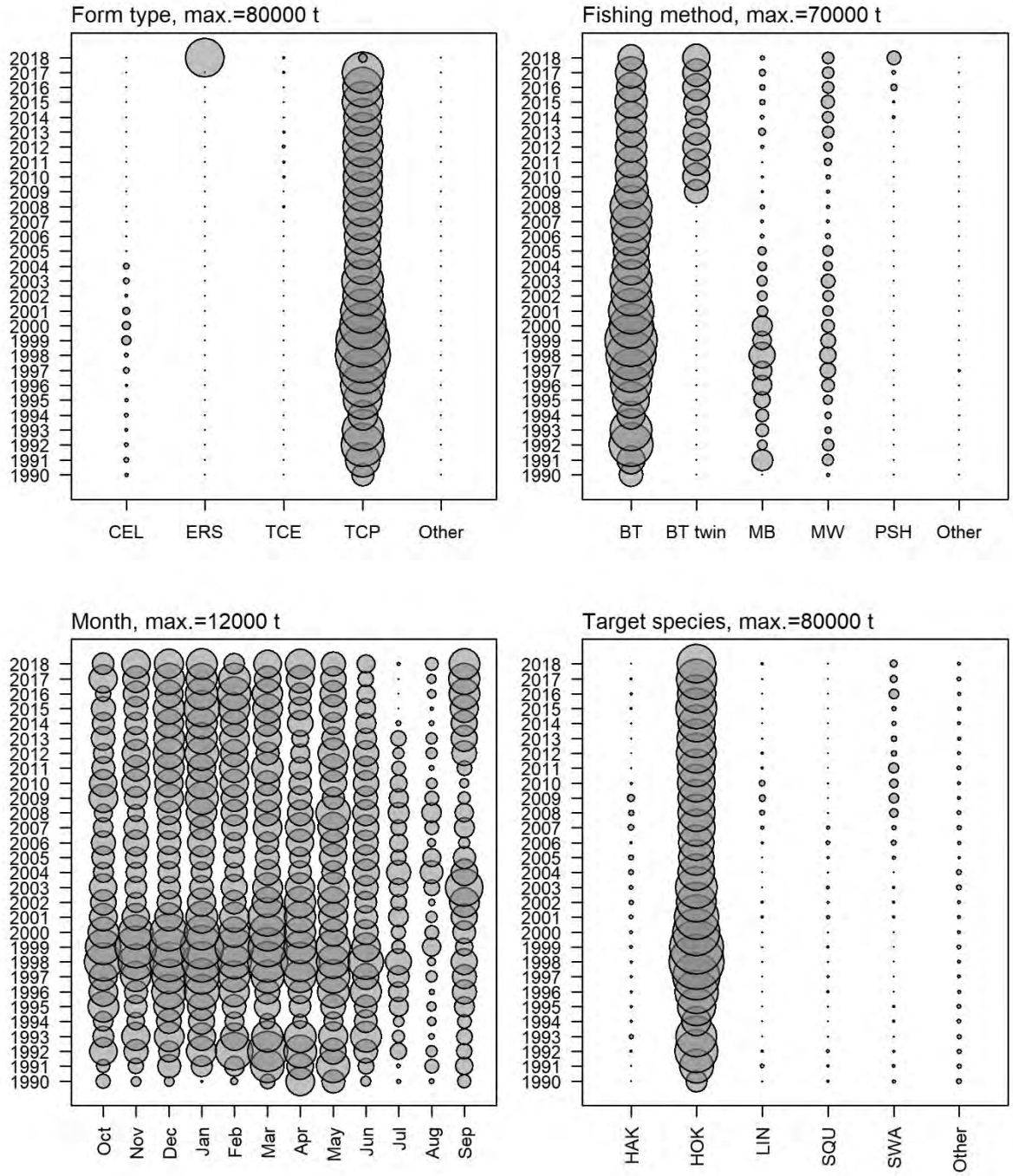


Figure 6: Distribution of Chatham Rise and ECSI non-spawning hoki catch by form type, fishing method, month and target species for the 1989–90 to 2017–18 fishing years.

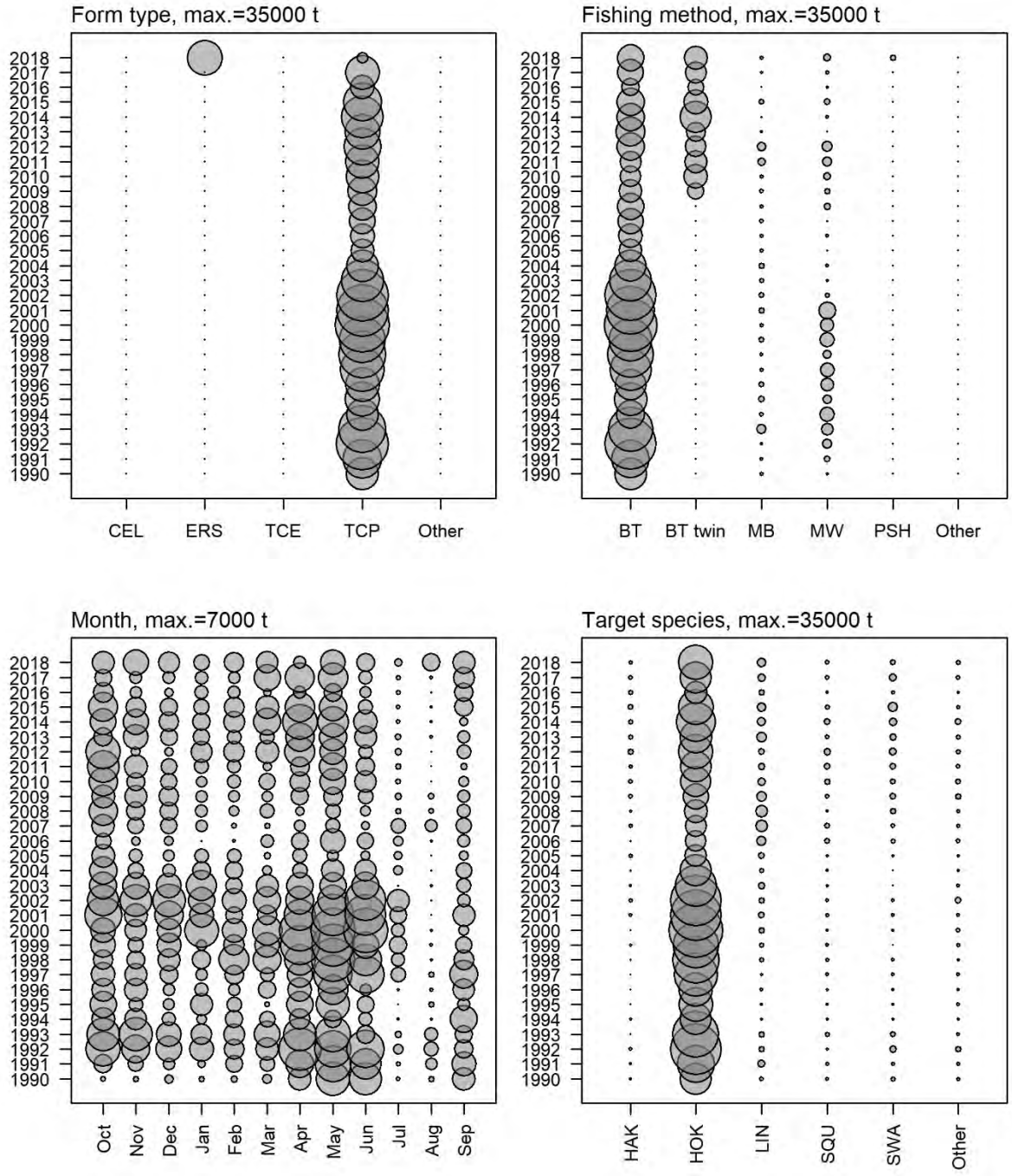


Figure 7: Distribution of Sub-Antarctic hoki catch by form type, fishing method, month and target species for the 1989–90 to 2017–18 fishing years.

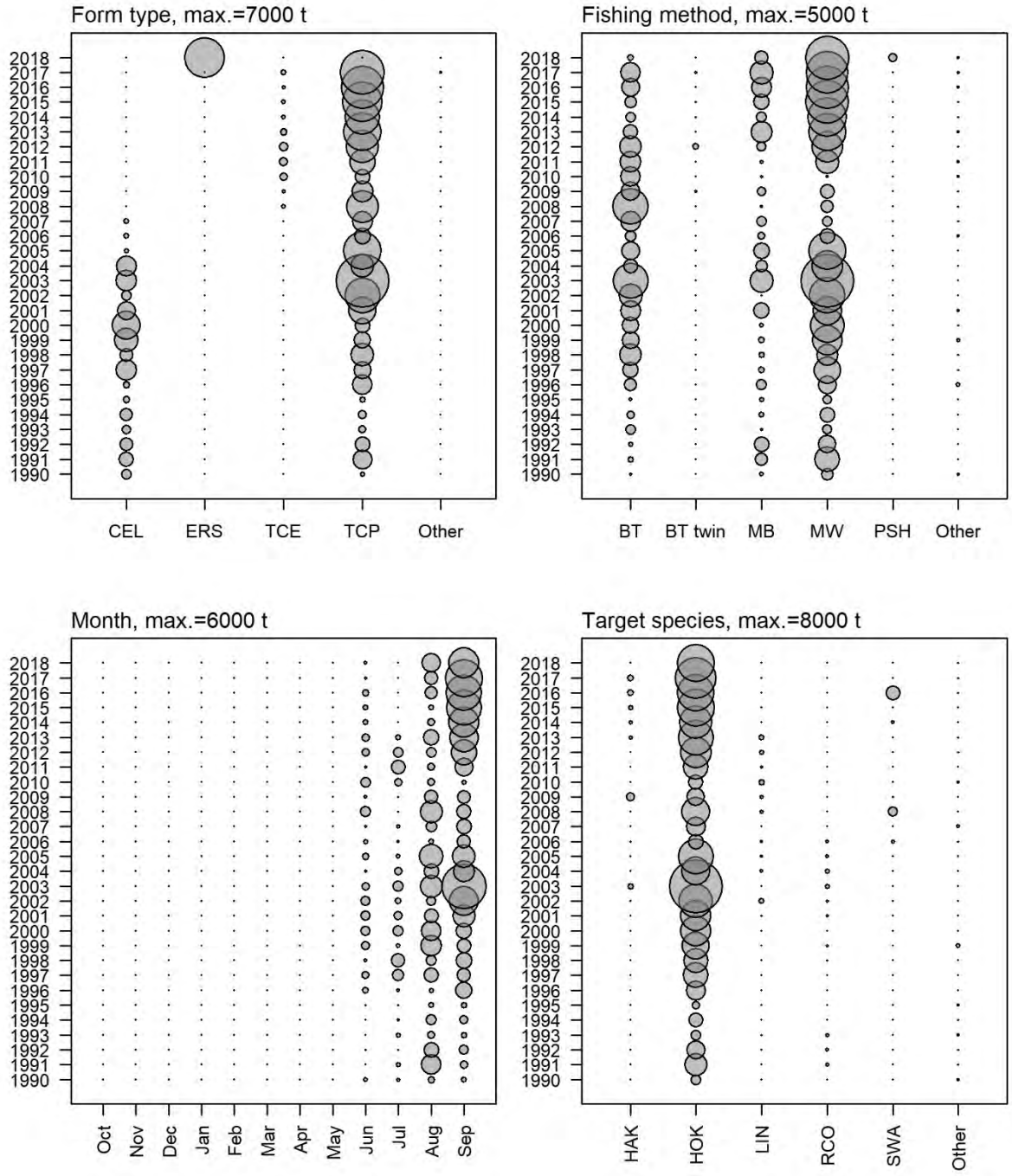


Figure 8: Distribution of ECSI spawning hoki catch by form type, fishing method, month and target species for the 1989–90 to 2017–18 fishing years.

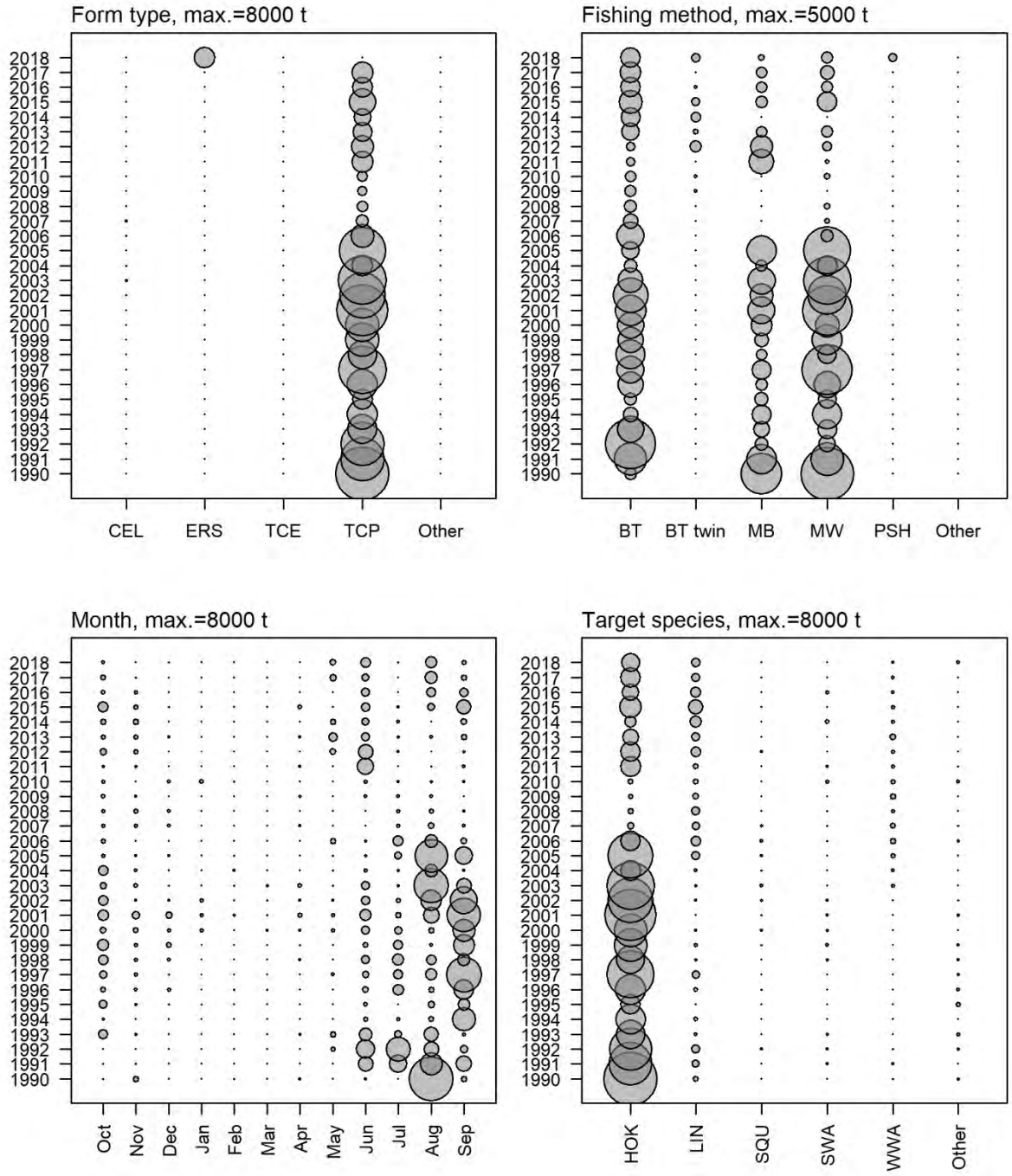


Figure 9: Distribution of Puysegur hoki catch by form type, fishing method, month and target species for the 1989–90 to 2017–18 fishing years.

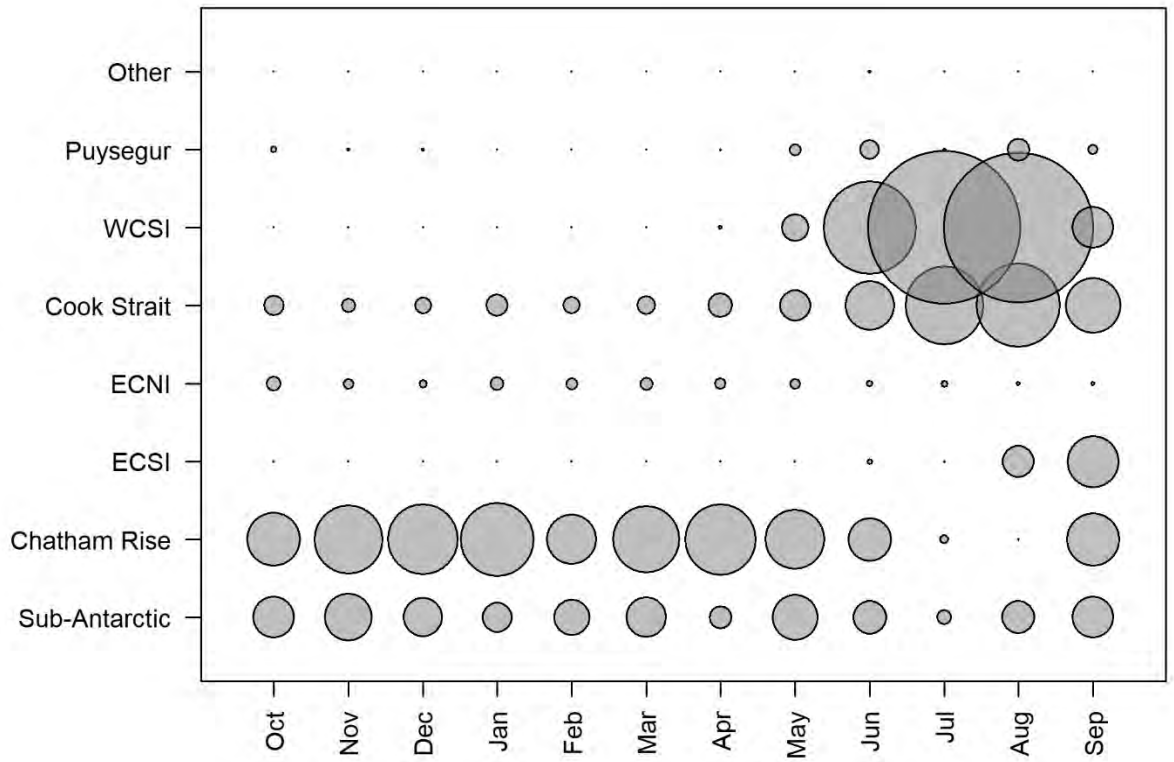


Figure 10a: Hoki catch by month and area for the 2017–18 fishing year (maximum circle size is 25 000 t).

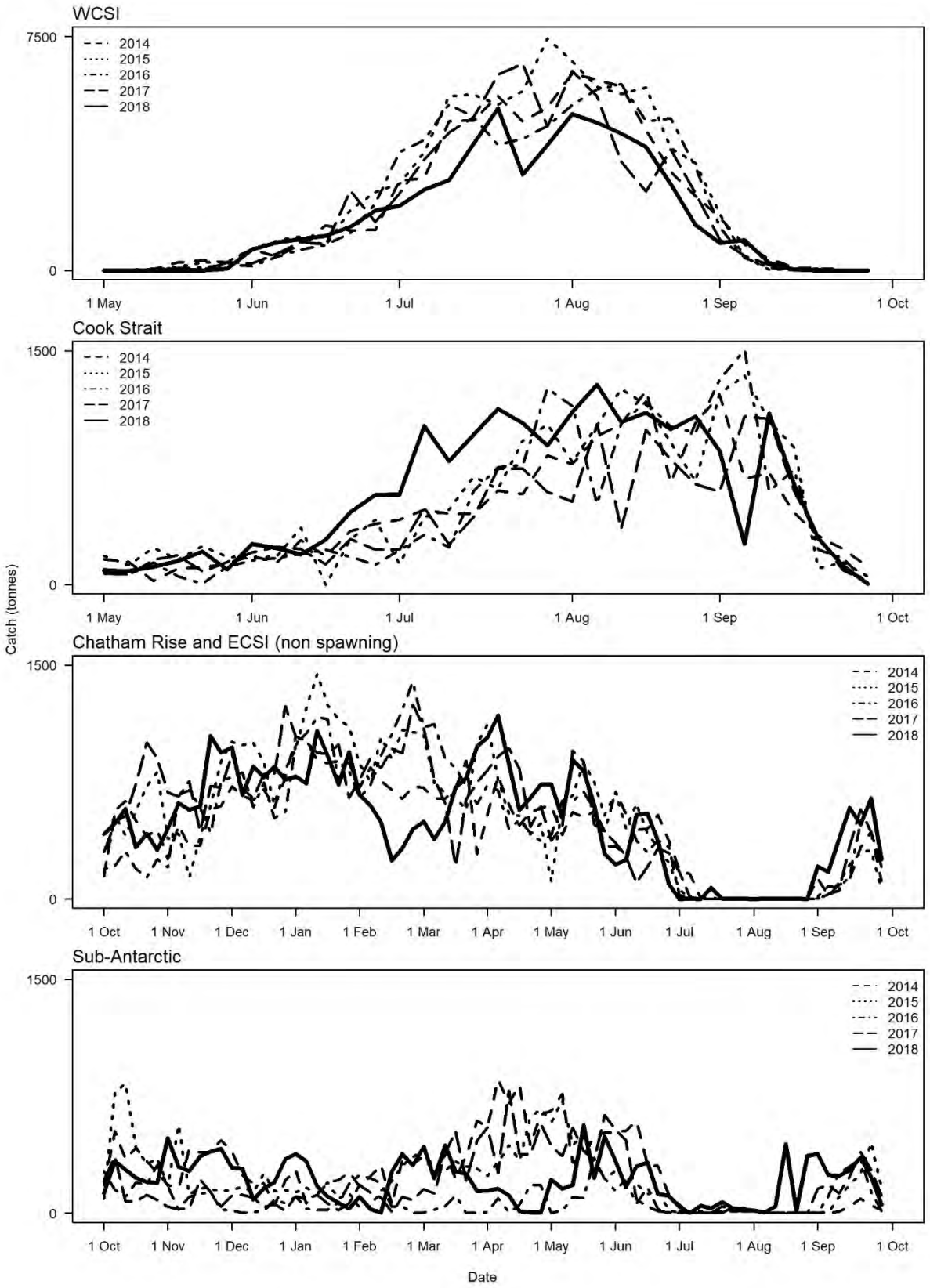


Figure 10b: Hoki catches by day of year in the four major fisheries in each of the past five years (2018 = 2017–18 fishing season).

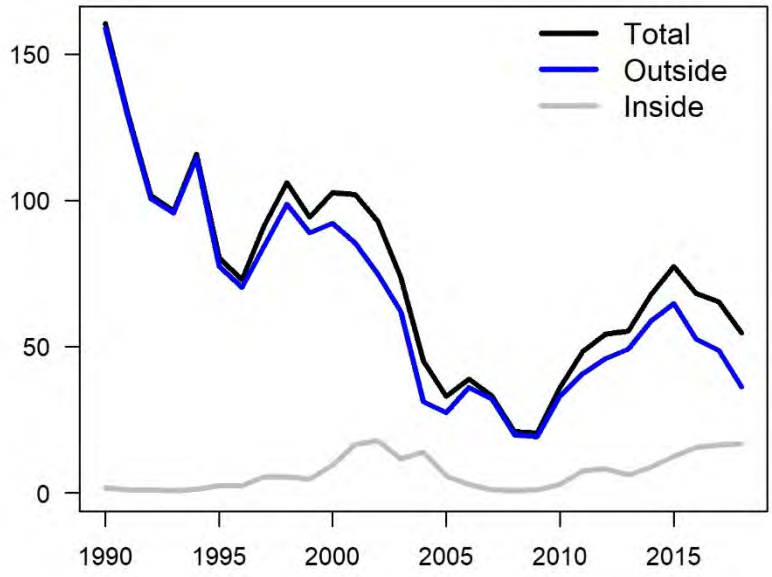


Figure 11 Catch (tonnes) inside and outside the 25 n. mile line in the WCSI spawning fishery from 1990–2018.

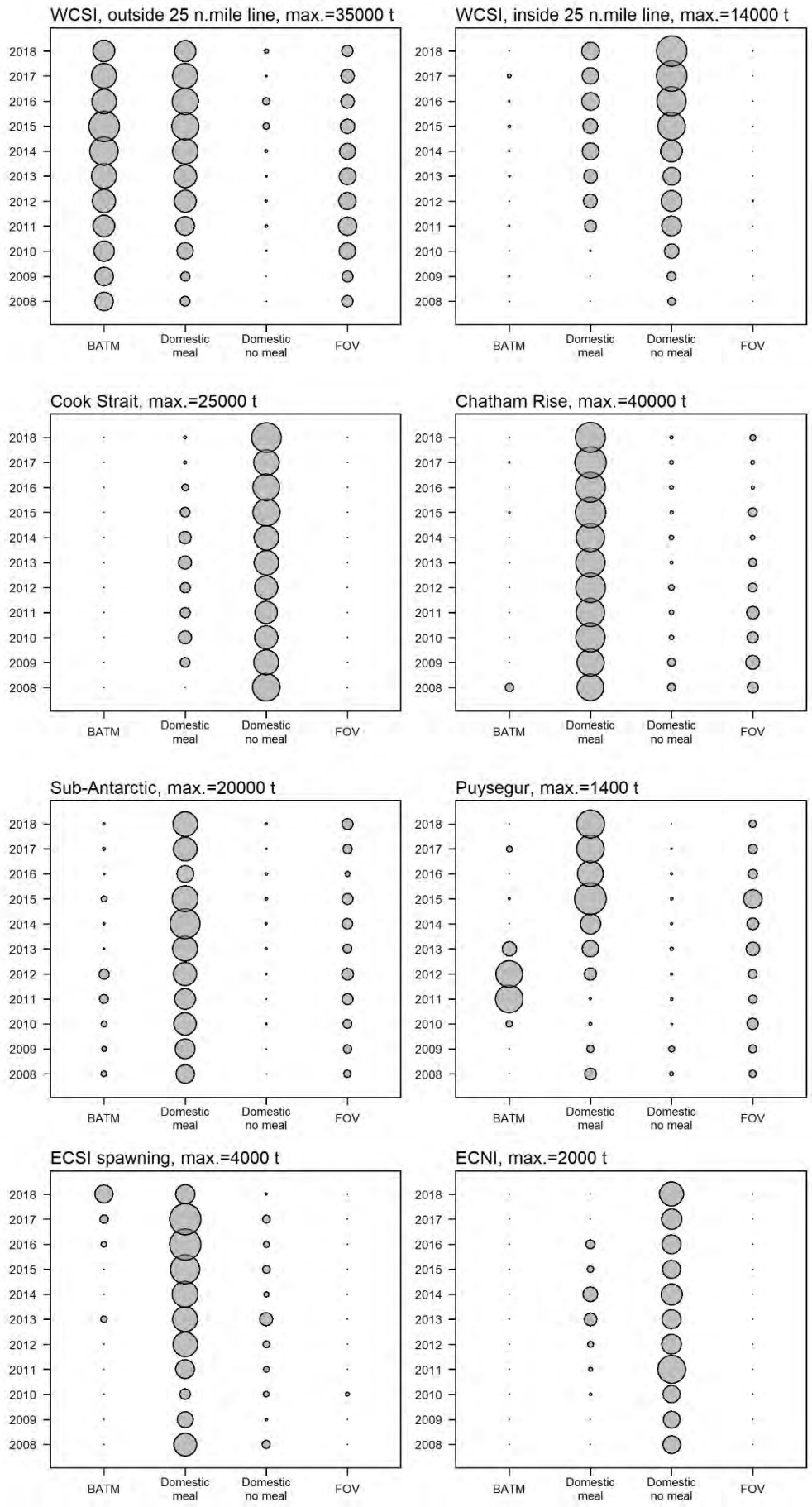


Figure 12: Distribution of hoki catch by fleet for the 2007–08 to 2017–18 fishing years. See Section 2.1.1 for fleet definitions.

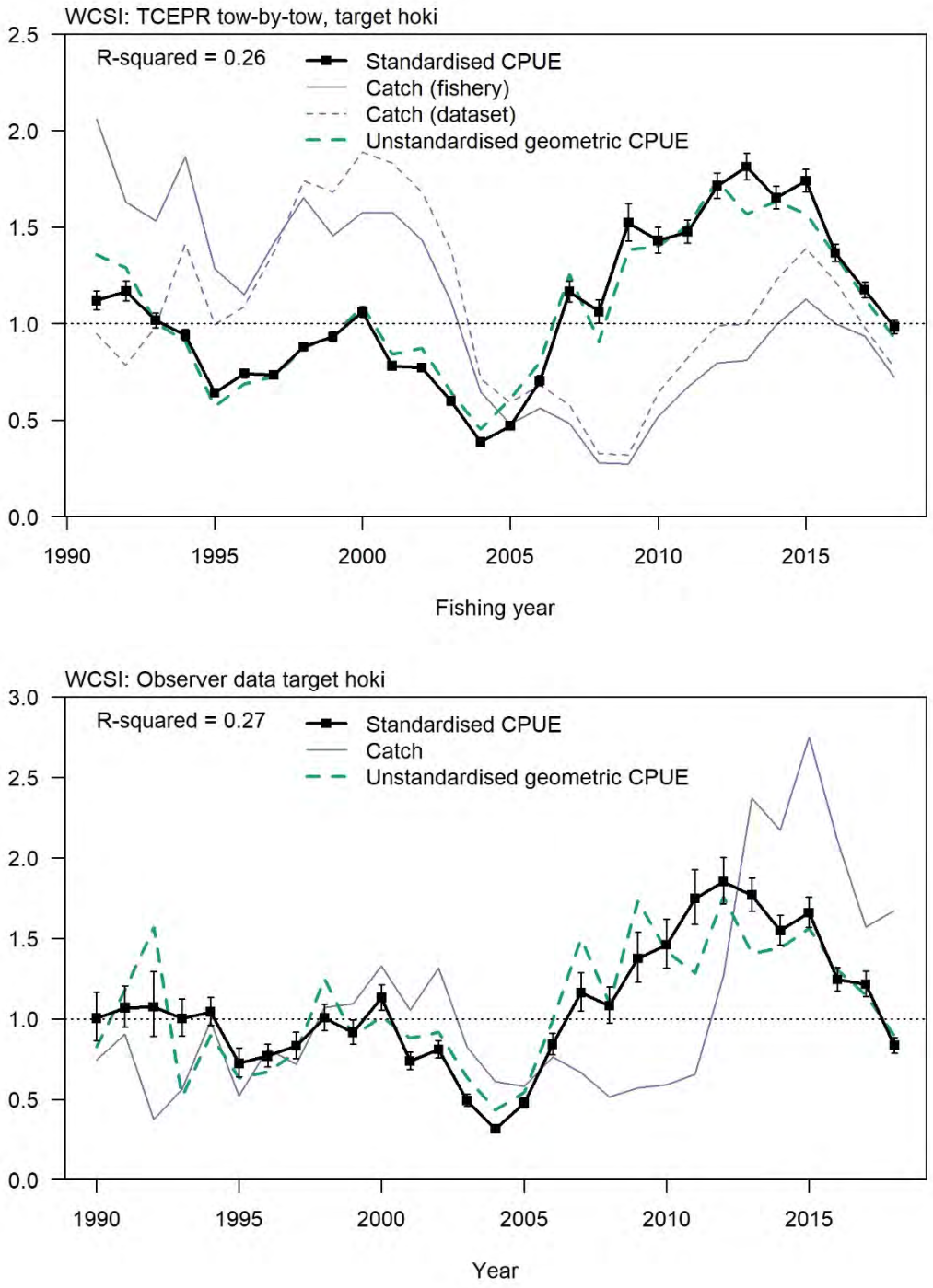


Figure 13a: Model catch, unstandardised geometric, and standardised CPUE indices for core vessel TCEPR data and observed (OP) hoki tows from the WCSI for 1990–2018. TCEPR data includes 'ERS-trawl' data in 2018.

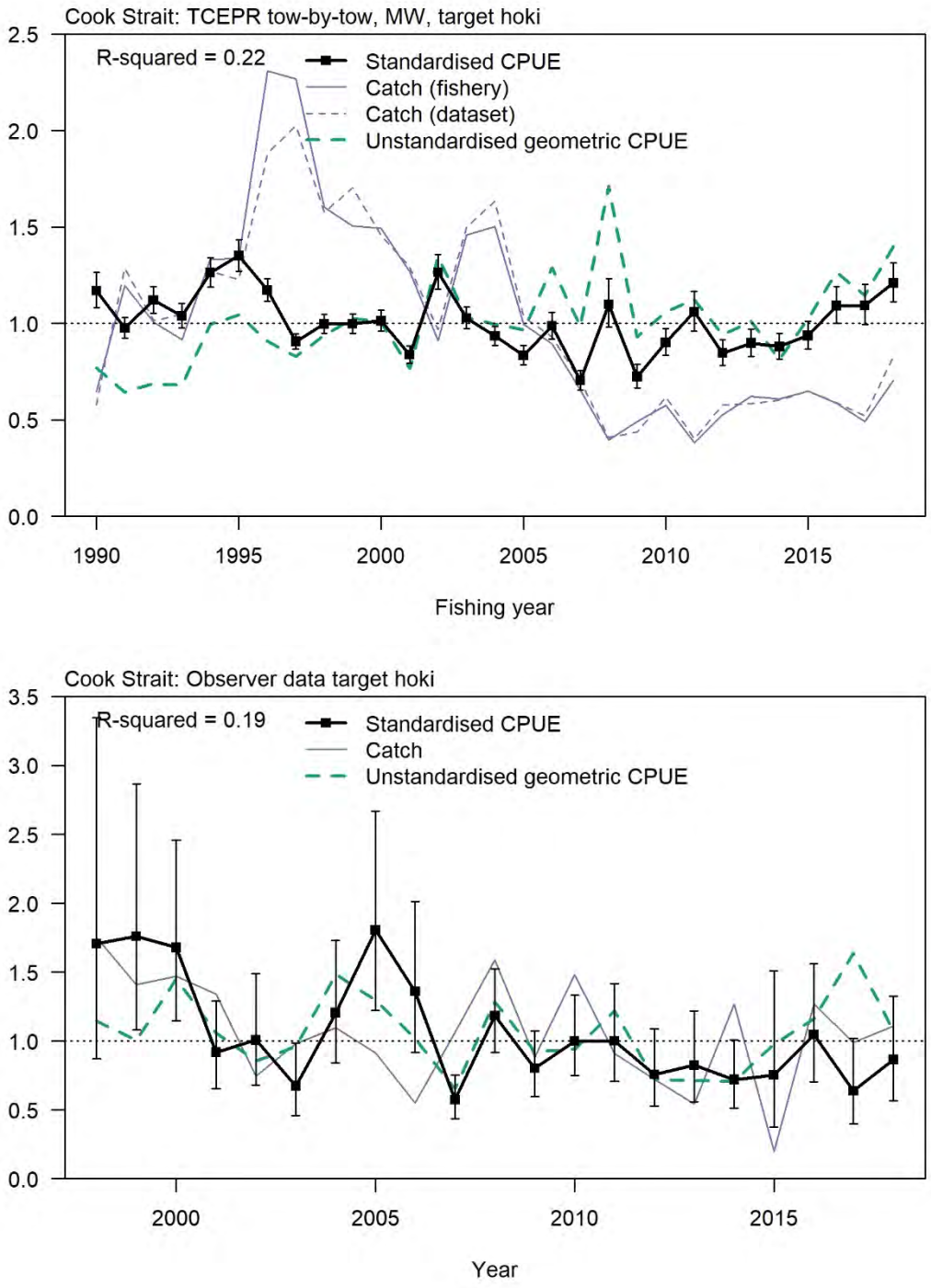


Figure 13b: Model catch, and unstandardised geometric and standardised CPUE indices for core vessel TCEPR data and observed hoki tows from Cook Strait for 1991–2018. Both data sets included only midwater tows. TCEPR data includes 'ERS-trawl' data in 2018.

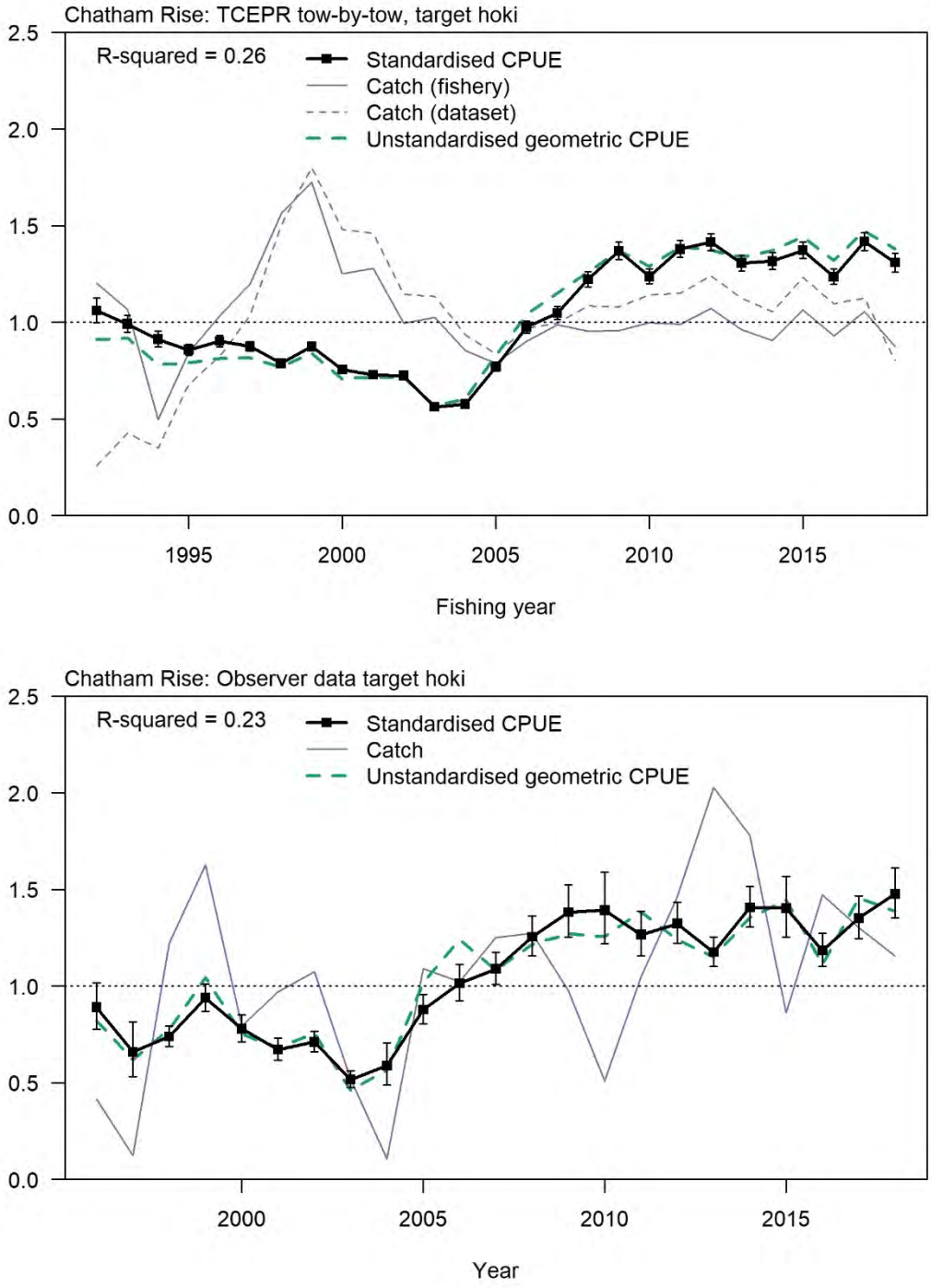


Figure 13c: Model catch, and unstandardised geometric and standardised CPUE indices for core vessel hoki tows from the Chatham Rise for 1992–2018. Dataset for Chatham Rise included only bottom trawl tows. TCEPR data includes 'ERS-trawl' data in 2018.

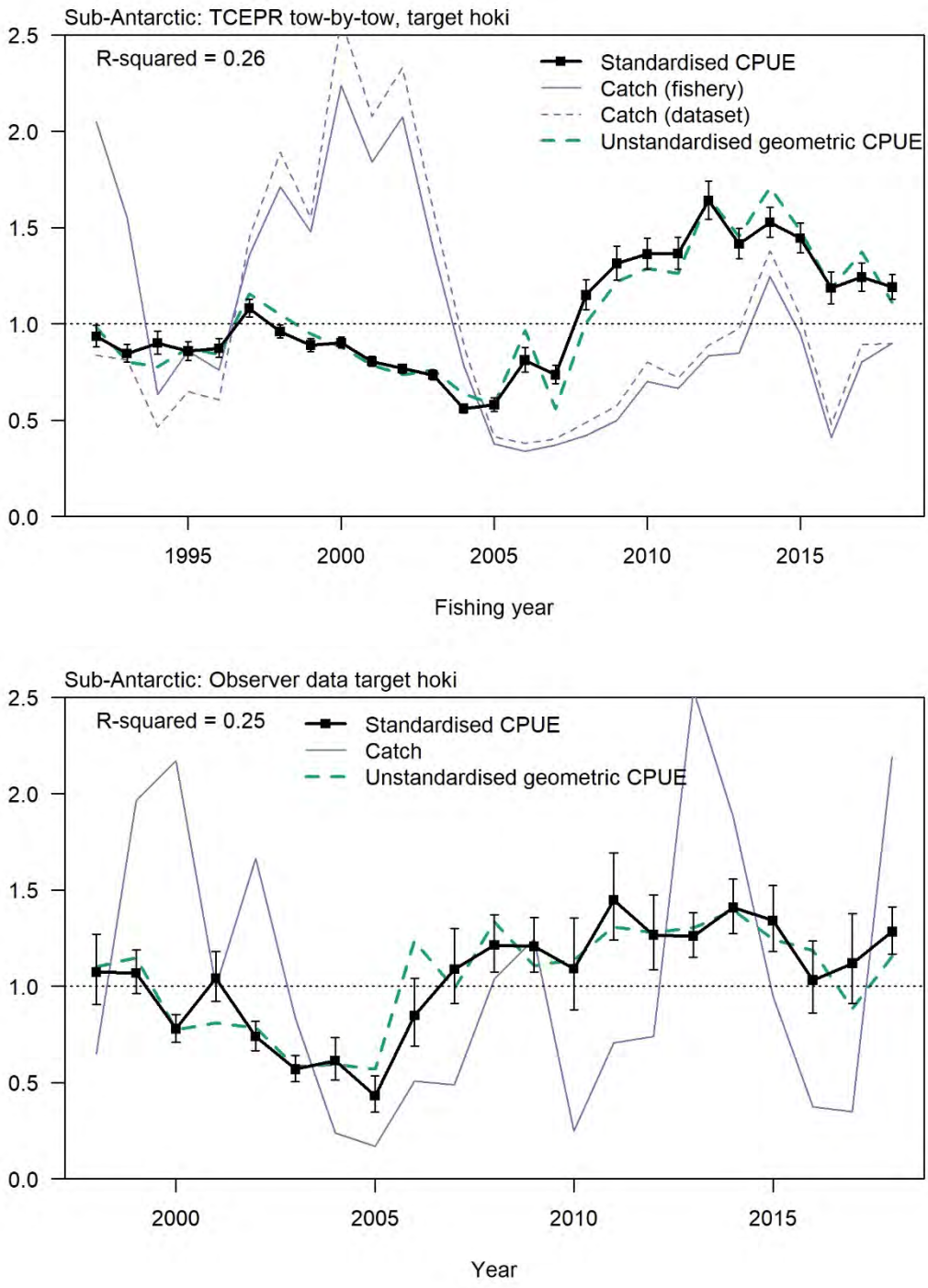


Figure 13d: Model catch, and unstandardised geometric and standardised CPUE indices for core vessel hoki tows from the Sub-Antarctic for 1992–2018. Datasets for Sub-Antarctic included only bottom trawl tows. TCEPR data includes 'ERS-trawl' data in 2018.

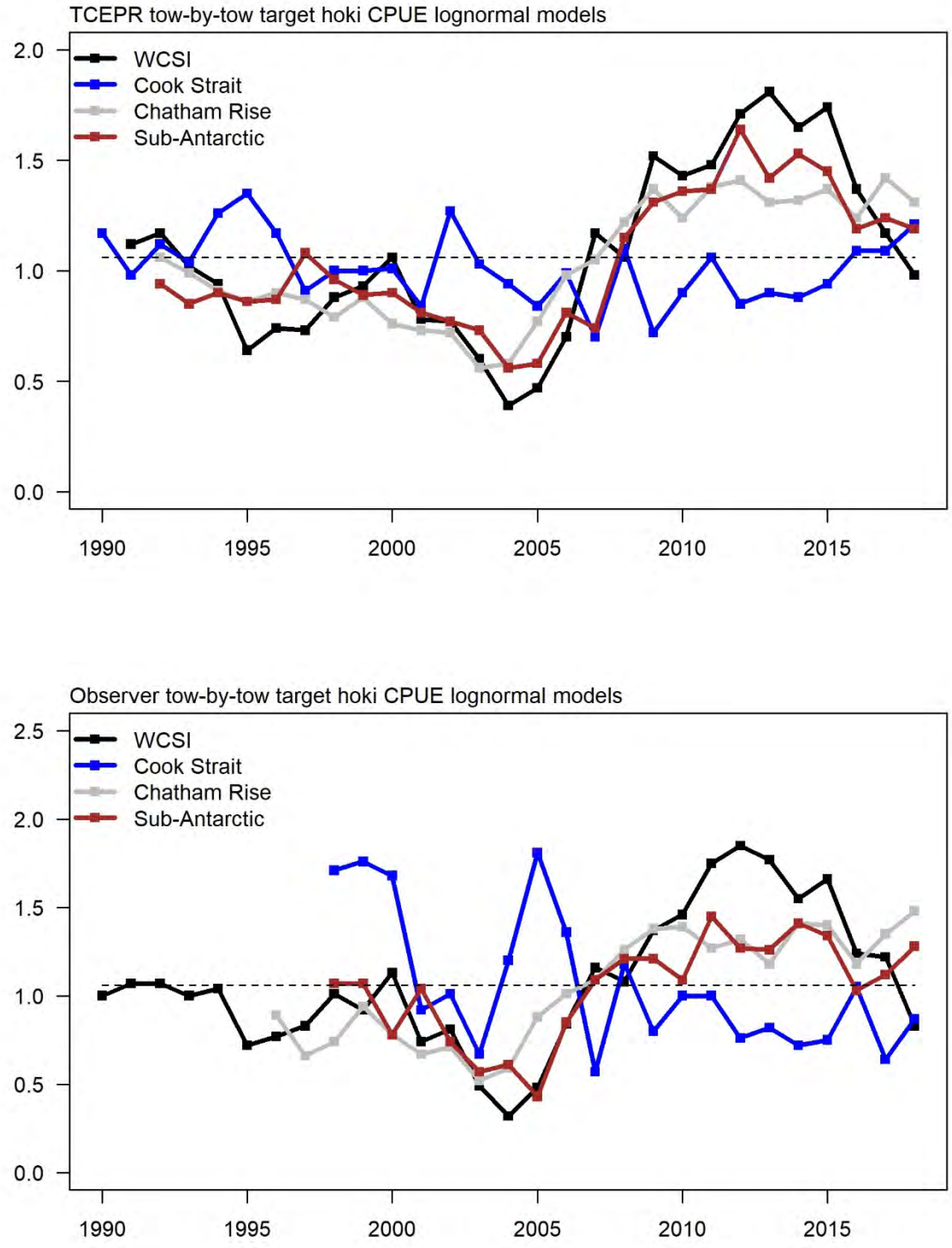


Figure 14: Comparison of relative standardised CPUE indices from model runs for each area. TCEPR data includes 'ERS-trawl' data in 2018.

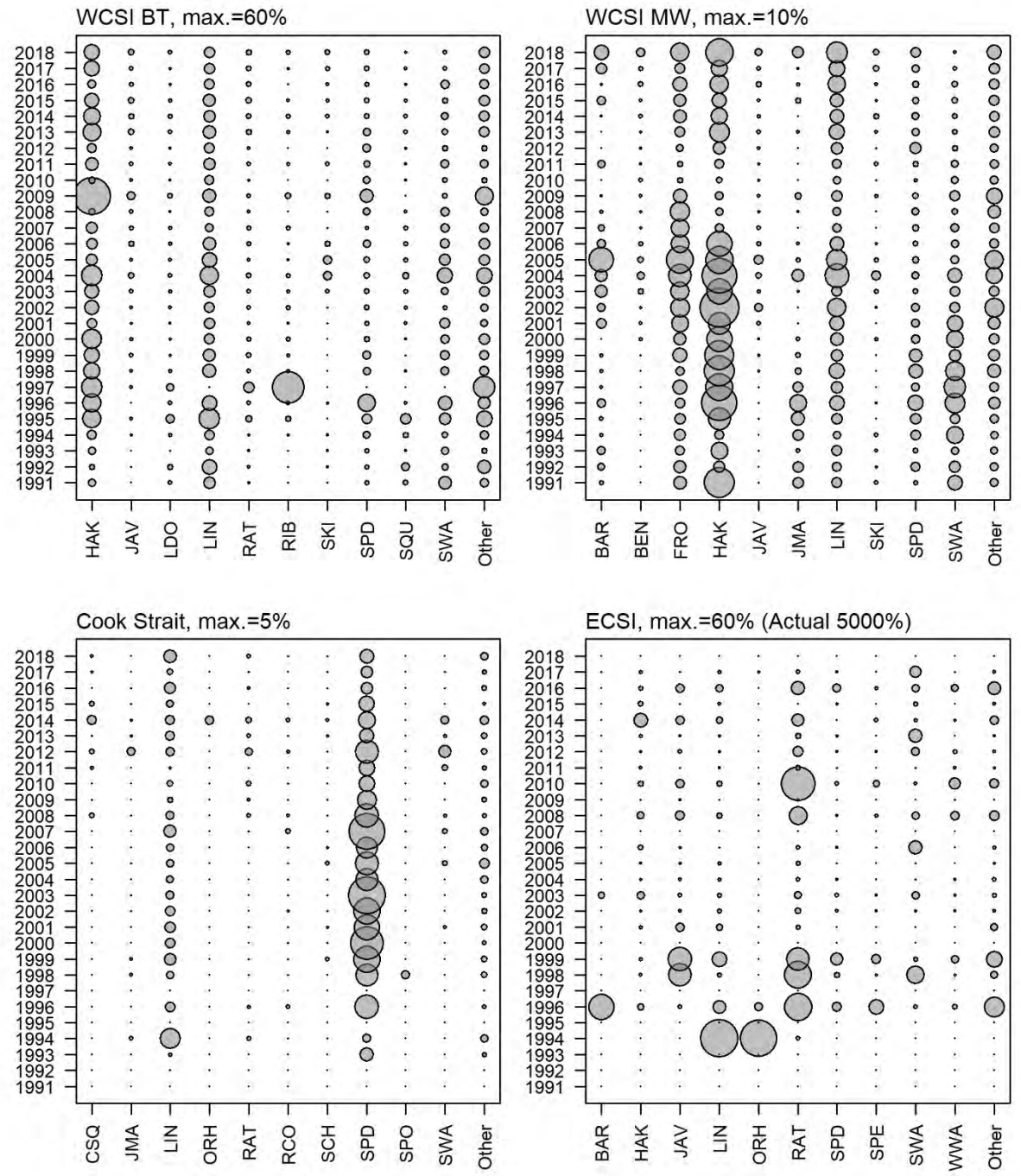


Figure 15: Bycatch rates on vessels with Observer Programme observers in the hoki fishery for tows targeting hoki from 1990–91 to 2017–18. WCSI (bottom and midwater trawls), Cook Strait, and ECSI data cover the spawning season (June–September) only. No observer data for Cook Strait 1994–95 and 1996–97, Puysegur 1997–98 to 2008–09, and ECSI 2006–07. Bycatch rates not calculated where observed hoki catch was less than 100 t. Species chosen are the top eight by observed catch in an area. Species include: BAR, barracouta; BEN, Scabbardfish; BOE, black oreo; BNS, bluenose; BYS, alfonsino; BYX, alfonsino & long-finned beryx; CSQ, leafscale gulper shark; FRO, frostfish; GSP, pale ghost shark; HAK, hake; JAV, javelinfish; JMA, jack mackerels; LDO, lookdown dory; LIN, ling; MDO, mirror dory; ORH, orange roughy; RAT, rattails; RBM, rays bream; RCO, red cod; RIB, ribaldo; SBW, southern blue whiting; SCH, school shark; SKI, gemfish; SND, shovelnose dogfish; SPD, spiny dogfish; SPE, sea perch; SPO, rig; SQU, arrow squid; SWA, silver warehou; and WWA, white warehou.

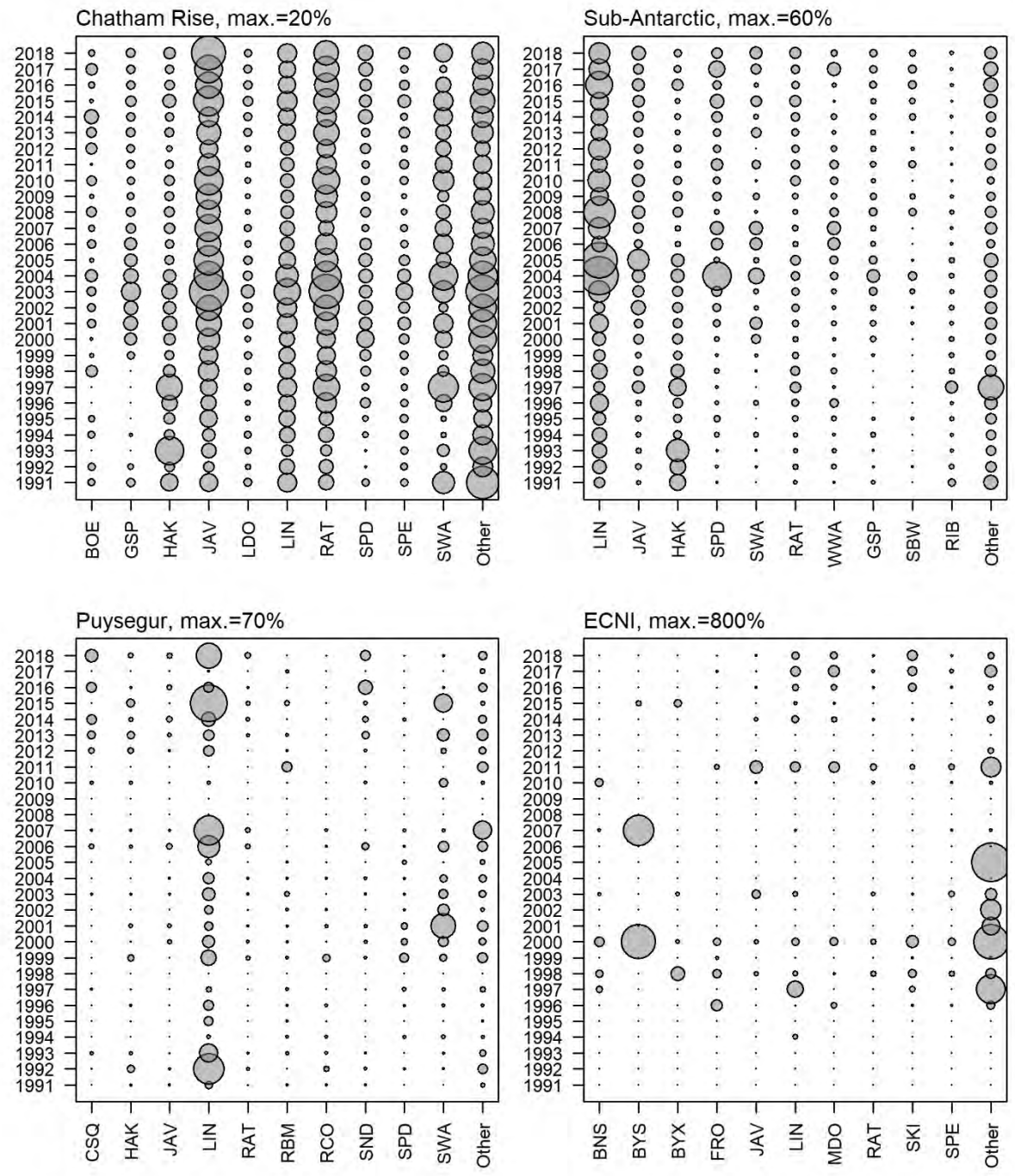


Figure 15: continued.

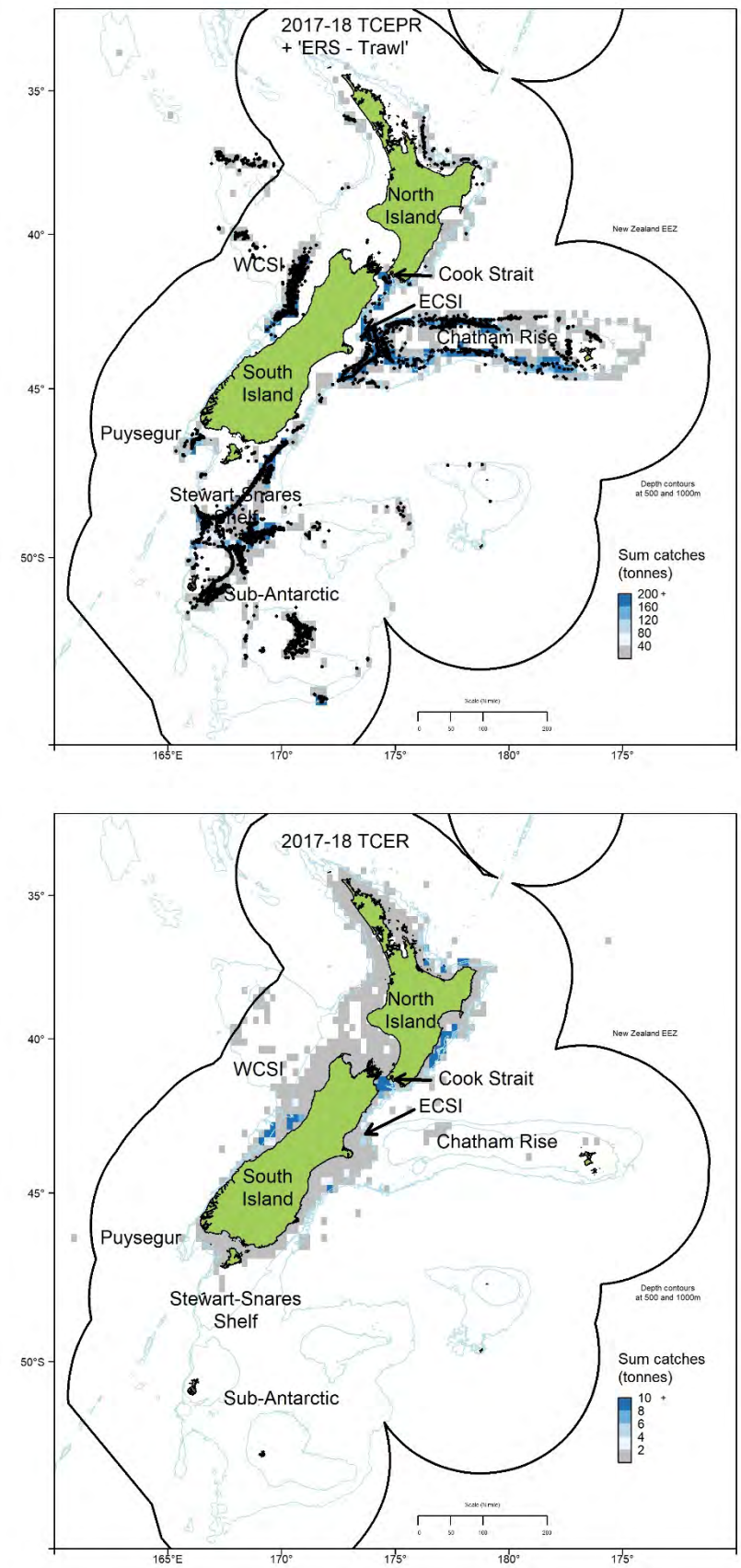


Figure 16: Density plots of all commercial trawls where hoki was caught and tow position recorded in the 2017–18 fishing year. Upper panel are data recorded on TCEPR + ERS. Lower panel are data recorded on TCER. TCEPR + ERS plot also shows observed tow positions as black dots.

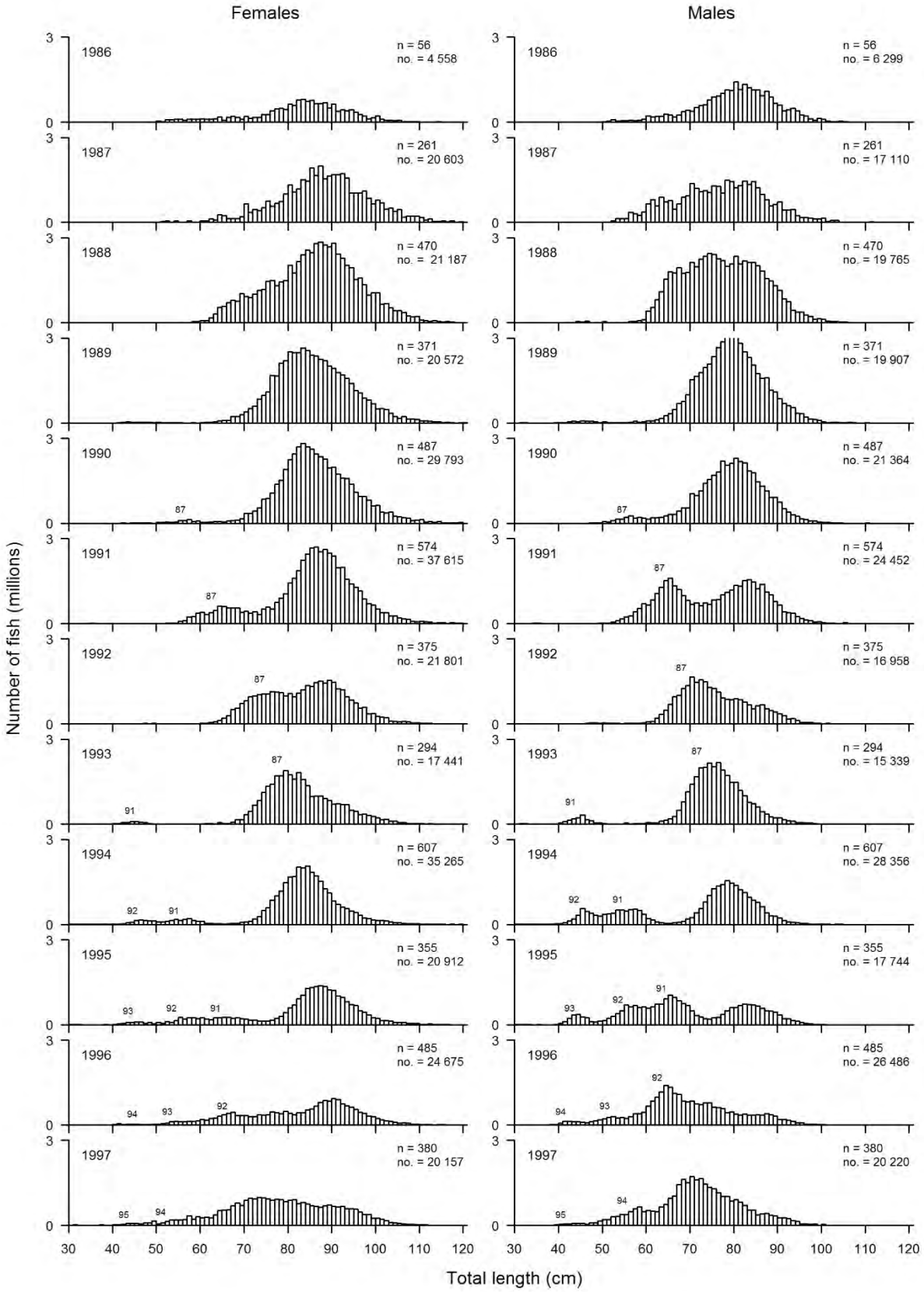


Figure 17: Length frequency distributions of hoki in commercial catches from the west coast South Island spawning fishery from 1989 to 1997 sampled at sea by the Observer Programme. n, number of tows sampled; no., number of fish sampled. Numbers above the histograms mark estimated year-class modes, e.g., 91 = 1991 year-class.

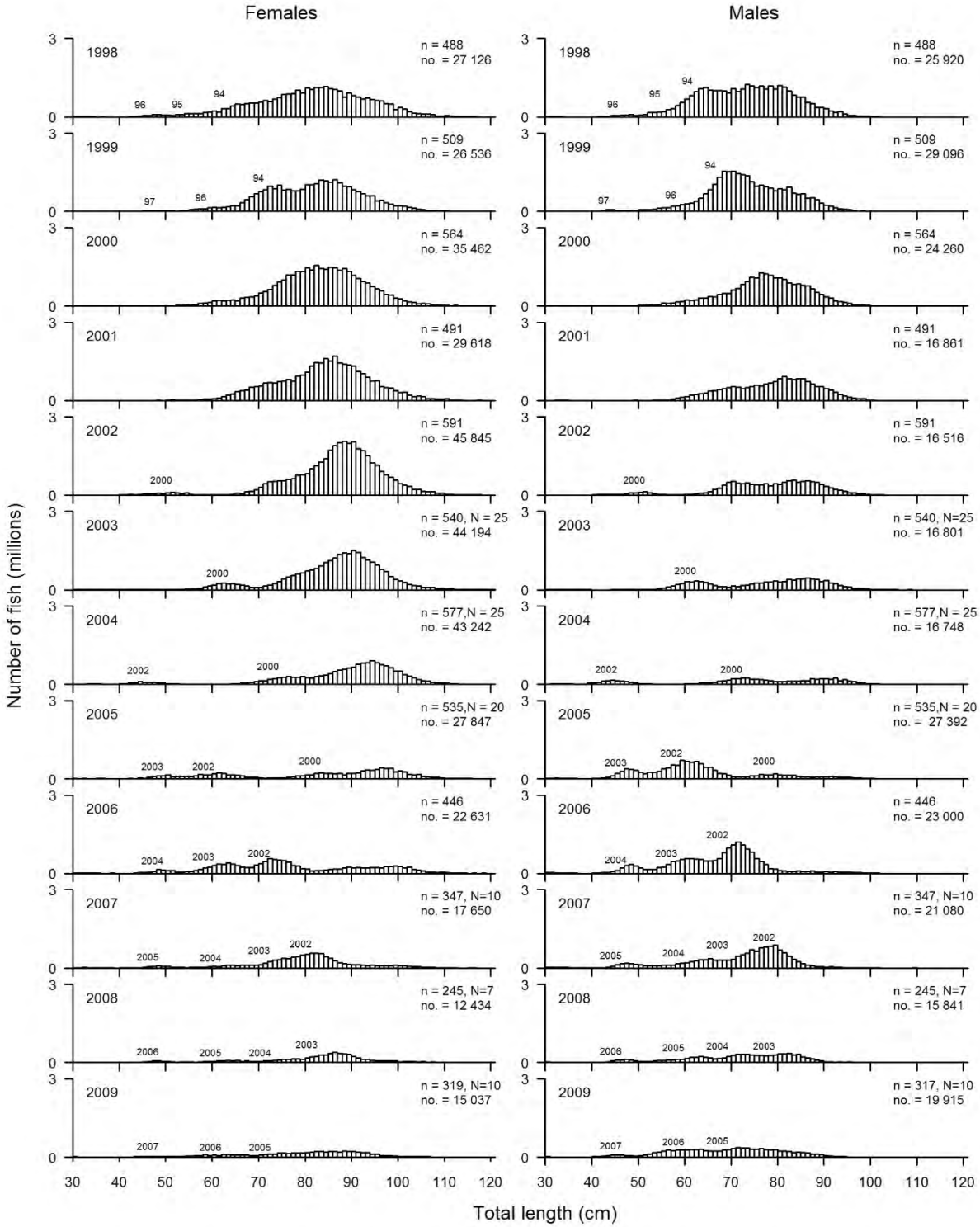


Figure 17 continued. Length frequency distributions of hoki in commercial catches from the west coast South Island spawning fishery from 1998 to 2009 sampled at sea by the Observer Programme. In 2003–05 and 2007–09, Observer Programme data were combined with samples of landings from inside the 25 n. mile line sampled by NIWA. n, number of tows sampled; N, number of landings sampled by NIWA; no., number of fish sampled. Numbers above the histograms mark estimated year-class modes, e.g., 2004 = 2004 year-class.

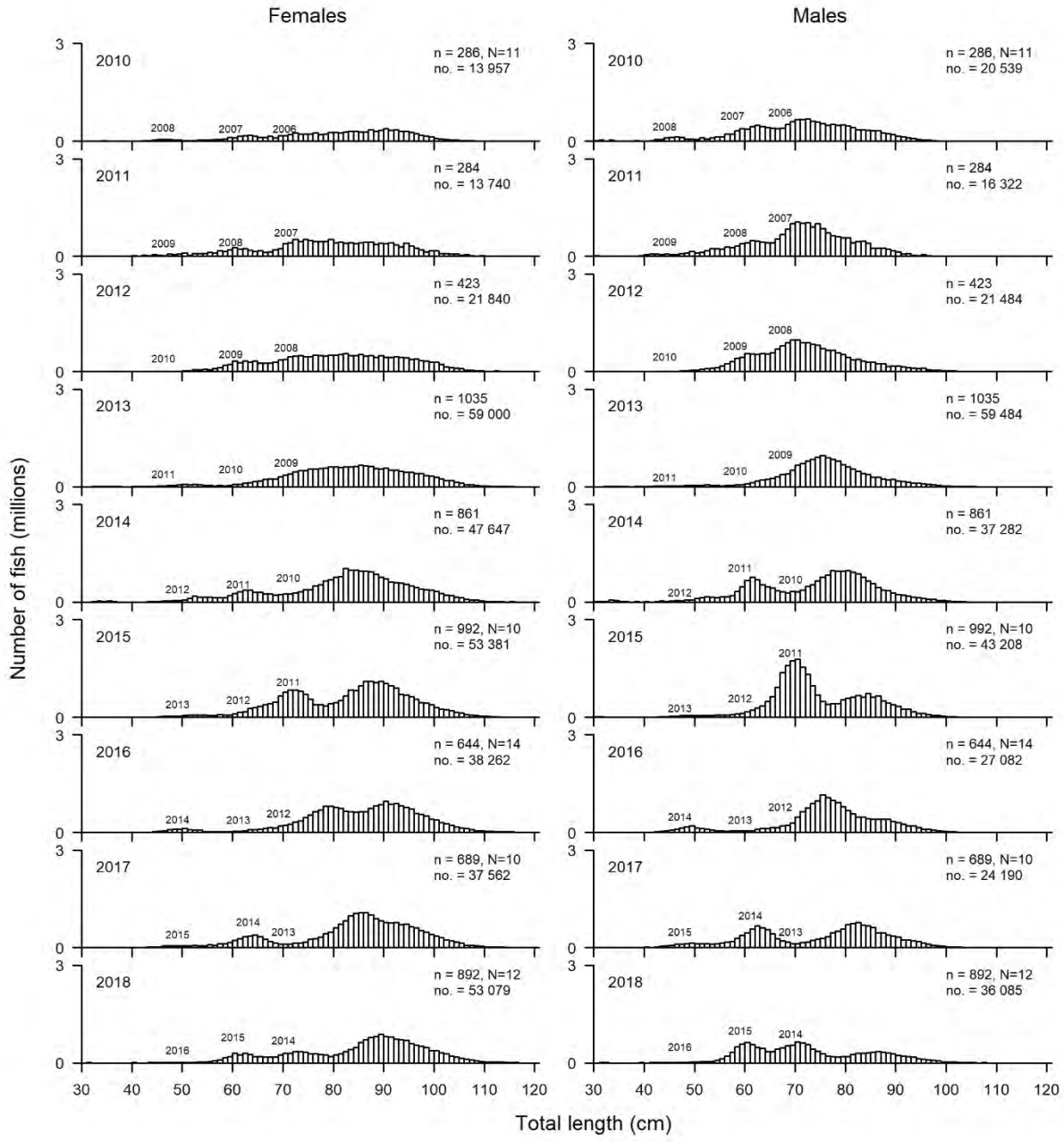


Figure 17 continued. Length frequency distributions of hoki in commercial catches from the west coast South Island spawning fishery from 2010 to 2018. In 2010, and 2015–2018, Observer Programme data were combined with land-based samples from inside the 25 n. mile line sampled by NIWA. n, number of tows sampled; no., number of fish sampled; N, number of landings sampled by NIWA. Numbers above the histograms mark estimated year-class modes, e.g., 2007 = 2007 year-class.

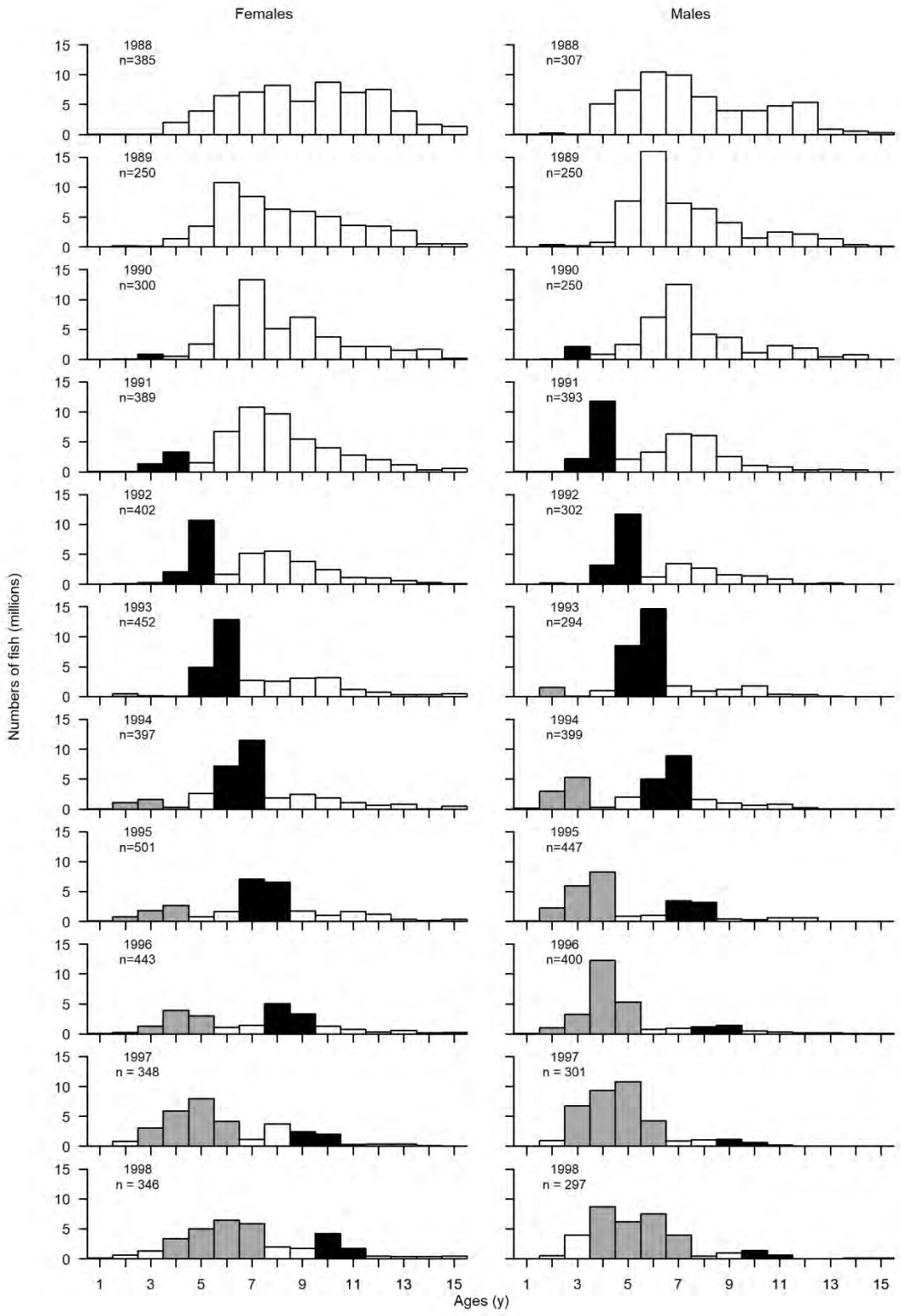


Figure 18: Catch-at-age of hoki in commercial catches from the west coast South Island spawning fishery from 1988 to 2018. n, number of fish aged. Black bars show 1987 and 1988 year-classes and dark grey bars show 1991–94 year-classes.

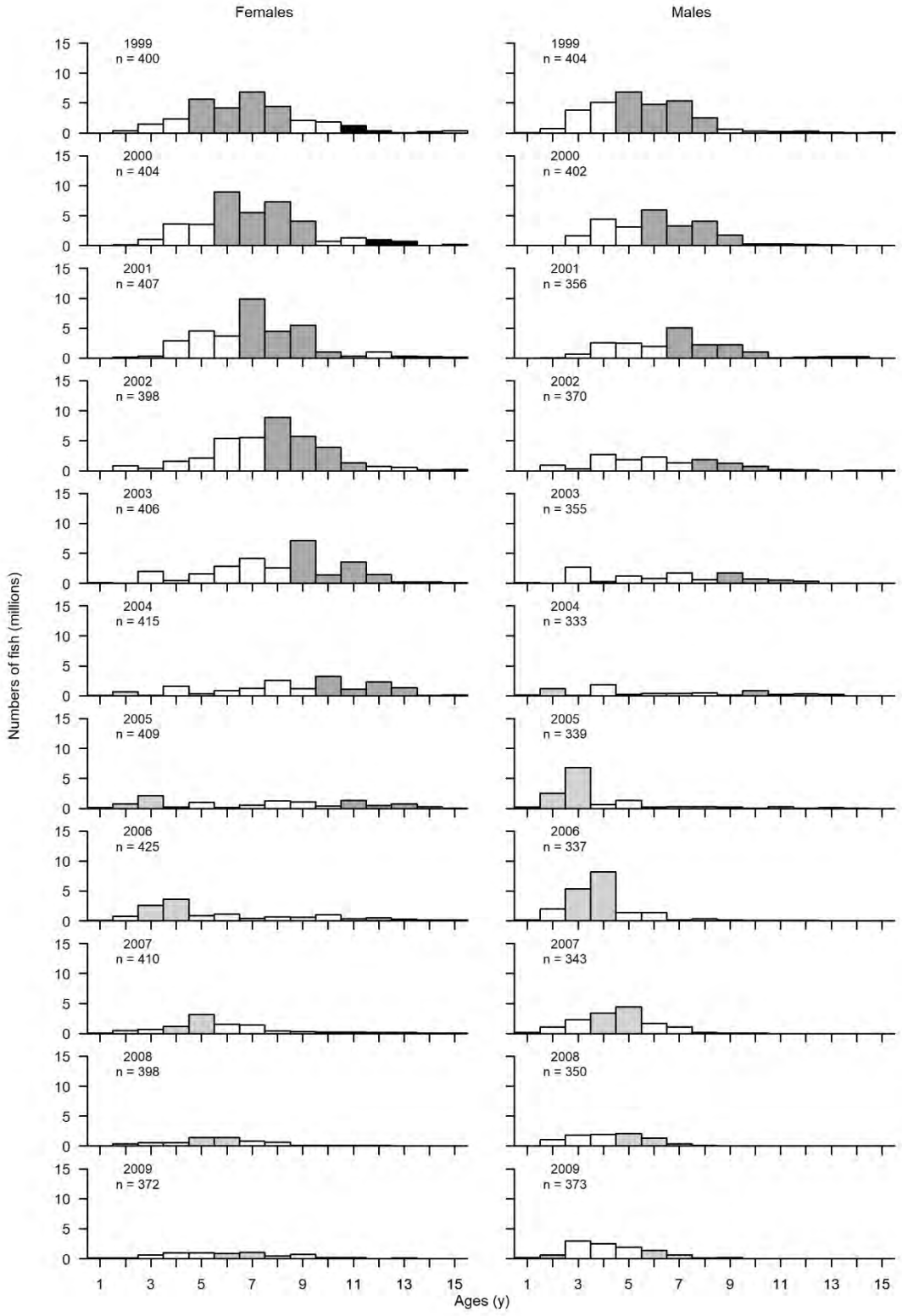


Figure 18 continued. Black bars show 1987 and 1988 year-classes and dark grey bars show 1991–94 year-classes, and light grey bars (from 2004 on) represent the 2002 and 2003 year classes.

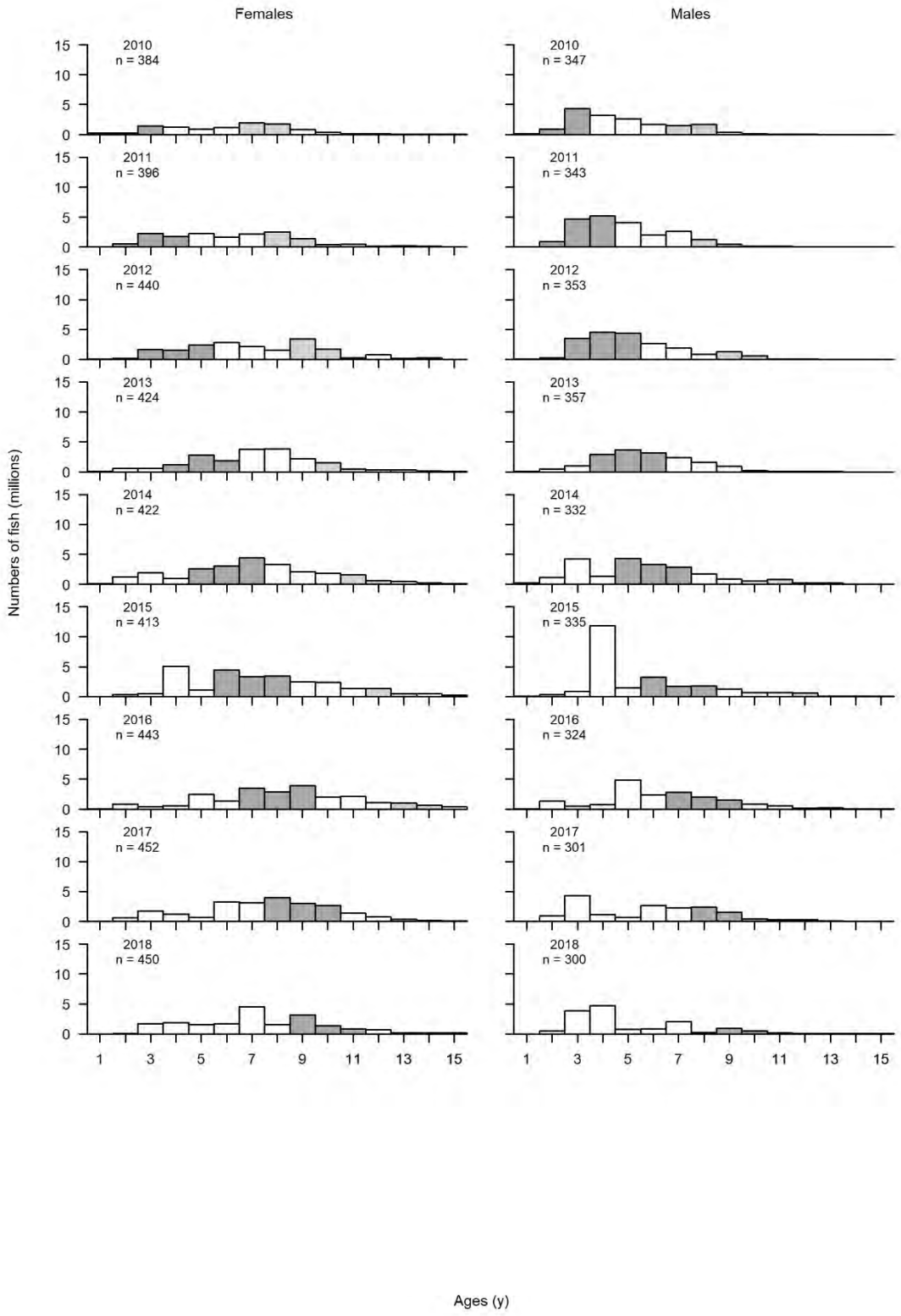


Figure 18 continued. Light grey bars represent the 2003 and 2002 year classes, and dark grey bars represent the 2007–2009 year classes.

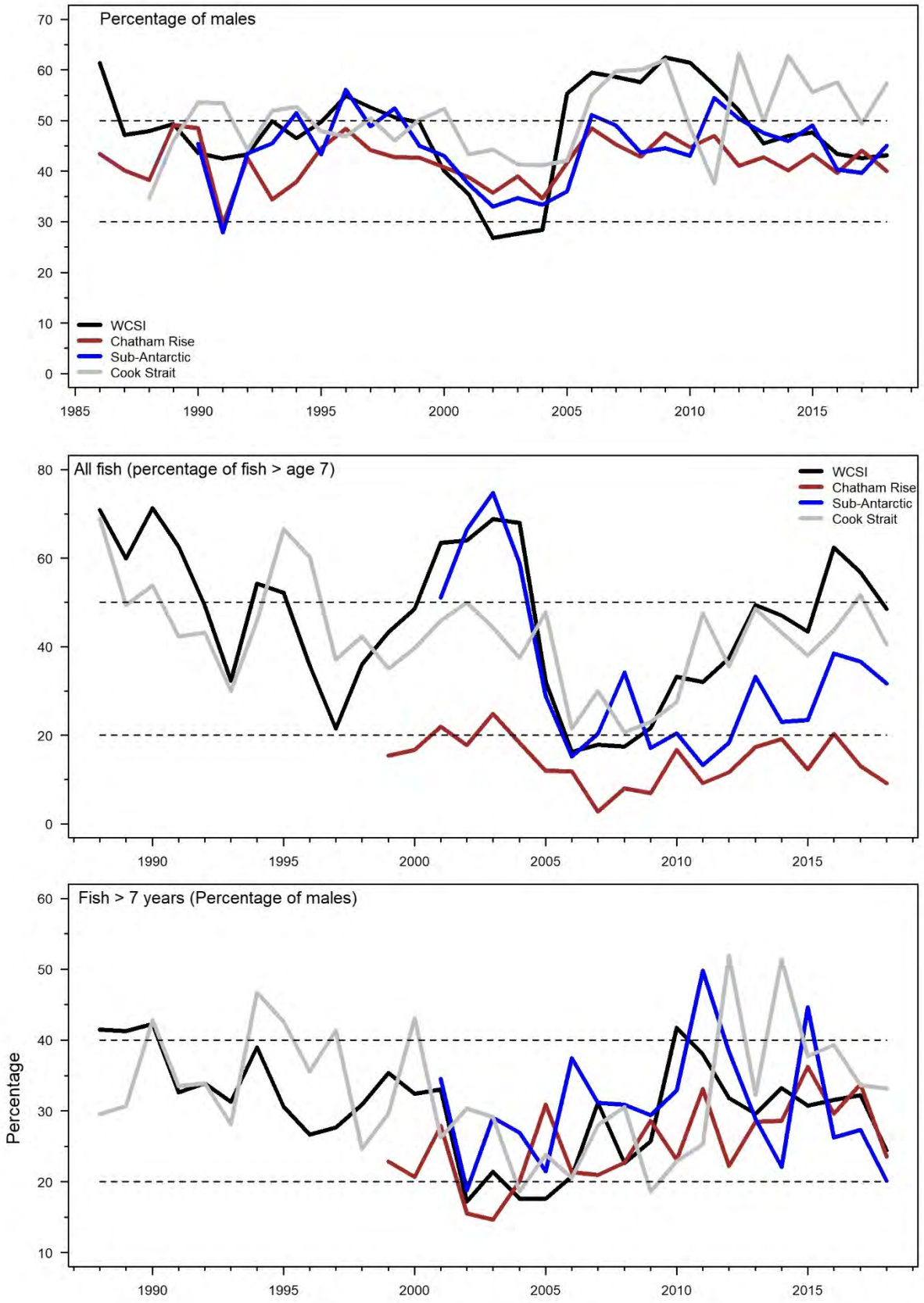


Figure 19a: Percentage of males in the catch, percentage of all fish aged 7 and older in the catch, and percentage of male fish (older than seven) in the catch, by area and fishing year. Legend for middle panel also applies to lower panel.

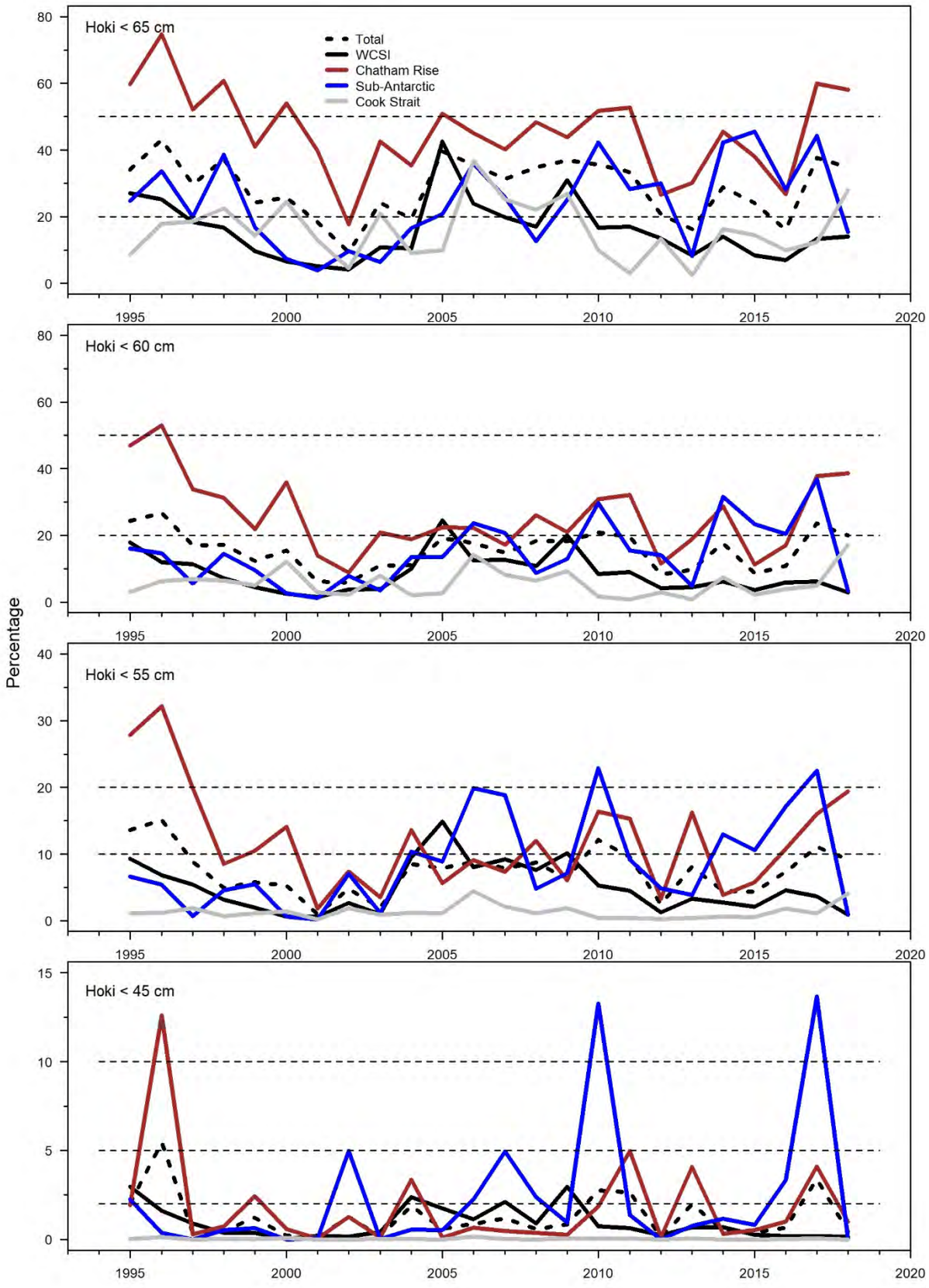


Figure 19b: Percentage of small fish in the catch by area and fishing year. Legend for top panel also applies to other panels.

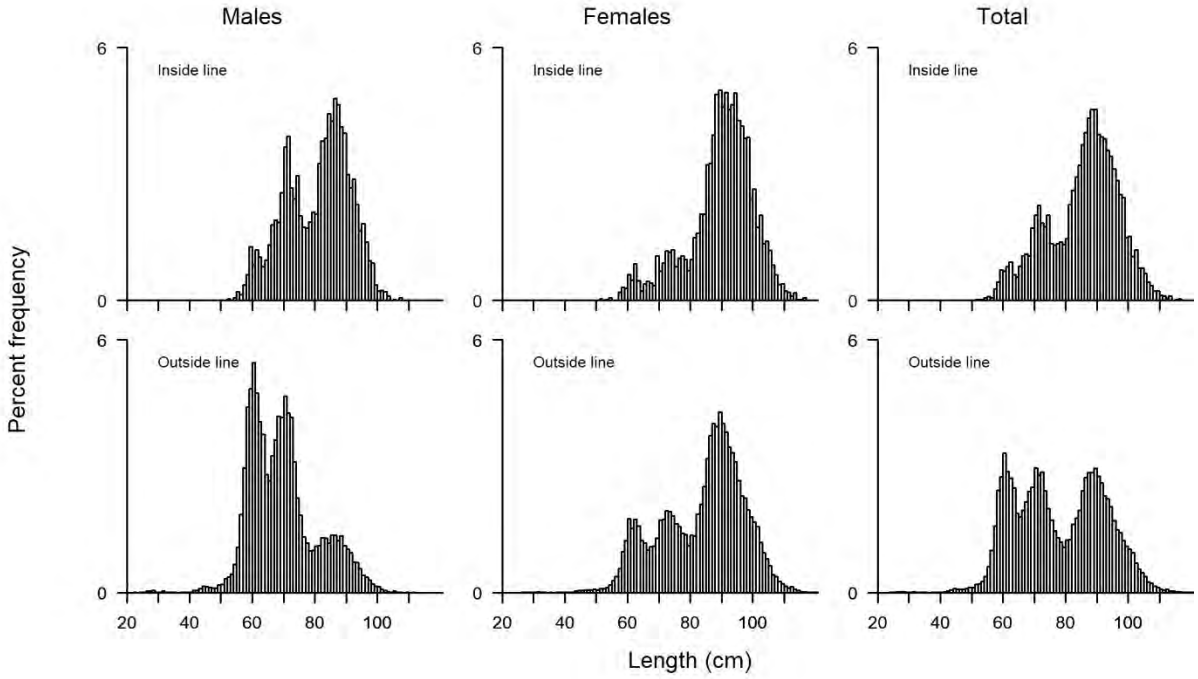


Figure 20: Comparison of length frequency distributions for WCSI hoki from inside and outside the 25 n. mile line in 2018. Inside the line length frequency distributions came from fish sampled at sea by the Observer Programme and from fish sampled in processing sheds by the NIWA land-based sampling programme, and outside the line length frequency distributions came from fish sampled at sea by the Observer Programme.

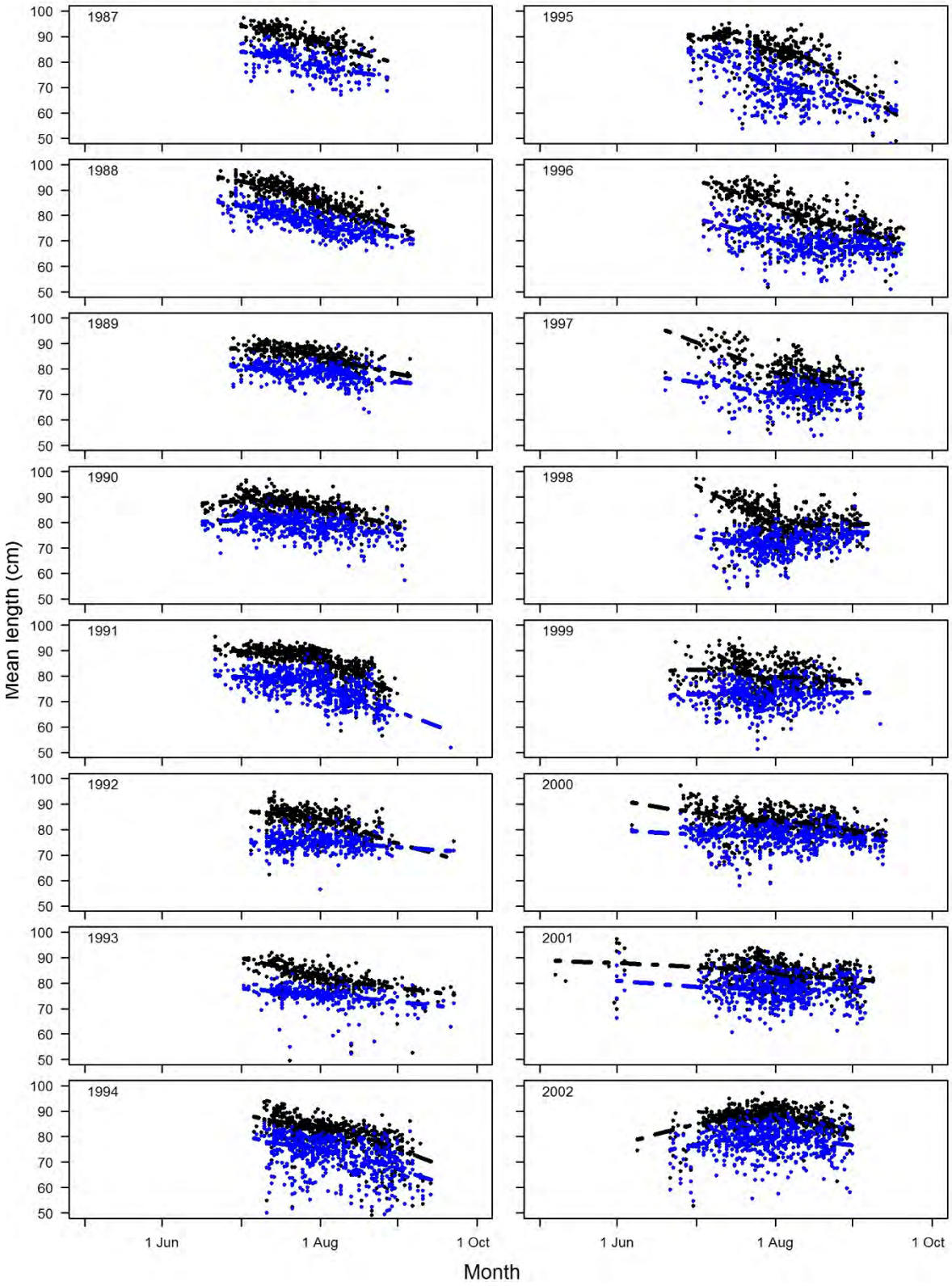


Figure 21: Mean length of female (black) and male (blue) hoki taken in commercial catches from the west coast South Island spawning fishery 1987–2018 sampled at sea by the Observer Programme. Dashed lines are a loess fit.

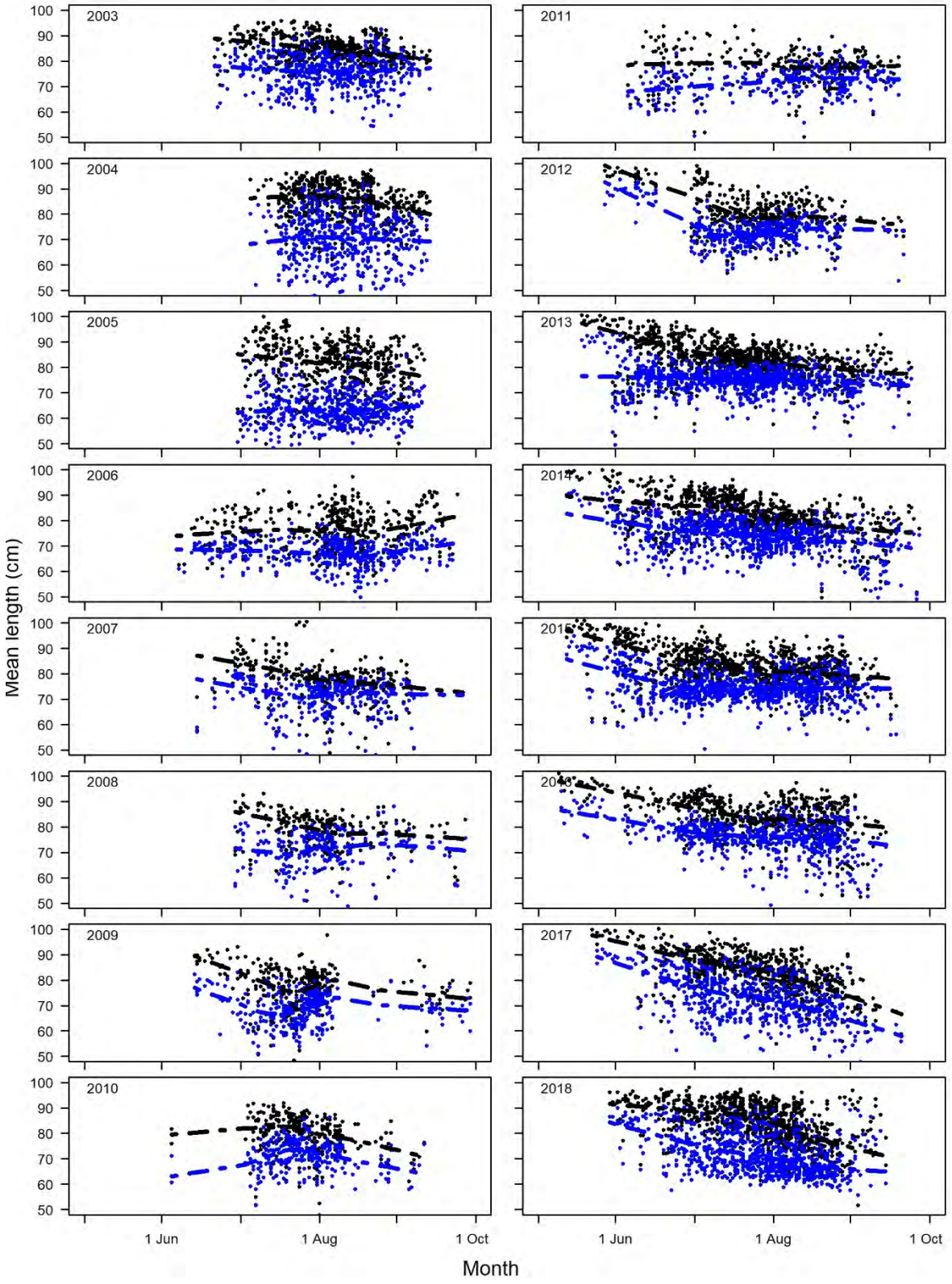


Figure 21 continued.

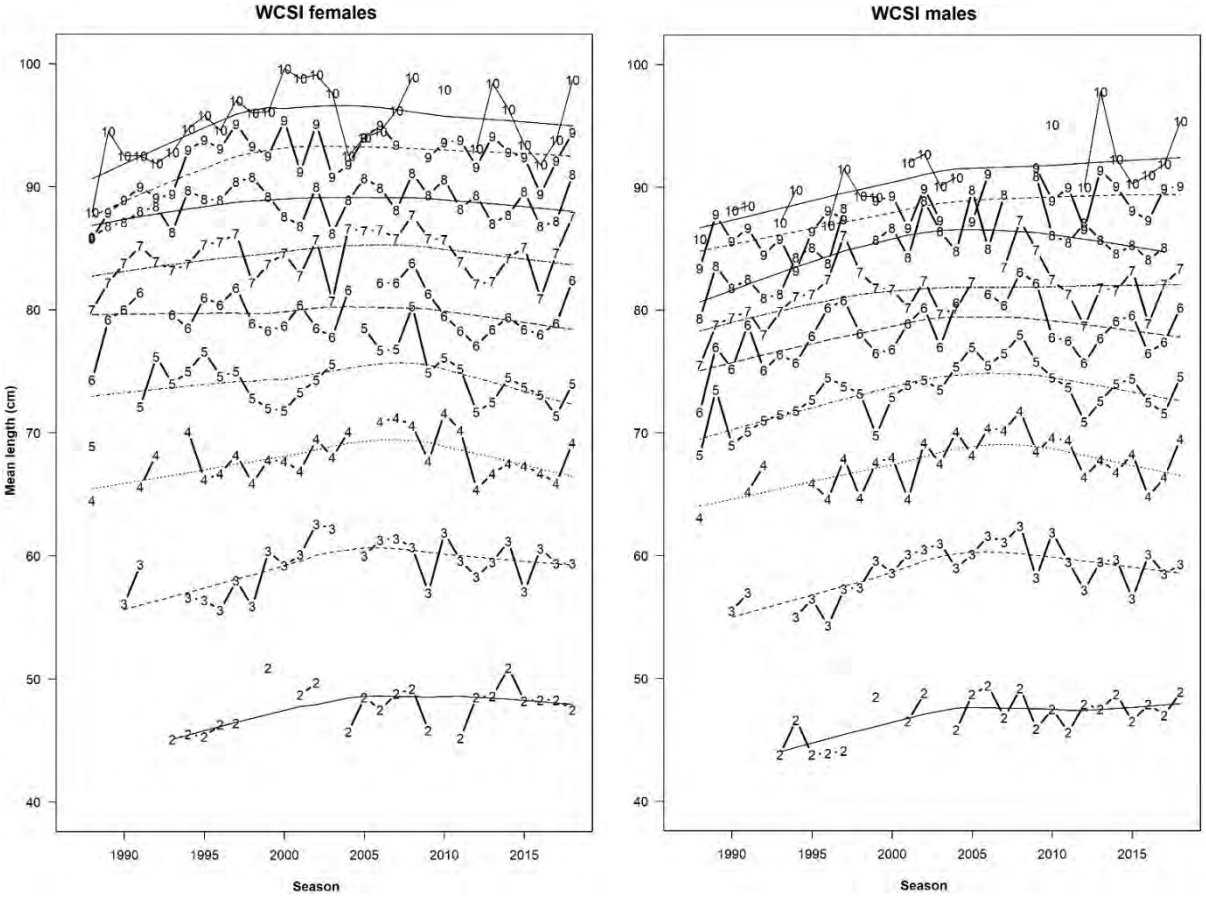


Figure 22: Mean length-at-age of female and male hoki taken in commercial catches from the west coast South Island spawning fishery 1988–2018 sampled at sea by the Observer Programme, and by NIWA in a land-based sampling programme in some years. Lines are a loess fit. Points with fewer than ten records were excluded.

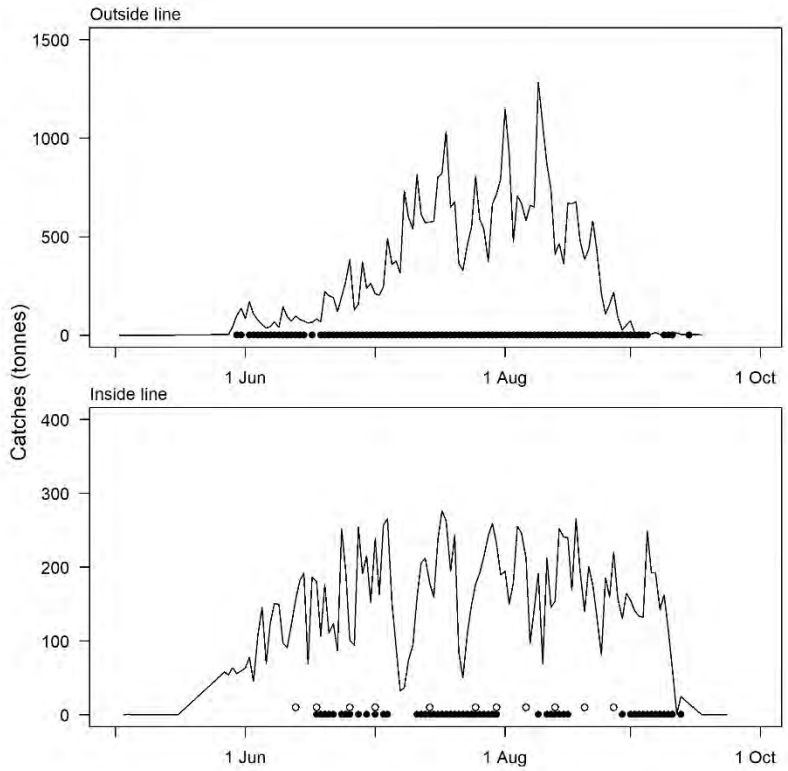


Figure 23a: WCSI 2018 catch by day for vessels from inside and outside the 25 n. mile line during the spawning season, showing timing of Observer Programme samples (black dots), and land-based samples (hollow dots).

(a)

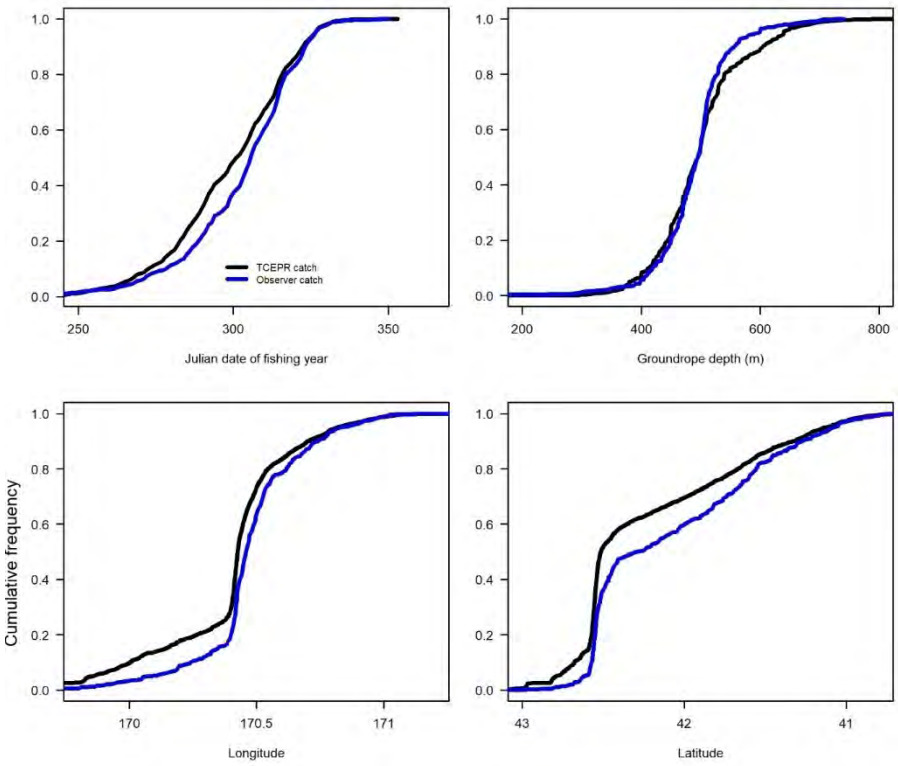


Figure 23b: Comparison of WCSI 2017–18 Observer Programme catch coverage outside the 25 n. mile line with TCEPR (includes ERS-trawl) catches by day of year, depth, latitude, and longitude. If sampling is representative of the fishery, then the blue lines (observed catches) should overlay the black lines (TCEPR and ERS-trawl catch).

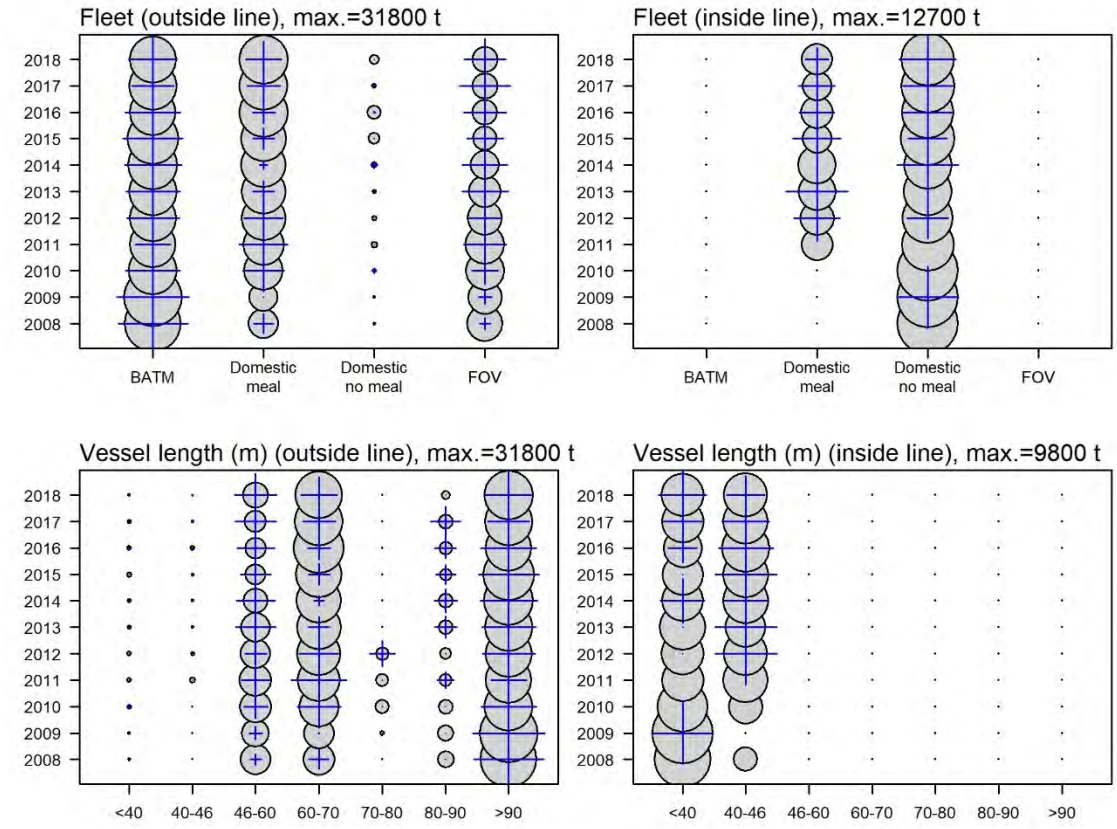
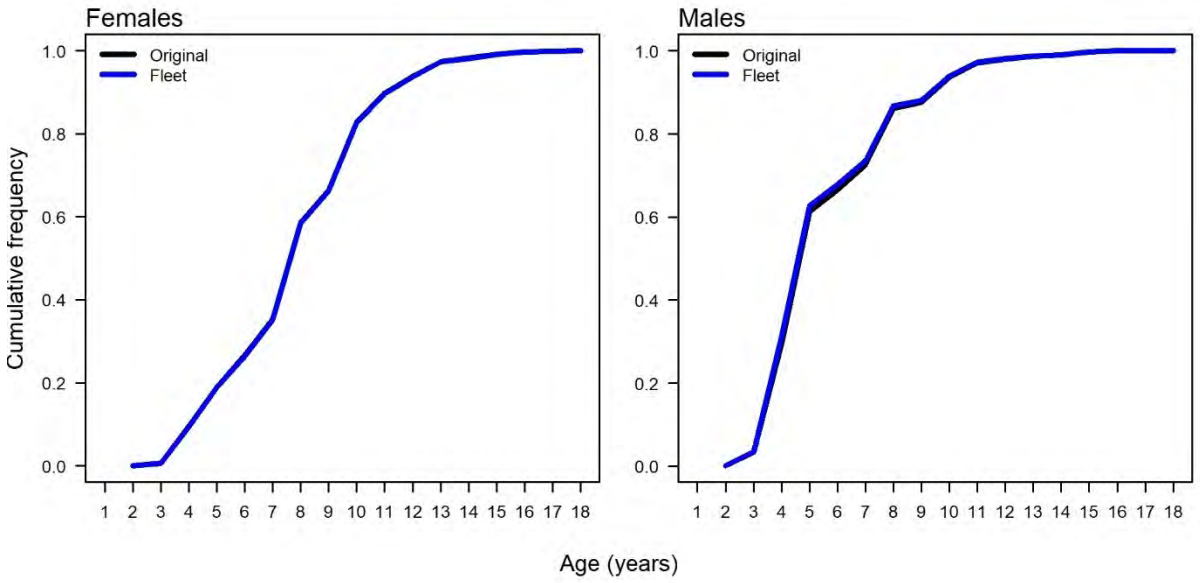


Figure 23c: Representativeness of observer sampling of WCSI hoki catch by fishing year and fleet or vessel length inside and outside the 25 n. mile line. Circles show the proportion of catch by fleet or vessel length within a year; crosses show the proportion of observed catch for the same cells. Representation is demonstrated by how closely the cross matches the circle diameter.



(b)

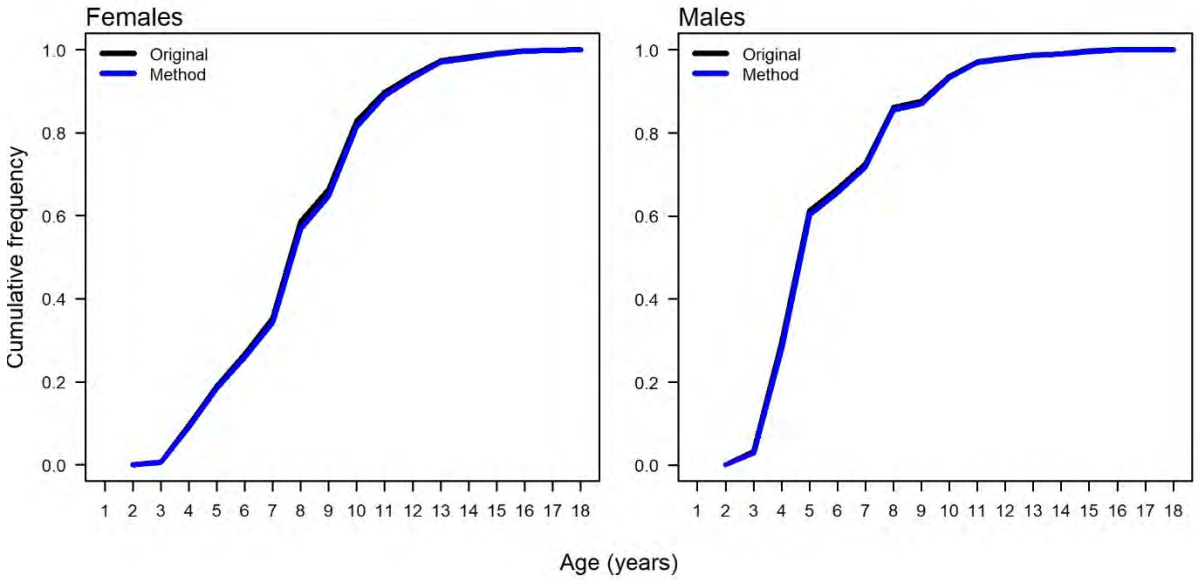


Figure 24: Cumulative 2017–18 WCSI frequency by age comparing original age frequencies with alternative post-stratification of fish size by (a) fleet or (b) fishing method. Original age frequencies are those presented in Figure 18 with length frequency stratification described in Table 7a.

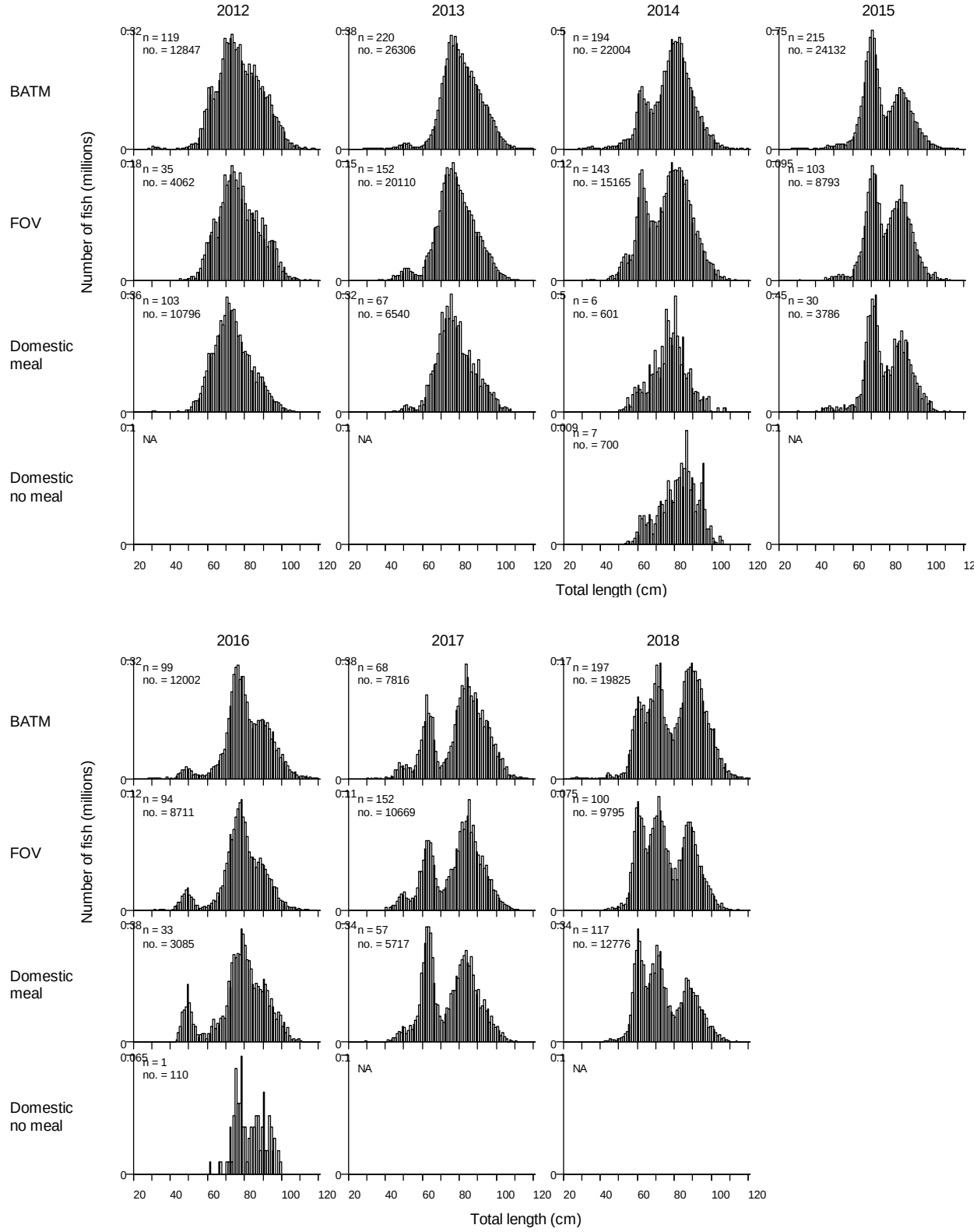


Figure 25: Scaled length frequency distributions by fleet for the WCSI 2012–2018 spawning seasons. Data is outside the 25 n. mile line and from mid-July to mid-August for each season. See Section 2.1.1 for definition of fleets.

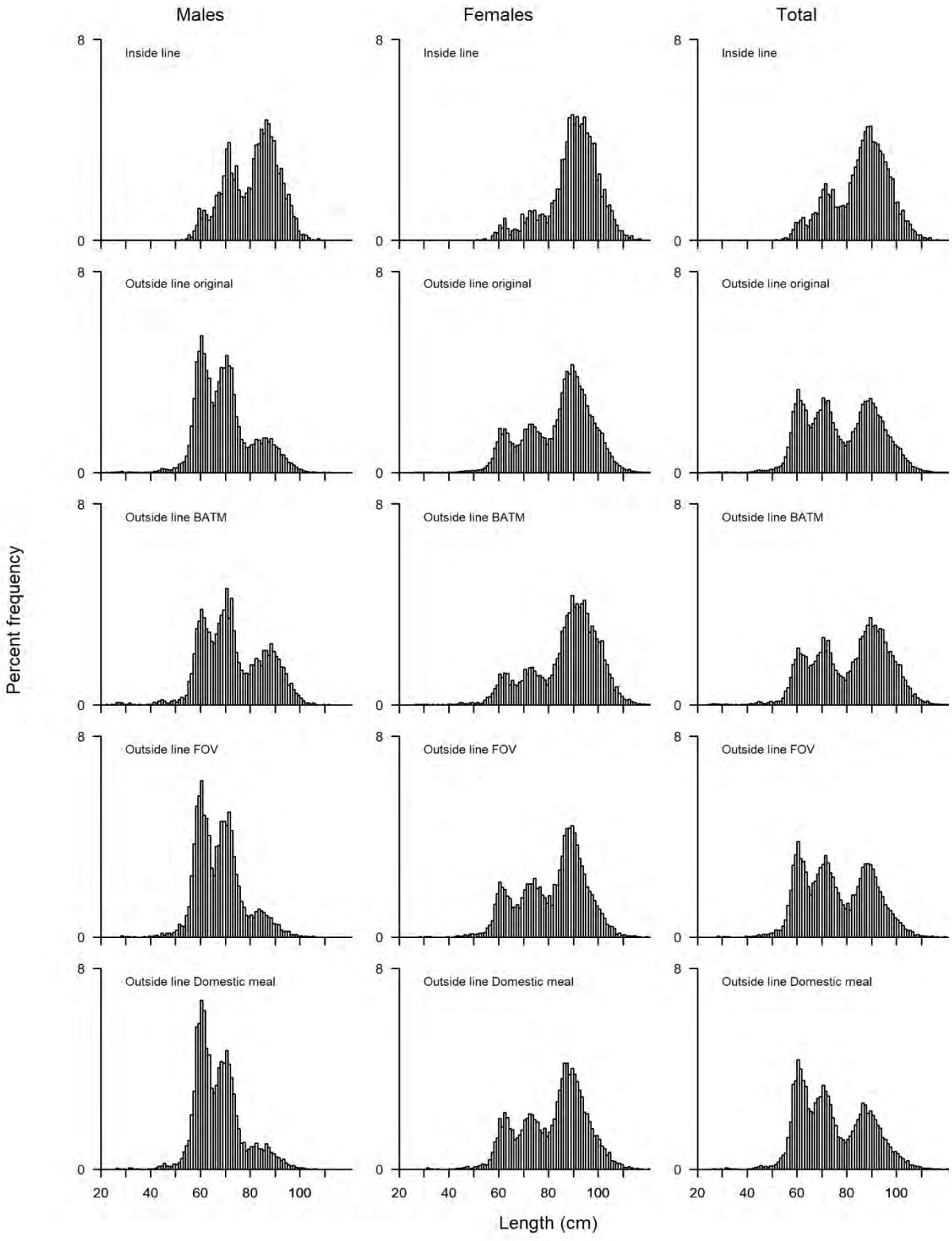


Figure 26a: Scaled length frequency distributions by fleet for the WCSI 2018 spawning season. See Section 2.1.1 for definition of fleets. Original length frequency distributions are those presented in Figure 18 with length frequency stratification described in Table 7a.

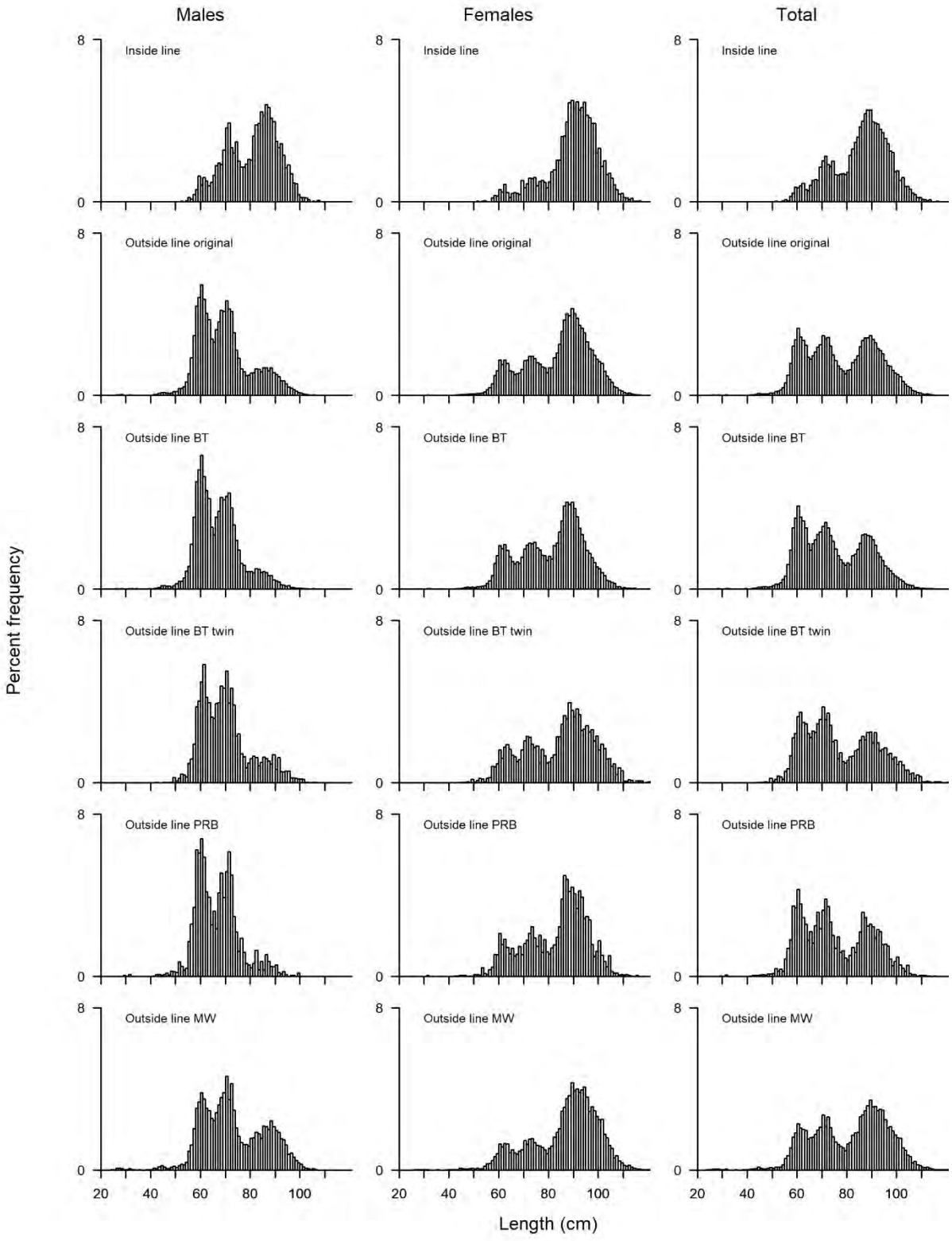


Figure 26b: Scaled length frequency distributions by fishing method for the WCSI 2018 spawning season. Original age frequency distributions are those presented in Figure 18 with length frequency stratification described in Table 7a.

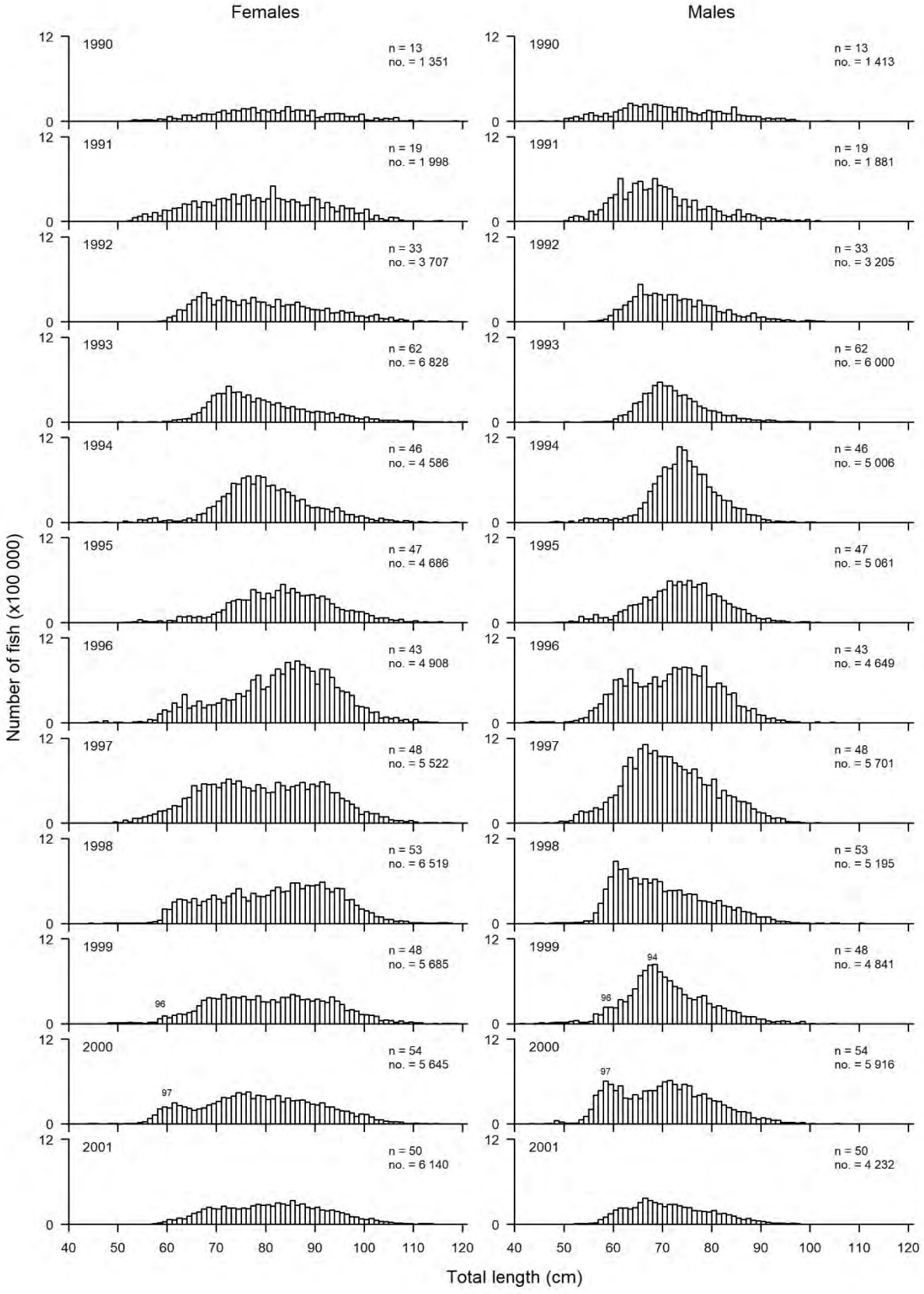


Figure 27: Length frequency distributions of hoki in commercial catches from the Cook Strait spawning fishery from 1990 to 2018 sampled by the land-based sampling programme, and at sea by the Observer Programme. n, number of landings sampled; no., number of fish sampled. Numbers above the histograms mark year-class modes, e.g., 91 = 1991 year-class.

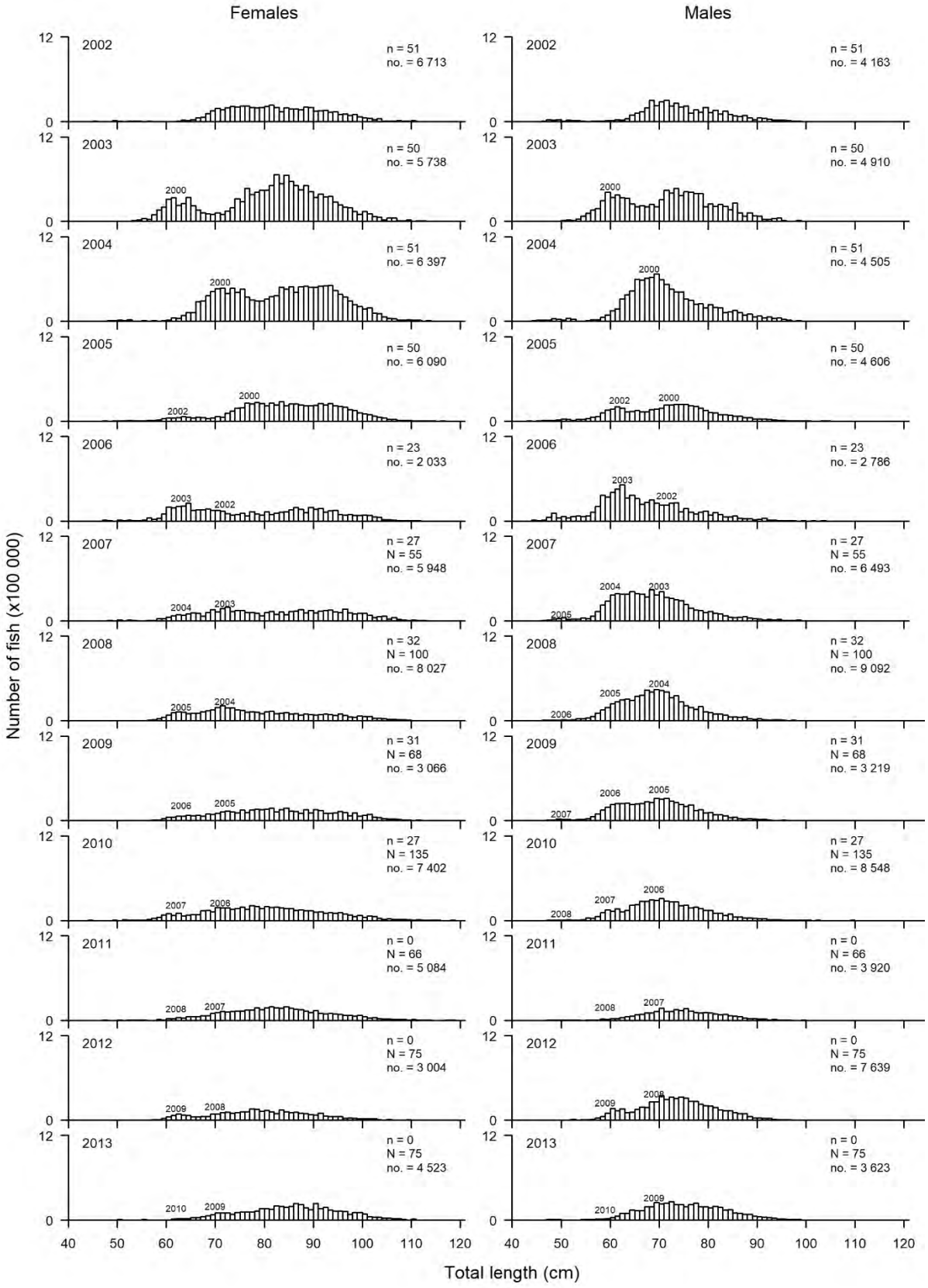


Figure 27 continued.

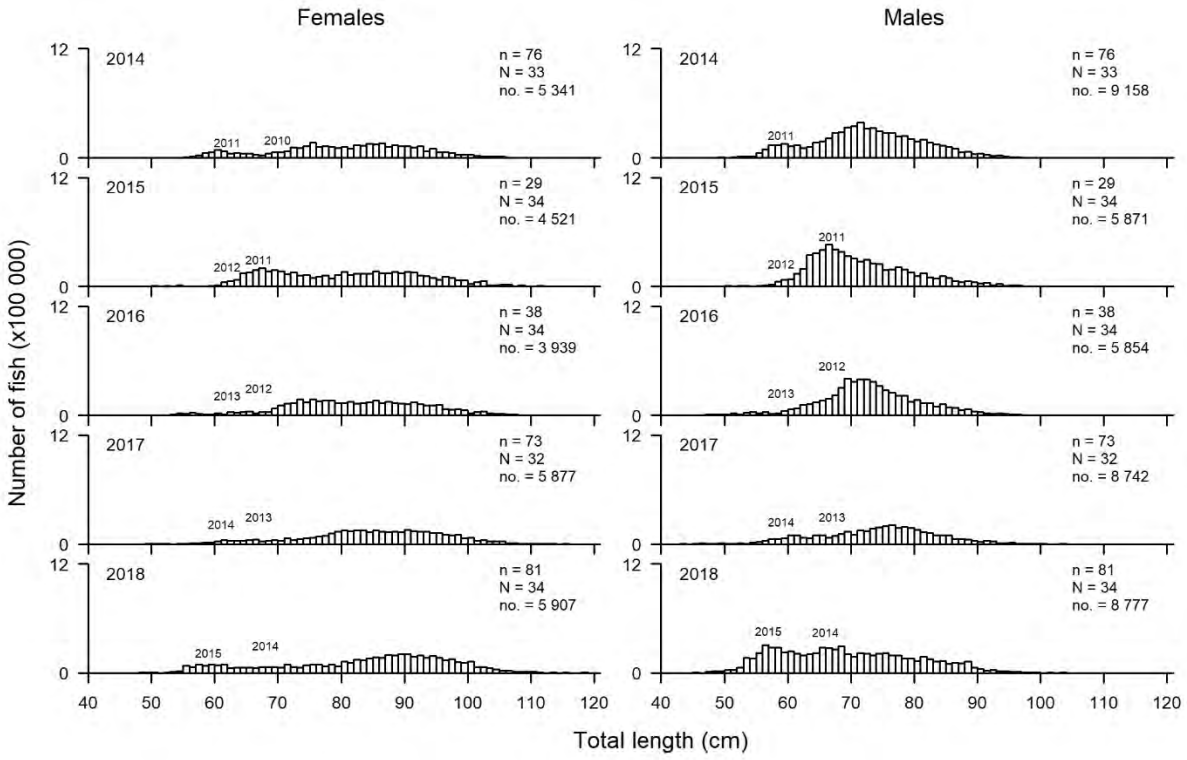


Figure 27 continued.

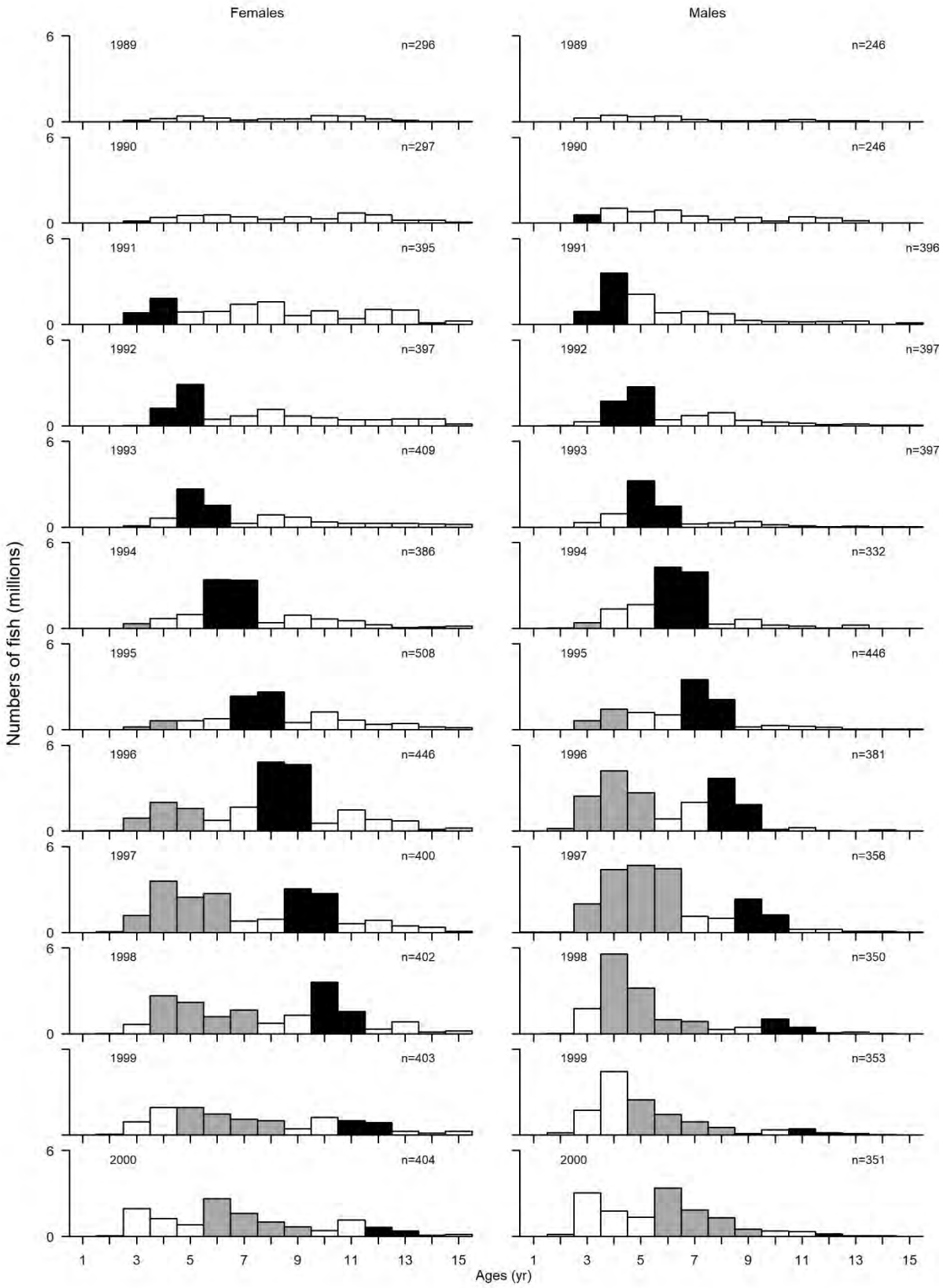


Figure 28: Catch-at-age of hoki in commercial catches from the Cook Strait spawning fishery from 1989 to 2018 sampled by the land-based sampling programme, and at sea by observers. 2006 data excluded Nelson land-based samples from vessels of at least 40 m length which sorted their catch at sea. Black bars show 1987 and 1988 year-classes; dark grey bars show 1991–94 year-classes.

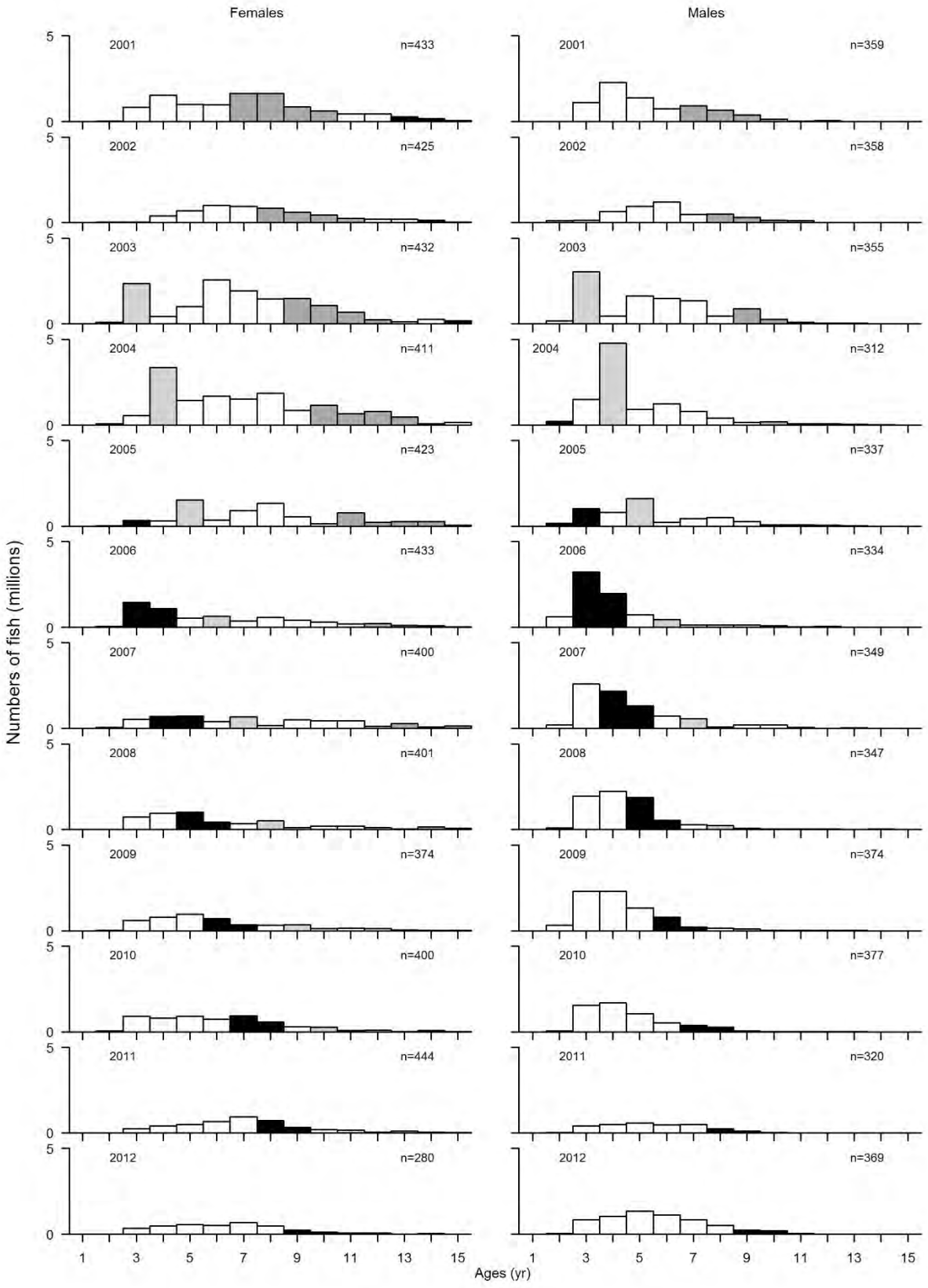


Figure 28 continued. Dark grey bars show 1991–94 year-classes; light grey bars show the 2000 year-class; and black bars show the 2002–2003 year-classes.

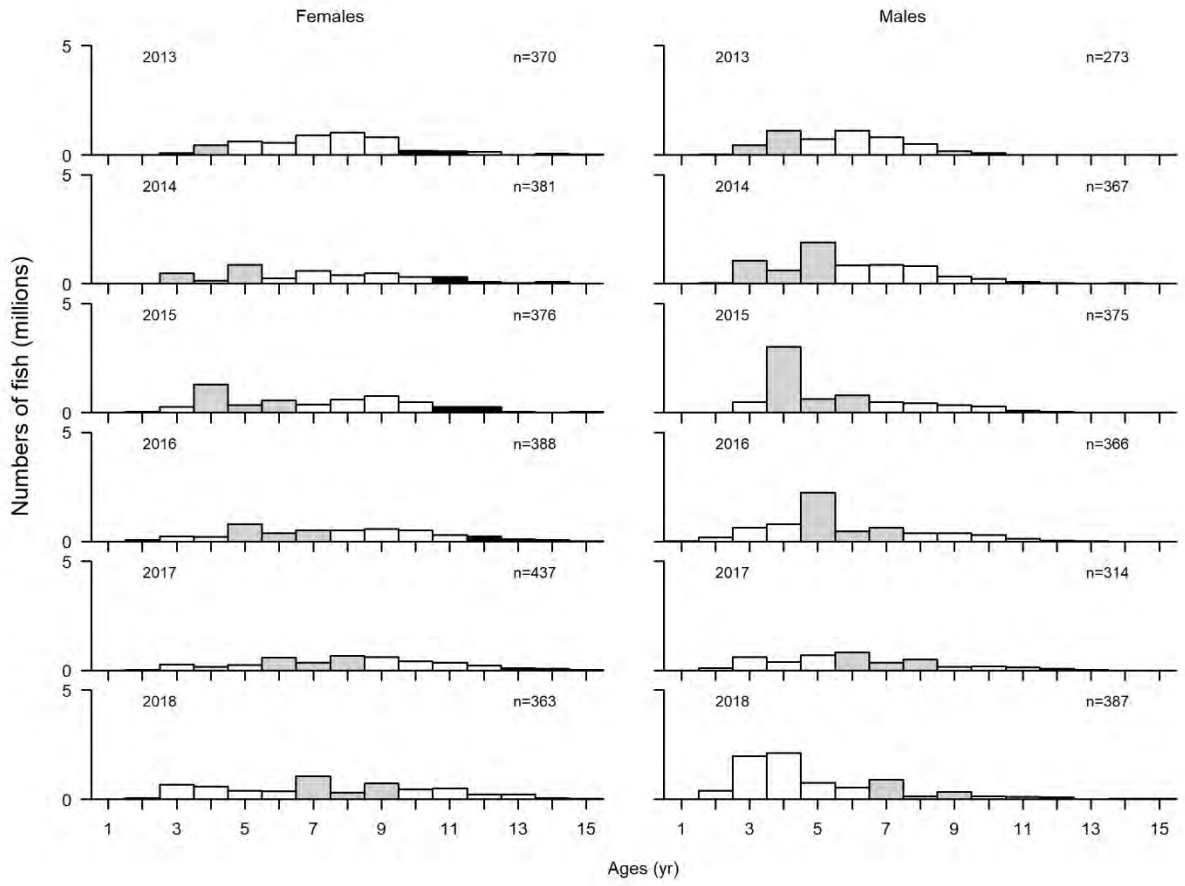


Figure 28 continued. Black bars show the 2002–2003 year-classes; dark grey bars represent the 2009–2011 year classes.

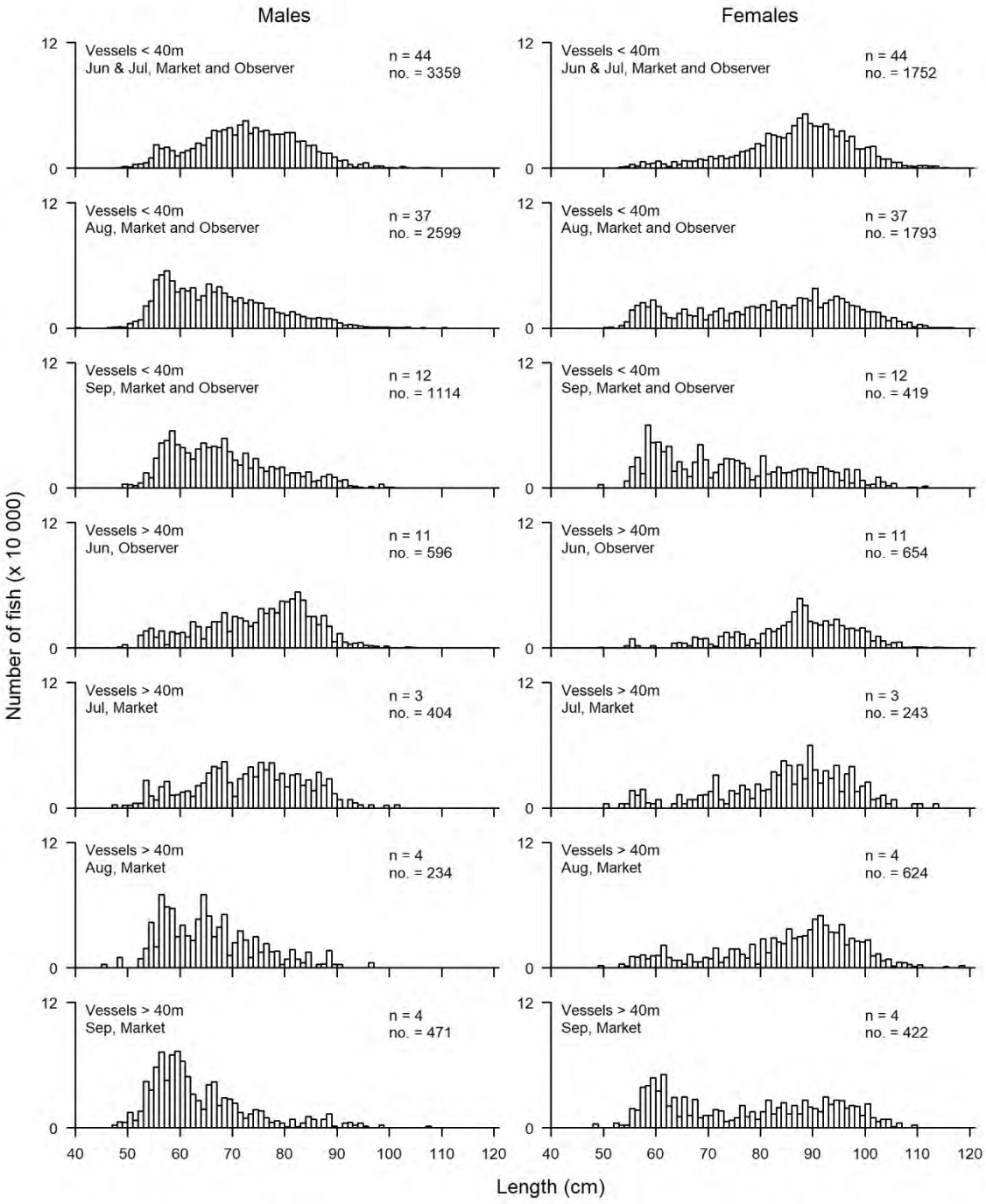


Figure 29: Comparison of length frequency distributions of hoki, by strata, taken in commercial catches from Cook Strait during 2018. Data from Observer Programme and land-based sampling. n, number of tows or landings sampled; no., number of fish sampled.

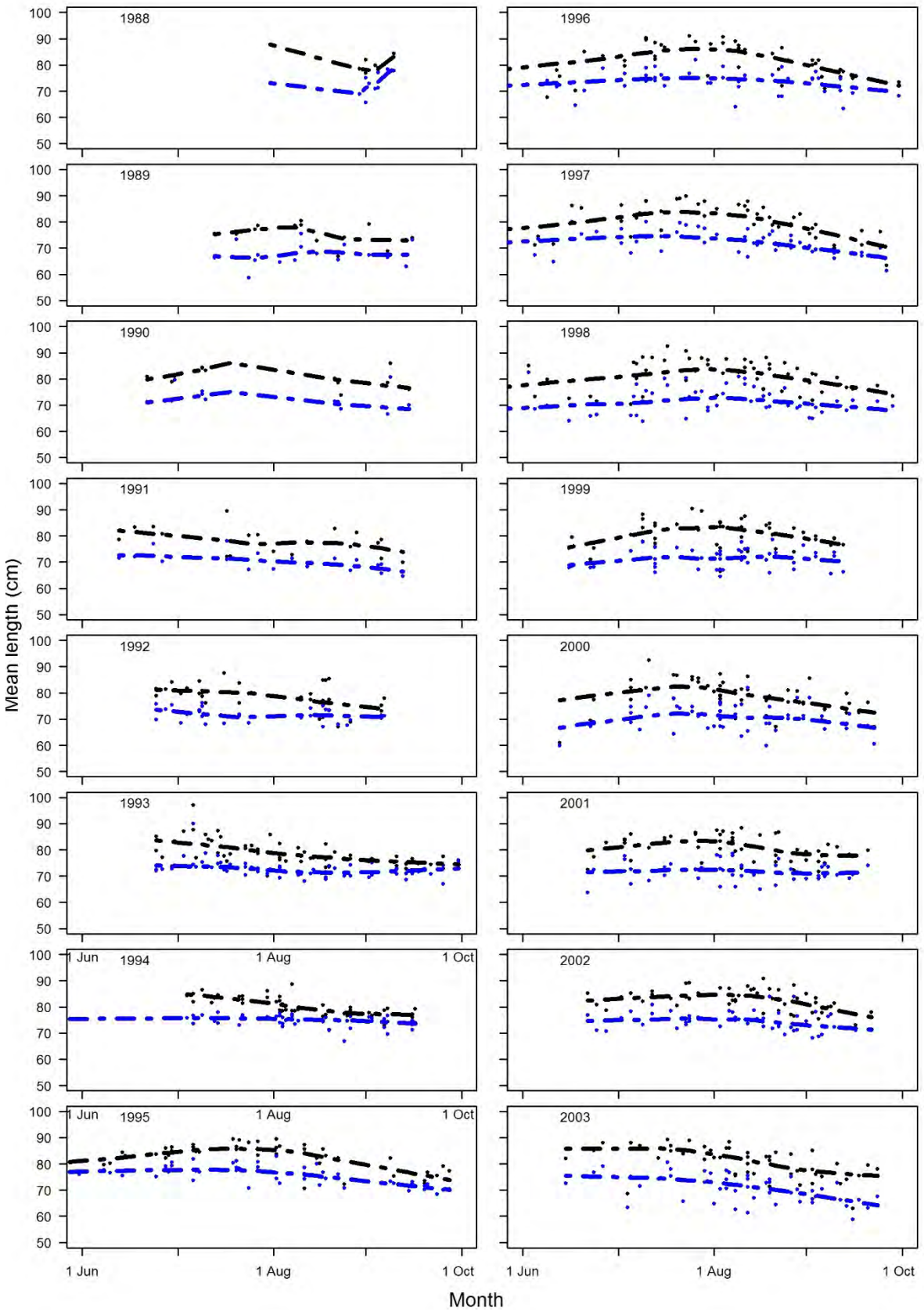


Figure 30: Mean length of female (black) and male (blue) hoki taken in commercial catches from the Cook Strait spawning fishery 1989–2018 sampled by NIWA in a land-based sampling programme. Lines are a loess fit.

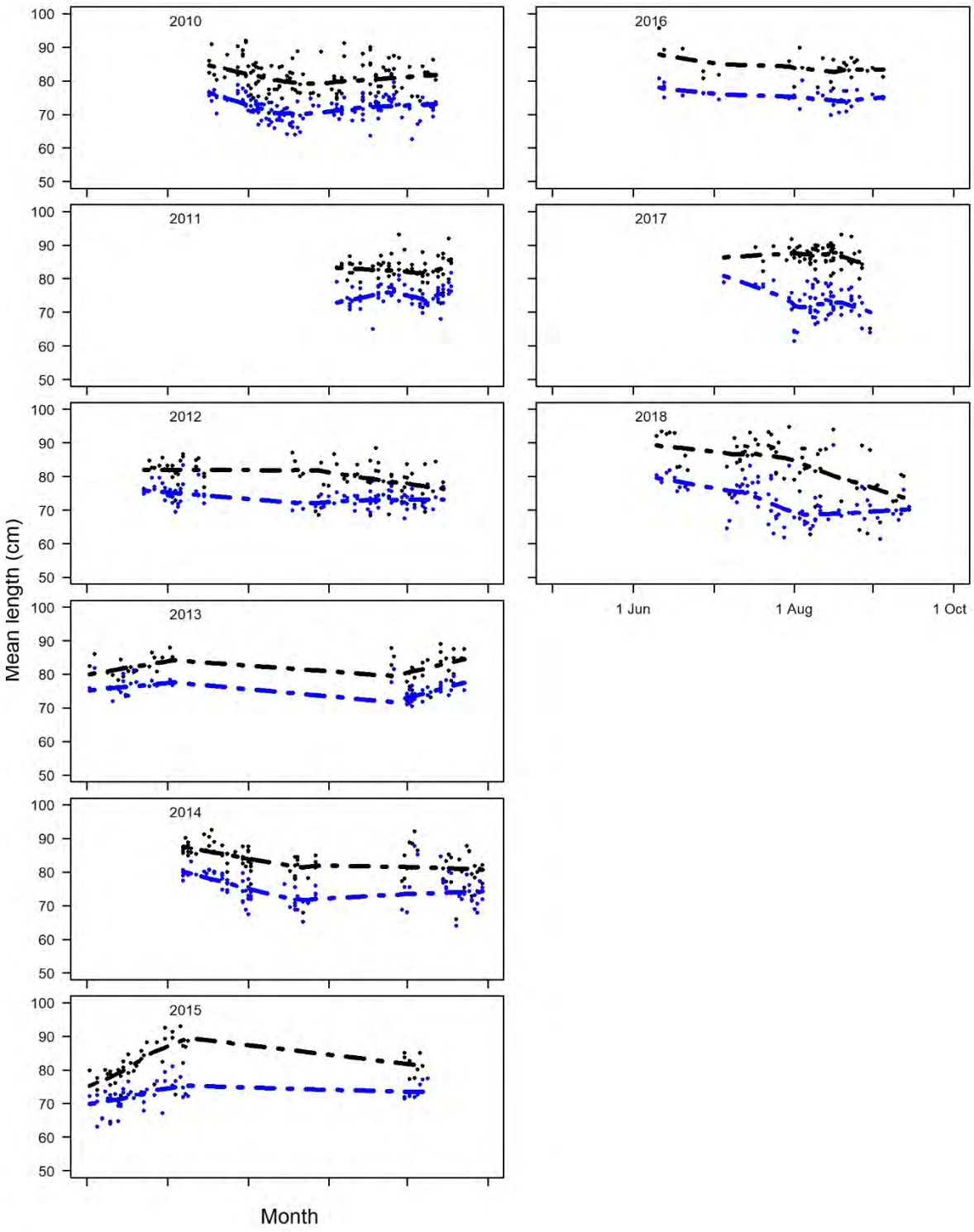


Figure 30 continued.

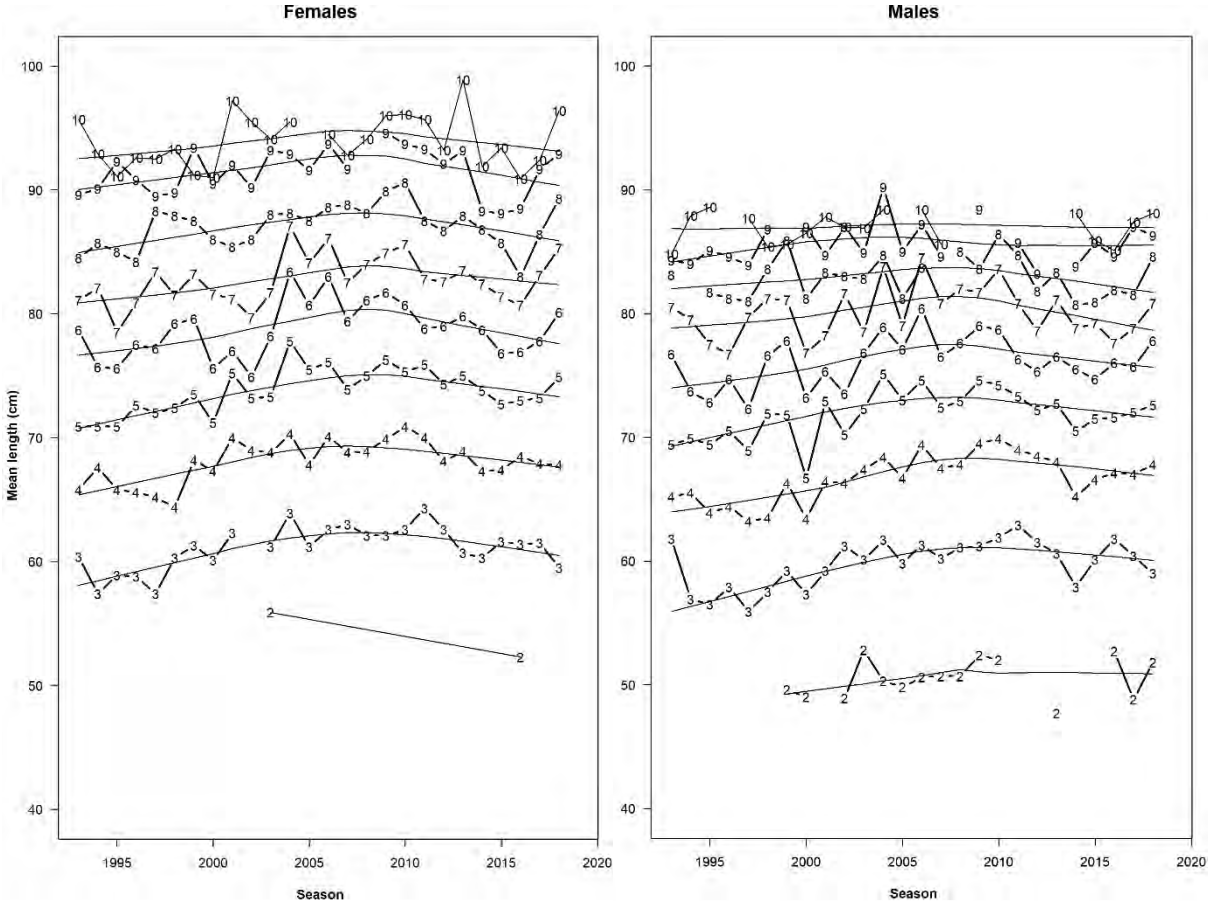


Figure 31: Mean length-at-age of female and male hoki taken in commercial catches from the Cook Strait spawning fishery 1988–2018 sampled at sea by the Observer Programme and by NIWA in a land-based sampling programme. Lines are a loess fit. Points with fewer than ten records were excluded.

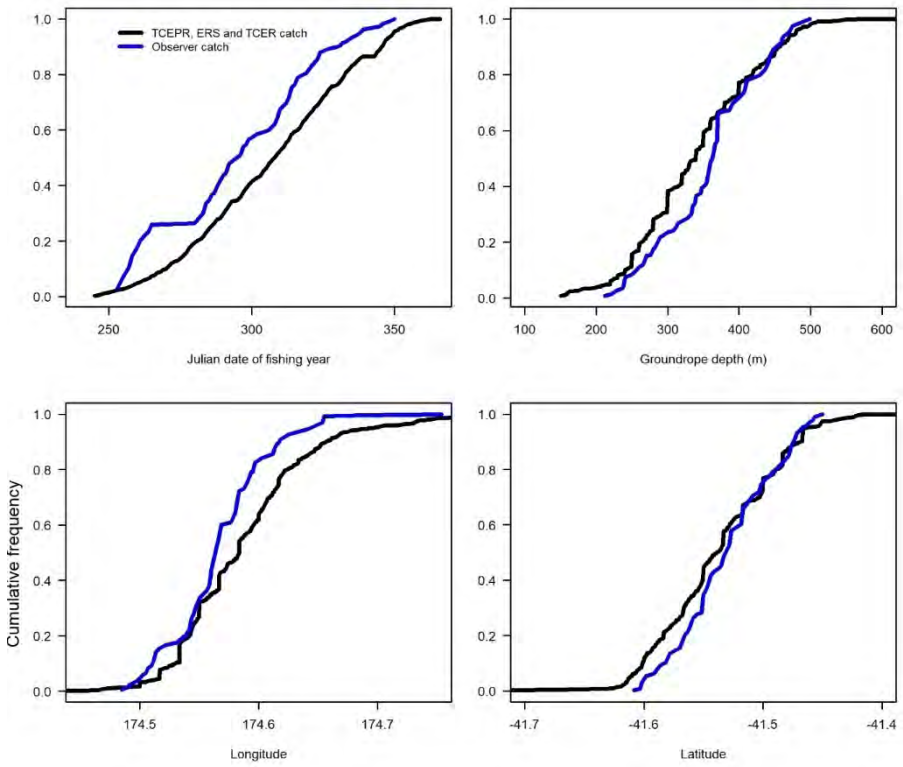


Figure 32a: Comparison of Cook Strait 2017–18 Observer Programme catch coverage for TCEPR and TCER catches (includes 'ERS-trawl' data) by day of year, depth, latitude, and longitude. If sampling is representative of the fishery, then the blue lines (sampled catches) should overlay the black lines (catches).

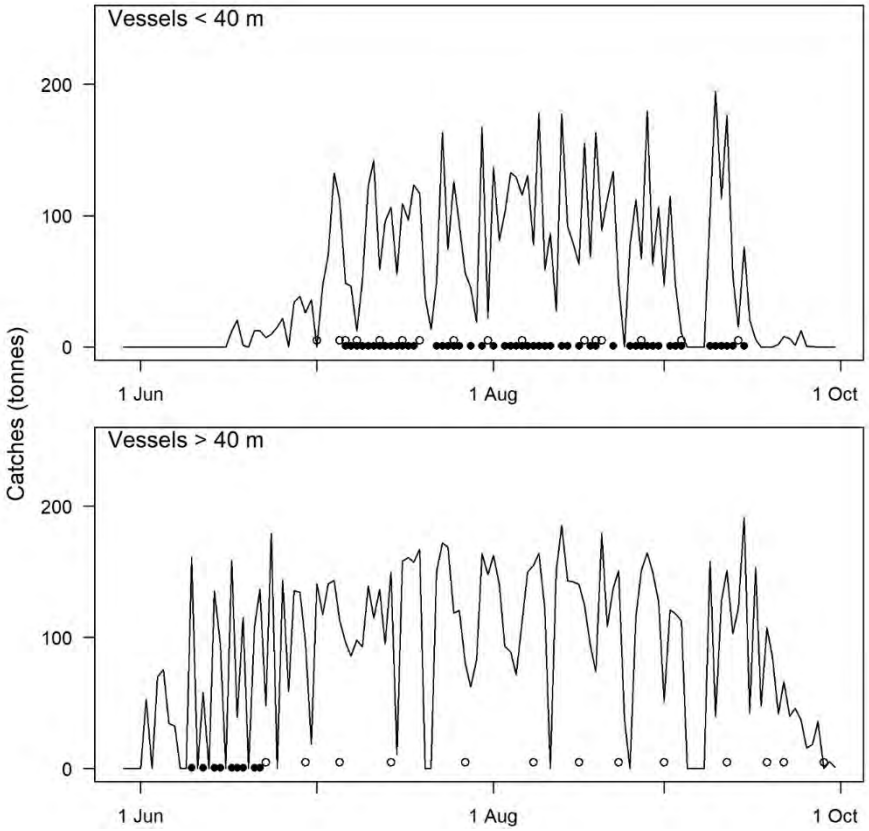


Figure 32b: Cook Strait 2017–18 catch by day for vessels less than 40 m and 40 m or longer during the spawning season, showing timing of Observer Programme samples (black dots), and land-based samples (hollow dots).

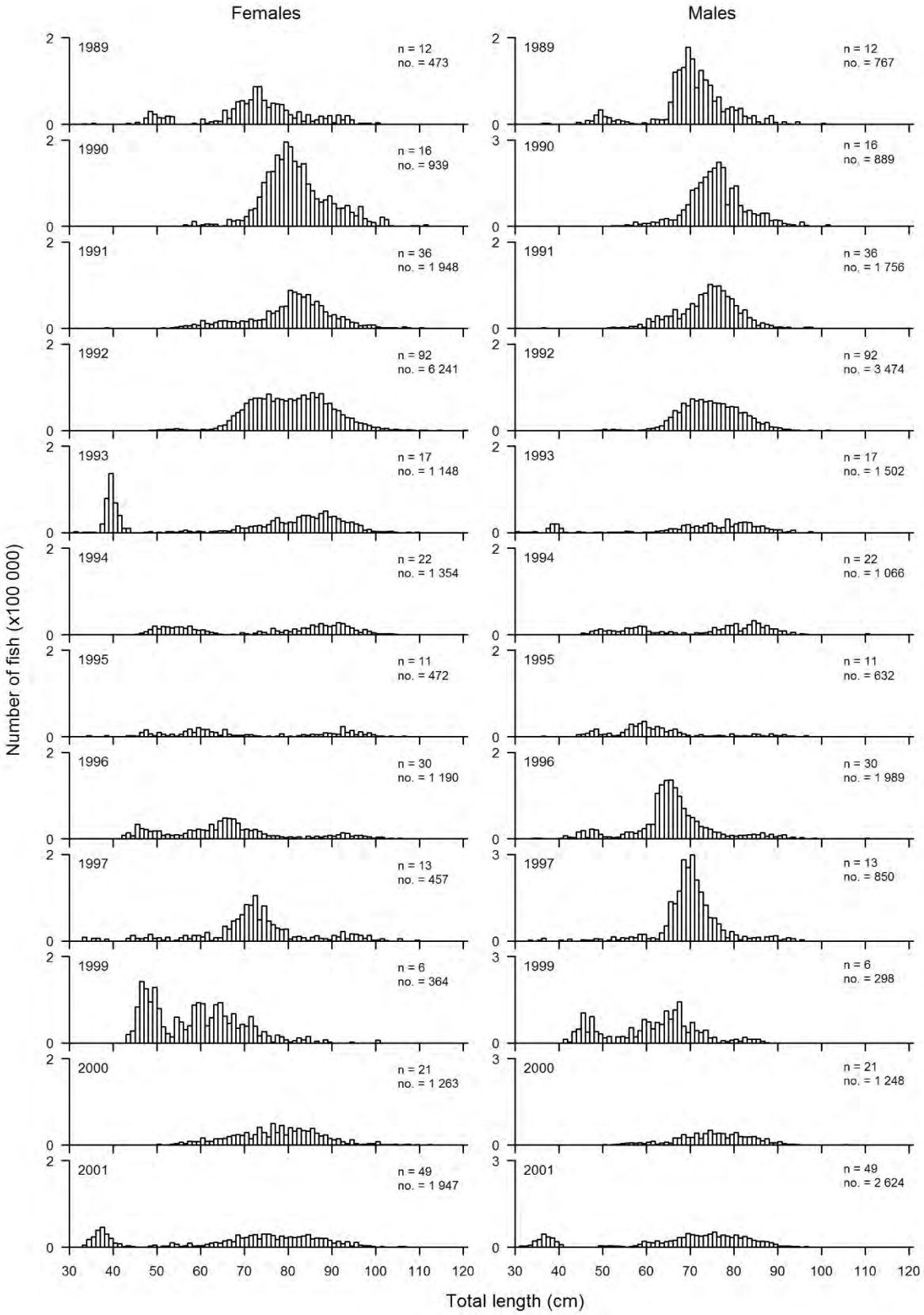


Figure 33: Length frequency distributions of hoki in commercial catches from the Puysegur spawning fishery from 1989 to 1997, and 1999 to 2018 sampled at sea by the Observer Programme. n, number of tows sampled; no., number of fish sampled.

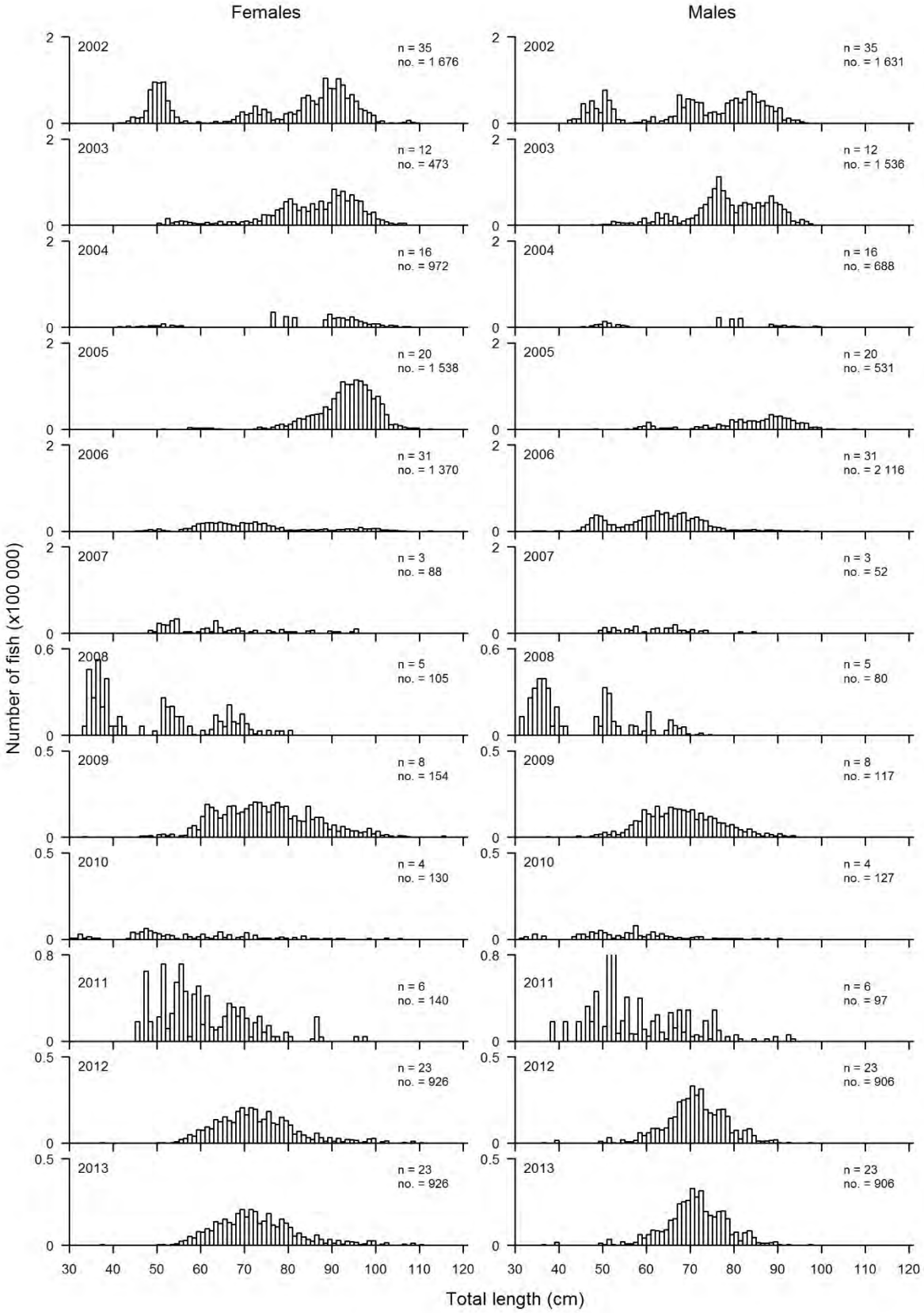


Figure 33 continued.

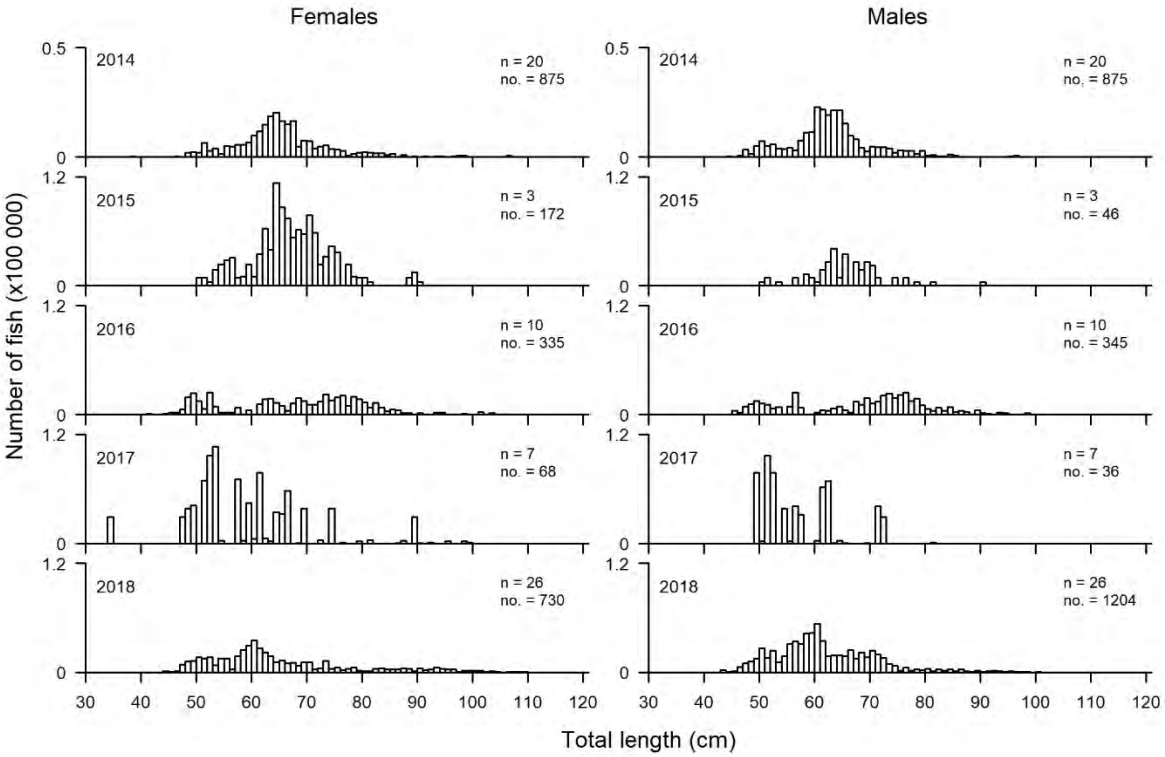


Figure 33 continued.

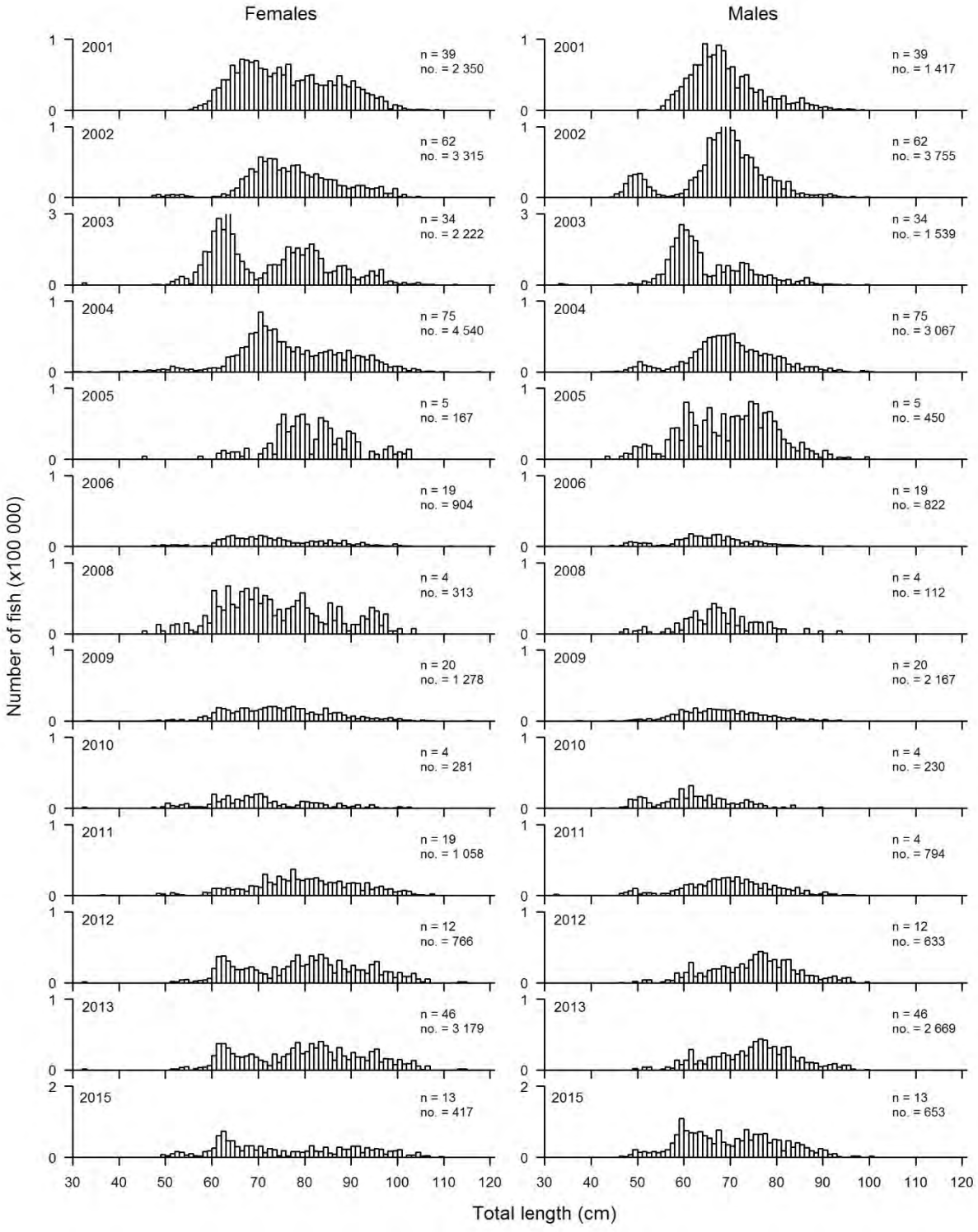


Figure 34: Length frequency distributions of hoki taken in commercial catches from the ECSI spawning fishery from 2001 to 2018 sampled by the Scientific Observer Programme (2001–2006, 2008–2013, 2015–2018), combined with Hoki Management Company data (2001 to 2005). n, number of tows sampled; no., number of fish sampled.

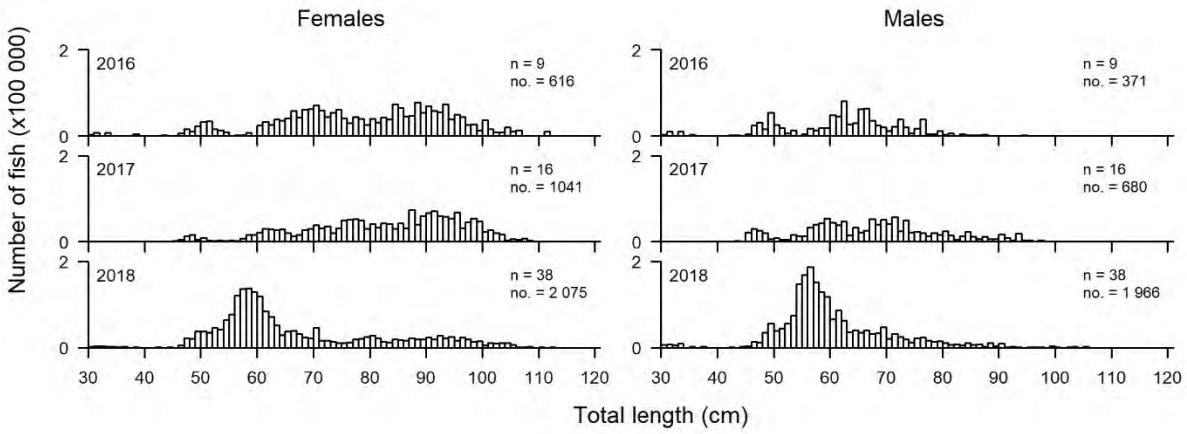


Figure 34 continued.

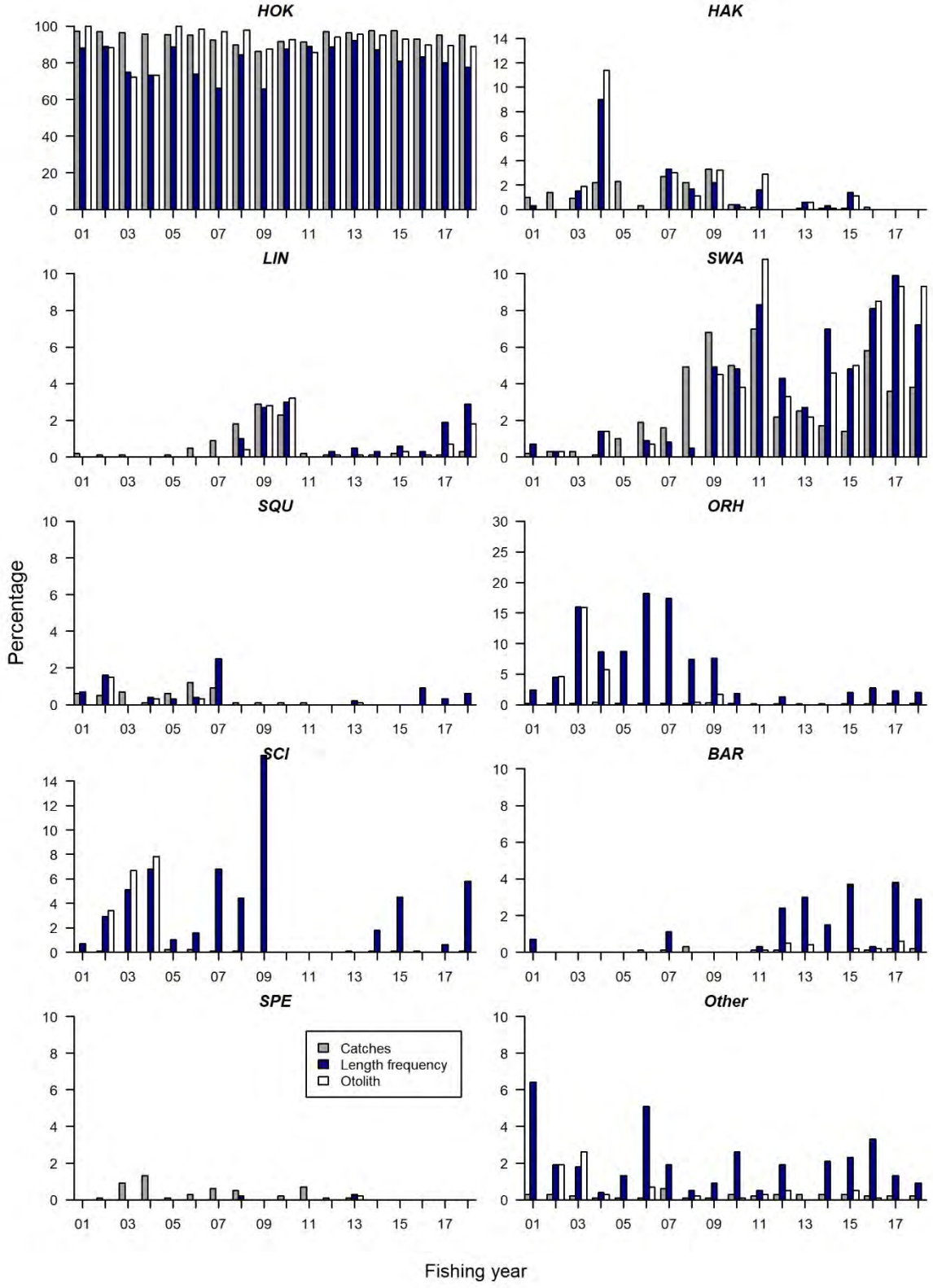


Figure 35: Percentage of hoki commercial catch, hoki length frequency samples, and hoki otoliths collected by the Observer Programme, by target species for the Chatham Rise fishery from 2000–01 to 2017–18. Three-letter codes denote target species: HOK, hoki; ORH, orange roughy; OEO, oreos; SQU, squid; SWA, silver warehou; HAK, hake; SCI, scampi; LIN, ling; BAR, barracouta; SPE, sea perch; Other, all other target species combined.

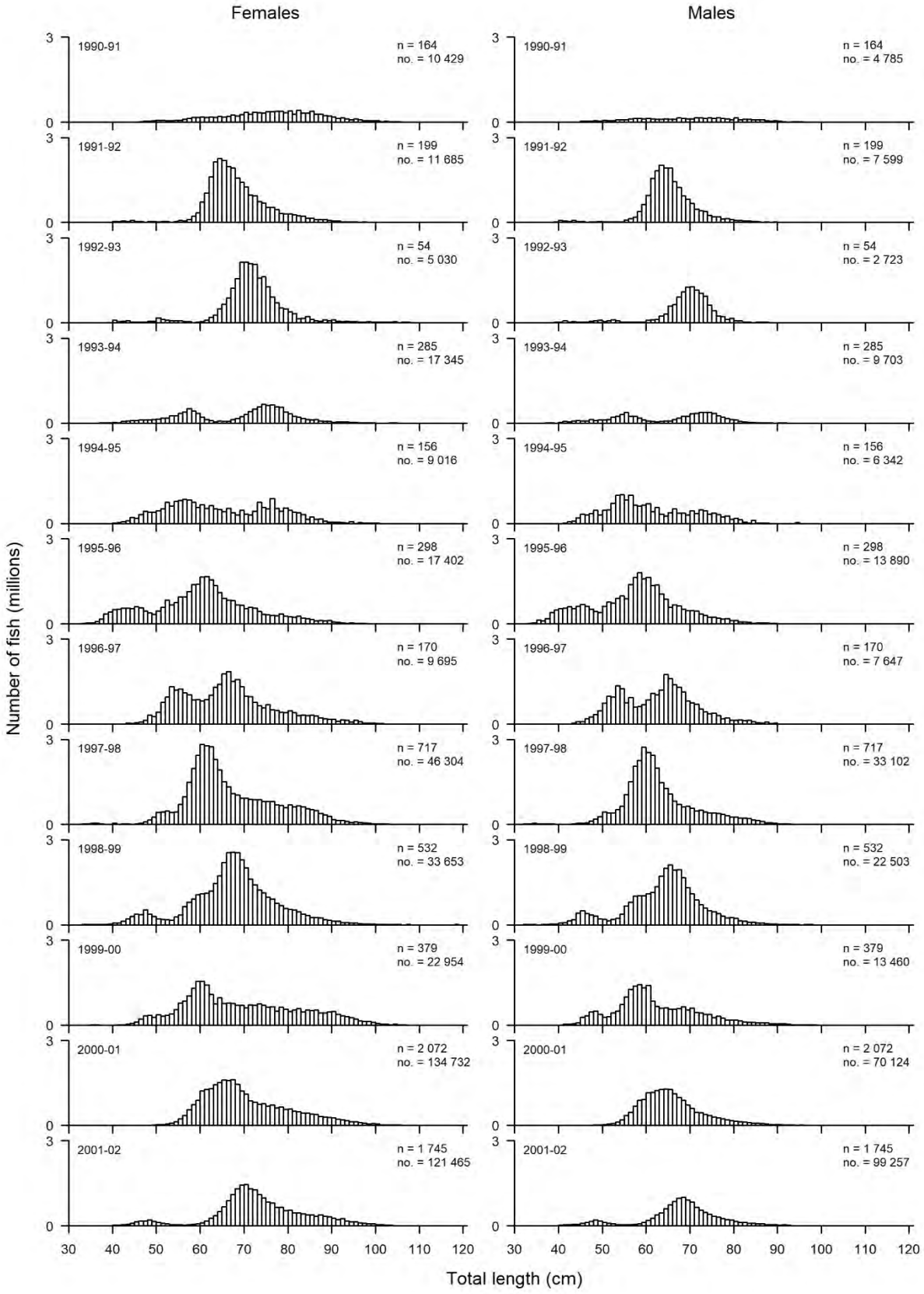


Figure 36: Length frequency distributions of hoki taken in commercial catches from the Chatham Rise fishery from 1990–91 to 2017–18 sampled by the Observer Programme (and combined with Hoki Management Company data in 2000–01 to 2003–04) for all target species. 2006–07 data included only target hoki and hake tows. n, number of tows sampled; no., number of fish sampled.

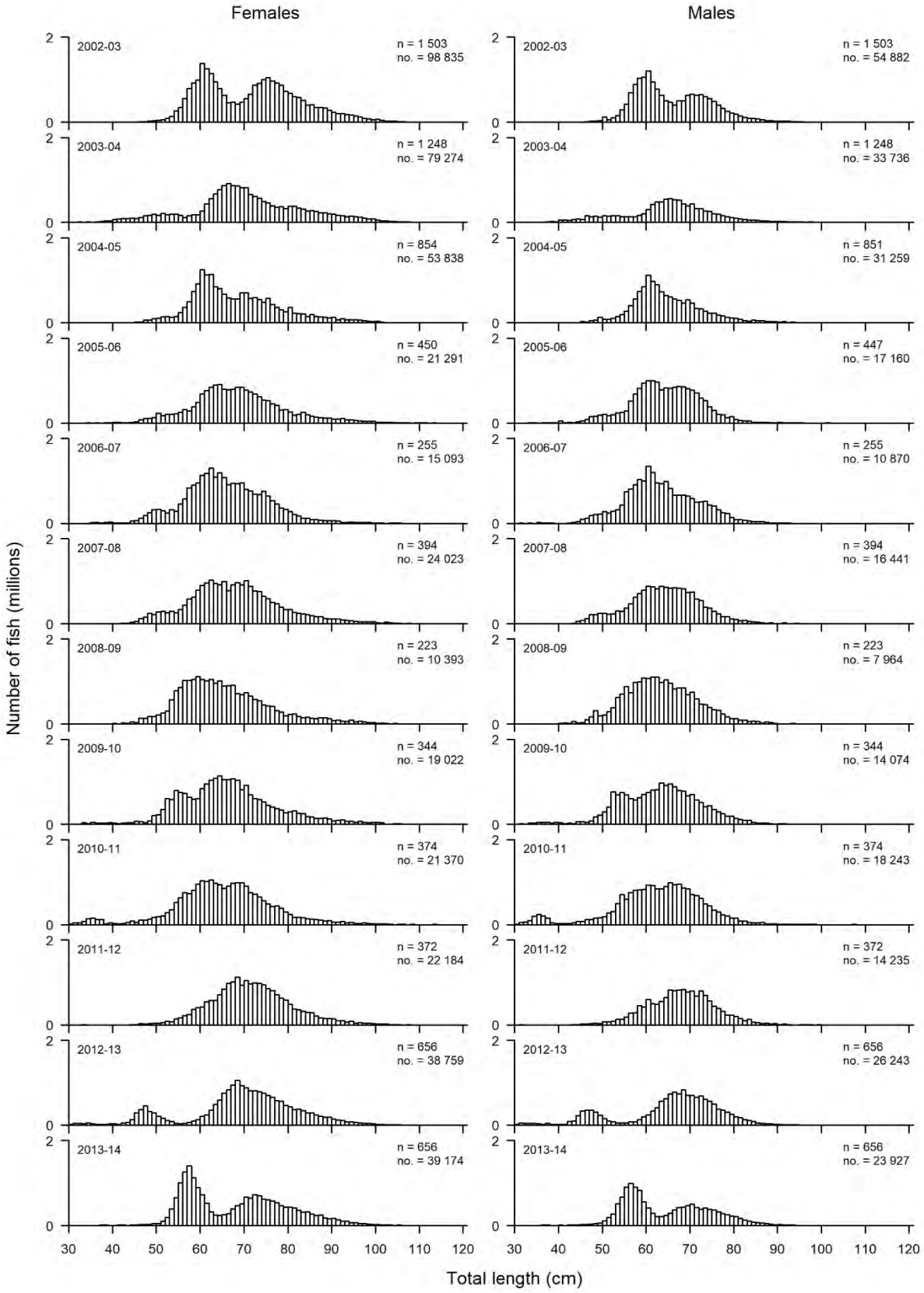


Figure 36 continued.

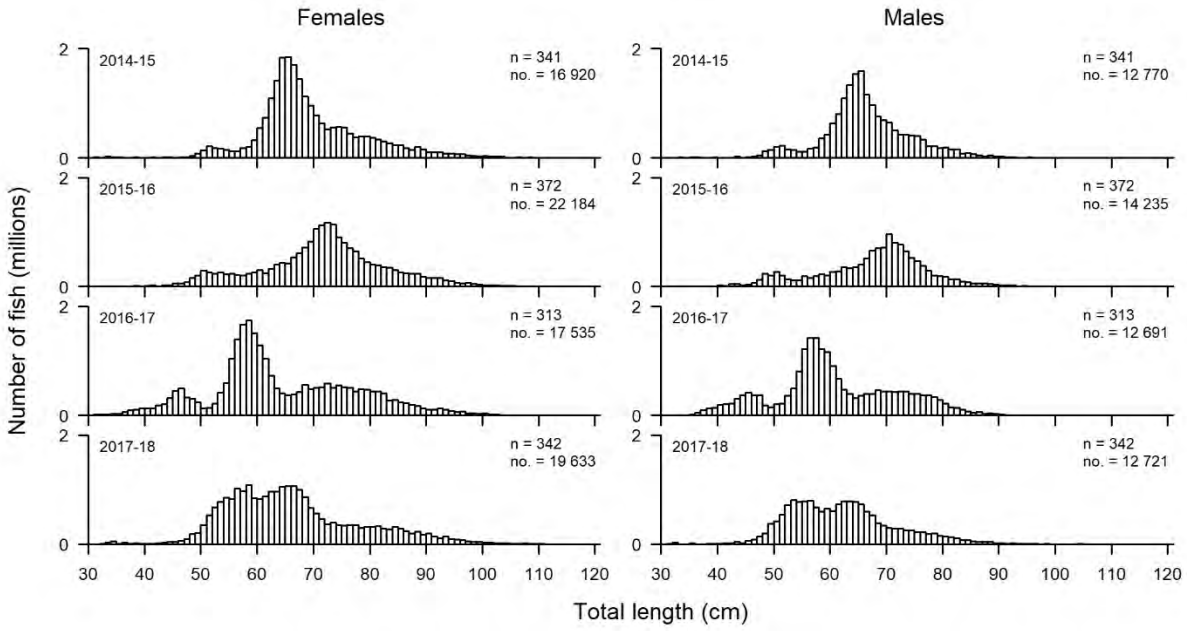


Figure 36 continued.

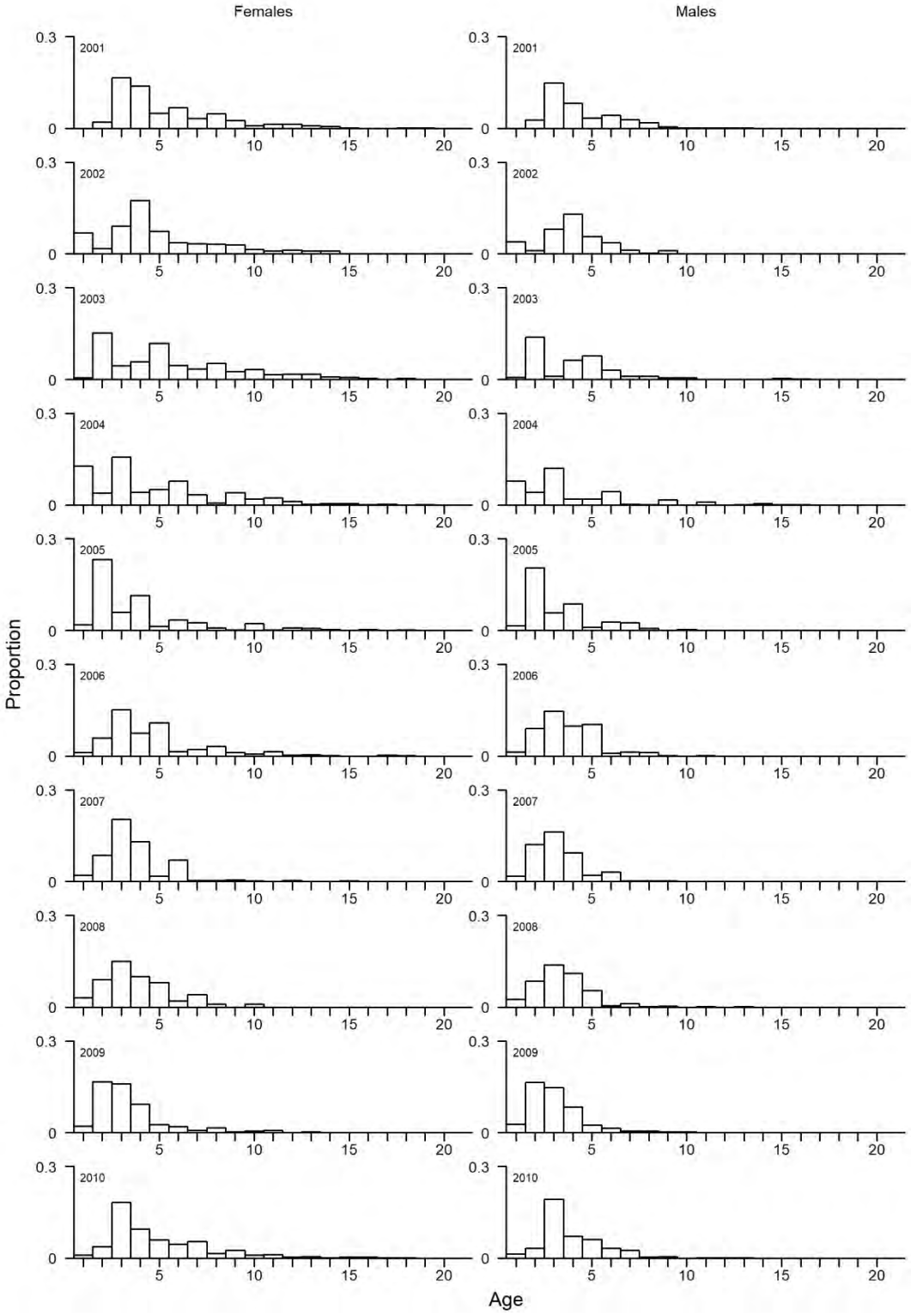


Figure 37: Proportions at age and sex in the catch from the Chatham Rise fishery estimated by direct ageing of otoliths from 2000–01 to 2017–18.

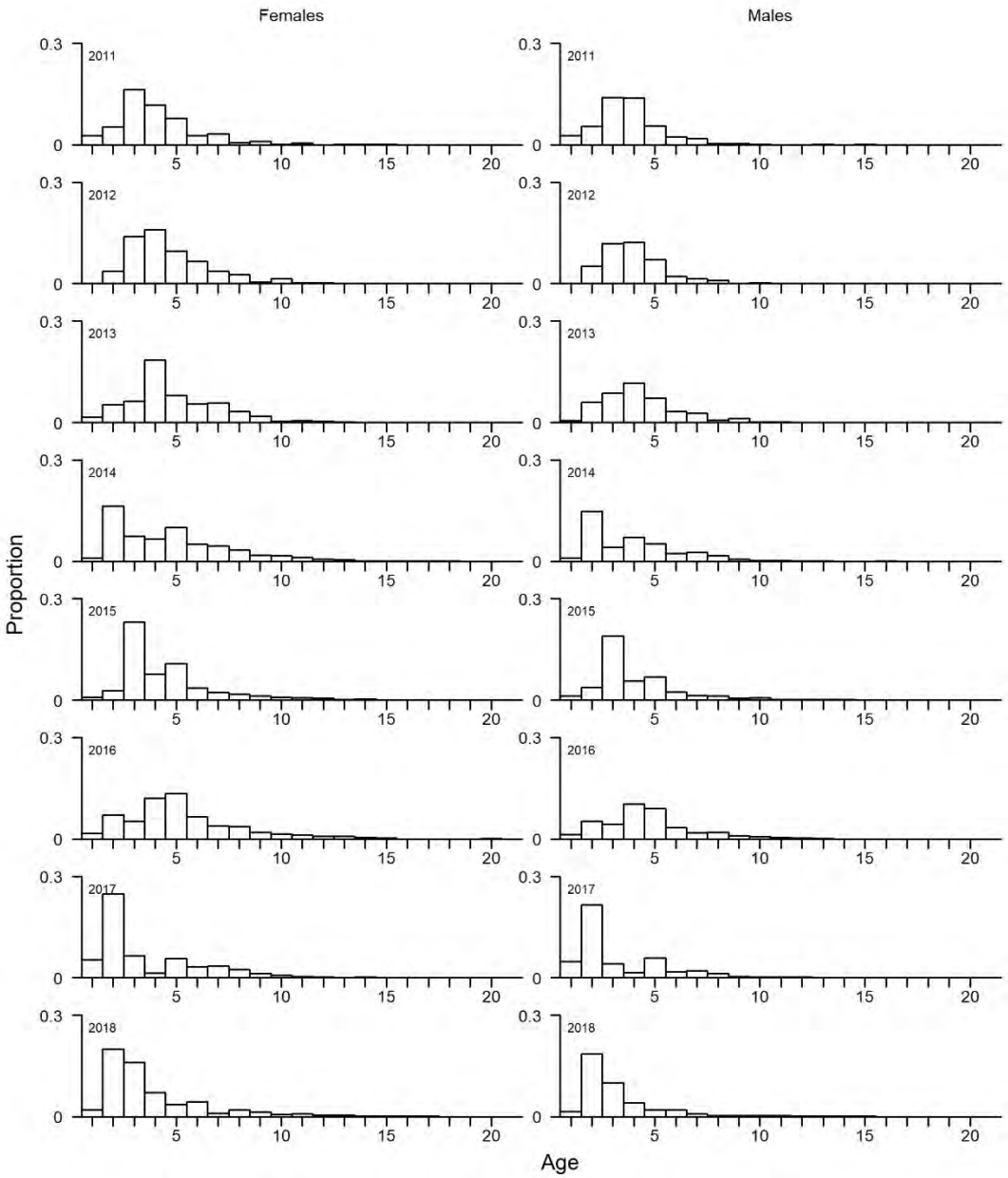


Figure 37: continued.

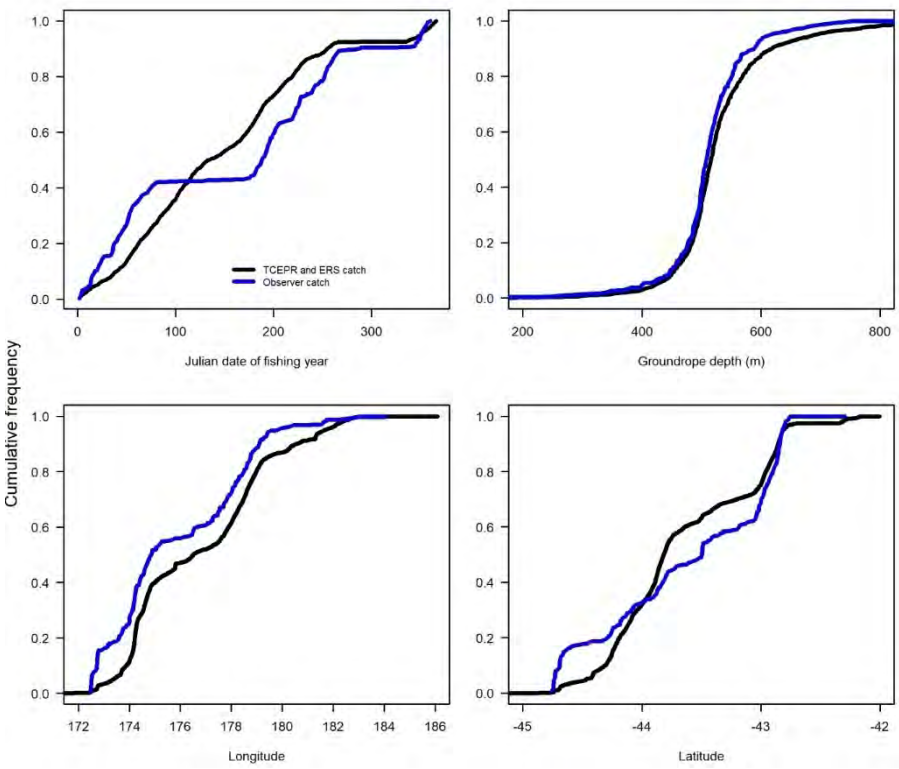


Figure 38a: Comparison of Chatham Rise 2017–18 Observer Programme catch coverage with TCEPR catches by day of year, depth, latitude, and longitude. If sampling is representative of the fishery, then the blue lines (observed catches) should overlay the black lines (TCEPR catch).

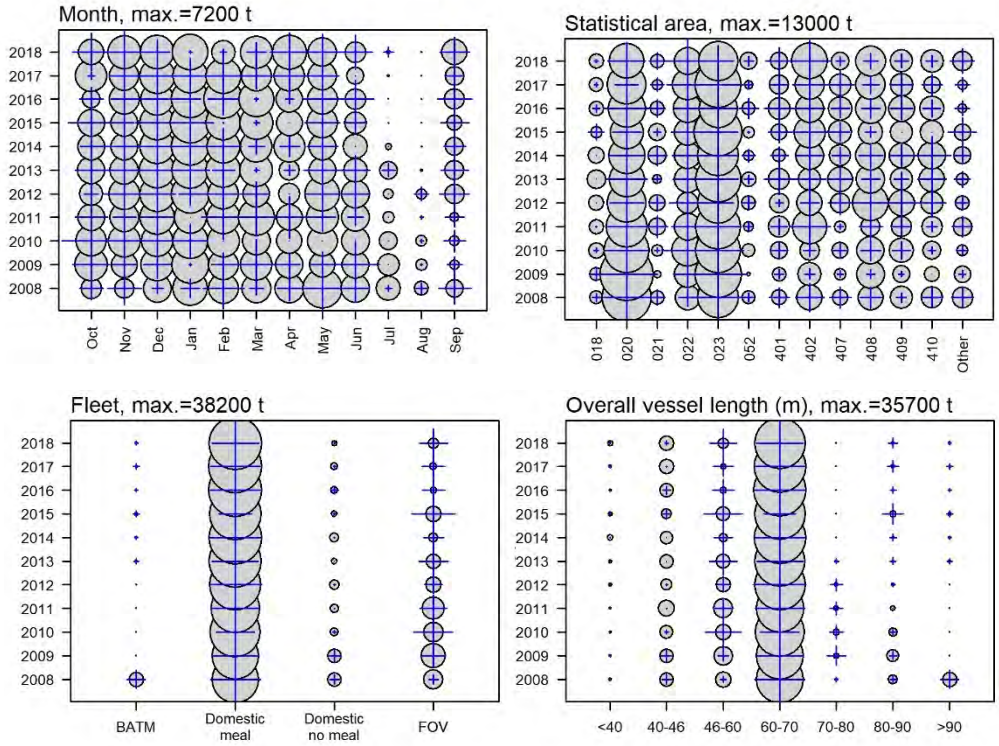


Figure 38b: Representativeness of observer sampling of Chatham Rise hoki catch by fishing year and month, statistical area, fleet or vessel length. Circles show the proportion of each variable within a year; crosses show the proportion of observed catch for the same cells. Representation is demonstrated by how closely the cross matches the circle diameter.

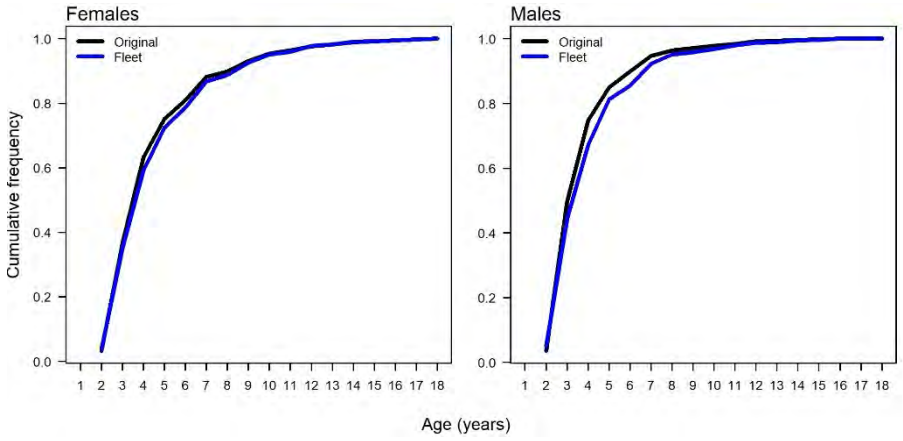


Figure 39: Cumulative 2017–18 Chatham Rise frequency by age comparing original age frequencies with alternative post-stratification of fish size by fleet. Original age frequencies are those presented in Figure 37 with length frequency stratification described in Table 8a.

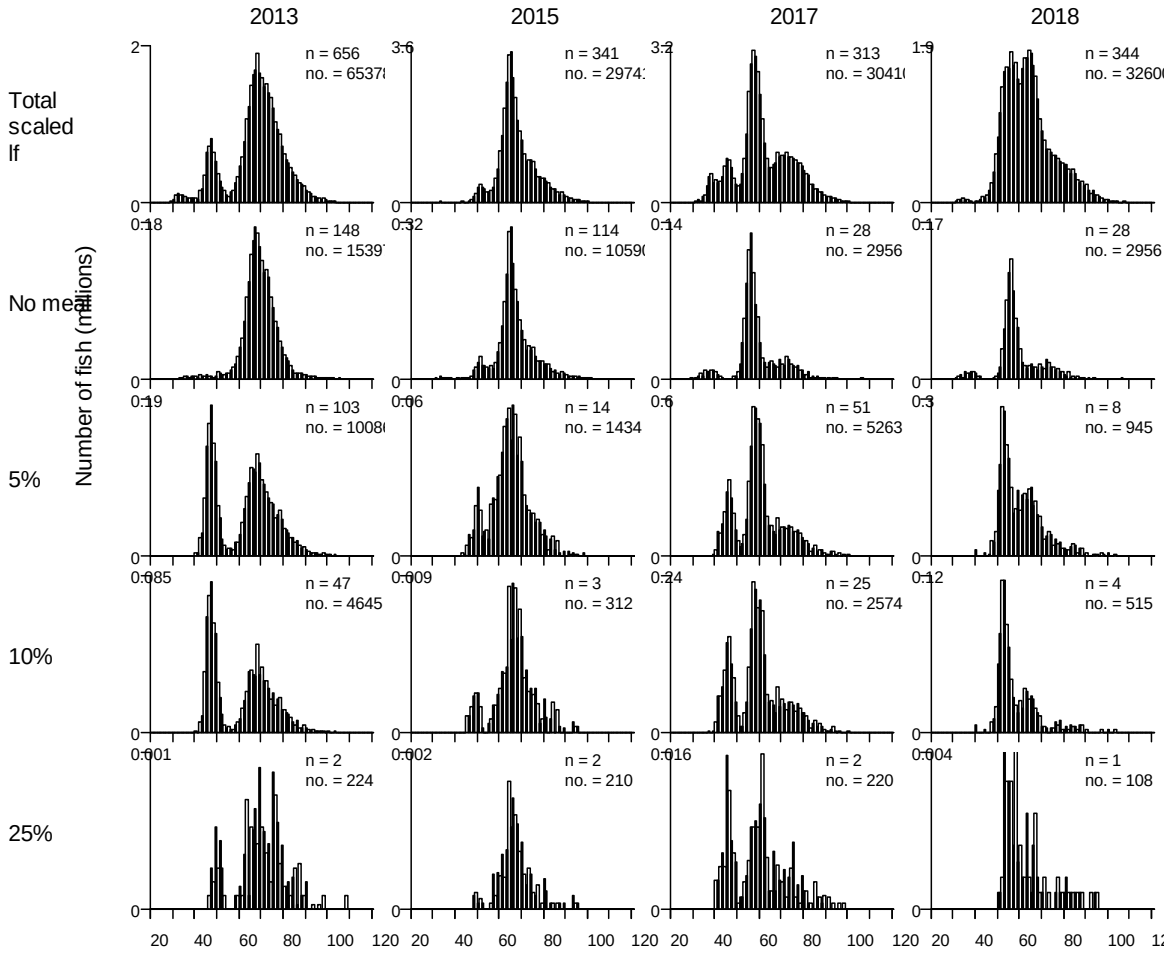


Figure 40: Chatham Rise and ECSI non-spawning hoki length frequency distributions split by estimated proportion of hoki going to meal. Data only includes catches and length frequencies from bottom tows from depths of 400-800 m and west of 179º E. Total scaled length frequency distributions are original length frequency distributions calculated each year. No meal: FOV and domestic no meal plant on board fleets; Percent 5, 10, and 25 are length frequency distributions from a vessel-date where 5%, etc of the total processed catch on that vessel-day was mealed.

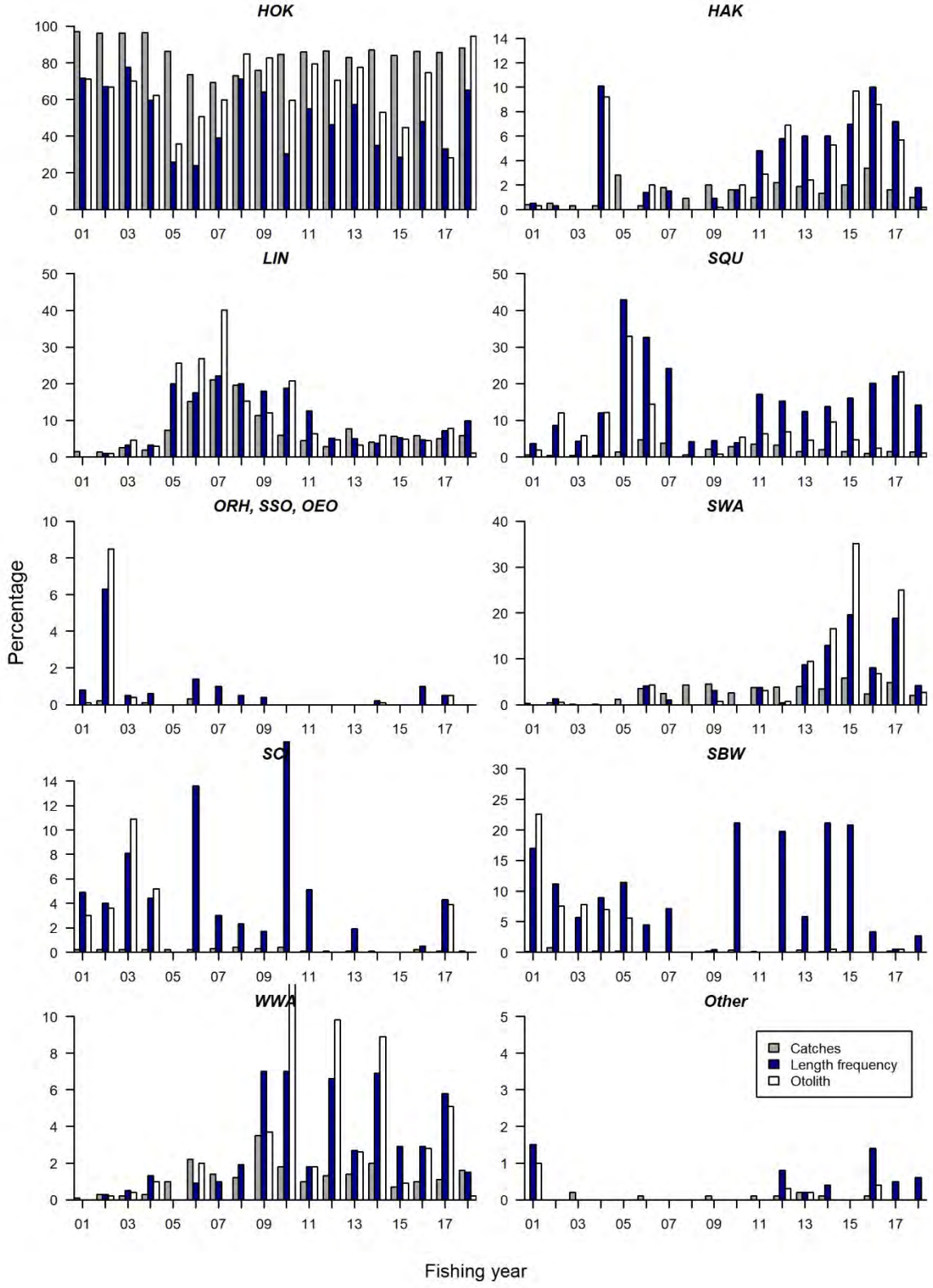


Figure 41: Percentages of hoki 'ERS-trawl', TCEPR, TCER and CELR catch, hoki length frequency samples, and hoki otoliths collected by the Observer Programme, by target species for the Sub-Antarctic fishery from 2000–01 to 2017–18. Three-letter codes denote target species: HOK, hoki; HAK, hake; SQU, squid; SWA, silver warehou; SBW, southern blue whiting; SCI, scampi; LIN, ling; WWA, white warehou; Other, other target species combined.

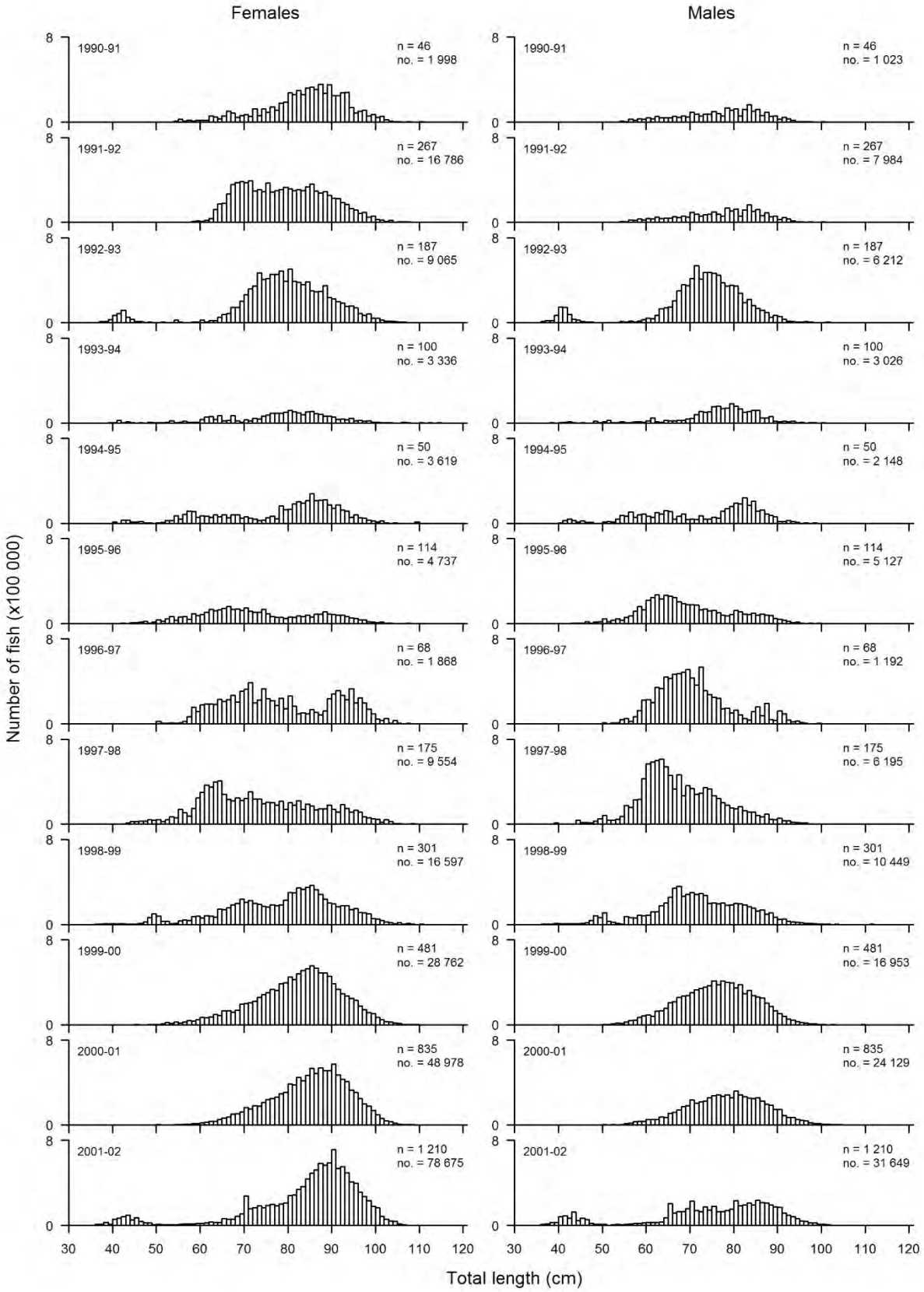


Figure 42: Length frequency distributions of hoki taken in commercial catches from the Sub-Antarctic fishery from 1990–91 to 2017–18 sampled by the Observer Programme (and combined with Hoki Management Company data in 2000–01 to 2004–05). n, number of tows sampled; no., number of fish sampled.

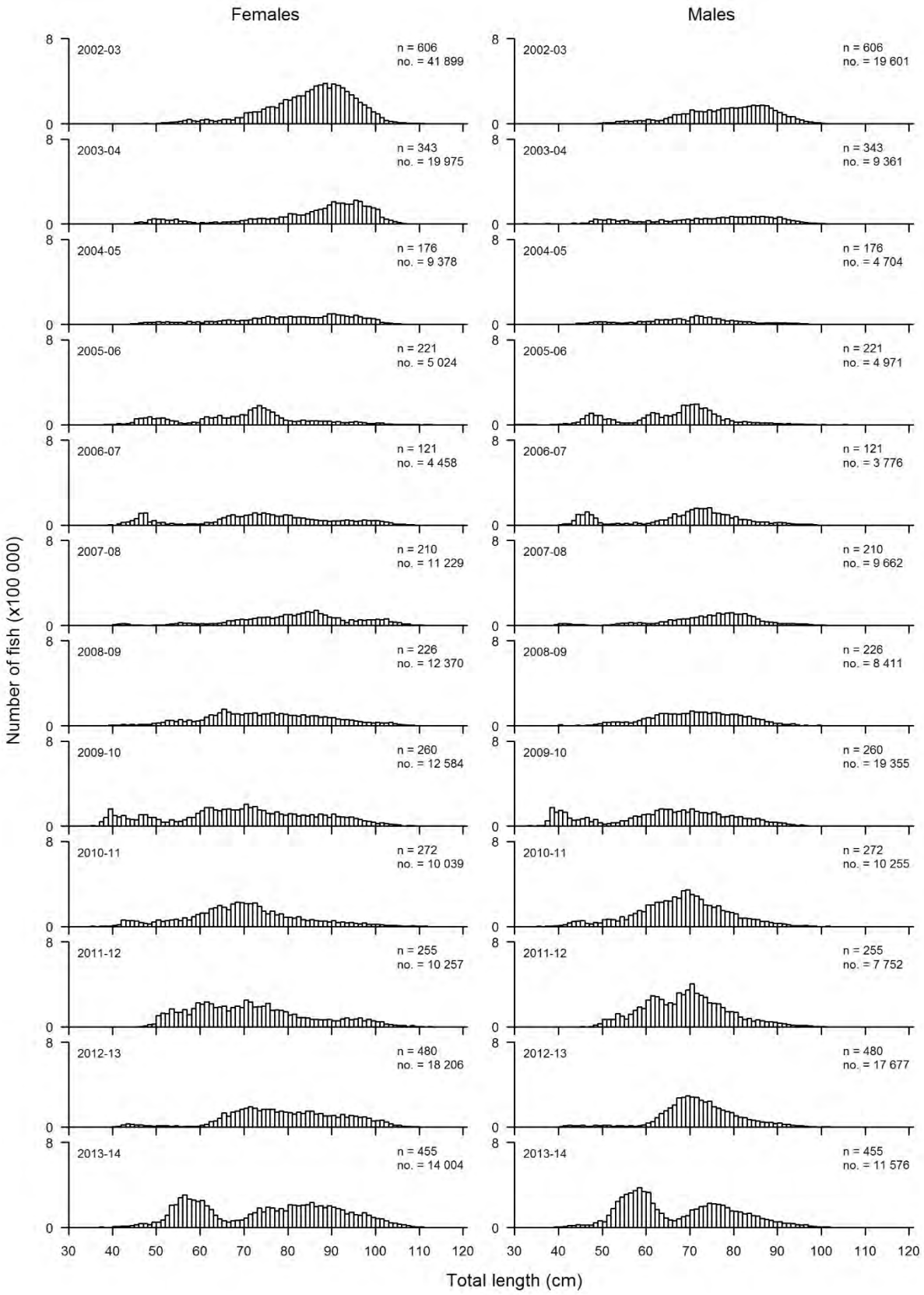


Figure 42 continued.

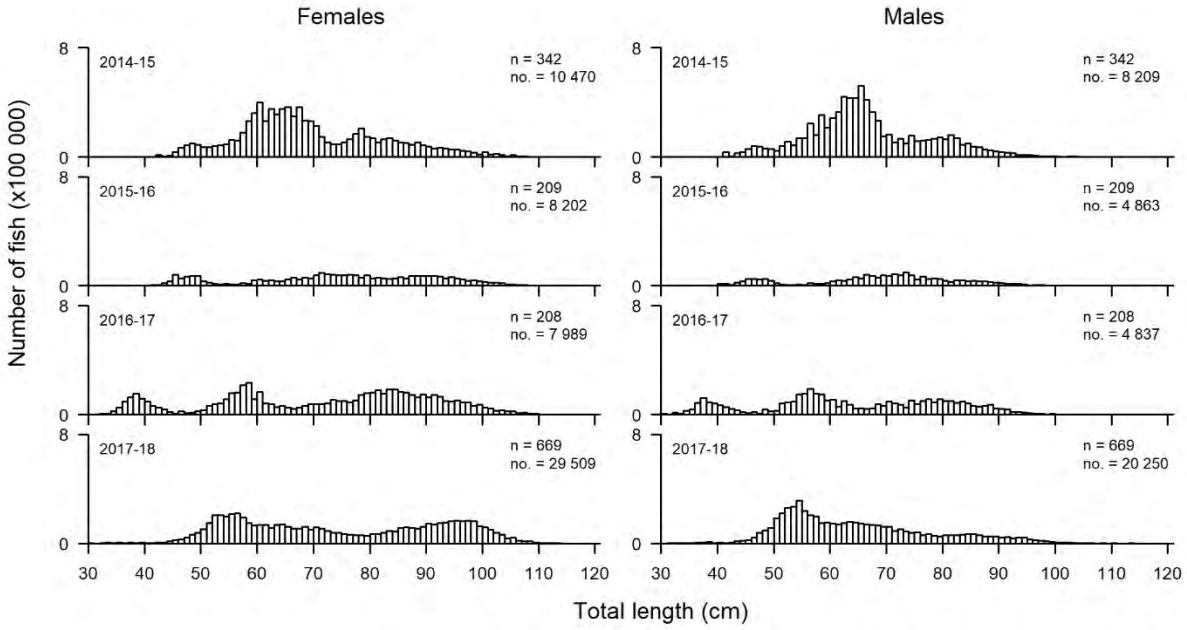


Figure 42 continued.

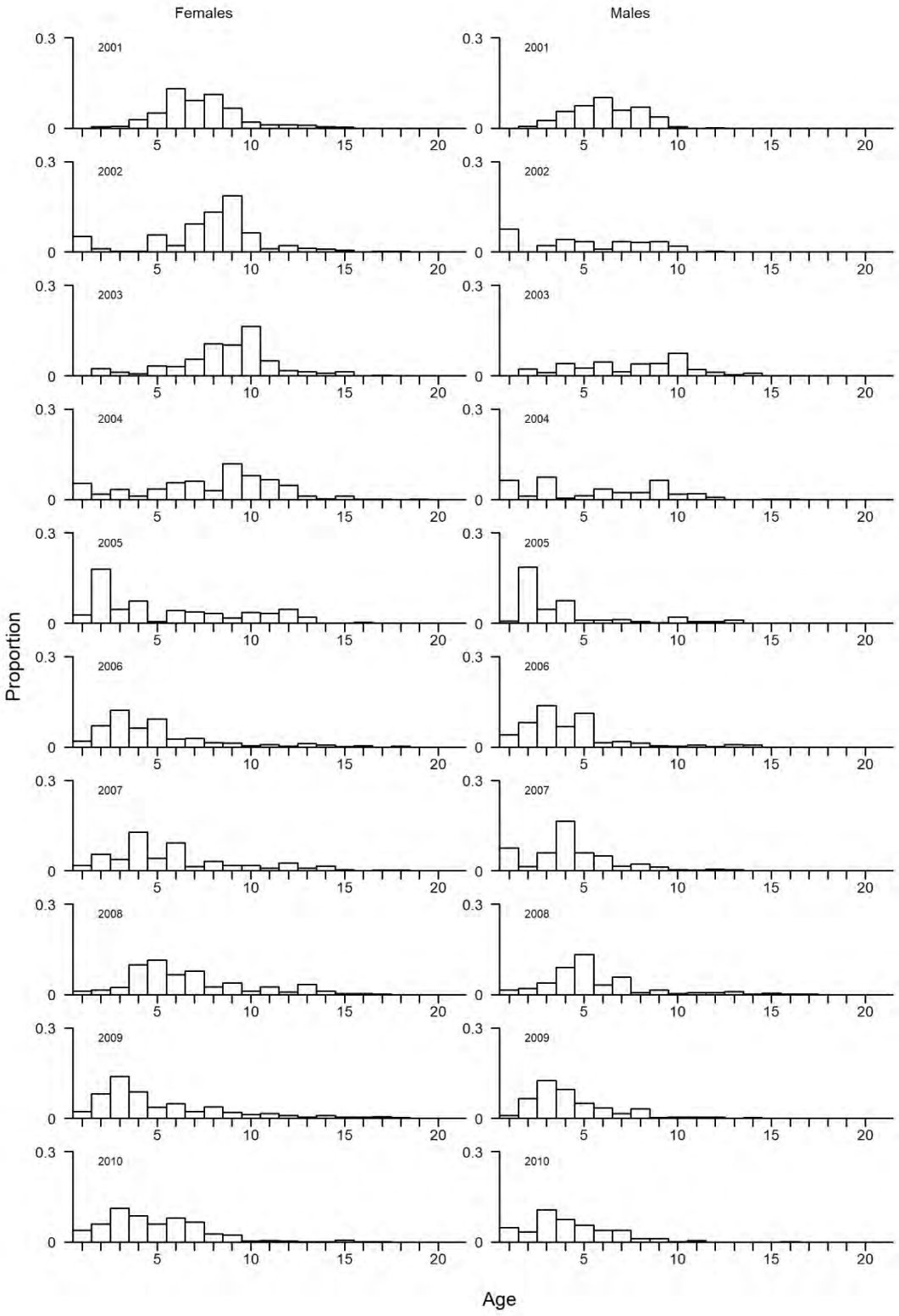


Figure 43: Proportions-at-age and sex in the catch from the Sub-Antarctic fishery as estimated by direct ageing of otoliths from 2000–01 to 2017–18.

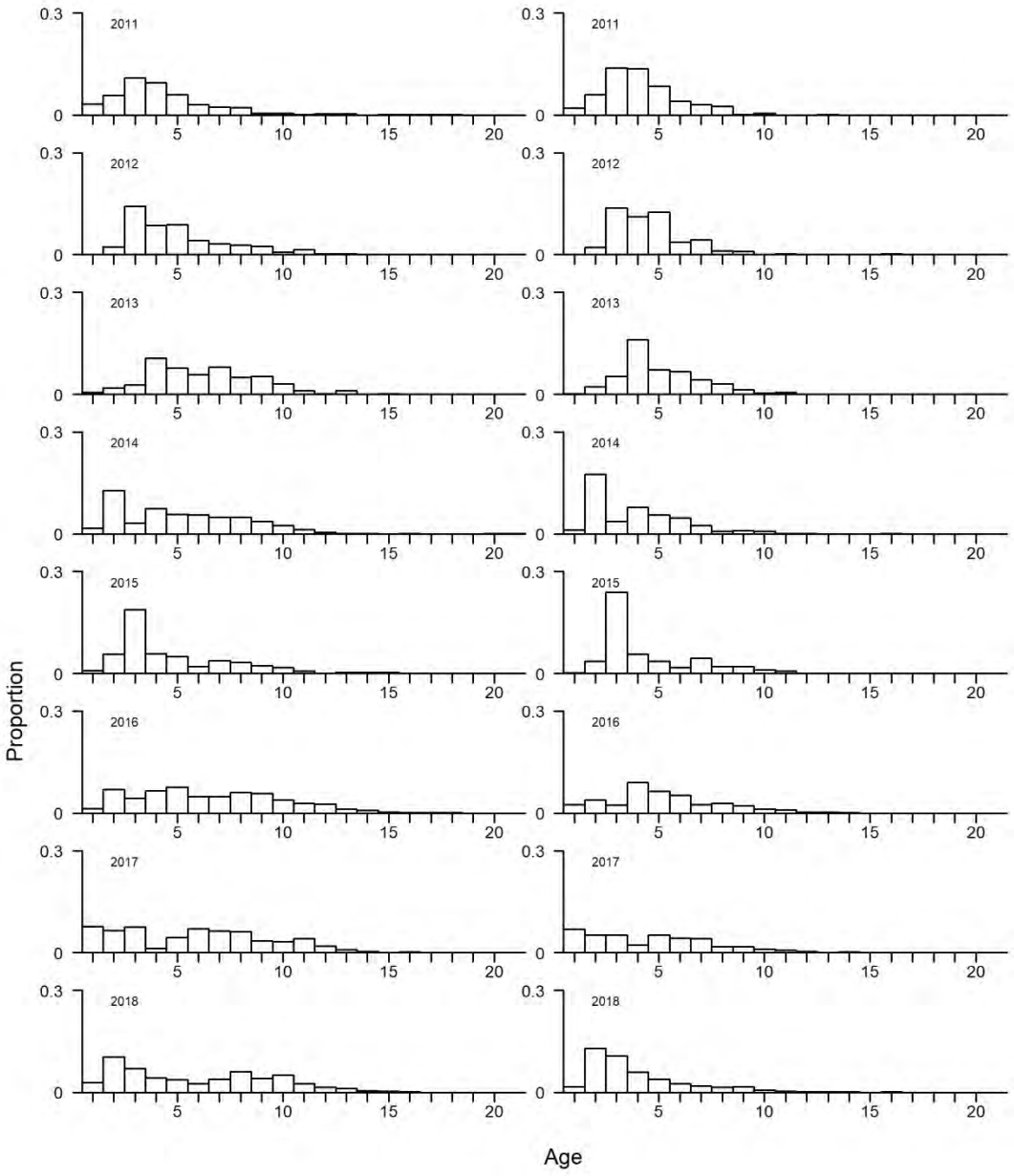


Figure 43: continued.

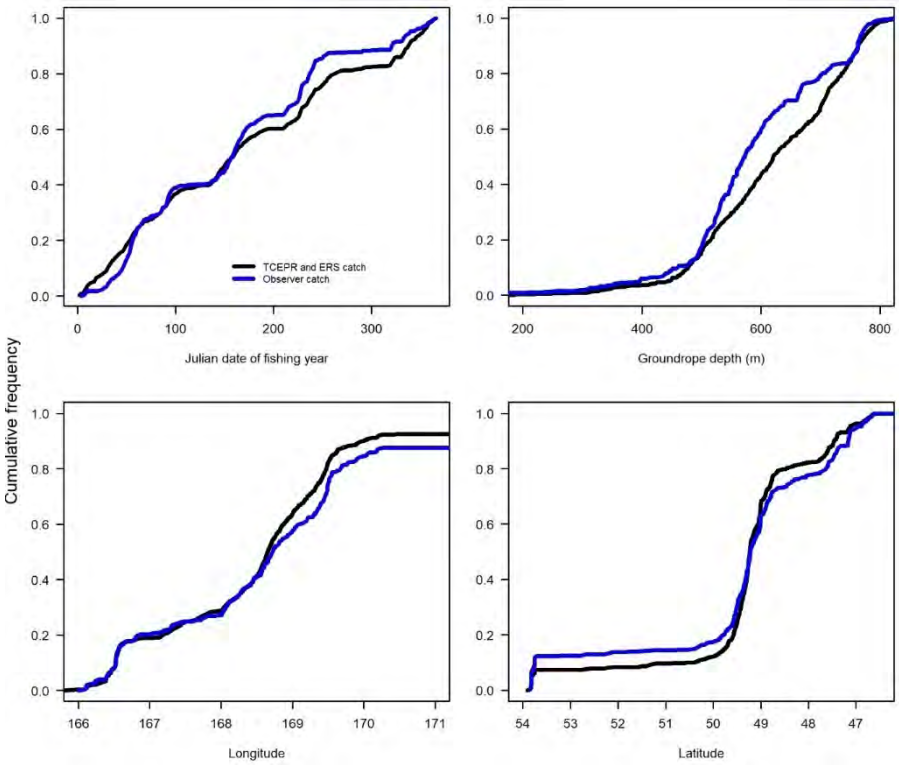


Figure 44a: Comparison of Sub-Antarctic 2017–18 Observer Programme catch coverage with 'ERS-trawl', TCEPR catches by day of year, depth, latitude, longitude and vessel length (m). If sampling is representative of the fishery, then the blue lines (observed catches) should overlay the black lines (TCEPR catch).

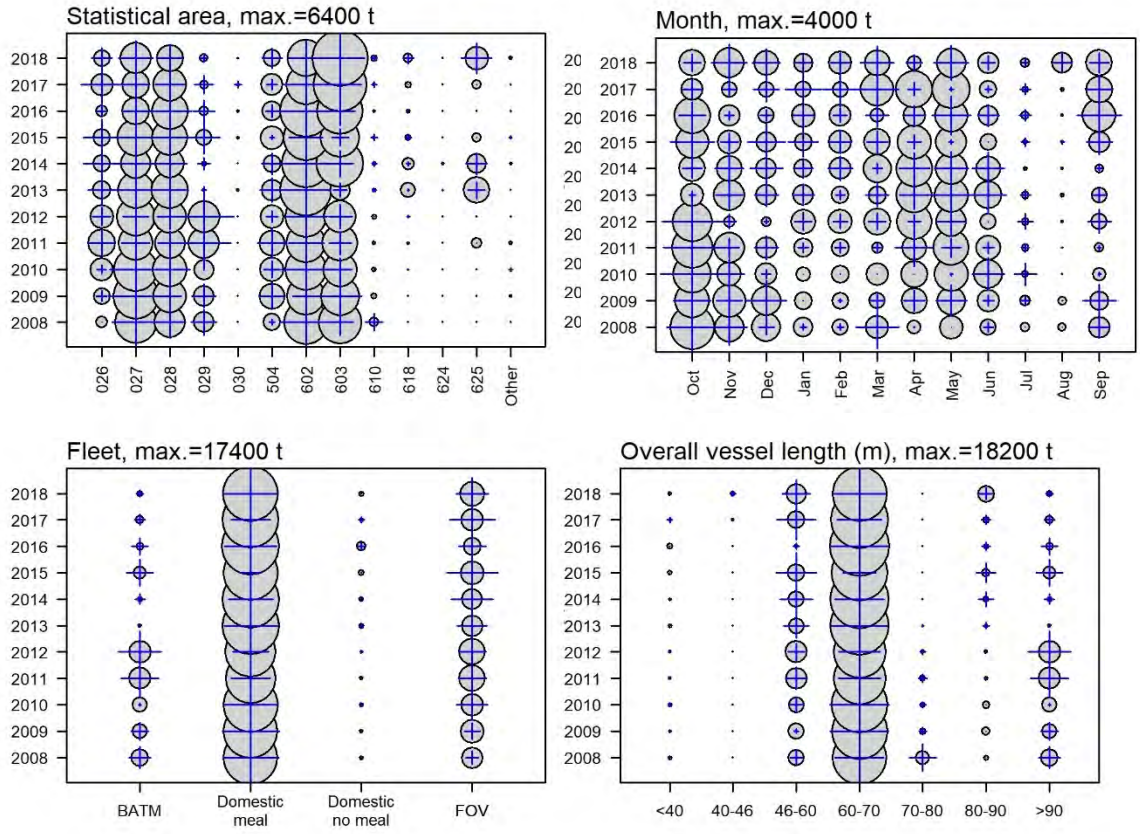


Figure 44b: Representativeness of observer sampling of Sub-Antarctic hoki catch by fishing year and month, statistical area, fleet or vessel length. Circles show the proportion of each variable within a year; crosses show the proportion of observed catch for the same cells. Representation is demonstrated by how closely the cross matches the circle diameter.

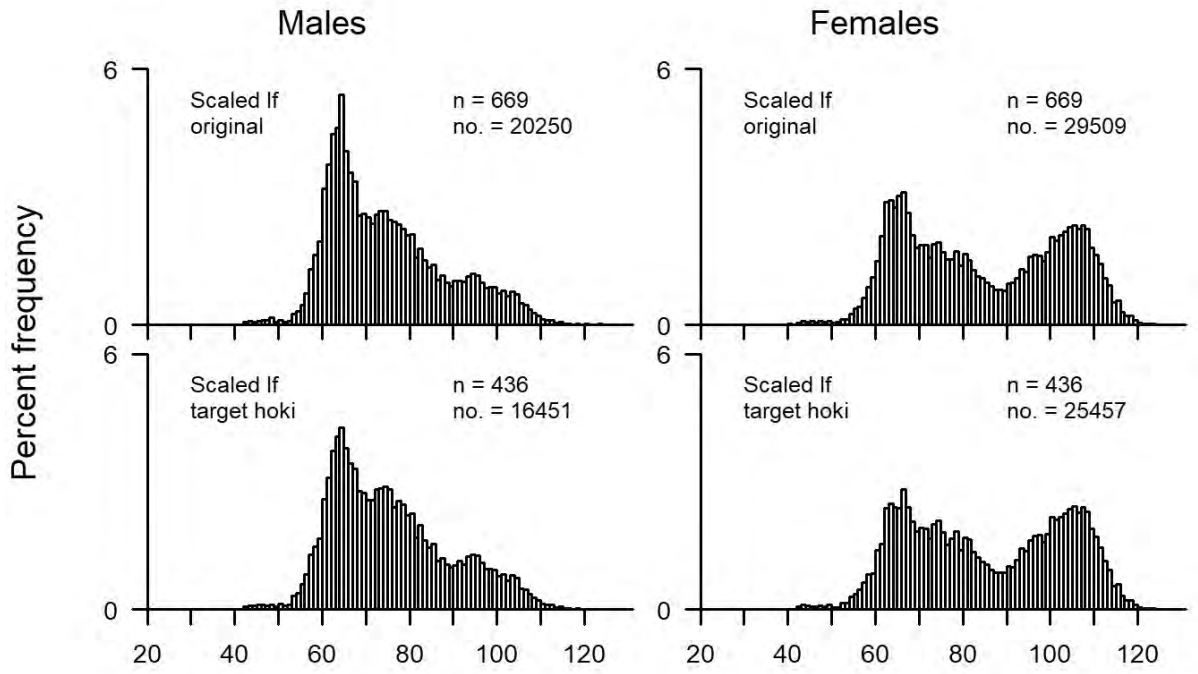


Figure 45: Length frequency distributions of hoki taken in commercial catches from the Sub-Antarctic fishery from 2017–18 sampled by the Observer Programme. Original length frequency distributions are those presented in Figure 42 with length frequency stratification described in Table 8c. n, number of tows sampled; no., number of fish sampled.

Figure 46: Cumulative 2017–18 Sub-Antarctic frequency by age comparing original age frequencies with alternative post-stratification of fish size by target hoki only. Original age frequencies are those presented in Figure 43 with length frequency stratification described in Table 8c.

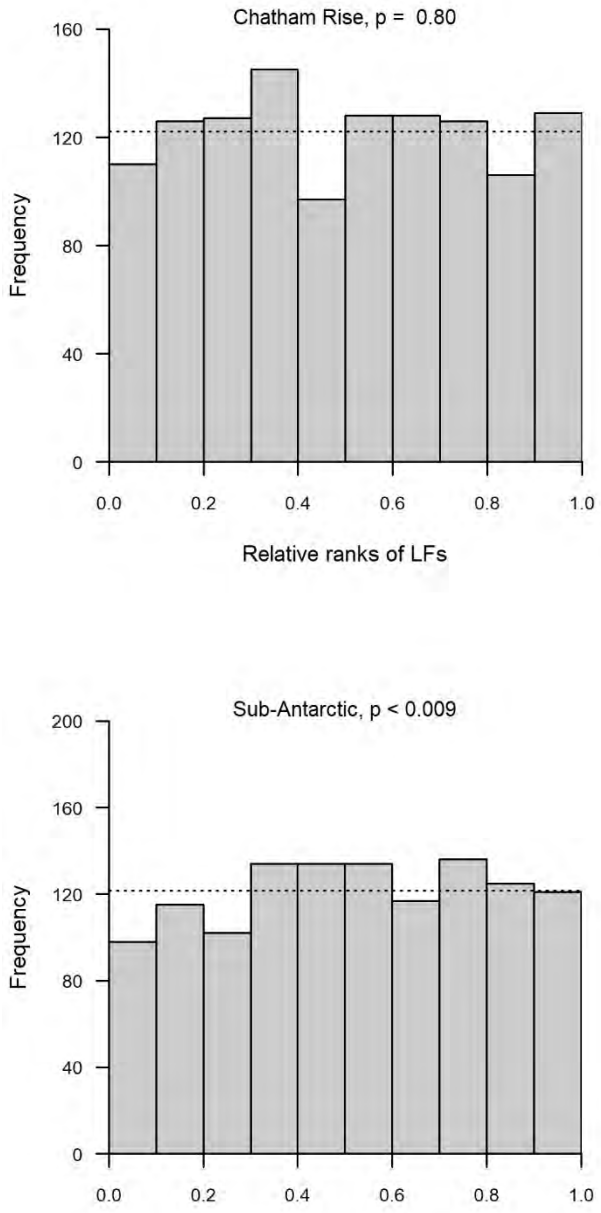


Figure 47: Histograms of ranks of the lengths that yielded 2017–18 Chatham Rise and Sub-Antarctic otoliths relative to the lengths of hoki measured for each tow. If sampling was random then the expected counts are given by the dotted line. The p-value was calculated using the rank-sum test.

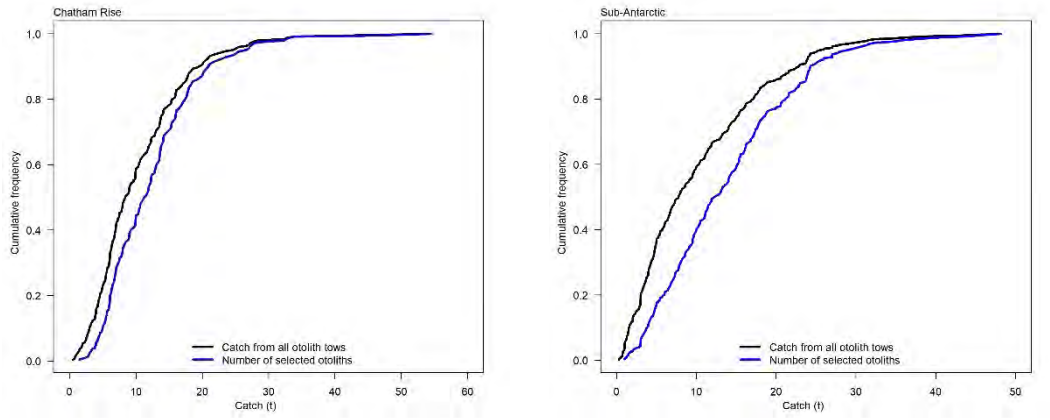


Figure 48: Cumulative plot of selected 2017–18 Chatham Rise and Sub-Antarctic otoliths and catches.

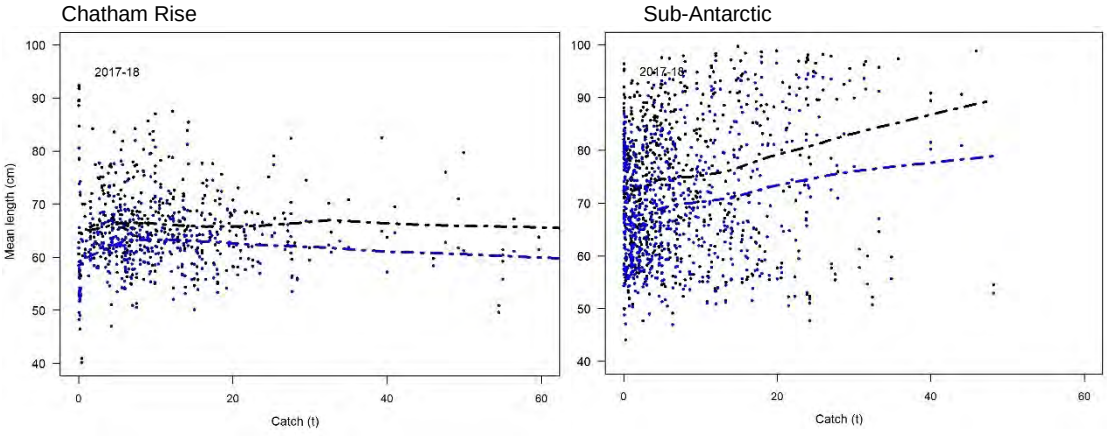
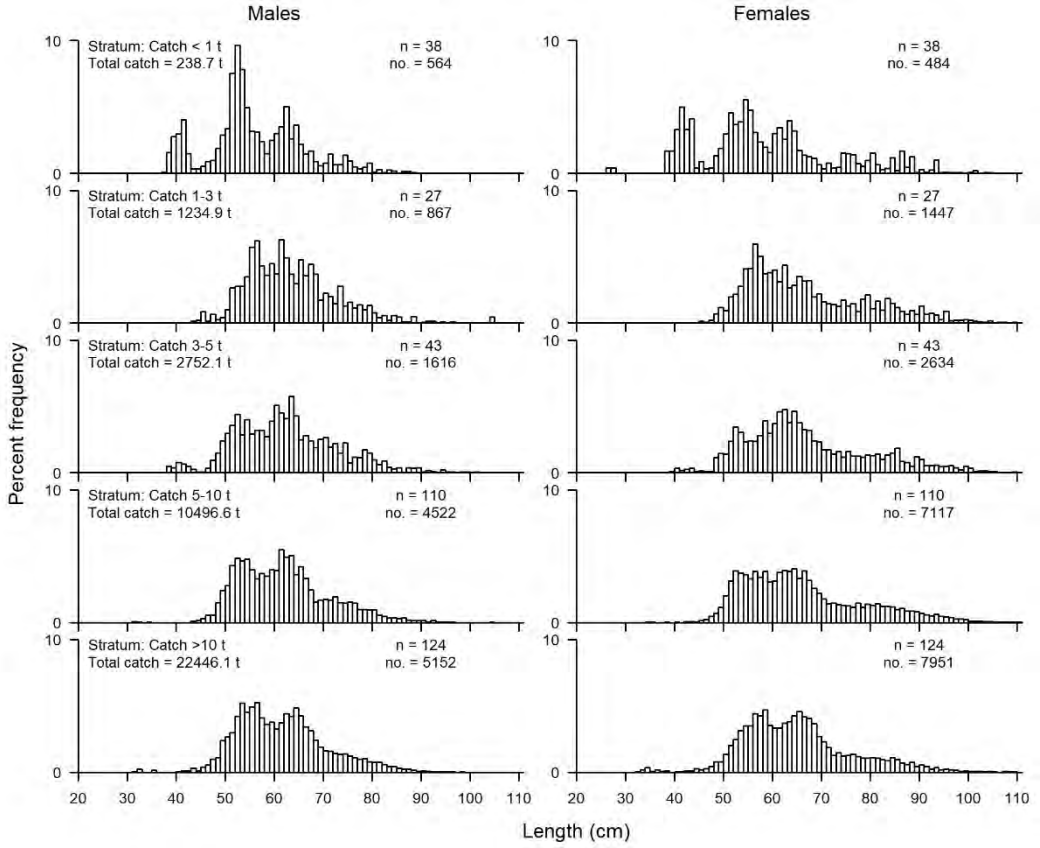


Figure 49: Mean length of selected Chatham Rise and Sub-Antarctic otolith-sampled fish by catch.

Chatham Rise



Sub-Antarctic

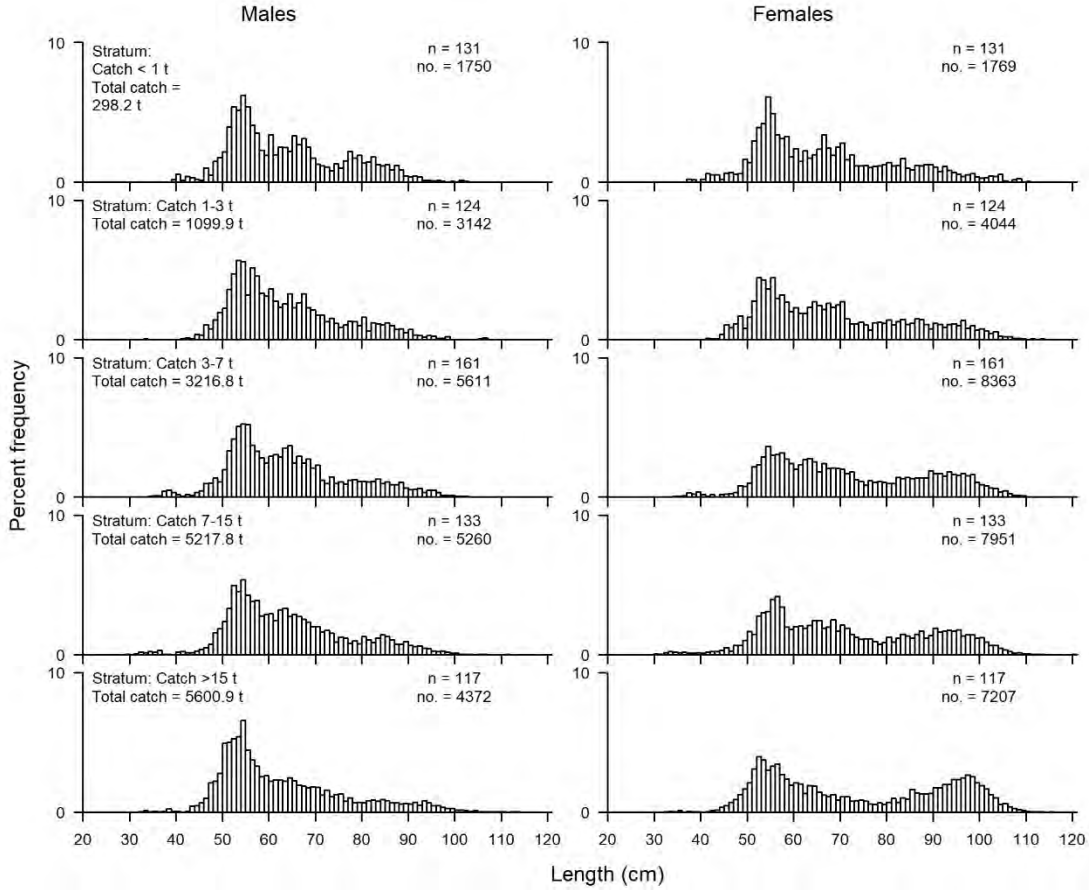


Figure 50: Scaled length frequency distribution of hoki taken in commercial catches from the Chatham Rise and Sub-Antarctic fisheries by catch bins used in selecting otoliths from 2017–18 sampled by the Observer Programme. n, number of tows sampled; no., number of fish sampled.

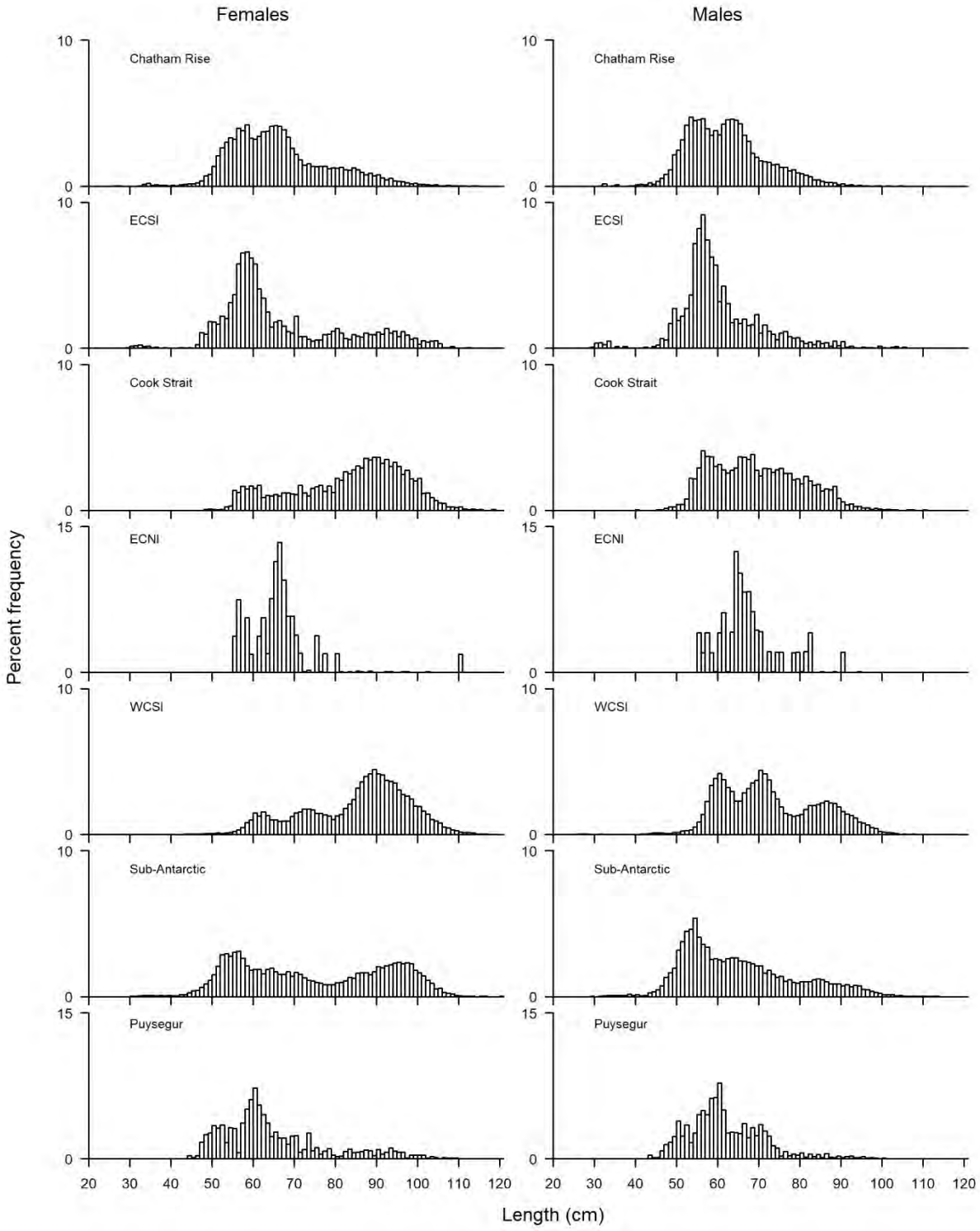


Figure 51: Length frequency distributions of female and male hoki taken in commercial catches from different areas during the 2017–18 fishing year.

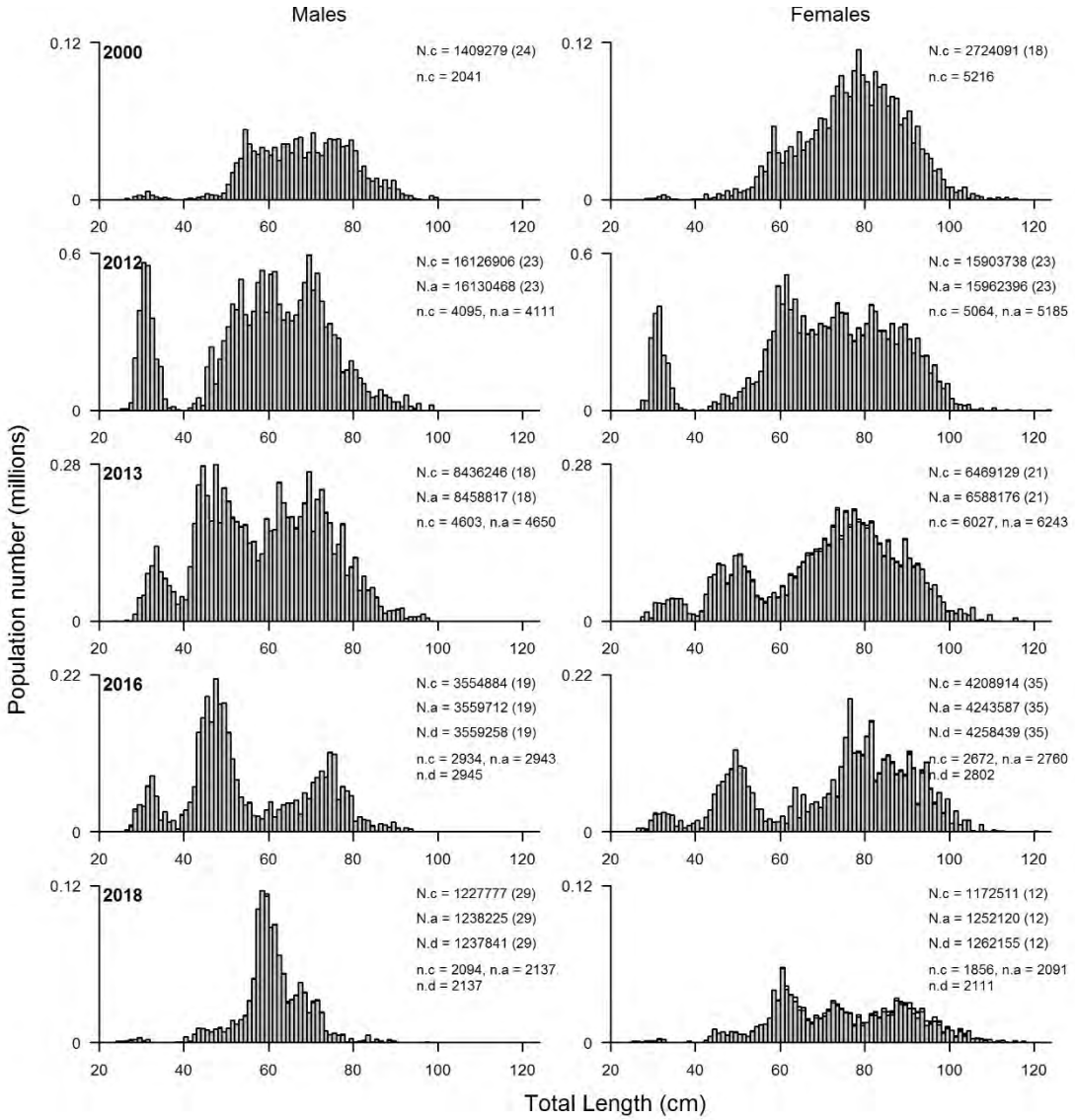


Figure 52: Length frequency distributions by sex of hoki for core (grey), all (white), and deep (black) strata from the 2000 (TAN0007), 2012 (TAN1210), 2013 (TAN1308), 2016 (TAN1609), and 2018 (TAN1807) WCSI trawl surveys. n.d, estimated scaled total number of fish for deep strata; n.a, estimated scaled total number of fish for all strata; n.c, estimated scaled total number of fish for core strata; and CV, the coefficient of variation (in parentheses).

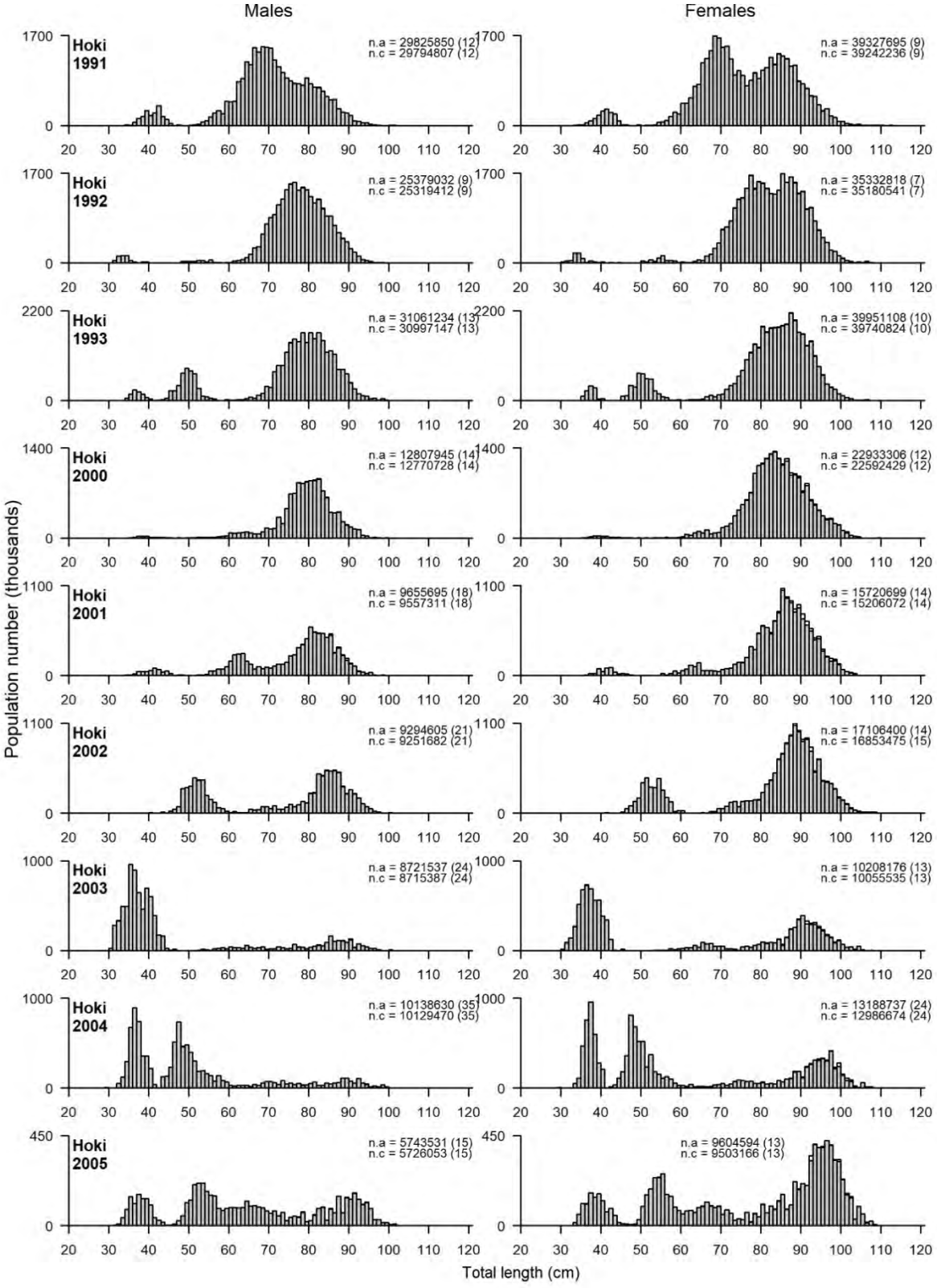


Figure 53: Scaled length frequency distributions by sex of hoki for core (grey), and all (white) strata from the Southland and Sub-Antarctic November–December *Tangaroa* surveys. n.a, estimated scaled total number of fish for all strata; n.c, estimated scaled total number of fish for core strata; and CV, the coefficient of variation (in parentheses).

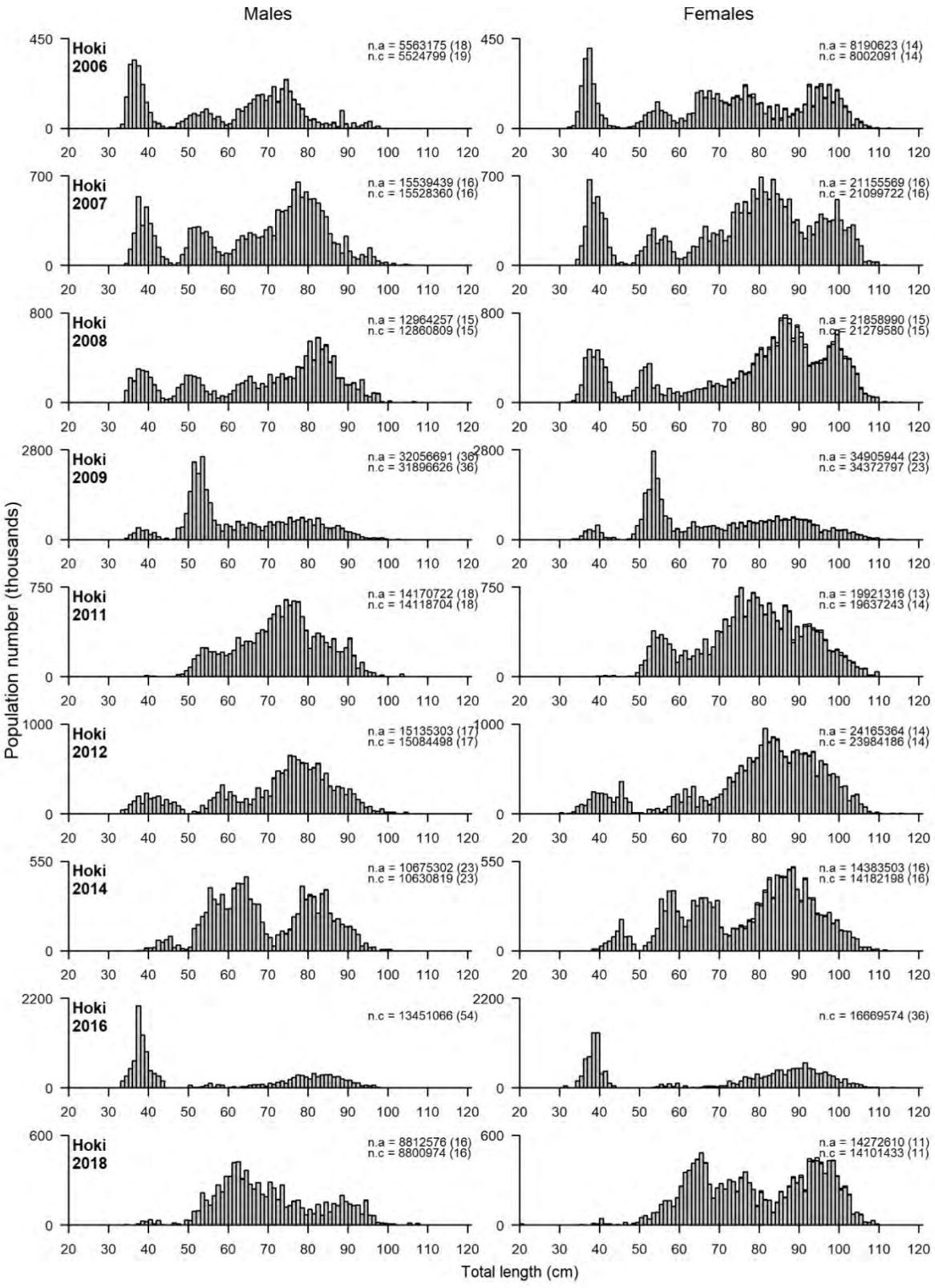


Figure 53 continued.

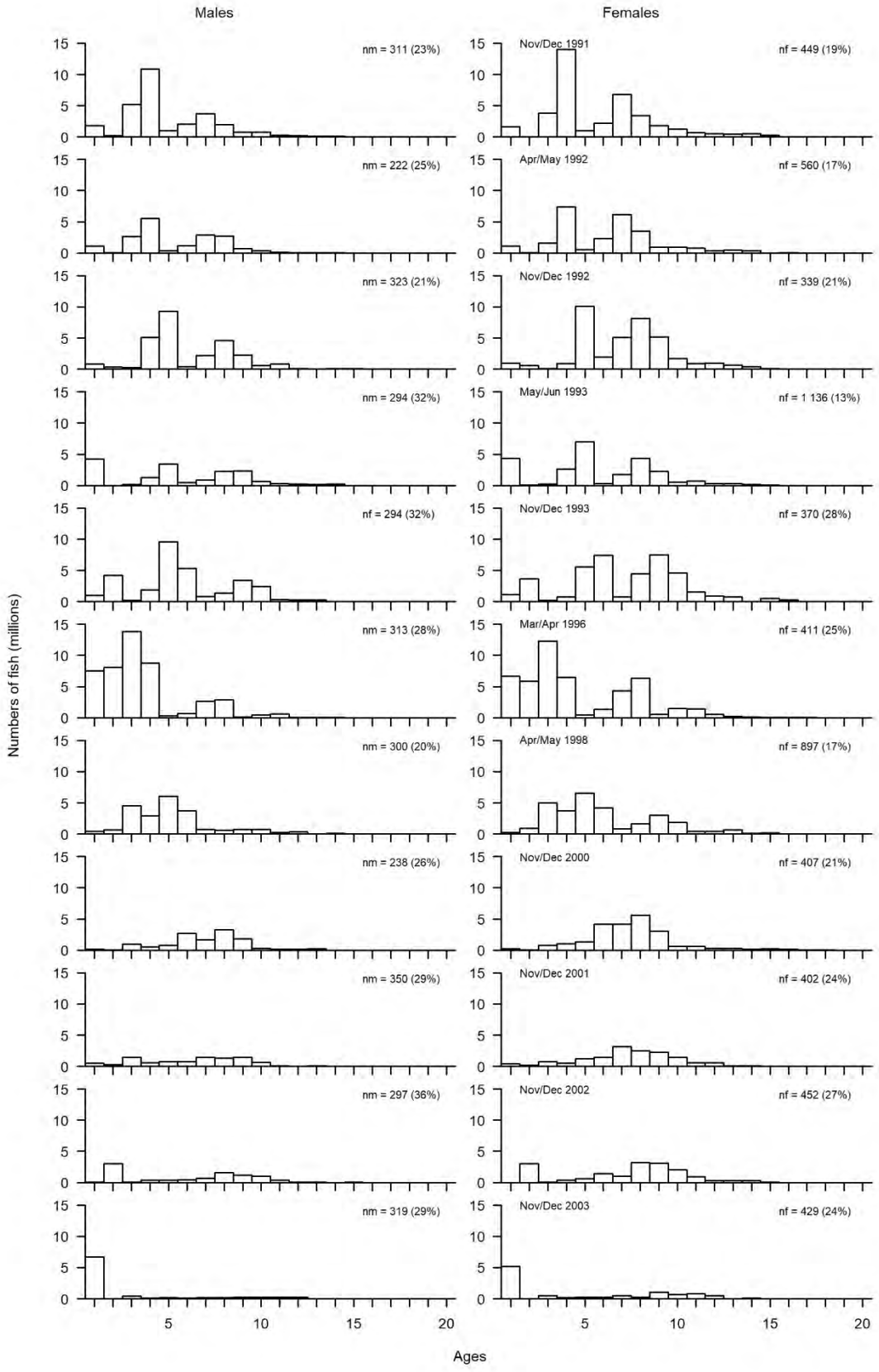


Figure 54: Scaled age frequency distributions for hoki from Sub-Antarctic *Tangaroa* trawl surveys for the core 300–800 m survey area. Number of fish aged (nf, female; nm, male) are given with CVs in parentheses.

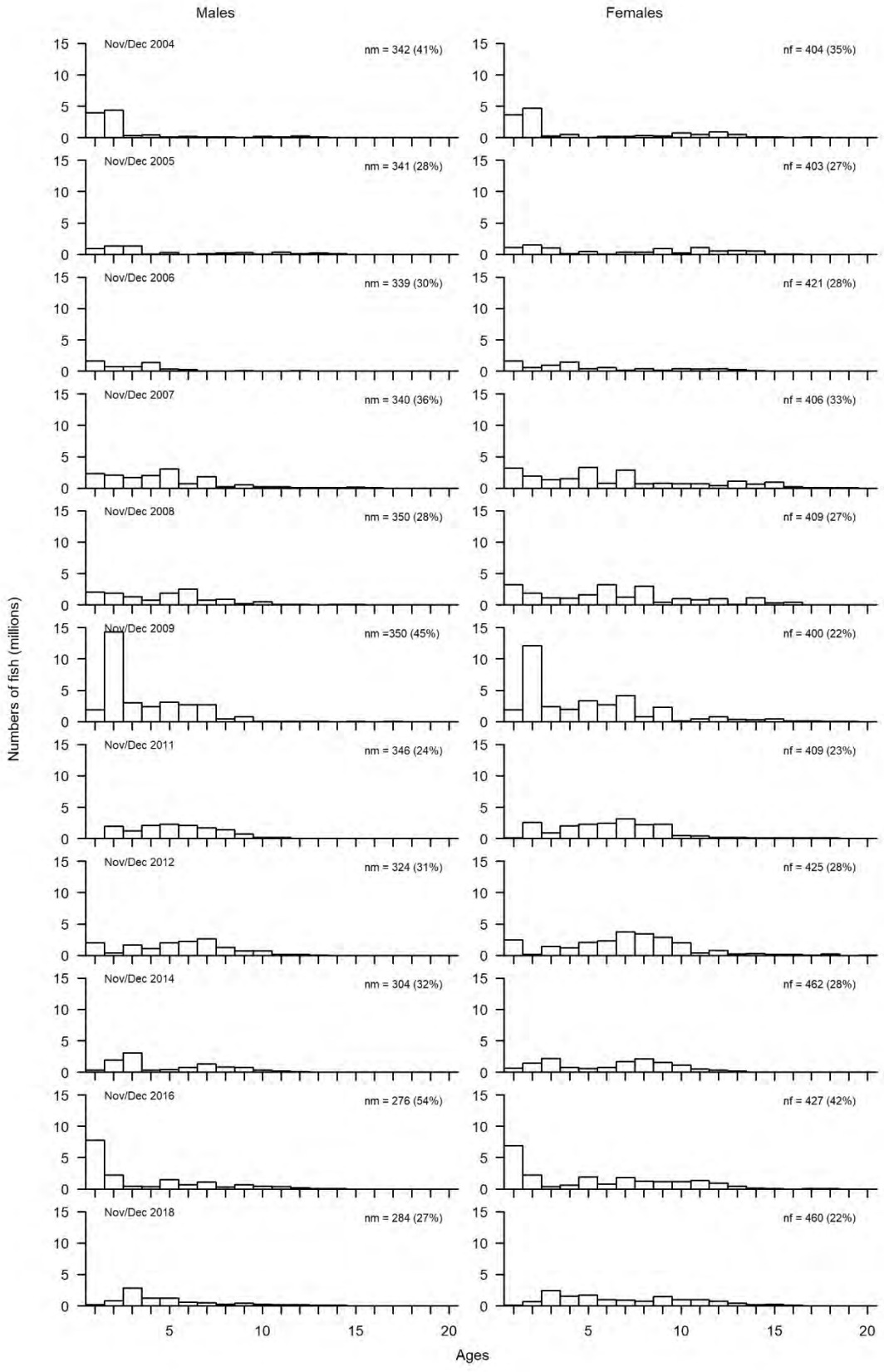


Figure 54 continued.

APPENDICES

Table A1a: Number of vessels, total hoki catch, number of tows, median tow duration, median catch per tow, and median catch per hour for all WCSI vessels by year. Year defined as June to September. Data are non-zero catches for TCEPR and 'ERS-trawl' midwater tows, and excludes MHS tows.

All target species mid-water tows:

Fishing year	Number of vessels	Total catch (t)	Number of tows	Median tow duration (h)	Median catch per tow (t)	Median catch per hour (t/h)
1990	70	149 269	6 779	4.20	10.30	2.60
1991	66	118 033	6 742	4.00	10.20	2.60
1992	61	92 005	5 191	3.60	12.40	3.50
1993	57	82 388	5 256	3.20	10.30	3.70
1994	65	105 262	7 141	3.00	8.90	3.20
1995	59	73 493	6 669	3.50	5.10	1.50
1996	59	65 943	5 149	3.50	6.90	2.00
1997	75	82 477	6 601	3.80	7.40	2.00
1998	66	95 760	6 674	3.50	10.40	2.80
1999	56	76 750	5 255	3.10	10.30	3.30
2000	51	79 534	5 314	2.80	12.00	4.30
2001	62	78 853	5 879	2.60	9.00	3.40
2002	56	61 528	4 654	2.30	9.80	4.10
2003	51	51 748	4 295	3.00	8.10	2.40
2004	51	32 036	4 223	2.40	4.70	1.50
2005	37	19 962	2 364	2.50	5.20	1.90
2006	36	21 459	2 015	3.00	6.90	2.50
2007	31	21 093	1 432	3.50	9.30	3.50
2008	15	12 046	884	1.80	6.40	3.80
2009	23	12 586	879	3.20	9.10	3.20
2010	26	23 033	1 216	2.60	15.30	5.20
2011	24	29 603	1 514	2.00	17.20	8.30
2012	27	30 122	1 567	2.10	16.30	7.90
2013	24	33 857	1 811	2.60	15.40	6.10
2014	26	43 805	2 317	2.80	15.10	5.90
2015	27	50 970	2 681	2.70	15.40	6.00
2016	24	38 311	2 639	2.20	11.70	5.00
2017	24	35 265	2 311	2.20	11.80	5.50
2018	20	25 489	2 063	2.00	9.80	4.90

Target hoki mid-water tows:

Fishing year	Number of vessels	Total catch (t)	Number of tows	Median tow duration (h)	Median catch per tow (t)	Median catch per hour (t/h)
1990	70	149 237	6 736	4.20	10.30	2.60
1991	66	117 913	6 725	4.00	10.20	2.60
1992	60	91 886	5 139	3.60	12.40	3.60
1993	56	81 992	5 023	3.10	10.50	4.10
1994	64	105 074	6 980	3.00	9.50	3.40
1995	59	73 065	6 411	3.50	5.10	1.60
1996	59	65 874	5 093	3.50	6.90	2.00
1997	75	82 060	6 495	3.80	8.00	2.10
1998	66	95 566	6 611	3.50	10.40	2.80
1999	56	76 516	5 141	3.10	10.30	3.40
2000	51	79 269	5 193	2.70	12.00	4.50
2001	62	78 512	5 726	2.60	9.30	3.60
2002	56	61 336	4 579	2.30	9.80	4.30
2003	51	51 466	4 208	3.00	8.10	2.50
2004	51	31 873	4 150	2.30	4.90	1.60
2005	37	19 899	2 266	2.40	5.80	2.00
2006	34	21 114	1 734	2.60	8.70	3.20
2007	31	20 786	1 136	2.80	15.00	5.50
2008	13	11 841	806	1.70	7.30	4.70
2009	15	12 363	679	2.70	14.50	5.00
2010	23	22 884	1 172	2.50	17.10	5.50
2011	24	29 468	1 495	2.00	17.40	8.50
2012	27	30 071	1 559	2.10	16.30	7.90
2013	24	33 703	1 793	2.60	15.40	6.20
2014	26	43 770	2 298	2.80	15.20	5.90
2015	27	50 906	2 649	2.70	15.50	6.10
2016	24	38 310	2 637	2.20	11.70	5.00
2017	24	35 227	2 307	2.20	11.80	5.50
2018	20	25 475	2 057	2.00	9.80	4.90

Table A1b: Number of vessels, total hoki catch, number of tows, median tow duration, median catch per tow, and median catch per hour for all WCSI vessels by year. Year is defined as June to September. Data are non-zero catches for TCEPR and 'ERS-trawl' bottom tows, and exclude MHS tows.

All target species bottom tows:

Fishing year	Number of vessels	Total catch (t)	Number of tows	Median tow duration (h)	Median catch per tow (t)	Median catch per hour (t/h)
1990	41	10 731	1 291	4.00	3.20	0.80
1991	36	10 949	1 457	4.00	3.60	0.90
1992	35	9 332	1 022	4.10	4.10	1.00
1993	34	13 656	1 726	3.80	5.20	1.40
1994	32	9 701	1 455	4.20	4.00	0.80
1995	27	6 028	1 296	4.50	2.60	0.50
1996	36	5 005	1 576	4.70	2.10	0.40
1997	48	5 148	1 416	5.00	2.30	0.50
1998	40	5 891	1 271	5.20	3.10	0.50
1999	38	12 881	1 803	4.70	4.40	0.90
2000	34	17 443	2 002	4.50	6.00	1.30
2001	40	18 238	2 397	4.50	5.00	0.90
2002	35	26 991	2 998	5.00	5.30	1.00
2003	39	17 044	3 146	5.30	2.40	0.40
2004	35	8 158	2 113	6.00	1.60	0.30
2005	30	10 834	1 740	6.20	2.70	0.40
2006	25	14 993	2 127	8.30	2.90	0.40
2007	22	10 223	1 316	7.00	3.10	0.40
2008	17	8 180	1 469	9.00	2.40	0.30
2009	18	6 732	1 079	9.20	3.00	0.30
2010	21	11 089	1 146	6.80	5.10	0.90
2011	21	15 071	1 561	6.10	6.30	1.00
2012	23	20 353	1 656	5.20	9.90	1.90
2013	18	17 776	1 427	5.10	10.80	2.30
2014	17	19 316	1 523	5.20	10.20	1.80
2015	19	20 997	1 795	5.20	8.40	1.50
2016	21	24 076	1 785	3.70	12.60	3.40
2017	18	23 374	2 257	4.80	6.40	1.30
2018	22	19 184	2 165	5.30	5.10	0.90

Target hoki bottom tows:

Fishing year	Number of vessels	Total catch (t)	Number of tows	Median tow duration (h)	Median catch per tow (t)	Median catch per hour (t/h)
1990	34	10 591	1 128	4.20	4.10	1.10
1991	31	10 875	1 320	4.00	4.10	1.10
1992	28	9 152	791	4.00	7.00	1.70
1993	29	13 611	1 588	3.80	5.90	1.60
1994	29	9 677	1 362	4.30	4.20	0.90
1995	24	6 013	1 263	4.50	2.70	0.60
1996	36	4 977	1 536	4.70	2.10	0.40
1997	42	5 112	1 340	5.00	2.50	0.50
1998	34	5 856	1 190	5.20	3.10	0.60
1999	34	12 849	1 669	4.70	5.10	1.00
2000	32	17 385	1 859	4.30	6.60	1.40
2001	37	18 216	2 314	4.60	5.00	1.00
2002	34	26 722	2 832	5.00	5.90	1.10
2003	39	16 793	2 789	5.10	3.00	0.60
2004	34	7 911	1 797	5.70	2.00	0.40
2005	27	9 870	1 240	5.60	4.60	0.80
2006	24	13 331	1 405	7.00	5.10	0.80
2007	20	8 874	731	4.80	9.30	1.70
2008	13	5 246	480	5.00	8.60	1.70
2009	13	4 460	348	4.50	11.30	2.60
2010	19	9 214	611	3.20	13.50	4.70
2011	17	11 707	908	4.10	11.40	2.90
2012	20	18 853	1 184	3.80	15.00	4.10
2013	16	16 063	996	3.50	15.60	4.80
2014	15	17 203	1 075	3.90	15.30	3.80
2015	17	18 209	1 216	3.60	14.30	4.00
2016	17	23 071	1 494	3.20	15.10	5.10
2017	16	22 134	1 874	4.40	8.70	1.80
2018	18	18 954	1 990	5.30	6.20	1.10

Table A1c: Number of vessels, total hoki catch, number of tows, median tow duration, median catch per tow, and median catch per hour for all Cook Strait vessels by year. Year defined as June to September. Data are non-zero catches for TCEPR and 'ERS-trawl' midwater tows, and exclude MHS tows.

All target species mid-water tows:

Fishing year	Number of vessels	Total catch (t)	Number of tows	Median tow duration (hr)	Median catch per tow	Median catch per hour (t/h)
1990	17	11 852	1 044	1.20	9.10	7.40
1991	21	21 978	2 069	1.50	8.20	5.00
1992	22	19 300	1 640	1.20	8.30	6.50
1993	20	16 970	1 498	1.00	8.30	6.90
1994	29	24 623	1 770	1.00	12.10	12.00
1995	24	24 599	1 948	1.00	10.10	12.30
1996	37	42 412	3 026	0.80	11.70	17.40
1997	34	42 654	3 478	0.90	10.60	11.90
1998	28	30 209	2 246	1.00	12.50	12.80
1999	21	27 787	1 928	1.00	14.40	15.80
2000	21	27 550	1 893	0.70	12.90	20.90
2001	25	23 478	1 807	0.80	11.60	14.40
2002	15	16 911	989	1.00	15.90	19.50
2003	20	26 795	1 758	0.90	13.70	17.80
2004	19	27 603	1 732	1.00	13.20	15.00
2005	13	18 293	1 310	1.00	13.60	17.90
2006	11	16 446	977	0.80	15.60	21.70
2007	7	12 181	895	0.90	11.90	15.50
2008	6	7 350	375	0.80	19.30	26.00
2009	7	9 040	727	0.60	10.10	18.20
2010	8	10 662	794	0.80	11.20	15.30
2011	6	7 070	482	0.70	12.30	19.90
2012	9	9 656	719	0.90	11.50	15.10
2013	9	11 462	826	0.70	12.30	17.90
2014	9	11 163	871	1.00	11.20	12.20
2015	9	11 941	767	0.60	15.00	22.20
2016	9	10 805	630	0.70	16.90	26.10
2017	9	9 056	555	0.90	14.70	17.00
2018	7	12 955	689	0.80	17.70	21.70

Target hoki mid-water tows:

Fishing year	Number of vessels	Total catch (t)	Number of tows	Median tow duration (hr)	Median catch per tow	Median catch per hour (t/h)
1990	17	11 852	1 044	1.20	9.10	7.40
1991	21	21 978	2 069	1.50	8.20	5.00
1992	22	19 300	1 640	1.20	8.30	6.50
1993	18	16 949	1 492	1.00	8.30	7.00
1994	29	24 582	1 764	1.00	12.10	12.00
1995	24	24 541	1 944	1.00	10.10	12.30
1996	37	42 334	3 017	0.80	11.70	17.50
1997	34	42 625	3 474	0.90	10.60	11.90
1998	28	30 172	2 244	1.00	12.50	12.80
1999	21	27 787	1 928	1.00	14.40	15.80
2000	21	27 550	1 893	0.70	12.90	20.90
2001	25	23 450	1 804	0.80	11.60	14.40
2002	15	16 911	989	1.00	15.90	19.50
2003	20	26 795	1 758	0.90	13.70	17.80
2004	19	27 603	1 730	1.00	13.20	15.10
2005	13	18 289	1 309	1.00	13.70	18.00
2006	11	16 446	976	0.80	15.60	21.70
2007	7	12 133	892	0.90	11.80	15.50
2008	5	7 347	368	0.80	19.80	26.80
2009	7	9 028	726	0.60	10.10	18.20
2010	8	10 606	792	0.80	11.20	15.30
2011	6	7 070	482	0.70	12.30	19.90
2012	9	9 656	719	0.90	11.50	15.10
2013	9	11 462	826	0.70	12.30	17.90
2014	9	11 163	871	1.00	11.20	12.20
2015	9	11 939	766	0.60	15.00	22.20
2016	9	10 805	630	0.70	16.90	26.10
2017	9	9 047	550	0.90	15.10	17.50
2018	7	12 955	689	0.80	17.70	21.70

Table A1d: Number of Chatham Rise and ECSI non-zero hoki bottom tows and vessels, total catches, median tow duration, median catch per tow, and median catch per hour by fishing year. Data source is un-groomed bottom non-zero TCEPR and 'ERS-trawl' tows catching hoki. Chatham Rise data includes data from October to September, and ECSI data includes non-spawning data from November to May. Data excludes MHS tows. Fishing year: "1990" = 1989–90.

All target species bottom tows:

Fishing year	Number of vessels	Total catch (t)	Number of tows	Median tow duration (h)	Median catch per tow (t)	Median catch per hour (t/h)
1990	47	12 996	3 277	4.00	1.50	0.50
1991	59	18 092	4 776	4.00	2.00	0.50
1992	71	43 418	8 142	4.00	3.10	0.80
1993	59	39 220	7 512	3.90	3.40	1.00
1994	64	18 104	5 283	3.50	2.10	0.70
1995	69	30 170	7 442	3.70	3.10	0.90
1996	82	37 002	8 867	3.60	3.20	0.90
1997	95	42 748	10 279	3.70	3.20	0.90
1998	82	55 749	12 447	4.00	3.30	0.90
1999	76	61 421	12 580	4.00	4.10	1.00
2000	60	44 683	10 706	4.10	3.00	0.80
2001	60	46 140	11 419	4.50	3.00	0.70
2002	55	36 215	9 470	4.50	2.90	0.70
2003	62	37 381	10 889	4.70	2.50	0.50
2004	57	31 498	9 094	5.00	2.30	0.50
2005	50	29 067	6 957	5.00	2.80	0.60
2006	50	33 357	6 874	4.80	3.50	0.80
2007	46	37 612	7 255	4.60	3.50	0.80
2008	38	37 366	6 879	4.80	3.60	0.80
2009	37	38 863	6 166	4.30	4.60	1.10
2010	38	38 378	5 814	4.50	5.30	1.20
2011	37	38 118	5 273	4.70	6.00	1.20
2012	35	38 814	5 426	4.80	5.70	1.30
2013	35	35 034	5 166	4.80	5.60	1.20
2014	32	32 570	5 153	4.80	5.10	1.10
2015	35	38 315	5 444	5.00	5.70	1.20
2016	32	35 067	5 243	4.70	5.50	1.20
2017	31	38 802	5 210	4.80	6.10	1.40
2018	33	32 324	5 199	4.50	4.70	1.10

Target hoki bottom tows:

Fishing year	Number of vessels	Total catch (t)	Number of tows	Median tow duration (h)	Median catch per tow (t)	Median catch per hour (t/h)
1990	31	11 785	1 894	4.00	3.90	1.00
1991	41	16 774	3 281	4.00	3.50	0.90
1992	46	42 285	5 407	3.80	5.70	1.50
1993	38	38 337	5 166	3.50	5.70	1.60
1994	36	17 508	3 369	3.20	4.20	1.30
1995	41	29 669	6 038	3.50	4.10	1.20
1996	56	36 577	7 614	3.50	3.40	1.10
1997	72	42 231	8 939	3.60	3.70	1.10
1998	63	55 251	11 131	4.00	4.20	1.00
1999	45	60 732	11 209	4.00	4.40	1.10
2000	34	44 043	9 378	4.10	3.70	0.90
2001	40	44 918	9 753	4.50	3.50	0.80
2002	31	35 031	7 753	4.40	3.40	0.80
2003	32	36 017	9 174	4.80	3.00	0.60
2004	28	30 050	7 108	4.90	3.00	0.60
2005	21	27 681	4 934	5.00	4.10	0.80
2006	20	31 713	4 785	4.80	5.10	1.10
2007	21	34 743	4 729	4.50	5.80	1.20
2008	22	33 519	4 182	4.80	6.60	1.40
2009	21	33 623	3 890	4.20	7.30	1.70
2010	21	35 075	4 332	4.60	6.90	1.50
2011	23	34 801	4 049	4.80	7.20	1.50
2012	24	37 635	4 378	4.80	7.20	1.60
2013	22	33 874	4 146	4.80	6.70	1.40
2014	18	31 864	3 946	4.90	6.60	1.40
2015	21	37 368	4 295	5.00	7.20	1.40
2016	14	32 653	4 048	4.80	6.80	1.50
2017	16	37 100	4 176	4.80	7.70	1.60
2018	19	30 813	3 619	4.70	7.50	1.60

Table A1e: Number of ECSI non-zero hoki midwater or bottom tows and vessels, total catches, median tow duration, median catch per tow, and median catch per hour by year. Data source is un-groomed midwater or bottom non-zero TCEPR and 'ERS-trawl' tows catching hoki. Year defined as June to October. No October data in 2018. Data not shown where there are fewer than 3 vessels, and exclude MHS tows.

All target species mid-water tows:

Fishing year	Number of vessels	Total catch (t)	Number of tows	Median tow duration (h)	Median catch per tow (t)	Median catch per hour (t/h)
2000	7	286	22	2.80	9.00	2.40
2001	14	1 260	121	2.40	6.00	2.20
2002	10	1 952	131	2.40	13.00	5.70
2003	18	4 452	300	2.10	13.70	5.20
2004	5	1 053	56	2.20	12.70	6.90
2005	5	2 677	131	1.70	18.20	11.80
2006	4	461	34	1.50	13.30	7.50
2007	3	284	19	1.00	14.30	13.50
2008	2	-	-	-	-	-
2009	1	-	-	-	-	-
2010	1	-	-	-	-	-
2011	4	879	57	1.00	14.70	10.80
2012	8	1 655	107	1.50	13.20	6.20
2013	10	2 932	189	2.00	14.60	6.70
2014	10	2 548	128	2.20	17.10	8.40
2015	8	3 359	188	2.20	17.40	7.00
2016	8	3 536	201	2.20	15.10	5.80
2017	9	3 680	182	2.60	18.40	6.40
2018	11	3 386	141	2.70	22.60	6.20

Target hoki mid-water tows:

Fishing year	Number of vessels	Total catch (t)	Number of tows	Median tow duration (h)	Median catch per tow (t)	Median catch per hour (t/h)
2000	7	286	22	2.80	9.00	2.40
2001	14	1 260	121	2.40	6.00	2.20
2002	10	1 952	131	2.40	13.00	5.70
2003	18	4 420	298	2.20	13.70	5.20
2004	5	1 053	56	2.20	12.70	6.90
2005	5	2 677	131	1.70	18.20	11.80
2006	4	453	33	1.40	14.20	7.80
2007	3	284	19	1.00	14.30	13.50
2008	2	-	-	-	-	-
2009	1	-	-	-	-	-
2010	1	-	-	-	-	-
2011	4	879	57	1.00	14.70	10.80
2012	8	1 655	107	1.50	13.20	6.20
2013	10	2 902	188	2.00	14.40	6.70
2014	10	2 491	126	2.20	16.90	8.40
2015	8	3 307	187	2.30	17.40	7.00
2016	8	3 018	189	2.30	14.00	4.80
2017	8	3 581	176	2.60	18.40	6.50
2018	11	3 386	141	2.70	22.60	6.20

Table A1e: ECSI continued.

All target bottom tows:

Fishing year	Number of vessels	Total catch (t)	Number of tows	Median tow duration (h)	Median catch per tow (t)	Median catch per hour (t/h)
2000	9	240	59	2.6	3.2	1.1
2001	12	385	64	2.7	4.7	1.7
2002	15	794	103	2.6	4.9	1.9
2003	12	1 922	218	2.8	6.1	2.0
2004	5	158	20	3.1	4.8	1.5
2005	8	514	56	2.7	4.8	1.9
2006	4	139	19	2.1	4.1	3.2
2007	9	657	70	2.2	8.0	3.4
2008	7	2 018	195	2.8	8.1	2.7
2009	6	559	57	3.1	9.1	2.6
2010	7	515	57	2.8	8.2	2.9
2011	6	588	54	3.5	11.0	3.0
2012	9	696	74	2.3	8.0	2.9
2013	7	263	31	3.0	8.2	2.3
2014	10	158	41	2.3	2.5	0.9
2015	6	220	31	2.8	5.2	1.9
2016	10	555	98	3.0	3.5	1.2
2017	8	655	84	2.1	5.1	2.9
2018	7	66	33	1.1	0.1	0.1

Target hoki bottom tows:

Fishing year	Number of vessels	Total catch (t)	Number of tows	Median tow duration (h)	Median catch per tow (t)	Median catch per hour (t/h)
2000	8	240	57	2.6	3.5	1.1
2001	12	385	64	2.7	4.7	1.7
2002	10	787	98	2.6	5.2	2.0
2003	12	1 865	211	2.8	6.1	2.1
2004	3	157	18	3.2	5.1	1.9
2005	6	512	54	2.5	4.9	2.1
2006	4	103	17	2.1	3.6	1.6
2007	7	656	64	2.3	9.0	3.5
2008	6	1 837	168	2.9	9.2	2.9
2009	5	536	50	3.0	10.1	2.7
2010	7	490	55	2.8	8.2	2.9
2011	6	588	53	3.5	11.1	3.0
2012	7	695	69	2.5	9.3	3.2
2013	6	263	30	3.0	8.5	2.4
2014	8	154	33	2.3	2.7	1.1
2015	6	220	31	2.8	5.2	1.9
2016	8	451	86	3.0	3.5	1.2
2017	7	655	83	2.1	5.1	2.9
2018	4	64	11	2.8	5.1	1.4

Table A1f: Number of Sub-Antarctic non-zero hoki bottom tows and vessels, total catches, median tow duration, median catch per tow, and median catch per hour for all vessels by fishing year. Data source is ungroomed bottom non-zero TCEPR and 'ERS-trawl' tows catching hoki, and excludes MHS tows. Fishing year: "1990" = 1989–90.

All target species bottom tows:

Fishing year	Number of vessels	Total catch (t)	Number of tows	Median tow duration (h)	Median catch per tow (t)	Median catch per hour (t/h)
1990	37	11 541	2 588	4.0	2.6	0.6
1991	43	16 177	4 420	4.3	2.6	0.6
1992	58	29 690	6 878	4.2	3.1	0.8
1993	39	22 314	5 649	4.0	3.1	0.8
1994	45	9 051	3 163	4.2	1.6	0.4
1995	42	12 135	3 184	4.3	2.4	0.6
1996	46	10 799	3 343	4.2	2.1	0.5
1997	58	19 288	4 522	4.5	3.2	0.7
1998	50	24 232	5 195	4.3	3.3	0.8
1999	49	20 966	4 673	4.5	2.9	0.7
2000	43	31 576	7 154	4.2	3.0	0.8
2001	46	26 222	6 669	4.5	2.7	0.6
2002	47	29 568	8 093	4.4	2.1	0.6
2003	44	19 870	5 556	4.9	2.4	0.5
2004	41	11 168	3 728	5.0	2.0	0.4
2005	40	6 059	2 466	5.2	1.0	0.2
2006	34	6 468	2 282	5.2	0.7	0.1
2007	31	7 419	2 877	5.2	0.8	0.2
2008	29	8 015	2 625	5.5	1.0	0.2
2009	25	9 195	2 807	5.0	1.0	0.2
2010	29	11 551	3 023	5.4	1.0	0.2
2011	28	10 973	2 689	5.0	1.5	0.3
2012	28	13 665	2 580	5.0	2.2	0.5
2013	29	14 053	2 773	4.8	2.6	0.5
2014	22	19 786	3 211	5.0	3.6	0.7
2015	25	15 606	2 835	5.1	3.3	0.7
2016	25	6 550	1 787	5.1	1.5	0.3
2017	27	12 939	2 413	5.3	2.0	0.5
2018	29	14 269	3 471	5.8	1.5	0.3

Hoki target bottom tows:

Fishing year	Number of vessels	Total catch (t)	Number of tows	Median tow duration (h)	Median catch per tow (t)	Median catch per hour (t/h)
1990	20	10 922	2 046	4.0	3.6	0.9
1991	30	15 229	3 862	4.4	2.8	0.6
1992	33	28 280	5 315	4.1	4.1	1.0
1993	24	21 369	4 819	3.8	3.6	0.9
1994	22	8 748	1 977	4.0	3.2	0.9
1995	25	11 861	2 260	4.0	4.1	1.0
1996	25	10 553	2 345	4.0	3.2	0.9
1997	42	18 920	3 293	4.2	4.6	1.1
1998	35	23 683	4 270	4.2	4.2	1.0
1999	33	20 391	3 563	4.2	4.1	1.0
2000	30	30 884	5 805	4.0	3.9	1.0
2001	31	25 397	5 324	4.2	3.5	0.8
2002	33	28 612	6 253	4.2	2.9	0.8
2003	33	19 101	4 322	4.8	3.0	0.7
2004	26	10 815	2 864	4.9	3.0	0.6
2005	25	5 197	1 346	5.1	2.5	0.5
2006	16	4 685	705	4.9	4.1	0.8
2007	20	5 143	1 136	4.5	2.2	0.5
2008	13	5 828	909	4.8	4.5	0.9
2009	12	6 883	918	4.4	5.1	1.2
2010	12	9 687	1 231	4.5	6.1	1.3
2011	15	9 210	1 237	4.5	5.5	1.2
2012	17	11 538	1 193	4.6	7.6	1.6
2013	16	11 705	1 363	4.3	6.2	1.5
2014	13	17 217	1 864	4.5	7.1	1.6
2015	15	13 052	1 610	4.9	6.2	1.3
2016	9	5 651	824	4.9	5.2	1.1
2017	15	11 063	1 257	4.8	6.1	1.3
2018	19	12 427	1 715	5.0	5.1	1.0

Table A1g: Number of Puysegur non-zero hoki bottom and midwater median tow duration, median catch per tow, and median catch per hour for all vessels by year. Data source is un-groomed midwater or bottom non-zero TCEPR and 'ERS-trawl' tows catching hoki. Year defined as June to December. No October to December data in 2018. Data not shown where there are less than 3 vessels, and excludes MHS tows.

All target species mid-water tows:

Fishing year	Number of vessels	Total catch (t)	Number of tows	Median tow duration (h)	Median catch per tow (t)	Median catch per hour (t/h)
1990	25	7 154	759	2.5	7.9	3.2
1991	16	3 188	269	2.4	10.2	4.1
1992	13	1 079	146	3.0	5.2	1.9
1993	10	663	75	2.0	6.1	2.5
1994	17	2 219	266	3.0	4.0	1.1
1995	15	687	104	2.3	3.1	1.5
1996	12	1 471	155	2.7	7.2	3.0
1997	20	4 728	409	3.5	8.5	2.5
1998	8	886	97	3.0	7.3	2.4
1999	16	1 407	140	3.3	4.8	1.3
2000	13	2 071	173	4.2	6.0	1.6
2001	22	5 213	373	4.3	10.0	2.2
2002	19	3 129	262	3.6	6.7	1.5
2003	20	5 137	309	2.8	12.1	3.6
2004	5	576	43	3.7	2.9	0.7
2005	9	5 018	218	2.1	22.3	10.0
2006	4	240	16	2.8	15.1	5.0
2007	1	-	-	-	-	-
2008	1	-	-	-	-	-
2009	1	-	-	-	-	-
2010	1	-	-	-	-	-
2011	2	-	-	-	-	-
2012	2	-	-	-	-	-
2013	2	-	-	-	-	-
2014	3	9	4	3.5	2.2	0.8
2015	3	864	50	2.5	16.4	3.7
2016	3	411	36	3.5	6.6	1.6
2017	5	504	37	3.2	12.3	3.1
2018	5	271	29	3.7	10.2	1.8

Hoki target mid-water tows:

Fishing year	Number of vessels	Total catch (t)	Number of tows	Median tow duration (h)	Median catch per tow (t)	Median catch per hour (t/h)
1990	25	7 149	758	2.5	7.9	3.2
1991	16	3 173	268	2.4	10.2	4.1
1992	12	1 048	134	3.0	5.2	2.0
1993	9	663	74	2.0	6.2	2.6
1994	17	2 197	264	3.0	4.0	1.1
1995	15	687	104	2.3	3.1	1.5
1996	12	1 471	155	2.7	7.2	3.0
1997	20	4 728	409	3.5	8.5	2.5
1998	8	885	96	3.0	7.7	2.4
1999	16	1 407	140	3.3	4.8	1.3
2000	13	2 071	173	4.2	6.0	1.6
2001	22	5 206	372	4.3	10.0	2.2
2002	19	3 129	262	3.6	6.7	1.5
2003	20	5 137	309	2.8	12.1	3.6
2004	3	572	29	3.5	13.2	5.1
2005	8	5 012	216	2.1	22.3	10.1
2006	4	240	16	2.8	15.1	5.0
2007	1	-	-	-	-	-
2008	1	-	-	-	-	-
2009	1	-	-	-	-	-
2010	1	-	-	-	-	-
2011	2	-	-	-	-	-
2012	2	-	-	-	-	-
2013	2	-	-	-	-	-
2014	3	9	4	3.5	2.2	0.8
2015	3	864	50	2.5	16.4	3.7
2016	3	411	36	3.5	6.6	1.6
2017	5	504	37	3.2	12.3	3.1
2018	5	271	29	3.7	10.2	1.8

Table A1g: Puysegur continued.

All target species bottom tows:

Fishing year	Number of vessels	Total catch (t)	Number of tows	Median tow duration (h)	Median catch per tow (t)	Median catch per hour (t/h)
1990	18	116	276	3.2	0.1	0.0
1991	26	1 664	380	4.3	3.1	0.7
1992	33	4 034	864	4.3	2.6	0.6
1993	15	1 052	241	4.2	3.0	0.7
1994	22	427	255	5.0	0.7	0.1
1995	15	292	240	6.1	0.5	0.1
1996	18	1 038	468	4.8	0.6	0.1
1997	27	1 237	486	5.9	0.5	0.1
1998	22	1 432	378	5.6	1.1	0.2
1999	23	1 111	436	5.5	1.0	0.2
2000	23	1 231	453	5.8	1.0	0.2
2001	26	953	277	4.4	1.0	0.3
2002	19	1 930	230	3.8	5.5	1.2
2003	20	839	227	4.5	1.3	0.3
2004	17	224	112	4.4	0.5	0.1
2005	21	522	261	5.5	0.8	0.1
2006	20	1 098	330	4.2	1.0	0.2
2007	16	370	251	4.7	0.5	0.1
2008	6	155	126	4.6	0.4	0.1
2009	9	163	80	4.2	1.0	0.2
2010	11	150	133	5.0	0.5	0.1
2011	13	299	141	4.5	1.0	0.2
2012	10	264	103	4.1	1.0	0.3
2013	10	528	114	4.4	3.1	0.6
2014	12	888	148	3.9	4.1	1.0
2015	12	559	166	4.9	1.0	0.2
2016	11	631	126	5.0	2.0	0.4
2017	13	467	86	4.2	2.1	0.6
2018	8	566	70	4.2	4.8	1.3

Hoki target bottom tows:

Fishing year	Number of vessels	Total catch (t)	Number of tows	Median tow duration (h)	Median catch per tow (t)	Median catch per hour (t/h)
1990	8	24	24	2.9	0.5	0.3
1991	21	1 541	312	4.1	4.1	0.9
1992	27	3 798	712	4.2	3.1	0.8
1993	12	1 019	202	4.0	3.9	0.9
1994	17	382	195	5.2	1.0	0.2
1995	11	251	167	6.1	0.5	0.1
1996	18	962	361	4.5	1.1	0.2
1997	25	1 062	427	5.8	0.5	0.1
1998	20	1 360	302	5.2	2.1	0.4
1999	22	1 060	387	5.5	1.0	0.2
2000	21	1 190	381	5.7	1.2	0.2
2001	23	919	210	4.3	2.2	0.5
2002	17	1 907	209	3.8	5.9	1.4
2003	14	810	151	4.6	3.0	0.6
2004	7	167	31	3.7	3.0	0.9
2005	8	243	51	3.2	2.2	0.9
2006	6	738	90	3.5	6.1	2.0
2007	2	-	-	-	-	-
2008	1	-	-	-	-	-
2009	1	-	-	-	-	-
2010	1	-	-	-	-	-
2011	1	-	-	-	-	-
2012	1	-	-	-	-	-
2013	4	221	21	3.9	11.5	2.7
2014	4	254	34	3.5	4.1	1.1
2015	4	371	26	3.2	16.0	4.5
2016	4	309	31	3.6	10.0	2.4
2017	4	320	24	3.9	11.6	3.3
2018	6	400	45	3.5	7.2	1.9

Table A1h: Number of ECNI non-zero hoki bottom and midwater median tow duration, median catch per tow, and median catch per hour for all vessels by fishing year. Data source is un-groomed midwater or bottom non-zero TCEPR and 'ERS-trawl' tows catching hoki. Year defined as October to September. Data are not shown where there are less than 3 vessels. Fishing year: "1990" = 1989–90.

All target species mid-water tows:

Fishing year	Number of vessels	Total catch (t)	Number of tows	Median tow duration (h)	Median catch per tow (t)	Median catch per hour (t/h)
1990	6	155	114	1.0	0.5	0.5
1991	9	240	73	1.2	0.3	0.3
1992	7	93	110	1.0	0.2	0.1
1993	7	180	166	1.5	0.5	0.3
1994	10	186	198	1.2	0.2	0.2
1995	11	112	86	0.8	0.1	0.2
1996	17	87	161	1.8	0.1	0.1
1997	19	108	85	1.5	0.4	0.3
1998	14	708	253	1.5	1.7	1.0
1999	11	368	226	2.1	0.4	0.3
2000	9	289	193	1.3	0.8	0.6
2001	9	643	234	1.2	1.7	1.2
2002	7	285	156	1.0	0.8	0.7
2003	8	161	175	0.9	0.4	0.3
2004	7	239	195	1.0	0.4	0.4
2005	6	98	147	1.1	0.2	0.2
2006	5	320	99	1.2	0.6	0.4
2007	5	131	67	1.0	0.3	0.4
2008	6	197	119	1.2	0.3	0.3
2009	5	190	99	0.8	0.9	1.0
2010	7	105	114	1.0	0.4	0.3
2011	6	628	138	1.0	2.8	2.4
2012	6	249	92	1.0	1.0	1.1
2013	5	175	85	1.0	0.4	0.6
2014	6	114	90	1.0	0.4	0.4
2015	6	274	98	1.1	1.5	0.9
2016	6	125	74	1.0	0.8	0.9
2017	5	90	34	1.0	2.0	2.3
2018	6	138	58	1.3	1.3	0.8

Hoki target mid-water tows:

Fishing year	Number of vessels	Total catch (t)	Number of tows	Median tow duration (h)	Median catch per tow (t)	Median catch per hour (t/h)
1990	3	33	3	0.8	11.7	15.6
1991	8	228	44	1.5	0.7	0.4
1992	4	63	39	1.4	1.2	0.8
1993	5	66	43	1.4	1.0	0.6
1994	7	89	33	1.8	0.3	0.3
1995	6	70	11	1.5	0.5	0.4
1996	14	61	45	2.6	0.8	0.3
1997	14	95	43	1.7	1.1	0.6
1998	12	675	184	1.7	2.3	1.4
1999	4	332	121	1.4	1.5	0.9
2000	4	233	112	2.0	1.5	0.8
2001	5	623	194	1.4	2.0	1.6
2002	4	261	107	1.2	1.2	1.0
2003	2	-	-	-	-	-
2004	3	215	140	1.4	0.7	0.4
2005	2	-	-	-	-	-
2006	2	-	-	-	-	-
2007	2	-	-	-	-	-
2008	2	-	-	-	-	-
2009	1	-	-	-	-	-
2010	2	-	-	-	-	-
2011	3	519	74	0.9	6.2	5.7
2012	3	218	47	1.3	4.1	2.6
2013	3	98	25	2.1	2.3	0.8
2014	5	47	22	1.2	2.0	1.0
2015	4	234	57	0.9	3.7	4.6
2016	4	71	35	1.0	1.1	1.0
2017	1	-	-	-	-	-
2018	3	91	25	1.5	2.4	1.8

Table A1h: ECNI continued.

All target species bottom tows:

Fishing year	Number of vessels	Total catch (t)	Number of tows	Median tow duration (h)	Median catch per tow (t)	Median catch per hour (t/h)
1990	14	127	1 676	3.9	0.1	0.0
1991	26	312	3 242	4.5	0.1	0.0
1992	26	273	2 520	5.2	0.1	0.0
1993	30	567	2 318	5.2	0.1	0.0
1994	44	960	2 996	5.3	0.1	0.0
1995	49	1 112	2 372	5.0	0.1	0.0
1996	70	1 871	3 339	4.2	0.2	0.0
1997	68	2 730	3 722	4.1	0.2	0.0
1998	58	1 934	3 388	4.5	0.2	0.0
1999	48	1 065	2 992	4.9	0.1	0.0
2000	40	754	3 042	5.5	0.1	0.0
2001	37	987	3 006	6.5	0.1	0.0
2002	40	838	4 249	7.0	0.1	0.0
2003	43	718	2 528	7.0	0.1	0.0
2004	39	612	2 067	6.5	0.1	0.0
2005	36	408	1 451	6.2	0.1	0.0
2006	35	356	1 170	5.8	0.1	0.0
2007	29	440	1 622	5.0	0.1	0.0
2008	26	317	1 288	5.8	0.1	0.0
2009	20	300	1 120	4.4	0.0	0.0
2010	22	283	1 655	6.2	0.0	0.0
2011	23	802	1 793	5.0	0.1	0.0
2012	24	442	1 489	5.7	0.1	0.0
2013	23	623	1 356	6.9	0.1	0.0
2014	25	795	1 269	4.4	0.1	0.0
2015	21	208	922	5.0	0.1	0.0
2016	18	305	867	6.8	0.1	0.0
2017	19	218	1 000	6.9	0.1	0.0
2018	20	268	1 215	6.9	0.1	0.0

Hoki target bottom tows:

Fishing year	Number of vessels	Total catch (t)	Number of tows	Median tow duration (h)	Median catch per tow (t)	Median catch per hour (t/h)
1991	3	7	23	0.7	0.2	0.3
1992	4	10	16	3.2	0.4	0.1
1993	9	75	77	5.0	0.7	0.1
1994	13	401	248	5.5	0.8	0.1
1995	18	576	155	2.2	1.4	0.6
1996	33	1 222	825	2.8	0.8	0.3
1997	47	2 145	1 396	3.0	0.8	0.3
1998	38	1 271	1 128	3.5	0.5	0.1
1999	23	656	528	3.0	0.8	0.3
2000	15	405	402	2.8	0.7	0.2
2001	18	566	324	2.7	1.0	0.4
2002	16	294	305	3.3	0.5	0.2
2003	14	379	283	2.5	0.8	0.3
2004	17	345	364	3.0	0.4	0.2
2005	10	242	252	3.0	0.5	0.1
2006	14	246	154	3.4	0.8	0.3
2007	13	232	150	4.0	0.6	0.1
2008	6	185	87	3.0	1.1	0.4
2009	6	146	74	3.5	1.2	0.3
2010	8	86	78	4.0	0.7	0.2
2011	9	547	157	3.7	2.1	0.7
2012	7	270	140	3.6	1.0	0.3
2013	6	472	137	4.0	2.1	0.6
2014	8	584	205	2.8	1.3	0.5
2015	6	110	118	4.3	0.4	0.1
2016	4	203	82	5.0	0.5	0.1
2017	4	74	115	4.8	0.5	0.1
2018	6	152	152	5.4	0.9	0.2

Table A2: CPUE data constraints for core datasets.

WCSI: TCEPR target hoki

Data source	TCEPR and 'ERS – trawl' tow-by-tow data
Year range	1991–2018
Year definition	June–September
Statareas	033–036, 703
Method	BT, MW, MB
Target species	HOK
Core vessel selection	80% of catch, ≥ 4 years vessel participation, ≥ 20 tows per vessel-year
Catch	< 100 t
Other	150–900 m; 0.2–15 hours; Exclude PSH tows

WCSI: Observed target hoki

Data source	Observer data
Year range	1990–2018
Year definition	June–September
Statareas	034–036
Method	BT, MW, MB
Target species	HOK
Core vessel selection	80% of catch, ≥ 2 years vessel participation, ≥ 20 tows per vessel-year
Catch	< 100 t
Other	150–900 m; 0.2–15 hours; latitude 40–43º; Exclude PSH tows

Cook Strait: TCEPR target hoki

Data source	TCEPR and 'ERS – trawl' tow-by-tow data
Year range	1991–2018
Year definition	June–September
Statareas	016, 017
Method	MW, MB
Target species	HOK
Core vessel selection	80% of catch, ≥ 4 years vessel participation, ≥ 20 tows per vessel-year
Catch	< 80 t
Other	150–800 m; 0.2–6 hours; Exclude PSH tows

Cook Strait: Observed target hoki

Data source	Observer data
Year range	1998–2018
Year definition	June–September
Statareas	016, 017
Method	MW, MB
Target species	HOK
Final vessel selection	≥ 4 years participation
Catch	< 80 t
Other	150–800 m; 0.2–6 hours; Exclude PSH tows

Table A2: continued.

Chatham Rise and ECSI non-spawning: TCEPR target hoki

Data source	TCEPR and 'ERS – trawl' tow-by-tow data
Year range	1992–2018
Year definition	Chatham Rise: October–September, ECSI non-spawning: November–May
Statareas	018–023, 049–052, 401–404, 407–410
Method	BT
Target species	HOK
Core vessel selection	80% of catch, ≥ 7 years vessel participation, ≥ 20 tows per vessel-year
Catch	< 50 t
Other	150–900 m; 0.2–15 hours; Exclude PSH tows

Chatham Rise and ECSI non-spawning: Observed target hoki

Data source	Observer data
Year range	1994–2018
Year definition	Chatham Rise: October–September, ECSI non-spawning: November–May
Statareas	018–023, 052, 401–404, 407–410
Method	BT
Target species	HOK
Final vessel selection	≥ 3 years participation
Catch	< 80 t
Other	150–900 m; 0.2–15 hours

Sub-Antarctic: TCEPR target hoki

Data source	TCEPR and 'ERS – trawl' tow-by-tow data
Year range	1992–2018
Year definition	October–September
Statareas	026–028, 504, 602–606, 610–612, 618, 619, 624–625
Method	BT
Target species	HOK
Core vessel selection	80% of catch, ≥ 6 years vessel participation, ≥ 20 tows per vessel-year
Catch	< 50 t
Other	150–900 m; 0.2–15 hours

Sub-Antarctic: Observed target hoki

Data source	Observer data
Year range	1998–2018
Year definition	October–September
Statareas	026–028, 504, 602–604, 610 618, 619,614,625
Method	BT
Target species	HOK
Final vessel selection	≥ 3 years participation
Catch	< 50 t
Other	150–900 m; 0.2–15 hours

Table A3: Variables retained in order of decreasing explanatory value by each lognormal CPUE model for each fishery area and the corresponding total R^2 value.

WCSI: TCEPR tow-by-tow, target hoki

Variable	R-squared
Year	6.36
Day of year	15.59
Vessel	22.19
Mid time of tow	25.61

WCSI: Observer catch, target hoki

Variable	R-squared
Year	6.80
Vessel	13.85
Day of year	21.83
Mid time of tow	25.32
Duration	26.33
Depth of net	27.34

Cook Strait: TCEPR tow-by-tow, target hoki

Variable	R-squared
Year	2.75
Day of year	15.49
Vessel	22.36

Cook Strait: Observer catch, target hoki

Variable	R-squared
Year	4.88
Vessel	10.98
Grid umber	14.50
Day of year	17.79
Vessel experience	18.84

Chatham Rise: TCEPR tow-by-tow, target hoki

Variable	R-squared
Year	11.09
Vessel	17.17
Start time of tow	19.83
Duration	22.75
Month	24.33
Grid number	25.53

Chatham Rise: Observer catch, target hoki

Variable	R-squared
Year	11.23
Grid number	13.88
Start time of tow	16.22
Duration	18.98
Vessel	21.01
Month	22.73

Sub-Antarctic: TCEPR tow-by-tow, target hoki

Variable	R-squared
Year	5.50
Grid number	11.14
Start time of tow	16.54
Month	21.51
Vessel	24.26
Duration	25.93

Sub-Antarctic: Observer catch, target hoki

Variable	R-squared
Year	5.11
Grid number	12.44
Start time of tow	18.17
Vessel	21.07
Duration	23.81
Month	25.02

Table A4: Summary of data used in the analyses of CPUE for all vessels and for core vessels for each fishing year. Vessels, number of unique vessels fishing; Tows, number of tow records; Zeros, proportion of tows (estimated) that caught zero catch; Catch, estimated; CPUE, unstandardised CPUE from the non-zero tow-by-tow. Fishing year: "1991" = 1990–91.

WCSI: TCEPR and 'ERS-trawl' tow-by-tow, BT and MW, target hoki

	All vessels					Core vessels				
Year	No. vessels	Catch	Effort	Prop. zeros	CPUE	No. vessels	Catch	Effort	Prop. zeros	CPUE
1991	73	102 894.9	7 655	0.04	13.44	25	46 687.7	2 434	0.03	19.18
1992	66	87 932.7	5 765	0.06	15.25	26	38 656.3	2 290	0.03	16.88
1993	60	85 503.1	6 432	0.06	13.29	30	48 577.7	3 516	0.06	13.82
1994	66	99 287.6	8 176	0.08	12.14	40	69 498.6	5 407	0.08	12.85
1995	62	64 547.8	7 432	0.09	8.69	43	48 966.2	5 502	0.08	8.90
1996	60	59 681.1	6 422	0.07	9.29	42	53 575.3	5 303	0.07	10.10
1997	75	78 774.9	7 667	0.07	10.27	50	67 538.9	6 222	0.07	10.85
1998	68	91 309.3	7 645	0.04	11.94	55	85 615.4	7 105	0.04	12.05
1999	58	83 038.0	6 730	0.03	12.34	51	82 690.2	6 682	0.03	12.38
2000	51	93 698.1	6 960	0.02	13.46	44	92 879.7	6 872	0.02	13.52
2001	63	93 803.4	7 982	0.02	11.75	48	90 059.6	7 507	0.02	12.00
2002	56	85 994.3	7 326	0.02	11.74	47	82 775.4	7 012	0.02	11.80
2003	51	68 096.2	6 978	0.02	9.76	45	67 901.8	6 924	0.02	9.81
2004	51	39 607.2	5 914	0.02	6.70	41	35 231.1	5 419	0.02	6.50
2005	37	29 356.5	3 465	0.02	8.47	36	29 130.8	3 448	0.02	8.45
2006	36	34 250.0	3 119	0.01	10.98	31	33 537.8	3 024	0.01	11.09
2007	32	29 209.2	1 820	0.01	16.05	28	28 416.7	1 778	0.01	15.98
2008	22	16 961.2	1 279	0.01	13.26	15	16 130.6	1 215	0.01	13.28
2009	20	16 781.8	1 022	0.01	16.42	13	15 781.6	960	0.01	16.44
2010	27	31 975.4	1 773	0.01	18.03	24	31 674.0	1 760	0.01	18.00
2011	27	41 009.1	2 392	0.01	17.14	24	40 571.7	2 358	0.01	17.21
2012	30	48 763.3	2 732	0.01	17.85	29	48 704.7	2 724	0.01	17.88
2013	26	49 532.9	2 775	0.01	17.85	23	49 063.5	2 746	0.01	17.87
2014	26	60 624.3	3 346	0.00	18.12	24	60 226.5	3 314	0.00	18.17
2015	28	68 963.5	3 856	0.00	17.88	24	68 366.1	3 800	0.00	17.99
2016	25	61 104.4	4 126	0.01	14.81	22	60 004.3	4 007	0.01	14.97
2017	27	56 951.7	4 177	0.01	13.63	22	48 150.9	3 520	0.01	13.68
2018	26	44 251.3	4 033	0.01	10.97	21	37 999.7	3 445	0.00	11.03

WCSI: Observer target hoki catch

	All vessels					Core vessels				
Year	No. vessels	Catch	Effort	Prop. zeros	CPUE	No. vessels	Catch	Effort	Prop. zeros	CPUE
1990	14	27 415.7	1 353	0.02	20.26	5	9 069.6	476	0.02	19.05
1991	14	19 416.0	1 149	0.02	16.90	5	11 045.3	484	0.02	22.82
1992	10	13 492.3	712	0.04	18.95	3	4 554.7	185	0.01	24.62
1993	15	12 936.1	981	0.02	13.19	8	6 878.9	637	0.01	10.80
1994	15	21 979.5	1 437	0.02	15.30	8	12 035.9	864	0.01	13.93
1995	9	13 121.1	700	0.02	18.74	6	6 359.1	395	0.01	16.10
1996	15	11 517.1	981	0.03	11.74	10	9 906.7	766	0.02	12.93
1997	12	10 317.3	644	0.02	16.02	10	8 766.6	583	0.02	15.04
1998	16	13 969.5	845	0.01	16.53	11	13 072.5	760	0.01	17.20
1999	14	14 151.4	1 048	0.02	13.50	11	13 344.0	912	0.02	14.63
2000	17	17 566.9	1 138	0.00	15.44	12	16 221.4	1 095	0.00	14.81
2001	21	14 250.9	979	0.01	14.56	15	12 871.4	904	0.01	14.24
2002	16	16 306.8	1 287	0.01	12.67	14	16 073.6	1 271	0.01	12.65
2003	13	10 085.7	908	0.01	11.11	13	10 085.7	908	0.01	11.11
2004	16	8 358.6	1 292	0.01	6.47	13	7 452.7	1 166	0.01	6.39
2005	13	7 165.4	971	0.00	7.38	11	7 094.2	958	0.00	7.41
2006	13	9 519.6	778	0.00	12.24	9	9 328.1	750	0.00	12.44
2007	16	9 238.0	458	0.00	20.17	10	8 113.8	400	0.00	20.28
2008	11	6 977.9	419	0.00	16.65	7	6 283.8	383	0.01	16.41
2009	12	7 231.2	361	0.00	20.03	6	6 956.3	327	0.00	21.27
2010	14	8 122.9	469	0.02	17.32	6	7 188.8	420	0.02	17.12
2011	11	8 601.3	489	0.01	17.59	8	7 994.8	466	0.01	17.16
2012	15	16 102.3	839	0.01	19.19	12	15 465.7	807	0.01	19.16
2013	17	29 069.5	1 600	0.00	18.17	16	28 933.2	1 590	0.00	18.20
2014	17	27 060.3	1 477	0.01	18.32	15	26 496.8	1 452	0.01	18.25
2015	20	34 027.8	1 644	0.01	20.70	17	33 582.1	1 613	0.01	20.82
2016	16	25 994.0	1 582	0.00	16.43	15	25 695.4	1 537	0.00	16.72
2017	20	19 652.4	1 361	0.01	14.44	18	19 165.6	1 326	0.01	14.45
2018	28	24 014.1	2 054	0.00	11.69	18	20 405.8	1 771	0.01	11.52

Table A4: continued.

Cook Strait: TCEPR and 'ERS-trawl' tow-by-tow, MW, target hoki

	All vessels					Core vessels				
Year	No. vessels	Catch	Effort	Prop. zeros	CPUE	No. vessels	Catch	Effort	Prop. zeros	CPUE
1990	17	11 709.9	1 036	0.03	11.30	11	8 595.4	772	0.03	11.13
1991	21	21 712.2	2 041	0.02	10.64	17	19 125.3	1 794	0.02	10.66
1992	22	17 794.3	1 565	0.03	11.37	16	15 069.1	1 307	0.03	11.53
1993	18	16 309.9	1 429	0.04	11.41	14	15 547.5	1 336	0.04	11.64
1994	28	23 388.0	1 682	0.04	13.90	15	18 851.0	1 275	0.03	14.79
1995	24	21 816.8	1 741	0.03	12.53	16	18 263.9	1 211	0.02	15.08
1996	36	35 296.7	2 560	0.03	13.79	22	27 960.3	1 908	0.03	14.65
1997	33	36 743.7	2 932	0.04	12.53	23	30 108.4	2 416	0.03	12.46
1998	28	26 110.3	1 935	0.03	13.49	19	23 422.3	1 716	0.03	13.65
1999	20	25 561.6	1 746	0.02	14.64	19	25 310.0	1 734	0.02	14.60
2000	21	21 977.0	1 532	0.01	14.35	19	21 679.0	1 501	0.01	14.44
2001	25	20 207.5	1 570	0.02	12.87	20	19 190.5	1 481	0.02	12.96
2002	15	15 143.1	866	0.01	17.49	10	14 408.1	815	0.01	17.68
2003	19	22 906.0	1 510	0.03	15.17	13	22 271.5	1 437	0.03	15.50
2004	19	25 215.8	1 589	0.01	15.87	15	24 255.3	1 537	0.01	15.78
2005	12	15 724.6	1 117	0.01	14.08	9	15 347.1	1 094	0.01	14.03
2006	11	14 026.7	850	0.01	16.50	9	13 803.8	832	0.01	16.59
2007	7	10 573.5	796	0.01	13.28	6	10 411.6	785	0.01	13.26
2008	5	6 164.3	310	0.01	19.88	3	6 072.4	301	0.01	20.17
2009	7	6 827.1	580	0.01	11.77	6	6 481.4	552	0.01	11.74
2010	8	9 381.7	715	0.01	13.12	5	9 213.1	704	0.01	13.09
2011	6	5 998.2	418	0.01	14.35	5	5 980.6	415	0.01	14.41
2012	9	8 750.5	662	0.01	13.22	6	8 582.6	650	0.02	13.20
2013	9	8 916.5	687	0.00	12.98	5	8 666.1	652	0.00	13.29
2014	9	9 361.6	780	0.01	12.00	8	8 971.8	750	0.01	11.96
2015	9	9 700.9	662	0.00	14.65	8	9 661.7	660	0.00	14.64
2016	9	9 069.8	541	0.01	16.76	6	8 752.8	515	0.00	17.00
2017	9	8 718.4	523	0.00	16.67	7	7 742.1	439	0.00	17.64
2018	7	12 677.0	661	0.00	19.18	4	12 284.8	605	0.00	20.31

Cook Strait: Observer target hoki catch

	All vessels					Core vessels				
Year	No. vessels	Catch	Effort	Prop. zeros	CPUE	No. vessels	Catch	Effort	Prop. zeros	CPUE
1998	11	2 816.7	170	0.05	16.57	9	2 670.3	153	0.04	17.45
1999	10	2 724.7	173	0.01	15.75	7	2 149.0	125	0.02	17.19
2000	7	2 236.5	111	0.00	20.15	7	2 236.5	111	0.00	20.15
2001	9	2 670.2	166	0.00	16.09	5	2 044.2	113	0.00	18.09
2002	9	1 467.3	106	0.03	13.84	5	1 133.9	81	0.00	14.00
2003	5	1 599.0	95	0.00	16.83	4	1 497.9	88	0.00	17.02
2004	7	2 123.9	107	0.02	19.85	5	1 667.8	75	0.01	22.24
2005	9	1 752.2	100	0.00	17.52	4	1 391.0	66	0.00	21.08
2006	4	837.2	48	0.00	17.44	4	837.2	48	0.00	17.44
2007	7	1 615.0	137	0.01	11.79	7	1 615.0	137	0.01	11.79
2008	6	2 842.7	165	0.01	17.23	4	2 420.0	128	0.01	18.91
2009	4	1 409.5	108	0.00	13.05	3	1 344.4	103	0.00	13.05
2010	9	2 673.5	201	0.00	13.30	6	2 257.2	167	0.01	13.52
2011	5	1 395.1	75	0.00	18.60	5	1 387.1	74	0.00	18.74
2012	7	1 306.7	124	0.04	10.54	6	1 100.5	94	0.02	11.71
2013	4	827.3	74	0.00	11.18	4	827.3	74	0.00	11.18
2014	4	2 075.5	182	0.01	11.40	3	1 928.6	160	0.01	12.05
2015	2	303.4	19	0.00	15.97	2	303.4	19	0.00	15.97
2016	4	1 933.8	123	0.01	15.72	4	1 933.8	123	0.01	15.72
2017	4	1 760.2	99	0.00	17.78	3	1 505.5	77	0.00	19.55
2018	7	2 129.4	175	0.00	12.17	4	1 690.1	108	0.00	15.65

Table A4: continued.

Chatham Rise (Year Oct–Sep) and ECSI non-spawning (Nov–May): TCEPR and 'ERS – Trawl' tow-by-tow, BT, target hoki

	All vessels					Core vessels				
Year	No. vessels	Catch	Effort	Prop. zeros	CPUE	No. vessels	Catch	Effort	Prop. zeros	CPUE
1992	43	35 287.3	4 889	0.03	7.22	7	7 564.4	1 207	0.01	6.27
1993	38	33 397.1	4 747	0.02	7.04	6	12 473.0	2 260	0.02	5.52
1994	36	16 846.5	3 328	0.02	5.06	6	10 229.3	2 134	0.02	4.79
1995	40	27 994.5	5 763	0.03	4.86	11	19 935.4	3 965	0.02	5.03
1996	52	35 322.2	7 434	0.04	4.75	13	24 160.4	4 320	0.02	5.59
1997	71	41 446.6	8 743	0.03	4.74	19	30 356.7	5 833	0.02	5.20
1998	61	53 615.0	10 891	0.03	4.92	23	44 047.0	8 709	0.02	5.06
1999	47	59 497.8	11 059	0.02	5.38	24	52 789.9	9 687	0.01	5.45
2000	34	43 572.6	9 268	0.01	4.70	22	43 341.8	9 145	0.01	4.74
2001	40	44 523.4	9 664	0.01	4.61	24	42 794.2	9 220	0.01	4.64
2002	32	34 789.8	7 700	0.01	4.52	17	33 592.9	7 326	0.00	4.59
2003	32	35 868.6	9 122	0.01	3.93	21	33 247.5	8 522	0.01	3.90
2004	28	29 834.7	7 000	0.01	4.26	20	27 410.5	6 571	0.01	4.17
2005	23	27 369.2	4 859	0.01	5.63	17	24 514.2	4 355	0.01	5.63
2006	19	31 593.9	4 747	0.00	6.66	12	28 348.9	4 240	0.00	6.69
2007	20	34 415.3	4 675	0.01	7.36	10	29 180.9	3 907	0.01	7.47
2008	22	33 210.3	4 123	0.00	8.05	14	31 771.5	3 904	0.00	8.14
2009	21	33 211.0	3 823	0.00	8.69	13	31 646.8	3 620	0.00	8.74
2010	20	34 823.4	4 282	0.00	8.13	12	33 499.4	4 114	0.00	8.14
2011	23	34 507.7	4 021	0.00	8.58	14	33 687.9	3 889	0.00	8.66
2012	24	37 246.1	4 321	0.00	8.62	15	36 374.6	4 213	0.00	8.63
2013	22	33 361.1	4 103	0.00	8.13	14	33 037.6	4 034	0.00	8.19
2014	19	31 676.8	3 913	0.00	8.10	10	30 949.6	3 645	0.00	8.49
2015	21	37 185.0	4 264	0.00	8.72	12	36 140.0	4 078	0.00	8.86
2016	14	32 422.6	3 995	0.00	8.12	10	32 142.5	3 961	0.00	8.11
2017	17	36 735.1	4 133	0.00	8.89	9	32 968.2	3 702	0.00	8.91
2018	19	30 481.5	3 582	0.00	8.51	8	23 495.3	2 710	0.00	8.67

Chatham Rise (Year Oct–Sep) and ECSI non-spawning (Nov–May): Observer tow-by-tow, BT, target hoki

	All vessels					Core vessels				
Year	No. vessels	Catch	Effort	Prop. zeros	CPUE	No. vessels	Catch	Effort	Prop. zeros	CPUE
1996	8	3 454.9	485	0.00	7.12	4	1 790.9	321	0.00	5.58
1997	7	1 017.3	217	0.01	4.69	4	539.4	110	0.02	4.90
1998	17	5 322.4	1 054	0.01	5.05	15	5 279.8	1 045	0.01	5.05
1999	14	7 607.8	1 184	0.01	6.43	12	7 025.0	1 097	0.01	6.40
2000	10	3 445.7	676	0.01	5.10	8	3 431.5	662	0.01	5.18
2001	15	4 212.5	925	0.08	4.55	13	4 198.9	918	0.00	4.57
2002	10	4 642.9	963	0.00	4.82	10	4 642.9	963	0.00	4.82
2003	13	2 246.3	758	0.00	2.96	13	2 246.3	758	0.00	2.96
2004	10	2 382.7	496	0.04	4.80	5	466.1	141	0.01	3.31
2005	9	4 766.8	762	0.00	6.26	7	4 704.9	749	0.00	6.28
2006	9	5 173.4	705	0.00	7.34	7	4 414.5	565	0.00	7.81
2007	10	5 532.3	793	0.00	6.98	9	5 409.0	783	0.00	6.91
2008	10	5 494.5	715	0.00	7.68	10	5 494.5	715	0.00	7.68
2009	11	4 219.5	496	0.02	8.51	11	4 219.5	496	0.02	8.51
2010	10	2 227.9	275	0.01	8.10	9	2 199.8	271	0.00	8.12
2011	11	4 548.2	558	0.00	8.15	10	4 527.3	554	0.00	8.17
2012	11	6 460.6	773	0.01	8.36	10	6 311.0	758	0.01	8.33
2013	15	9 293.5	1 312	0.01	7.08	14	8 752.4	1 243	0.01	7.04
2014	10	7 686.9	962	0.01	7.99	10	7 686.9	962	0.01	7.99
2015	14	3 748.8	423	0.00	8.86	13	3 724.9	420	0.00	8.87
2016	12	6 368.7	900	0.00	7.08	11	6 354.7	893	0.00	7.12
2017	10	6 528.2	792	0.00	8.24	9	5 631.5	674	0.00	8.36
2018	14	5 889.7	670	0.00	8.79	13	4 994.0	587	0.01	8.51

Table A4: continued.

Sub-Antarctic: TCEPR and 'ERS-trawl' tow-by-tow, target hoki (Year as Oct–Sep)

	All vessels					Core vessels				
Year	No. vessels	Catch	Effort	Prop. zeros	CPUE	No. vessels	Catch	Effort	Prop. zeros	CPUE
1992	34	27 506.5	5 223	0.02	5.27	5	9 847.0	1 795	0.02	5.49
1993	24	21 238.8	4 785	0.02	4.44	6	9 557.9	2 073	0.01	4.61
1994	24	8 739.1	1 973	0.03	4.43	6	5 451.7	1 296	0.02	4.21
1995	24	11 844.7	2 249	0.03	5.27	6	7 635.5	1 588	0.02	4.81
1996	26	10 463.4	2 307	0.06	4.54	7	7 119.8	1 527	0.02	4.66
1997	42	18 508.9	3 183	0.04	5.81	14	17 049.0	2 736	0.03	6.23
1998	35	23 351.5	4 223	0.02	5.53	14	22 223.8	3 883	0.02	5.72
1999	34	20 005.1	3 526	0.03	5.67	15	18 222.5	3 147	0.02	5.79
2000	30	30 618.4	5 742	0.02	5.33	20	30 339.9	5 602	0.02	5.42
2001	32	25 221.9	5 294	0.02	4.76	21	24 376.1	5 060	0.02	4.82
2002	33	28 473.1	6 235	0.03	4.57	18	27 353.1	5 823	0.03	4.70
2003	32	19 060.2	4 312	0.02	4.42	19	18 674.9	4 139	0.01	4.51
2004	27	10 785.7	2 854	0.05	3.78	13	10 442.9	2 713	0.05	3.85
2005	25	5 194.2	1 345	0.06	3.86	10	4 880.0	1 204	0.05	4.05
2006	16	4 677.1	698	0.02	6.70	7	4 451.2	628	0.02	7.09
2007	20	5 123.9	1 131	0.05	4.53	10	4 740.2	1 031	0.03	4.60
2008	14	5 813.1	904	0.02	6.43	5	5 737.4	872	0.02	6.58
2009	13	6 874.3	917	0.01	7.50	4	6 776.5	890	0.01	7.61
2010	12	9 686.7	1 231	0.02	7.87	6	9 425.5	1 184	0.01	7.96
2011	15	9 201.5	1 235	0.01	7.45	5	8 451.6	1 131	0.01	7.47
2012	17	11 474.1	1 191	0.01	9.63	7	10 454.8	1 107	0.01	9.44
2013	16	11 645.3	1 362	0.01	8.55	7	11 453.2	1 321	0.01	8.67
2014	13	16 985.3	1 859	0.00	9.14	6	16 205.2	1 677	0.00	9.66
2015	15	13 022.8	1 606	0.01	8.11	9	12 226.4	1 444	0.00	8.47
2016	10	5 643.9	823	0.01	6.86	6	5 608.0	806	0.01	6.96
2017	15	10 899.8	1 248	0.02	8.73	6	10 514.9	1 181	0.01	8.90
2018	19	12 286.7	1 711	0.01	7.18	11	10 552.2	1 486	0.00	7.10

Sub-Antarctic: Observer catch for target hoki (Year as Oct–Sep)

	All vessels					Core vessels				
Year	No. vessels	Catch	Effort	Prop. zeros	CPUE	No. vessels	Catch	Effort	Prop. zeros	CPUE
1998	7	1 854.0	317	0.00	5.85	5	1 493.8	249	0.00	6.00
1999	10	4 690.8	728	0.01	6.44	9	4 518.4	677	0.01	6.67
2000	10	4 993.0	1 043	0.01	4.79	10	4 993.0	1 043	0.01	4.79
2001	15	2 739.1	506	0.01	5.41	11	2 296.6	395	0.01	5.81
2002	8	3 823.7	728	0.00	5.25	8	3 823.7	728	0.00	5.25
2003	11	1 998.0	538	0.01	3.71	8	1 917.6	506	0.01	3.79
2004	7	548.0	191	0.14	2.87	5	546.9	187	0.12	2.92
2005	5	390.6	97	0.03	4.03	5	390.6	97	0.03	4.03
2006	5	1 169.6	147	0.00	7.96	5	1 169.6	147	0.00	7.96
2007	7	1 121.9	177	0.00	6.34	6	1 121.9	176	0.00	6.37
2008	5	2 384.8	314	0.00	7.59	5	2 384.8	314	0.00	7.59
2009	5	2 858.4	396	0.02	7.22	5	2 858.4	396	0.02	7.22
2010	5	572.4	90	0.05	6.36	5	572.4	90	0.05	6.36
2011	7	1 627.2	218	0.02	7.46	7	1 627.2	218	0.02	7.46
2012	8	1 700.6	197	0.00	8.63	8	1 700.6	197	0.00	8.63
2013	14	5 828.5	756	0.00	7.71	14	5 828.5	756	0.00	7.71
2014	12	4 320.6	557	0.00	7.76	12	4 320.6	557	0.00	7.76
2015	12	2 194.8	304	0.00	7.22	11	2 178.9	301	0.00	7.24
2016	5	879.8	141	0.02	6.24	4	861.2	133	0.02	6.48
2017	9	807.1	112	0.03	7.21	8	806.3	111	0.03	7.26
2018	14	5 783.5	754	0.01	7.67	11	5 040.5	662	0.01	7.61

Table A5: Lognormal CPUE standardised indices (with 95% confidence intervals).

WCSI: TCEPR and ERS-trawl tow-by-tow, target hoki

Year	Index	CI
1991	1.12	(1.07–1.17)
1992	1.17	(1.12–1.22)
1993	1.02	(0.98–1.06)
1994	0.94	(0.91–0.97)
1995	0.64	(0.62–0.66)
1996	0.74	(0.72–0.76)
1997	0.73	(0.71–0.75)
1998	0.88	(0.86–0.90)
1999	0.93	(0.91–0.96)
2000	1.06	(1.03–1.09)
2001	0.78	(0.76–0.80)
2002	0.77	(0.75–0.79)
2003	0.60	(0.58–0.61)
2004	0.39	(0.38–0.40)
2005	0.47	(0.46–0.49)
2006	0.70	(0.68–0.73)
2007	1.17	(1.11–1.22)
2008	1.06	(1.00–1.12)
2009	1.52	(1.43–1.62)
2010	1.43	(1.37–1.50)
2011	1.48	(1.42–1.54)
2012	1.71	(1.65–1.78)
2013	1.81	(1.75–1.88)
2014	1.65	(1.60–1.71)
2015	1.74	(1.68–1.80)
2016	1.37	(1.32–1.41)
2017	1.17	(1.14–1.22)
2018	0.98	(0.95–1.02)

WCSI: Observer catch, target hoki

Year	Index	CI
1990	1.00	(0.86–1.16)
1991	1.07	(0.95–1.20)
1992	1.07	(0.89–1.29)
1993	1.00	(0.89–1.12)
1994	1.04	(0.96–1.13)
1995	0.72	(0.64–0.82)
1996	0.77	(0.70–0.84)
1997	0.83	(0.75–0.92)
1998	1.01	(0.93–1.09)
1999	0.92	(0.84–0.99)
2000	1.13	(1.05–1.21)
2001	0.74	(0.69–0.79)
2002	0.81	(0.76–0.86)
2003	0.49	(0.46–0.53)
2004	0.32	(0.29–0.34)
2005	0.48	(0.44–0.51)
2006	0.84	(0.78–0.91)
2007	1.16	(1.05–1.29)
2008	1.08	(0.97–1.20)
2009	1.37	(1.23–1.54)
2010	1.46	(1.32–1.62)
2011	1.75	(1.59–1.93)
2012	1.85	(1.72–2.00)
2013	1.77	(1.67–1.87)
2014	1.55	(1.46–1.64)
2015	1.66	(1.57–1.76)
2016	1.24	(1.17–1.32)
2017	1.22	(1.14–1.30)
2018	0.83	(0.79–0.88)

Cook Strait: TCEPR and ERS-trawl MW tow-by-tow target hoki

Year	Index	CI
1990	1.17	(1.08–1.27)
1991	0.98	(0.93–1.03)
1992	1.12	(1.05–1.19)
1993	1.04	(0.98–1.10)
1994	1.26	(1.19–1.34)
1995	1.35	(1.27–1.44)
1996	1.17	(1.12–1.23)
1997	0.91	(0.87–0.95)
1998	1.00	(0.95–1.05)
1999	1.00	(0.95–1.05)
2000	1.01	(0.96–1.07)
2001	0.84	(0.79–0.88)
2002	1.27	(1.18–1.36)
2003	1.03	(0.97–1.09)
2004	0.94	(0.89–0.99)
2005	0.84	(0.79–0.89)
2006	0.99	(0.92–1.06)
2007	0.70	(0.65–0.76)
2008	1.10	(0.98–1.23)
2009	0.72	(0.66–0.79)
2010	0.90	(0.84–0.97)
2011	1.06	(0.96–1.17)
2012	0.85	(0.78–0.92)
2013	0.90	(0.83–0.97)
2014	0.88	(0.82–0.95)
2015	0.94	(0.87–1.01)
2016	1.09	(1.00–1.19)
2017	1.09	(0.99–1.20)
2018	1.21	(1.11–1.31)

Cook Strait: Observer catch, target hoki

Year	Index	CI
1998	1.71	(0.87–3.35)
1999	1.76	(1.08–2.87)
2000	1.68	(1.15–2.46)
2001	0.92	(0.65–1.29)
2002	1.01	(0.68–1.49)
2003	0.67	(0.46–0.99)
2004	1.20	(0.84–1.73)
2005	1.81	(1.22–2.67)
2006	1.36	(0.92–2.01)
2007	0.57	(0.44–0.75)
2008	1.18	(0.92–1.52)
2009	0.80	(0.60–1.08)
2010	1.00	(0.75–1.33)
2011	1.00	(0.71–1.42)
2012	0.76	(0.53–1.09)
2013	0.82	(0.56–1.22)
2014	0.72	(0.51–1.01)
2015	0.75	(0.38–1.51)
2016	1.05	(0.70–1.56)
2017	0.64	(0.40–1.02)
2018	0.87	(0.57–1.32)

Table A5: continued.

Chatham Rise: TCEPR and ERS-trawl tow-by-tow, target hoki

Year	Index	CI
1992	1.06	(1.00–1.13)
1993	0.99	(0.95–1.04)
1994	0.91	(0.87–0.95)
1995	0.86	(0.83–0.89)
1996	0.90	(0.87–0.93)
1997	0.87	(0.85–0.90)
1998	0.79	(0.77–0.81)
1999	0.88	(0.86–0.89)
2000	0.76	(0.74–0.77)
2001	0.73	(0.71–0.74)
2002	0.72	(0.71–0.74)
2003	0.56	(0.55–0.58)
2004	0.58	(0.56–0.59)
2005	0.77	(0.75–0.79)
2006	0.98	(0.95–1.01)
2007	1.05	(1.01–1.08)
2008	1.22	(1.18–1.26)
2009	1.37	(1.32–1.42)
2010	1.24	(1.20–1.28)
2011	1.38	(1.34–1.42)
2012	1.41	(1.37–1.46)
2013	1.31	(1.26–1.35)
2014	1.32	(1.27–1.36)
2015	1.37	(1.33–1.42)
2016	1.24	(1.20–1.28)
2017	1.42	(1.37–1.47)
2018	1.31	(1.26–1.36)

Chatham Rise: Observer catch, target hoki

Year	Index	CI
1996	0.89	(0.78–1.02)
1997	0.66	(0.53–0.82)
1998	0.74	(0.69–0.79)
1999	0.94	(0.87–1.01)
2000	0.78	(0.71–0.85)
2001	0.67	(0.62–0.73)
2002	0.71	(0.66–0.77)
2003	0.52	(0.47–0.56)
2004	0.59	(0.49–0.71)
2005	0.88	(0.80–0.96)
2006	1.01	(0.93–1.11)
2007	1.09	(1.01–1.18)
2008	1.26	(1.16–1.36)
2009	1.38	(1.25–1.52)
2010	1.39	(1.22–1.59)
2011	1.27	(1.16–1.39)
2012	1.32	(1.22–1.44)
2013	1.18	(1.10–1.26)
2014	1.41	(1.31–1.52)
2015	1.40	(1.26–1.57)
2016	1.18	(1.10–1.27)
2017	1.35	(1.25–1.47)
2018	1.48	(1.35–1.61)

Sub-Antarctic: TCEPR and ERS-trawl tow-by-tow, target hoki

Year	Index	CI
1992	0.94	(0.88–0.99)
1993	0.85	(0.80–0.89)
1994	0.90	(0.84–0.96)
1995	0.86	(0.81–0.91)
1996	0.87	(0.83–0.92)
1997	1.08	(1.04–1.13)
1998	0.96	(0.93–1.00)
1999	0.89	(0.86–0.93)
2000	0.90	(0.88–0.93)
2001	0.81	(0.78–0.83)
2002	0.77	(0.75–0.79)
2003	0.73	(0.71–0.76)
2004	0.56	(0.54–0.59)
2005	0.58	(0.55–0.62)
2006	0.81	(0.75–0.88)
2007	0.74	(0.69–0.78)
2008	1.15	(1.07–1.23)
2009	1.31	(1.23–1.41)
2010	1.36	(1.28–1.45)
2011	1.37	(1.29–1.45)
2012	1.64	(1.54–1.74)
2013	1.42	(1.34–1.50)
2014	1.53	(1.45–1.60)
2015	1.45	(1.37–1.52)
2016	1.19	(1.11–1.27)
2017	1.24	(1.17–1.32)
2018	1.19	(1.13–1.26)

Sub-Antarctic: Observer catch, target hoki

Year	Index	CI
1998	1.07	(0.91–1.27)
1999	1.07	(0.96–1.19)
2000	0.78	(0.71–0.86)
2001	1.04	(0.92–1.18)
2002	0.74	(0.67–0.82)
2003	0.57	(0.51–0.64)
2004	0.61	(0.51–0.73)
2005	0.43	(0.35–0.54)
2006	0.85	(0.69–1.04)
2007	1.09	(0.91–1.30)
2008	1.21	(1.07–1.37)
2009	1.21	(1.07–1.36)
2010	1.09	(0.88–1.36)
2011	1.45	(1.24–1.69)
2012	1.27	(1.09–1.48)
2013	1.26	(1.15–1.38)
2014	1.41	(1.27–1.56)
2015	1.34	(1.18–1.52)
2016	1.03	(0.86–1.23)
2017	1.12	(0.91–1.38)
2018	1.28	(1.17–1.41)