Ministry for Primary Industries
Manatū Ahu Matua

Characterisation and CPUE analyses for barracouta (*Thyrsites atun*) in BAR 1, 1989–90 to 2013–14

New Zealand Fisheries Assessment Report 2016/37

S J Baird

ISSN 1179-5352 (online)
ISBN 978-1-77665-307-2 (online)
June 2016

New Zealand Government

Growing and Protecting New Zealand

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-resources/publications.aspx
http://fs.fish.govt.nz go to Document library/Research reports

EXECUTIVE SUMMARY

Baird, S.J. (2016). Characterisation and CPUE analyses for barracouta (*Thyrsites atun*) in BAR 1, 1989–90 to 2013–14.

***New Zealand Fisheries Assessment Report 2016/37.* 183 p.**

Barracouta fisheries exploited by large domestic vessels and foreign-licensed vessels were managed by an annual Total Allowable Catch of 30 000 t from 1983 until 1 October 1986 when the Quota Management System was introduced and a Total Allowable Commercial Catch (TACC) of 30 050 t was set. Barracouta are currently managed as four main stocks. For the barracouta Quota Management Area presented in this report, BAR 1, the annual TACC increased from an initial 8510 t in 1987 to 9969 t for 1993–96, and finally to 11 000 t since 1997. [Note that throughout this report, the years represent fishing years; for example, 1987 is fishing year 1 October 1986 to 30 September 1987]. The BAR 1 area accounted for 30–45% of the annual landings reported between 1987 and 2003, 18–25% between 2004 and 2008, and 33–43% for 2009 to 2014. The annual TACC was exceeded in 1987, 1988, 1995, 1996, 1997, 1998, 2011, and 2014, but the over-runs were generally less than 5% with the greatest being 13% in 1996. There was one prolonged period of lower catches relative to the TACC: during 2001–08 when the annual landed catches accounted for 49–69% of the TACC.

In BAR 1, most of the barracouta catch was from bottom trawl fisheries, mainly in waters shallower than 250 m. Barracouta were caught as targeted catch and as bycatch from other targets such as tarakihi (*Nemadactylus macropterus*) and red gurnard (*Chelidonichthys kumu*) in the waters off the east coast of the North Island (ECNI) and red cod (*Pseudophycis bachus*) and arrow squid (*Nototodarus* sloanii, *N. gouldi*) in waters off the east coast of the South Island (ECSI). Barracouta were also caught during midwater trawls targeted at barracouta and jack mackerel near the shelf edge in the ECSI area. The ECSI data accounted for 86% of the total landed catch of 211 886 t for BAR 1 during 1990–2014.

Standardised annual catch per unit effort (CPUE) indices were developed for fishing years 1990–2014 for the two BAR 1 areas (ECNI and ECSI). The relatively small amount of catch from the ECNI area was characterised by a marked decrease in targeting of barracouta from the mid-2000s, with most of the annual catch caught during tows for tarakihi off the east coast south of East Cape to Cook Strait. Annual catches from Trawl Catch Effort Processing Returns (TCEPR) decreased from 245–320 t in the mid-late 1990s to 100–200 t during the 2000s, and 16–87 t during 2011–14. Annual catches from Catch Effort Landing Returns (CELR) and Trawl Catch Effort Returns (TCER) were generally more than twice the TCEPR catches, with most between 200–400 t (median 310 t) during 2000–14. Catches were highest during July-September and December. The main ECNI models were for catch and effort reported from bottom trawls for major target species, either at the day or tow level and explained 33–42% of the null deviance. The variables *vessel*, *target species*, and *month* were retained in each model, with *vessel* having the most influence. Overall, no trends were evident in the models. The lack of targeting and the low rate of catch from tarakihi and other inshore target species relative to when barracouta was the target, as well as the large vessel effect evident in this area, limit the usefulness of these data to determine the status of barracouta in these northern waters of BAR 1. No other data are available for analysis in this area: trawling in ECNI receives little observer coverage and no appropriate trawl survey data exist.

Apart from 2001–08 when 4000–6000 t of barracouta were reported annually from the ECSI area, annual catches were greater than 8000 t from the mid-1990s, with close to 11 000 t reported from 2009. About 70% of the total ECSI catch was from TCEPR vessels. Annual catches from TCEPR records were generally 3000–4500 t during the 1990s, 1000–2800 t during 2002–06, then variable (600–2620 t) in subsequent years, as effort decreased and most catch was reported from a few vessels. Annual catches from the TCER vessels (2008–14) were between 1825 and 3110 t – slightly higher than in previous years when reporting on CELRs. Catches were highest in inshore areas of Statistical Areas 022, 020, and 024, during February–May and October–January, with 51% of the total catch from barracouta target tows, 22% from red cod tows, and 11% from arrow squid tows.

During 2009–14, there was increased effort targeting barracouta with midwater gear by a small fleet of large vessels. The effort and catch by these vessels was considered by the Southern Inshore Working Group to be unrepresentative of the majority of the vessels catching barracouta in the ECSI area over the time series. Therefore only bottom trawl effort and catch, targeting major target species, either at the day or tow level, were used in the CPUE models for ECSI. These models explained 23–43% of the null deviance. *Target species* and *vessel* were the main predictor variables, with *depth*, *start time*, *trawl region*, and *month* also retained in the TCEPR tow-by-tow lognormal model, and *start time* and *depth* in the TCER tow-by-tow lognormal model, and *month* and *fishing duration* in the CELR/TCER lognormal day-level model. Each model showed an apparent increase in CPUE towards the end of the time series after a decrease during 1999–2008. After 2008, less effort was expended each year and a small number of vessels accounted for large barracouta catches as barracouta became a more important target species relative to red cod and arrow squid. Industry sources confirmed that increased market demand at this time led to an increase in effort targeted at barracouta.

Biomass indices from the latter years of the ECSI trawl survey series (2009, 2012, and 2014) conducted in similar waters during May–June showed a marked increase over previous years. Industry sources indicated that a new market for barracouta was developed during these years. Thus, it appears that the increase in barracouta abundance identified by the ECSI trawl survey was able to be exploited by the industry and resulted in the larger catches evident in the commercial data. The highest points in the CELR/TCER CPUE in 2012 and 2013 are similar in magnitude to those in 1997 and 1998. There is no trawl survey information for comparison with this earlier part of the commercial time series. Adult sized fish (over 50 cm) were present throughout the trawl survey series and were the main mode in the observer data in years when a reasonable number of observed tows were sampled for barracouta (2010–14). Observer data for the ECSI area come mainly from the TCEPR fleet from waters on the shelf edge, primarily during October and February-April. The trawl survey catches were mainly from shallower more inshore waters than the observer data and included juveniles, pre-recruits, and adults, with some progression of younger year classes evident from year to year. The current understanding of this stock is that adult fish migrate during autumn from the ECSI waters to spawn in northern waters in ECNI during July–September. Ripe and running ripe barracouta were also reported by observers mainly in February, and from September through to December, in commercial catches near the shelf edge in the ECSI area.

It is likely that continuation of the biennial ECSI May–June trawl survey series will provide a useful index of abundance, and increased sampling by observers from the ECSI commercial fishery, throughout the year, from large vessel and small vessel fleets would better inform this characterisation. More data are required to better understand spawning seasons and stock movement. A combined analysis of the commercial catch of the BAR 5 and BAR 1 stocks may help to identify any barracouta stock movements. For the larger vessels, it is apparent that they may operate in ECSI waters and waters off the Stewart-Snares shelf within one season.

1. INTRODUCTION

The fishstock area of BAR 1 encompasses the east coasts of the North Island and the South Island, New Zealand (Figure 1) and is considered to contain a single biological stock of barracouta (*Thyrsites atun*). Under the Inshore Finfish Fisheries Draft National Plan (Ministry of Fisheries 2011), as a Group 4 stock, the management objective for barracouta in BAR 1 is to maintain relative stock abundance at or above a target level accepted as a proxy for B*msy*. When this project was initiated no target reference level had been established for BAR 1 (Ministry for Primary Industries 2013). The primary indices for abundance used to monitor BAR 1 are based on separate standardised catch-per-unit-effort (CPUE) series for bottom trawl catches from off the North Island and off the South Island, with the most recent report by Hurst et al. (2012) indicating that CPUE indices declined during the 2000s but appeared to show signs of recovery after 2005.

1.1 Overview

Barracouta fisheries developed in the late-1960s when Japanese vessels commenced fishing in New Zealand waters. The fisheries came under quota management under the Deepwater Policy on 1 October 1983 and The Quota Management System in 1986, with an annual TAC set at 31 000 t. The annual TAC for all barracouta fishstocks has been set at 32 672 t since 2001–02.

Previous characterisations of all New Zealand barracouta fisheries were carried from 1936–37 to 1983–84 by Hurst (1988a, 1988b) and from 1989–90 to 2007–08 by Hurst et al. (2012). Specific area analyses were carried out for BAR 1 from 1989–90 to 1999–2000, by Langley & Walker (2002a, 2002b), and for BAR 5 from 1989–90 to 1997–98, by Harley et al. (1999). Stock structure has been reviewed by Hurst (1988a, 1988b), Hurst & Bagley (1989) and Langley & Bentley (2002). Age determination using otoliths has been validated by Horn (2002).

The most recent characterisation that included BAR 1 was a comprehensive review of all barracouta fishstocks up to 2007–08 (Hurst et al. 2012). Barracouta in BAR 1 were primarily target fished by bottom trawls, mainly off the east coast South Island, where CPUE indices were provided for the BAR 1 east coast South Island (ECSI) fishery based on a variety of target species fisheries, including analyses at the trip and tow levels. Trends in inferred year class strengths from length frequency data were consistent with some of the trends in CPUE, suggesting that they may have potential for monitoring stocks. Trends in ECSI inshore *RV Kaharoa* trawl surveys were potentially useful for monitoring recruitment. Previous tagging research showed that this species can exhibit large seasonal migrations associated with spawning movements and is known to migrate north from the east coast of the South Island during late autumn/winter to spawn off the east coast of the North Island up to Bay of Plenty in late winter/spring (Hurst & Bagley 1989). The Hurst et al. (2012) review indicated that stock structure remained unclear, with some potential movement or mixing of summer/autumn feeding schools between the Southland (BAR 5) and the ECSI (BAR 1).

The overall specific objectives of this project are:

- Objective 1: To characterise the BAR 1 fishery.
- Objective 2: To analyse existing commercial catch and effort data to the end of the 2013–14 fishing year with the aim to develop separate standardised CPUE indices of abundance for the North Island and the South Island.

This report summarises BAR 1 fishery catch and landings data, and provides standardised CPUE indices for the bottom trawl ECSI fishery and the east coast North Island (ECNI) bottom trawl fishery, for 1989–90 to 2013–14. Summaries of relevant information from observer data and trawl survey data are also included.

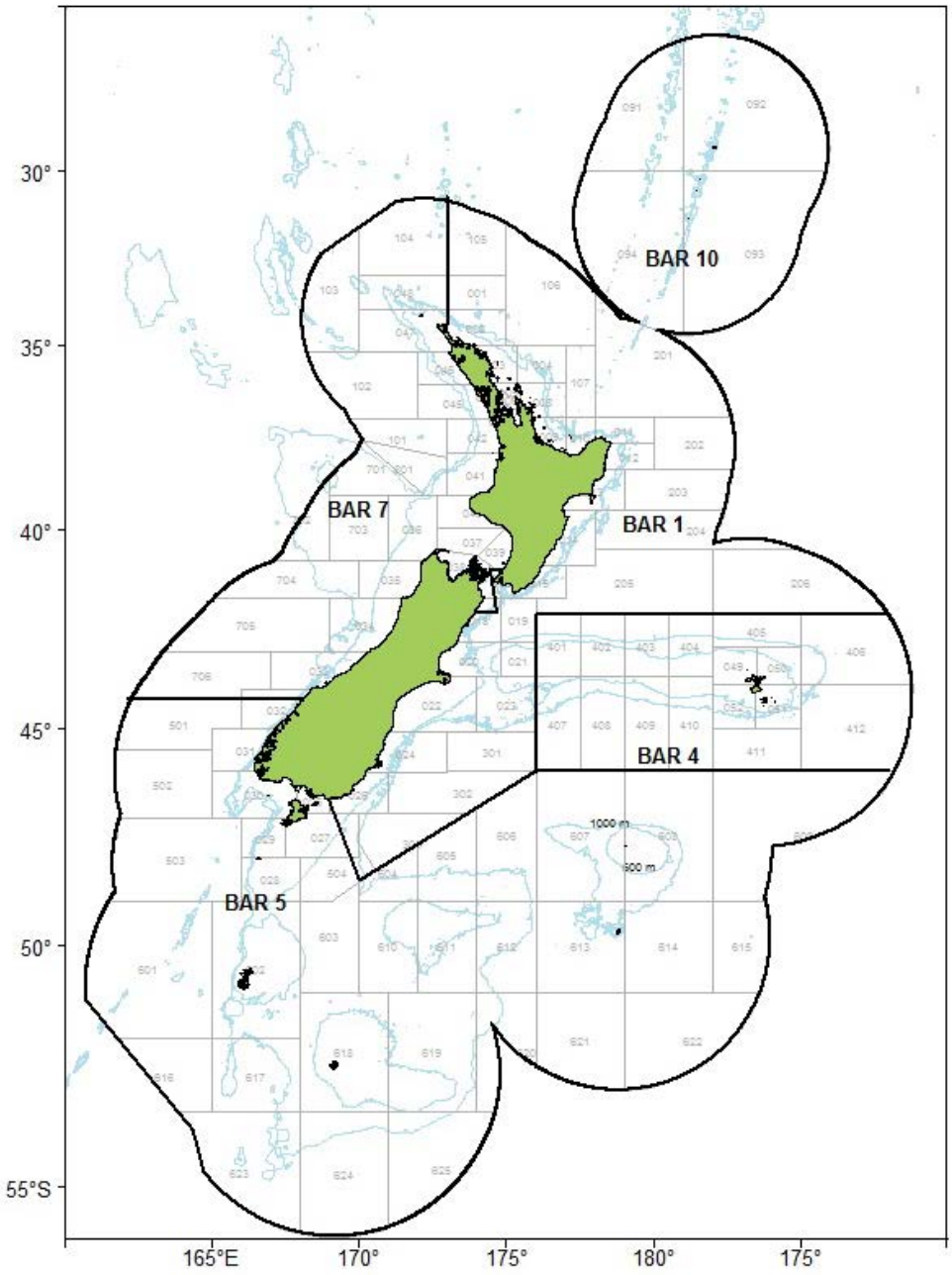


Figure 1: Map showing the administrative fish stock boundaries for BAR 1, 4, 5, 7, and 10, including statistical areas, and the 500 m and 1000 m depth contours.

2. REVIEW OF THE BAR 1 FISHERIES

2.1 Commercial fisheries

A summary of the commercial fisheries is provided by Hurst et al. (2012). The division of BAR 1 into ECNI and ECSI is defined by latitude 42° S at the northern ends of Statistical Areas 018 and 019, to the eastern longitude of 176° E in Area 019 (see Figure 1 and Figure B1).

Annual TACCs for BAR 1 increased steadily from 8510 t in 1986–87 to 9969 t in 1992–93, and then again to 11 000 t in 1996–97 where it has remained (Table 1). Between 1994–95 and 1997–98, reported annual landings overran the TACC, before dropping to about 50% of the TACC in the mid-2000s. Since 2008–09 landings have been close to the TACC, with small overruns in 2010–11 and 2013–14.

Before 2002–03, between 30 and 47% of the total New Zealand barracouta landings were reported from BAR 1, with that fishstock contributing 40–47% during 1994–95 to 1999–2000 (Figure 2). At that time, annual landings were 21 500–26 300 t (Ministry for Primary Industries 2015). From 2002–03 to 2007–08, annual landings increased to 22 500–28 000 t, and BAR 1 landings contributed generally less than 25%. Since 2008–09, annual landings were about 25 000–28 500 t, and between 33 and 43% of annual landings were from BAR 1.

Table 1: Total landings (t) and TACC (t) for barracouta in BAR 1 from 1983–84 to 2013–14. From Ministry from Primary Industries (2015). Data marked with an asterisk are Fisheries Statistics Unit data.

Fishing year	Landings	TACC	Fishing year	Landings	TACC
1983–84*	7 805	–	1999–00	10 032	11 000
1984–85*	5 442	–	2000–01	7 118	11 000
1985–86*	5 395	–	2001–02	6 900	11 000
1986–87	8 877	8 510	2002–03	7 595	11 000
1987–88	9 256	8 837	2003–04	5 949	11 000
1988–89	5 838	9 426	2004–05	6 085	11 000
1989–90	9 209	9 841	2005–06	7 030	11 000
1990–91	9 401	9 957	2006–07	5 351	11 000
1991–92	6 733	9 957	2007–08	5 987	11 000
1992–93	9 032	9 969	2008–09	8 861	11 000
1993–94	7 299	9 969	2009–10	10 635	11 000
1994–95	10 023	9 969	2010–11	11 420	11 000
1995–96	11 252	9 969	2011–12	9 305	11 000
1996–97	11 873	11 000	2012–13	9 740	11 000
1997–98	11 543	11 000	2013–14	11 309	11 000
1998–99	9 229	11 000			

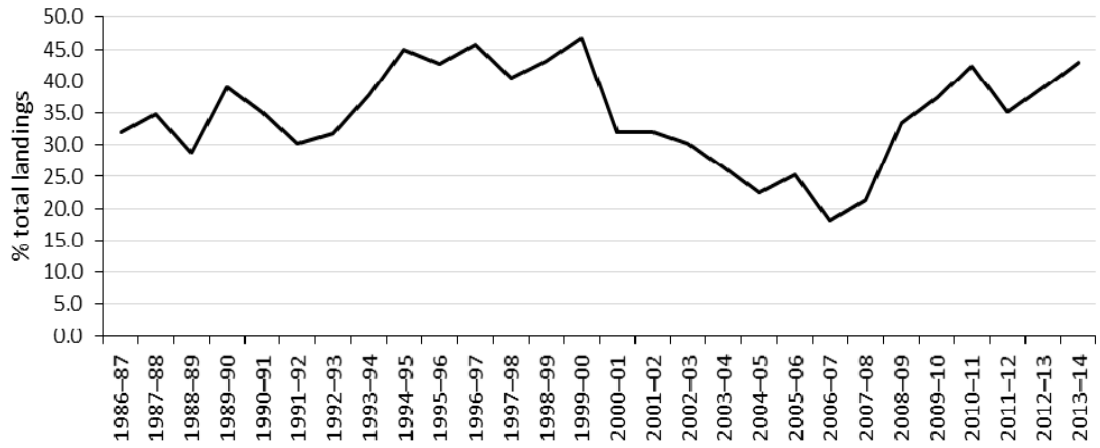


Figure 2: Percentage of total annual barracouta landings that were reported from BAR 1, for years in which barracouta were included in the Quota Management System.

3. BIOLOGY AND DISTRIBUTION

Hurst et al. (2012) provide a comprehensive summary of barracouta biology, reproduction, and ageing information. Information particularly relevant for the BAR 1 stock is included here.

3.1 Distribution and spawning

Barracouta occupy waters from shallow depths out to about 670 m, with catches indicating a peak distribution between about 30–350 m, particularly in 100–200 m (Anderson et al. 1998, Bagley et al. 2000). Mature-sized fish (from about 50–60 cm fork length: 2–3 y old) are found throughout this depth range; juveniles are mainly caught in waters shallower than 150 m (Hurst et al. 2000a, 2000b).

Their distribution varies seasonally, with extensive spawning migrations (Hurst & Bagley 1989). Barracouta are caught by trawl fisheries in the ECSI area of BAR 1 during October to June, mainly off the Canterbury Bight in Statistical Area 022 (Hurst et al. 2012). Mature fish from the ECSI waters are thought to migrate northwards after June to spawn in the ECNI area during August–September, based on tagging experiments (Hurst & Bagley 1989); however observer data from the shelf edge waters indicate spawning activity off ECSI in October–December (see Section 5.0). There is no evidence of spawning within Canterbury Bight waters, but data are sparse; fish caught during the ECSI trawl surveys are not staged and there are no observer data from the commercial barracouta catch in these waters. This migration appears to be represented in the commercial fishery catch as well as in research trawl survey data (see Hurst et al. 2012).

3.2 Stock structure

The most recent stock review was completed by Hurst et al. (2012). The basis of the separation of the EEZ waters into four main management stocks was evidence from trawl surveys of spawning locations and movement (from tagging data). Hurst et al. (2012) suggest that there may be mixing between the summer/autumn feeding schools in the ECSI area of BAR 1 and the Stewart-Snares shelf waters (in BAR 5). Data examined in this 1990–2014 BAR 1 characterisation indicated that vessels moved between these two areas during the same season; further work is required to understand the relationship between the fish in these areas. Biological data that represent good annual coverage and the spatial distribution of barracouta in eastern and southern waters are lacking. Certainly the tagging evidence that showed movements of fish from ECSI to ECNI to spawn in northern waters (Hurst 1988a) is supported by the higher bycatch of barracouta in the tarakihi/red gurnard target fisheries in ECNI during July-September, but the general lack of commercial and observer barracouta data for ECNI restricts any further clarification, and the presence of ripe and running ripe fish off the ECSI during October–December further clouds the issue.

3.3 Age and growth

Fish aged through examination of otoliths collected from four Southland trawl surveys on the Stewart-Snares shelf in the mid-late 1990s indicated that maximum ages for the sampled fish were 12 years for females and 10 years for males (Horn 2002). Fish that measured about 38 cm fork length were aged at 1 year; fish at about 52 cm at 2 years; about 60 cm at 3 years; 64–65 cm at 4 years; 69 cm at 5 years; 71–73 cm at 6 years; 74–77 cm at 7 years; 79–82 cm at 8 years; 79–85 cm at 9 years; 81–86 cm at 10 years; and 88 cm at 11 years (where larger values pertain to females) (Horn 2002). These mean length-at-age values were similar to those calculated for Chatham Island fish (see Horn 2002). The extended spawning season evident in the Southland data may be the reason for the bi-modal length distributions seen in some cohorts (Horn 2002). Fish are considered mature at about 50–60 cm (aged 2–3 years).

Further work on observer data collected from commercial effort in the main fishery times of October-December (Statistical Areas 025–027) and January-April (Statistical Areas 028–030, 504) was completed by Horn et al. (2012). The main mode for barracouta from these areas was at 60–65 cm in 2004–05 and about 65 cm in 2009–10. There was a moderately strong year class at 1+ age (30–35 cm) apparent in 2004–05. Overall, the catch sampled by observers in these areas was dominated by 3 and 4 year old fish.

Von Bertalanffy growth parameters derived for Southland (Stewart-Snares shelf) barracouta males and females were given by Harley et al. (1999) and Hurst et al. (table 5, 2012).

3.4 Natural mortality

No new information is available for natural mortality *M* for New Zealand barracouta since the information provided by Hurst et al. (table 5, 2012).

3.5 Length-weight relationship

No new information is available on length-weight parameters since the characterisation by Hurst et al. (table 5, 2012).

3.7 Feeding and trophic status

Feeding records from barracouta caught during trawl surveys throughout New Zealand shelf waters indicate that crustaceans, in particular euphausiids, as well as *Munida*, are the most important dietary component, being recorded present in 77% of stomachs containing food (Stevens et al. 2011). Teleost fish and cephalopods, particularly squid, comprised 18% and 9%, respectively. No differences were found in the diets of different sized fish; however, euphausiids, *Munida*, and squids appeared to be more important than teleosts in the diet of barracouta caught off the east and south coasts of South Island.

4.0 FISHERY INDEPENDENT OBSERVATIONS

4.1 Research surveys

Hurst et al. (2012) summarised historical trawl survey catch and biological data relating to barracouta throughout the EEZ up to 2009. The information for the winter trawl survey of the ECSI component is updated here to 2014, based on the trawl survey reports from this series.

The relevant research survey for BAR 1 is the series undertaken off the east coast of the South Island by *RV Kaharoa*. This series consists of several parts, based on the timing and frequency of surveys and the depth ranges surveyed. The core survey sampled depths of 30–400 m in the Canterbury Bight area (within Statistical Area 022) and Pegasus Bay (020). The first part was in May–June for consecutive years from 1991 to 1994 inclusive, then again in 1996. The second part was from 2007 to 2009 on an annual basis, when stations were added in the 10–30 m depth range; but this stratum was sampled only if time and resources allowed (Beentjes & MacGibbon 2013). The series was started again in 2012 (April–June), on a biennial basis, and the addition of the 10–30 m stratum was formally instigated.

For these surveys in the core depth range, barracouta was generally in the top three species caught (by weight), and the species occurred in 82–95% of tows within a survey, accounting for between 15 and 37% of the survey catch. The species targeted on these autumn-winter trawl surveys are: dark ghost shark, elephant fish, giant stargazer, red cod, red gurnard, sea perch, spiny dogfish, and tarakihi. Thus, barracouta is not a target species so the biological data are limited to length and sex measurements.

4.2 Biomass indices, length frequencies, and gonad stage data for relevant surveys

The biomass indices from this April/May-June ECSI trawl survey indicate a marked increase in barracouta in the second part of the series, from 2007 on, when the CVs were under 20% (Table 2). Larger catch rates from survey tows were evident in the 2007–14 series, particularly in the Canterbury Bight area from 30 m out to the shelf edge (see Beentjes & MacGibbon 2013 and Beentjes et al. 2015). The most recent survey (2014) resulted in a biomass substantially larger than the 2007 survey, but within the error bounds of the 2009 and 2012 surveys (see Beentjes & MacGibbon 2013). When the shallow stratum of 10–30 m was able to be included (in 2007, 2012, and 2014), the estimated biomass was increased by 16%, 6%, and 1% respectively (Beentjes & MacGibbon 2013, Beentjes et al. 2015).

A comparison of the pre-recruit and recruited biomass (where recruited fish are over 60 cm long) for the ECSI winter survey, based on the core strata, is shown in Figure A1. During the 1991–93 surveys, the pre-recruit and recruited estimates were similar, but in 1994 and 1996, most of the total biomass was from the recruited fish. For the renewed series, from 2007, the main increase has come from the recruited fish, with significantly higher biomass of recruited fish compared with pre-recruits in the 2009 and 2102 surveys. The 2014 survey indicated an increase in the pre-recruit biomass, though the uncertainty around this estimate is high.

Length frequency distributions were determined using SurvCalc (Francis & Fu 2012) which involves scaling by the proportion sampled and area trawled to estimate the population size structure in the survey area available to the trawl. The length-weight coefficients used to determine the frequencies were $a = 0.0055$ and $b = 2.9813$ for all surveys.

Fish ranged in size from about 8 cm to 114 cm (see Figure A2). Strong modes were present in most years, and in the plots of total fish there are three clear pre-recruit modes representing 0+, 1+, and 2+, fish at around 15–25 cm, 35 cm, and 50 cm (see Harley et al. 1999, Horn 2002). In the first part of the series (1991–96) and for the 2007–09 data, it is possible to see movement of the younger cohorts through to the large fish modes at between 60–80 cm. Similar modes were evident in the 2014 data (see Beentjes et al. 2015). These data appear to represent strong year classes for 1989, 1990, 1995, 2003 to 2005, and 2007 (see Hurst et al. 2012), and 2011. Horn (2002) noted the importance of the strong 1989 year class, negligible recruitment evident in the 1990–94 commercial data, with 1+ and 2+ fish from the 1995 year class appearing in the commercial catch from 1997.

The distributions of length data from all research trawl barracouta are shown in Figure A3. Adult-sized fish (over 60 cm FL) tend to be caught on the edge of the continental shelf around New Zealand, as well as across some features such as the Stewart-Snares shelf and Mernoo Bank. Smaller fish were caught in the Canterbury Bight area off east coast South Island, Golden Bay-Tasman Bay, and close inshore off the east coast of North Island, especially in the Bay of Plenty and Hauraki Gulf.

Table 2: Relative biomass indices (t) and coefficients of variation (CV) for barracouta from the "winter" east coast South Island *Kaharoa* (KAH) trawl survey series* (with assumptions: areal availability, vertical availability, and vulnerability = 1), in core strata depths of 30–400 m. The estimates were produced using NIWA's research trawl survey analysis program "SurvCalc" (Francis & Fu 2012).

Trip code	Date	Reference	Biomass (t)	% CV
KAH9105	May–Jun 1991	Beentjes & Wass (1994)	8 361	29
KAH9205	May–Jun 1992	Beentjes (1995a)	11 672	23
KAH9306	May–Jun 1993	Beentjes (1995b)	18 197	22
KAH9406	May–Jun 1994	Beentjes (1998a)	6 965	34
KAH9606	May–Jun 1996	Beentjes (1998b)	16 848	19
KAH0705	May–Jun 2007	Beentjes & Stevenson (2008)	21 132	17
KAH0806	May–Jun 2008	Beentjes & Stevenson (2009)	25 544	16
KAH0905	May–Jun 2009	Beentjes et al. (2010)	33 360	16
KAH1207	Apr–Jun 2012	Beentjes et al. (2013)	34 325	17
KAH1402	Apr–Jun 2014	Beentjes et al. (2015)	46 563	19

* Summary reviews of this trawl survey time series are given by Beentjes & Stevenson (2000) for 1991–96 and by Beentjes & MacGibbon (2013) for all years in the table above, except 2014.

5.0 FISHERY DEPENDENT OBSERVATIONS

5.1 Observer data

All tables and figures relating to MPI observer data collected from BAR 1 barracouta fisheries are provided in Appendix B (Tables B1–B7, Figures B1–B7). The number of observed trips and tows, including those with barracouta catches, are given by fishing year for ECNI and ECSI in Table B1. The distribution of this observed effort is shown in Figure B1.

About a third of the observed tows were in ECNI, but nearly all of the total observed catch of barracouta was from ECSI observed effort. Less than 9% of observed ECNI trips and tows caught barracouta and under 4% of tows with barracouta catch were sampled (n = 505 fish, about 8% were females). However, barracouta catches were reported from 38% of observed trips in ECSI and 16% of observed tows. Biological data were recorded from 40% of trips and 16% of tows that caught barracouta. A total of 59 675 barracouta caught in ECSI were measured and sexed: about 50% were females.

The amount of observer effort in these areas was similar in some years, but when there were significant numbers of tows (at least 1000) observed in an area, the proportion of tows with barracouta catch tended to be markedly higher in ECSI than in ECNI. More than 1000 tows were observed per year in ECSI in most fishing years between 1998 and 2014 (ranging from 693–2759), and the percentage of tows in which barracouta were caught ranged from 4% to 51%. There was a large increase in the observed catch and in the number of tows in which barracouta were caught in fishing years 2013 and 2014. The number of observed tows in these years accounted for about 12% of the time series total, 45% of the total observed ECSI barracouta catch, and 46% of the ECSI barracouta samples. On a much smaller scale, about 42% of the total observed tows in ECNI and almost 45% of the observed barracouta catch was reported from the 2014 fishing year.

Most observed effort in the ECNI area targeted scampi, hoki, and orange roughy (Table B2), but the target species with the greatest number of tows with barracouta catch were hoki, tarakihi, snapper, and John dory (Table B2). The observed catch was small, with most from tows that targeted tarakihi and hoki in most months (Table B3), as well as from gemfish (November) and silver warehou (August and September) tows.

The primary target species for the observed effort in the ECSI area was hoki, which accounted for 60% of the observed tows, with at least 500 tows observed in most years (see Table B2). Another 13% targeted deepwater species such as orange roughy and oreo. About 6% targeted barracouta and another 11% were from jack mackerel, arrow squid, and silver warehou tows, with more than 100 tows observed for each of these species in the last few years combined. Since about 2010, however, barracouta-targeted tows accounted for 35% of observed tows with barracouta catch, and 75% of the observed barracouta catch. The months with the greatest observed catch were October, February–April, June–September (see Table B3). Another 16% of the observed catch was from jack mackerel tows, during February–April.

The spread of the observed catch relative to the commercial catch, for each area, is shown in Figure B2 by month for each fishing year. If the proportions are the same, the plotting symbols align; if over- or under-sampling has occurred, the crosses are either larger or smaller than the circles. The small amount of BAR 1 catch from ECNI was mainly caught in July-September, but observer coverage of these months was inconsistent. For the larger BAR 1 catch represented in the ECSI data, the relative amounts of catch for commercial and observed data are reasonably well matched in most years since the late-1990s. This catch, for a large part, represents the catch taken by vessels targeting species such as red cod, arrow squid, and tarakihi during late summer-autumn (see Figure C19c in Appendix C).

Observers measured, sexed, and staged a proportion of the observed barracouta catch (Tables B4–B7). This sampling is dependent on the size of the catch and varied greatly between years in each area. Overall, 505 fish were sampled from 34 tows in ECNI, with 52% of fish from 2014. In ECSI, 59 675 barracouta

were sampled from 978 observed tows. The months with the most tows sampled in ECSI were October (mainly since 2010), and February–April (with most sampling from the early 2000s and from 2010 onwards). Overall, 47% of observed tows and almost 50% of the sampled ECSI fish were from the 2013 and 2014 fishing years. Since 2010, most ECSI barracouta sampling (including the recording of reproductive stage) occurred mainly in October and February-June. In most years, about 50% of the fish sampled and staged were females.

5.1.1 Length frequency distributions

The spatial distribution of length data from observed barracouta catches throughout New Zealand waters is shown in Figure B3; the distribution of length data for males was similar to that for females. The length range was from 30–115 cm, with most between 50 and 80 cm in length (Figures B4a and B4b). Overall, barracouta from BAR 1 showed several peaks, with the main one at about 70 cm, a second one at about 55 cm, and a relatively small one at about 40 cm. Most of these fish were from ECSI. The relatively very small number from ECNI were generally between 60 and 80 cm. The longest barracouta were from ECNI.

For months in which there are relatively more data, the ECSI barracouta caught in October peaked at about 55 cm, with smaller peaks at about 65 cm and around 40 cm; whereas in February–April, most fish were about 70 cm. In the following months, the numbers sampled are less, and fish sizes are less consistent, with peaks in the smaller ranges. The distribution of lengths by month for each sex was very similar to that shown for all fish.

Scaled length frequency distributions were determined using the 'catch-at-age' software (Bull & Dunn 2002) which scales the length frequency data from each catch up to the tow catch, sums over catches in each stratum, scales up to the total stratum catch, and then sums across the strata, to yield overall length frequency distributions. Numbers of barracouta were estimated from catch weights using an overall length-weight relationship provided by Beentjes & Stevenson (2000) where $a = 0.0091$ and $b = 2.88$. The length frequency plots shown in Figure B5 for ECSI are generated from length data from tows with at least six measured barracouta. This resulted in some fishing years having too few data to plot (for example, 1991, 1992, 1996, 1998, and 2008), and relatively few data for other years until 2010. For 2010–14, the data indicate the movement of a cohort identified at about 50 cm in 2010 (but not present in the 2009 data) through to about 70 cm. It is evident that the trawl nets observed in ECSI generally catch fish smaller than 80 cm. All the observed data from this area are from Korean, Russian, and Ukrainian vessels between about 55 and 104 m in length. These vessels targeted barracouta, arrow squid, and jack mackerels mainly in February–April, and barracouta and silver warehou in October.

Data from the observer programme indicate that commercial catch in ECSI primarily consists of the larger fish, although with greater observer sampling after 2009, fish as small as about 30 cm were recorded by observers in some years. There is some modal progression evident in the recent years when observed sample numbers were higher. Few fish larger than 80 cm were present in the observer data, or the trawl survey data. The fish from the observed catch were likely to be caught closer to the shelf edge than those from the trawl surveys; most of the barracouta catch from trawl surveys was from stations in 50–200 m (Beentjes & MacGibbon 2013) west of the main observer effort on larger vessels targeting species in waters 200 m or deeper, at or near the shelf edge. Although monitoring of adult-sized fish is considered less than optimal for the winter trawl series, there may be some merit in using these trawl survey data in conjunction with the observer data.

There is some evidence, in the observer data, of the smaller fish modes seen in the trawl survey distributions, e.g., in 2102 (35 cm fish), and in 2010 and 2014 (50 cm fish). These smaller fish are probably less vulnerable to capture by the commercial fleet than larger fish. These data match the data from the *Kaharoa* trawl surveys for corresponding years.

6. DESCRIPTIVE ANALYSIS OF CATCH

6.1 Catch and effort data sources

Catch-effort, daily processed, and landed data were requested from the Ministry for Primary Industries catch-effort database "warehou" as extract 9934 (Table C1). The dataset consists of all fishing and landing events associated with a set of fishing trips that reported a positive catch or landing of barracouta in BAR fish stock areas (see Figure 1) between 1 October 1989 and 30 September 2014. Data were analysed by fishing year (1 October to 30 September), and each fishing year is referred to as the most recent year (that is, 1990 for the 1989–90 fishing year).

The estimated catches associated with the fishing events were reported on the Ministry for Primary Industries Catch Effort Landing Returns (CELR), Trawl Catch Effort Returns (TCER), Trawl Catch Effort and Processing Returns (TCEPR), and Netting Catch Effort and Landing Returns (NCELR). The greenweight associated with landing events was reported on the bottom part of the CELRs and NCELRs, or where fishing was reported on the two other forms it was recorded on the associated Catch Landing Return (CLR).

TCEPR and TCER forms record tow-by-tow data and summarise the estimated catch for the top five species and eight species, respectively (by weight), for individual tows, together with latitude and longitude of the tow. CELR forms summarise daily fishing effort and catch estimates of the top five species, stratified by statistical area, method of capture and target species. NCELR forms record set-by-set data and summarise the estimated catch for the top eight species (by weight) for individual sets, together with latitude and longitude. Trawl vessels less than 28 m in length can use either CELR or TCEPR forms, whereas trawl vessels over 28 m must use TCEPR forms. From 1 October 2007, TCER forms have been used by vessels over 6 m and under 28 m (if under 6 m the CELR is still used). NCELR forms were introduced on 1 October 2006 for set net vessels over 6 m (if less than 6 m the CELR is still used).

Information on total harvest levels were provided via the Quota Management Report/Monthly Harvest Return (QMR/MHR) system, but only at the resolution of Quota Management Area. Concerns were expressed (e.g. Phillips 2001) that bycatch species, such as barracouta, may not be well reported at the fishing event level on TCEPRs. The daily processed part of the TCEPR contains information regarding the catch of all quota species caught and processed that day, and these data may provide a more accurate account of low and zero catch observations. However, it is not possible to assign processed catch to a specific day or amount of effort because catch is not always processed on the day it is caught and can be split among days. The daily processed catch was examined in this study as a comparison in the initial data exploration.

The extracted data were groomed and restratified to derive the datasets required for the characterisation and CPUE analyses using a variation of the data processing method developed by Starr (2007) and further developed by Langley (2014). The method allows catch-effort and landings data collected using different form types that record data with different spatial and temporal resolutions to be combined. It also overcomes the main limitation of the CELR, TCER, and TCEPR reporting systems, i.e., frequent non-reporting of species that make up only a minor component of the catch. The major steps are as follows.

Step1: The fishing effort and landings data are groomed separately. Outlier values in key variables that fail a range check are corrected using median imputation. This involves replacing missing or outlier values with a median value calculated over some subset of the data. Where grooming fails to find a replacement, all fishing and landing events associated with the trip are excluded.

Step 2: The groomed fishing effort data for each valid trip reported on form types TCER and TCEPR are restratified by vessel, date, and method into a daily dataset in a format equivalent to the

CELR data. The groomed estimated catch data for TCEPR and TCER are assigned to the associated fishing effort data as daily sum of estimated catch, based on the top 5 catch species per day. For TCER catch data (for which the top 8 species per tow are recorded), where the day has no barracouta in the top 5 species, zero is assigned to the estimated catch in the daily record. The groomed estimated catch data are assigned to the CELR effort data. Lastly, the CELR data are combined with the newly created daily effort and catch data from the TCER and TCEPR forms.

Step 3: The groomed greenweight landings data are allocated to the daily effort strata using the total estimated catch in each effort stratum as a proportion of the total estimated catch for the trip. If estimated catches are not recorded for the trip, but a landing was recorded for the trip, the total fishing effort in each effort stratum, as a proportion of the total fishing effort for the trip, is used to allocate the greenweight landings.

Data for many species are reported using a combination of form types. The original intent of the merging process was to allow trip level landings data to be mapped to CELR effort strata. The grooming and merging process also allows an evaluation of the amount of catch and effort that is not captured using TCEPR and TCER forms at the fishing event level. If this is substantial, the best characterisation dataset is likely to be the merged trip level data. If the amount of lost catch and effort is predictable, minor, and stable over time and area, the estimated catch at the level of the fishing event provides a much more detailed dataset for characterisation and CPUE analysis.

Processed product weights are converted to greenweight catches using species and product-form-specific conversion factors. Some product form conversion factors for barracouta have changed since the full implementation of the QMS (even though fish processing has not); with the result that different amounts of greenweight catch are associated with the same amount of processed catch for particular product forms throughout the database. During the grooming process, these changes are standardised relative to the latest conversion factor defined for each product state, based on the assumption that the changes in conversion factors reflect improving estimates of the actual conversion when processing, rather than real changes in processing methodology across the fleet. The catch-consistency checking algorithm designed by Blackwell et al. (2005) is used to systematically compare the different catch weights recorded for a particular fishing trip against one another, and this returns the single most consistent catch type for each trip. The following adjustments were made for several conversion factors, apart from the minor adjustment of 5.556 to 5.6 for fishmeal on 1 October 1990. From 1 October 1996, the value for "HGU -headed and gutted" was changed from 1.5 to 1.45. The value for "DRE - dressed" was changed from 1.5 to 1.55 from 1 October 1997, then this change was reversed from 1 April 2008.

The landings data kept in the dataset and adjusted for any changes in conversion factors were allocated using the 'centroid' method to the effort strata, based on the statistical areas within each fish stock. Thus, the midpoint of each statistical area was used to allocate the data to the larger fish stock area.

The landings data provide a verified green weight landed for a fish stock on a trip basis. However, landings data include all final landing events where a vessel offloads catch to a Licensed Fish Receiver, and interim landing events where catch is transferred or retained, and may therefore appear subsequently as a final landing event (SeaFIC 2007). Starr's procedure separates final and interim landings based on the landing destination code, and only landings with destination codes that indicate a final landing are generally retained (see table 2 in Starr (2007)).

6.2 Summary of catches

All tables and figures for the characterisation of barracouta fisheries are in Appendix C (Tables C1–C10, Figures C1–C24). Table C1 provides a summary of the data requested from MPI for this characterisation which focusses on BAR 1.

The reported QMR/MHR landings, ungroomed catch-effort landings, and TACCs for fish stocks BAR 1 are shown in Figure C1. The ungroomed catch-effort landings were similar to the reported QMR/MHR

landings in most years, and both sets of landings data were generally under the TACC, except in fishing years 1996–98, 2011, and 2014. Both data sources indicated that landings in more recent years (2010–14) were closer to the TACC limit than data from 2001–08 when annual landings were between 6000 and 8000 t and the TACC was at 11 000 t.

Landings of catch-effort data reported on TCEPRs and TCERs are recorded on CLRs. Overall, the numbers of landings events peaked in the mid-late 1990s (about 5500–7000 events per year), then steadily dropped to about 3000–3500 events for 2008–14 (Table C2). The increase in landing events recorded on CLRs from 2008 onwards reflects the change in form type used by 6–28 m trawl vessels (from CELR to TCER). Landing events on both CELRs and CLRs were primarily coded as "L" (landed to New Zealand). Small numbers of events were coded as "R" (retained on board) throughout the time series, "T" (transferred to another vessel) up until the end of the 1998 fishing year on CLRs, and "C" on CELRs between 1990 and 1993. For all years combined, 95% of landings (in terms of weight) were coded as "L" (209 797 t), with another 3% as "T" (7036 t) (Table C3). Landings with destination codes of "B", "Q", and "R", or where the code was missing, were ignored for the final landings dataset: these represented about 1.6% of the landings by weight and 1.9% of the landing events. These codes are described as "interim" codes (Starr 2007), but although landings coded as "T" are often considered as "interim", they were retained in the dataset. The retained landings, interim landings, and total landings dropped during data grooming are shown in Figure C2.

The main processed state for retained landings of barracouta in BAR 1 was "GRE" (greenweight), with a lesser amount reported as "DRE" (dressed weight) (Figure C3); for 2009–11 and 2014, more barracouta catch was reported as "DRE" than "GRE". The "DRE" code use reflects the catch of larger vessels that operate more offshore and process fish on board. The recovery rates, defined as the groomed and merged landings as a proportion of the groomed and unmerged landings (after Manning et al. 2004), are plotted in Figure C4. The recovery rates were close to 100% in most years, indicating a consistent match between the recorded statistical areas on the catch forms and the stocks reported on landings forms on a trip basis.

Annual QMR/MHR landings, groomed retained landings, merged landings, and merged estimated catches are plotted in Figure C5 and summarised in Table C4. The merged estimated catches generally followed the same trend as merged landings and the groomed retained landings, but were lower than landings for some fishing years. Estimated catches tend not to be recorded when catches are small (because vessels only report the top five species caught on TCEPRs and top eight on TCERs). Some inconsistencies may result from catch being allocated to the wrong fishing year for trips that straddle fishing years.

The reporting rate (the ratio of the annual estimated catch to the retained landings in the groomed and merged dataset) is shown in Figure C6 for the main form types. The TCEPR/CLR reporting rate for BAR 1 has been reasonably steady at between about 0.9 and 1.0, apart from in 1991 and 2005. Any barracouta catches reported from TCER and TCEPR vessels not in the top 8 species by estimated catchweight per tow (for TCER) or top 5 (for TCEPR) will be in the merged landings data, but not in the merged estimated data. The value of this ratio also depends on how well the statistical areas recorded on the TCEPRs and TCERs are matched to the stocks reported on the CLR on a trip basis. The reporting rates for the TCER/CLR data were close to 1.0, whereas the rates reported from CEL/CEL data suggested consistently higher estimated catch data relative to landings data for 1996 to 2003.

Comparisons of the annual estimated catches and retained landings by form type are shown in Figure C7. Annual landings reported on CLRs were generally larger than those from CELRs, and from 2008, when TCERs were introduced (and thus landings from this form were reported on CLRs), effectively all trawl landings were from CLRs. The annual estimated catches reported on TCEPRs was higher than that from TCERs during 2008–14.

Over the time series, the total number of trips reported each year on CELRs has decreased from about 4500–5200 trips per year during 1992–98 to 2200–2912 trips during 2001–07 (Table C5). For those years, about 60–70% of the trips reported estimated catches of barracouta. After 2007, following the introduction of the TCER, there were 220–430 trips a year on CELRs and between about 1760 and 2225 trips reported

on TCERs. About 88% of TCER trips each year had estimated barracouta catches. For years when between about 950 and 1420 trips were reported (1995–2005) on TCEPRs, 76–84% of trips had estimated barracouta catch compared with about 80–90% for years 2008–14 when 400–500 trips were reported each year.

6.3 Barracouta BAR 1 trawl fishery summary

Barracouta catches in BAR 1 were from inshore-shelf waters off the east coasts of the North Island and the South Island, and as shown in Figure C8 and Table C6, two subareas were defined as "ECNI" and "ECSI" based on the boundaries of Statistical Areas. The density of barracouta catches where data were reported on TCEPRs (for fishing years 1990 to 2014 combined) was greatest off the South Island, particularly near the shelf edge off Banks Peninsula and in the inshore waters of the Canterbury Bight. For TCER catches (for 2008 to 2014 combined), the density was also highest off the South Island east coast, but generally more inshore than the TCEPR catches. The main Statistical Areas from which these east coast South Island catches were reported are 018, 020, 022, and 024. For all forms, 60% of the total landed catch (1990–2014) from all trawlers was reported from 022, 12% from 020, and 8% from 024.

Off the North Island east coast, catches from TCERs were predominantly in waters south of East Cape (particularly in Statistical Areas 013–014), whereas catches reported on TCEPRs were from the entire coastline. The main Statistical Areas for all three trawl form types were 002, 003, 009–017 (see Table C6).

Annual catches by the two subareas are given in Table C7, based on the merged data. Overall, 86% of the catch was from the ECSI area; generally over 80% of the annual catch was from the ECSI, with at least 90% for each fishing year during 2008–14. Annual catches from ECNI peaked in 1994–99 with over 1300 t per fishing year, then ranged from 700 to 1000 t up to 2007, and were about 600 t for 2008–14. In contrast, catches from the ECSI were generally over 6000 t in most years. Catches from ECSI also peaked in the mid-late 1990s, at about 7300–9700 t per year, before dropping to a low of almost 3000 t in 2007, and increasing again with catches between 8600 t and 10 900 t for the 2009–14 fishing years.

The composition of the fleet nationalities that reported barracouta catches has changed over the time series. New Zealand vessels have consistently reported most of the annual barracouta catch throughout the time series, particularly small vessels (under 30 m) (Figure C9). Towards the end of the time series, the increased catches by large Ukrainian vessels surpassed the catches by smaller vessels during 2010, 2011, and 2014.

6.3.1 ECNI fishery

Almost 29 000 t of barracouta were reported from ECNI during the fishing years 1990–2014. Annual catches were generally between about 1000 and 2300 t up to the end of 2001, about 800–950 t from 2002 to 2007, and 570–780 t a year for 2008–14. New Zealand vessels have consistently reported almost 100% of the annual ECNI catch (Table C8a). Generally, about 50% of the annual catch came from TCEPRs, particularly from the mid-1990s when smaller vessels changed to reporting on more detailed forms, from CELR to TCEPR (Table C8b, Figure C10). Since the introduction of the TCER in 2008, at a time when annual catches were generally decreasing relative to the 1990s, the percentage of catch from TCEPRs dropped from 50% to about 30% for 2012–14. Bottom trawl gear accounted for 97% of the total catch (Table C8c).

The main months that contributed consistently to the annual catches were July, August, and September (Table C8d, Figures C10, C11a). Overall, about 44% of the total catch was from these months; another 9% from October, and the remainder was fairly evenly spread throughout the period November–June. The main target species for the ECNI catch were tarakihi and barracouta; across all years since 1990 these two targets accounted for 33% and 22% of the total barracouta catch respectively (Table C8e, see Figure C10). Barracouta-targeted catch was mainly from July-September and annual catches decreased from about 368–570 t a year in the 1990s to generally less than 50 t after 2004. In contrast, the catch from

tarakihi effort has remained fairly steady, at about 260–560 t each year during 2005–14. Tarakihi-targeted catch of barracouta was also higher during July–September, but catches were spread over other months throughout the time series. Other important target species include red gurnard (1993–2014), gemfish and blue warehou (1992–98), and snapper (1990–2001); though annual catches were variable.

Statistical Areas 014 and 013 accounted for consistent proportions of the annual catch throughout the time series relative to other areas, and overall, these two areas contributed 36% of the total catch (Table C8f, Figures C10, C11b). Statistical Area 009 in the Bay of Plenty was important in late 1990s, but in the last 10 years most of the catch has come from areas 012–017 (East Cape south to Cook Strait). Distinct differences were evident in the catches by area for the main target species over the time series (see Figure C10). Barracouta-targeted effort yielded catches mainly form 009 and 013–016 in the 1990s. Areas 013 and 014 were important for catches during effort targeted at tarakihi, red gurnard, gemfish, and blue warehou in the 1990s, whereas the more northern areas 002–010 were important for snapper effort.

The location of effort reported on TCEPRs and TCERs by target species is shown in Figures C12a and C12b. Barracouta catches were generally reported from throughout the range of the effort targeted at other species (Figures C12a, C12b). This effort was widespread for most species, but more constrained geographically (e.g., snapper, blue warehou, ghost shark, and red cod) or by depth for others (e.g., gemfish). The patchiness, annual variation, and low level of the catches is evident in annual catch distribution plots (Figures C13a, C13b).

The distribution of effort variables that describe the TCEPR vessels for the main target species are shown in Figure C14a. These characteristics can be summarised as follows: wingspread values of about 20–30 m; headline heights of 4–6 m for barracouta, 3–5 m for red gurnard, snapper, tarakihi, trevally, and hoki, and 5–8 m for gemfish and blue warehou. Tow speed was fairly uniform across the targets, as was the distance towed, though median values for barracouta, gemfish, and tarakihi tows were higher than for other targets, especially John dory and snapper. Small vessels (under 28 m) made up most of the effort for all targets other than hoki.

Figures C14b and C14c summarise the data distribution of the fishing duration and depth variables for the main TCEPR target species across the time series. Fishing duration values appeared to be more stable after the mid-1990s for all target species except for some with fewer data, as indicated by the larger intervals around the medians for gemfish (SKI), blue warehou (WAR), and silver warehou (SWA). Tarakihi tows were consistently longer in duration than other tows, with median values of about 4–5 h. Target barracouta median values were slightly lower, and snapper and other inshore target species had median values of generally less than 3 h, as did hoki targeted effort.

Distinct differences were evident in the depths fished, based on target species reported on TCEPRs (see Figure C14c). Tarakihi and barracouta targeting was in similar depths (100–200 m), the main inshore species were generally in depths of 50–100m, and hoki, gemfish, and silver warehou targeting were in depths of over 200 m.

Similar ranges were evident in the TCER tow-by-tow data (Figures C15a–C15c), although values for headline height and vessel size for these smaller vessels were slightly lower than those for TCEPR vessels. The reported fishing duration data suggest that tows for tarakihi and red gurnard were slightly longer than for the other main targets, especially red cod, ghost shark, and snapper. Depths fished by TCER vessels are similar to those reported by TCEPR vessels (Figures C14c, C15c), and are reasonably consistent across the TCER time series of 2008–14.

6.3.1.1 ECSI fishery area

The total landed catch from the ECSI fishery was 182 968 t for 1990 to 2014, with peak annual catches close to or just over 10 000 t in 1997, 2010, 2011, and 2014 (see Table C7). New Zealand vessels reported at least 60% of the annual ECSI catch in most years between 1990 and 2007 (Table C9a). From 2008, New Zealand vessels generally accounted for less than 50% of the catch in most years, despite reporting

higher catches. This resulted from occasional larger catches from Korean vessels and large, though variable catches from Ukrainian vessels.

Throughout the time series, at least 60% of the annual catch was reported on TCEPRs, except when smaller catches were reported on TCEPRs during 2004–08 (Table C9b, Figure C16). Before 2008, the catch was largely from bottom trawl effort, but in recent years, the increased annual catches have come mainly from midwater TCEPR vessels targeting mainly barracouta in Statistical Area 022 (Table C9c, Figure C16).

Over the time series, barracouta was caught mainly during October to June, with 55% of the total catch caught during February–May (see Table C9d, Figure C16). In 2008–14, the months with the highest catches were October and February–April in the TCEPR data, whereas the season was broader for the TCER and CELR data (Figures C17a–C17c). July, August, and September had consistently small catches, relative to other months and together accounted for 7.5% of the total catch.

The main target species for the ECSI catch were barracouta, red cod, arrow squid, and jack mackerel, with barracouta target accounting for the increased catches after 2008, as well as occasional large catches from jack mackerel tows and increased catches for effort targeted at tarakihi, silver warehou, and blue warehou (Figure C16, Table C9e). Overall, effort targeted at barracouta accounted for 51% of the total catch, red cod for 22.5%, and arrow squid for 11%. The barracouta-target catch dropped from over 4000 t in the early 1990s to about 1200 t in 2007, then peaked at about 8100 t in 2010, and was between 5200 and 6300 t in subsequent years. Most of the red cod and squid catches were from 1994 to 2002, where catches were between about 1000 t and 4000 t for red cod effort and 1000 t to 2200 t for arrow squid effort. In subsequent years, catches from these two species were generally under 1000 t, with large annual variation in the annual catches from squid effort. Whereas barracouta was the primary target for the catch from TCEPRs, barracouta and red cod were both important for catch reported on CELRs and TCERs, as well as tarakihi from TCERs (Figures C17b, C17c).

Where barracouta is the target, the proportion of tows with zero catches is low relative to other targets for the TCEPR and TCER forms (Figures C18a, C18b). The daily CELR landed catch data indicate that from the early 1990s to the early 2000s, fewer zero catches were made each day when targeting red cod and various flatfish species than when targeting barracouta (Figure C18c). The distribution of catches by month and target were similar for all form types, with catches from barracouta and red cod mainly between October and June, whereas catches from arrow squid were from January to May and from tarakihi on TCER were mainly January–June but also from July–September, and even October in recent years (see Figures C19a–C19c).

Statistical Area 022 consistently accounted for between about 60 and 77% of the annual catch, relative to other areas, and overall contributed 36% of the total catch, with most of the remainder from 020 and 024 (Table C9f, Figures C20a–C20c). The distribution of catch from effort targeted at barracouta and red cod was primarily from Statistical Area 022 for all forms, with lesser catches from 018, 020, and 024. Statistical Area 022 was also the most important area for catch from arrow squid effort, but the secondary areas were 020, 024, and 026. Since the mid-2000s, the catch from tarakihi effort recorded on CELRs and TCERs was primarily from areas 022, 020, and 018.

The location of effort reported on TCEPRs and TCERs by target species is shown in Figures C21a and C21b. Barracouta catches were generally reported from throughout the range of the effort targeted at other main species, except for some deeper effort targeted at hoki and silver warehou; thus representing the overlap of targeting with the waters preferred by barracouta. Barracouta catches were reported from TCER effort targeted at a variety of species across the shelf off the east coast South Island, with distinct differences in distribution depending on the target species. However, the primary targets with respect to barracouta catch and bycatch (barracouta, tarakihi, and red cod) have very similar distributions.

For TCEPRs, the distribution of bottom trawl catches by year is variable, but higher catches were reported from close to the shelf edge and closer inshore between about 44° and 45° S where barracouta and red

cod are targeted (compare Figures C21a and C22a). Catches appear to be more constrained in their distribution in the 2000s, and the higher catches are restricted mainly to the shelf edge, with low catches inshore. This reflects the geographic difference in the spread of the larger and smaller vessels that reported on TCEPRs and the change in the relative importance of the target fisheries in terms of barracouta catch. For the TCER catch distribution, the effect of target species is evident in some years (compare Figures C21b and C22b) with a reasonably even spread of catches across the shelf, from year to year. Areas of higher catches in most years are evident around the border of Statistical Areas 020 and 022 and in the southern part of area 022.

The distribution of effort variables that describe the TCEPR bottom trawl vessels for the main target species are shown in Figures C23a–C23c. These distributions identify the different species targeted by different vessel sizes, with larger variable values generally corresponding to effort by the larger New Zealand and foreign vessels targeting species such as arrow squid, hoki, and silver warehou. The main variables are summarised as: wingspread values of about 20–40 m; headline heights of 3–5 m; tow speed of 3–4.5 kn., with slower speeds for barracouta, red cod, tarakihi, and elephant fish targets; and tow lengths of 10–30 km, with most median values around 20 km. Smaller vessels (under 46 m) accounted for most of the effort for barracouta, red cod, tarakihi, blue warehou, and elephant fish, as well as a proportion of the arrow squid effort.

Figures C23b and C23c summarise the data distribution of the fishing duration and depth variables for the main TCEPR target species across the time series. Fishing duration values were fairly constant across the time series for barracouta except for the higher values seen in 2008 when a small group of vessels had longer tow durations and fished in slightly deeper water than usual. For most other main target species with consistent data, tow durations were reasonably steady across the time series, at less than about 5 h. Tow duration for arrow squid and silver warehou increased towards the end of the series. Target species with a wide range of duration data are generally from years in which both large and small vessels targeted that species; for example, towards the end of the series, red cod was targeted mainly by smaller vessels.

Distinct differences were evident in the depths fished, based on target species reported on TCEPRs (see Figure C23c). Red cod and barracouta targeting was in similar depths (about 60–150 m), with tarakihi having a tighter distribution at around 60–115 m and arrow squid in 150–275 m. Hoki targeting was generally in the deepest water, over 400 m, and silver warehou in about 200–400 m.

The midwater TCEPR explanatory variable data are shown in Figures C23d–C23f. There are few differences between the main variables for the target species barracouta, jack mackerel, and arrow squid which were mainly targeted by large vessels (over 80 m). Wingspreads were about 100 m and headline heights were between about 20 and 50 m, except when hoki was targeted (headline height of about 60 m). The tow speed for hoki, at 4 kn., was generally slower than for the other targets, but target had no effect on the distance towed for midwater nets. Fishing duration for barracouta and jack mackerel midwater effort increased over the time series, whereas hoki duration values decreased (Figure C23e). The depths fished varied by the midwater target species, with barracouta and jack mackerel effort consistent over the time series at about 100–150 m, arrow squid generally in 100–200 m, and hoki mainly in 300–500 m (Figure C23f).

The tow-by-tow data reported on TCERs represent the smallest trawl vessels operating bottom trawl gear, with most vessels less than about 20 m, except for the 20–26 m vessels targeting arrow squid (Figure C24a). Wingspread values ranged from 20–40 m, except where the target was tarakihi or flatfish, where most values were around 20 m. Tows for the main species with barracouta catch (barracouta, red cod, and tarakihi) used nets with headline heights of 3–4 m, towed at about 3 kn., for about 3–4 h, though tarakihi tows were slightly longer in duration. There were few differences in the distribution of fishing duration values by target species across years (Figure C24b) and small differences in the depths fished, though for the three targets with the most barracouta catch tarakihi effort was slightly deeper than that for barracouta and red cod (Figure C24c). Arrow squid effort was deepest, in 200–300 m.

6.4 Trawl fishery summary

A summary of the characterisations by trawl fishery area is given in Table 3, and the catch information summarises the groomed merged landed catch. The ECSI area accounted for 86.4% of the total landed catch from trawl fishing, for 1990–2014 fishing years, with 51% of the total catch from barracouta-targeted effort, and another 22% from red cod tows and 11% from arrow squid effort. Other target fishing that has resulted in barracouta bycatch includes effort targeted at red gurnard, gemfish, snapper, and blue warehou in the ECNI fishery area, and jack mackerels, tarakihi, and blue warehou in the ECSI fishery area. The increases in catches seen after 2008 largely represent an increase in targeting barracouta by New Zealand bottom trawls and Ukrainian midwater trawls; with catches from barracouta-targeted tows increasing from 2000–4000 t to 5000–8000 t during 2009–14. Industry sources indicated that the development of at least one new market for barracouta was responsible for the increase in targeting this species. This market demand does not appear to have had any influence on the barracouta catch by vessels operating in the ECNI area.

Most of the ECSI catch was from Statistical Area 022 (60%), 020 (12%), and 024 (8%), in depths of about 50–145 m. February–May accounted for 54.5% of the catch, with another 31% from October–January. Bottom trawl gear was the primary method with barracouta catch, though post-2008, large catches were reported from midwater gear targeted at barracouta and jack mackerel. About 72% of the ECSI area barracouta catch was reported on TCEPRs and in the years in which the TCER data have been available (2008–14), 29% of the catch was from TCERs.

In comparison, the ECNI barracouta catch is small and annual catches have decreased over the time series to less than 60 t a year during 2005–14. The ECNI catches were from a wider variety of species targeted by bottom trawls operated by New Zealand vessels in coastal waters. About 33% of the catch was from tarakihi tows and 22% from barracouta tows. Small catches of barracouta were made throughout the year, but more consistent catches were made during July–September and from waters in Statistical Areas 013 and 014 in particular, as well as 015–17. For all years, 47% of the catch is from TCEPR forms, and for the 2008–14 period, 60% was from TCERs.

Table 3: Summary of features of the ECNI and ECSI subareas of BAR 1 fishery, based on the merged landed catch data, where TCEPR is Trawl Catch Effort Processing Return, TCER is Trawl Catch Effort Return. Area definitions are shown in Figure 1 and Figure C8; species codes are explained in Table C10.

QMA area	ECNI	ECSI
Key fishery areas	East Coast North Island	East Coast South Island
Key statistical areas	013, 014, 015–017, 009	022, 020, 024
Secondary statistical areas	002, 003, 010–012	018, 026, 021
Season	July–September;	February-May; October–January
Gear type (% catch)	98% bottom trawl	72% bottom trawl; 28% midwater trawl
Target species		
Key target species (% catch)	Tarakihi (33%), barracouta (22%)	Barracouta (51%); red cod (22%); arrow squid (11%)
Secondary target species	Red gurnard, gemfish, snapper, blue warehou	Jack mackerels, tarakihi, blue warehou
Target barracouta catch trends	Decreasing: ~ 500 t 1990–2004; < 60 t 2005–	Increasing: ~ 2000-4000 t in 1990–2008; 5000–8000 t in 2009–14
Catch		
Landed catch (t)	28 918.7 t	182 967.7 t
Landed catch (% total BAR 1 catch)	13.6%	86.4%
Annual catch	1990–2001: ~ 1000 t 2002–14: < 1000 t	1990–94: < 8000 t. 1994–2000: ~ 8000–9000 t. 2001–08: 4000–6000 t. 2009–14: 8000–11000 t
Total area catch (% total from barracouta target effort)	22%	51.3%
Total area catch (% total by TCEPR)	47%	70%
Total area catch (% total by TCER for 2008–14)	60%	29%
Start depths of tows with barracouta	82 m (52–120 m)	99 m (53–143 m)
Vessel nationality	99.8% New Zealand	58.5% New Zealand; 16% Korea; 16% Ukraine

7. CPUE ANALYSES

Small trawl vessels that do not process fish at sea were the main vessels with barracouta catch in BAR 1. The reasonable proportion of data collected on tow-by-tow data forms, especially in ECSI, allowed the separate use of bottom trawl data from TCEPRs and TCERs, as well as merged data for the full set of CELR and TCER data for 1990–2014. The similarity between the trends shown by the groomed estimated catch data and the groomed landings data indicated that the estimated catch data could be used to calculate a representative CPUE index. The tow-by-tow data include a range of descriptive variables that may influence a CPUE model (such as target species, tow distance, or bottom depth) and any trends in catch rates can be modelled at smaller spatial and temporal scales. When the tow-by-tow data are merged to daily data, the variables available for CPUE analyses require summing over the day or converting to a daily mean. However, in fishery areas where consistent amounts of annual data come from CELR forms, the merging of data from all form types is necessary. Thus, for both areas, CPUE analyses were run for the full time series (where data allowed) on the merged daily CELR and TCER data and the tow-by-tow TCEPR data, and the TCER tow-by-tow data (2008–14).

Prior to development of the CPUE datasets, the ECSI tow-by-tow data were allocated to the trawl regions shown in Figure 4 (TCEPR data) and Figure 5 (TCER data) in recognition of the catch pattern as opposed to using the Statistical Area. This variable was added to the datasets as *trawl region*.

Annual unstandardised (raw) CPUE indices were calculated as the mean of the catch per tow (kg) for tow-by-tow data. Estimates of relative year effects were obtained from a stepwise multiple regression method, where the data were fitted using a lognormal model using log transformed non-zero catch-effort data. A forward stepwise multiple-regression fitting algorithm (Chambers & Hastie 1991) implemented in the R statistical programming language (R Development Core Team 2015) was used to fit all models. The algorithm generates a final regression model iteratively and used the year term as the initial or base model in all cases. The reduction in residual deviance (denoted r^2) was calculated for each single term added to the base model. The term that resulted in the greatest reduction in the residual deviance was then added to the base model, where the change was at least 1%. The algorithm was then repeated, updating the base model, until no more terms were added. A stopping rule of 1% change in residual deviance was used as this results in a relatively parsimonious model with moderate explanatory power. Alternative stopping rules or error structures were not investigated.

The variable *year* was treated as a categorical value so that the regression coefficients of each year could vary independently within the model. The relative year effects calculated from the regression coefficients represent the change in CPUE through time, all other effects having been taken into account. Hence, it represents a possible index of abundance. Year indices were standardised to the mean and were presented in canonical form (Francis 1999).

Categorical and continuous variables offered to the models are listed in Table D1. Fits to continuous variables were modelled as third-order polynomials, though a fourth-order polynomial was also offered to the models for *duration*. In each analysis *trawl region* and *start latitude* or *start longitude* were not allowed to enter the same model at the same time as they were correlated. For the estimated catch runs all variables were included.

A vessel variable was incorporated into the CPUE standardisation to allow for differences in fishing power between vessels. A core set of vessels was determined for each model in an attempt to restrict any model over-fitting by the inclusion of vessels that had limited participation in each defined fishery (Francis 2001). Thus, CPUE analyses were undertaken for "core" vessels that reported at least 80% of the barracouta catch and had steady involvement in the fishery (see Table D2).

The TCER data were modelled separately because they represent the inshore fleet of smaller vessels and include records for the top 8 catch species. Although they are only available for 7 years, these data provide tow level information on target species, location, and tow parameters in generally shallower waters than fished by the larger vessels.

Model fits 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., lognormal errors). Binomial and a combination of the lognormal and binomial (delta-lognormal models) were also run, but only the indices are provided in this report.

The bottom trawl CPUE analyses for the ECSI fishery area are presented first in the following sections. The final CPUE models are listed in Table D2a:

1. a tow level TCEPR mixed target, bottom trawl, estimated catch dataset defined by trawl regions for October–June to incorporate the main target species in the barracouta catch data, 1990–2014;
2. a tow level TCER mixed target, bottom trawl, estimated catch dataset defined by trawl regions for October–September, 2008–14;

3. a day level merged CELR/TCER mixed target, bottom trawl, landed catch dataset for October–September to incorporate the main target species in the barracouta catch data for the small vessels, 1990–2014.

The bottom trawl CPUE analyses presented here for ECNI are listed in Table D2b:

1. a tow level TCEPR mixed target, bottom trawl, estimated catch dataset defined by 4 seasonal quarters for October–September to incorporate the main target species in the barracouta catch data, 1994–2014;
2. a tow level TCER mixed target, bottom trawl, estimated catch dataset by 4 seasonal quarters for October–September, 2008–14;
3. a day level merged CELR/TCER mixed target, bottom trawl, landed catch dataset for October–September to incorporate the main target species in the barracouta catch data for the small vessels.

The annual catches in the ECNI fishery area were inconsistent and relatively small, with most of the catch caught as bycatch; thus the results of the CPUE analyses may offer little explanation for barracouta in this part of BAR 1. The TCEPR data prior to the 1994 fishing year were too sparse; thus, the TCEPR CPUE dataset was restricted to the fishing years 1994–2014.

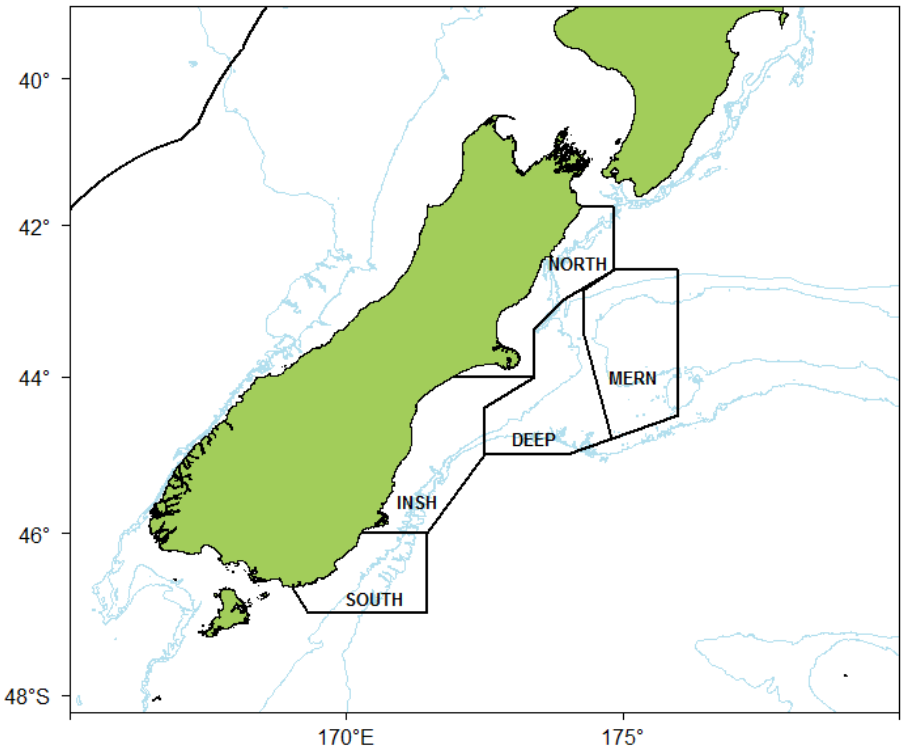


Figure 4: Areas used to analyse the barracouta catch from tow-by-tow TCEPR records. The areas here denote activity by different fleets: catch from New Zealand vessels was generally in less than 250 m and primarily from the INSH area (southern part of Statistical Area 022 and 024); catch from Korean, Ukrainian, and Russian vessels was mainly from the edge of the shelf in the DEEP area (also in 022) and in the SOUTH area (026). Data from the MERN area were not included. See Figure C22a for annual catch distribution.

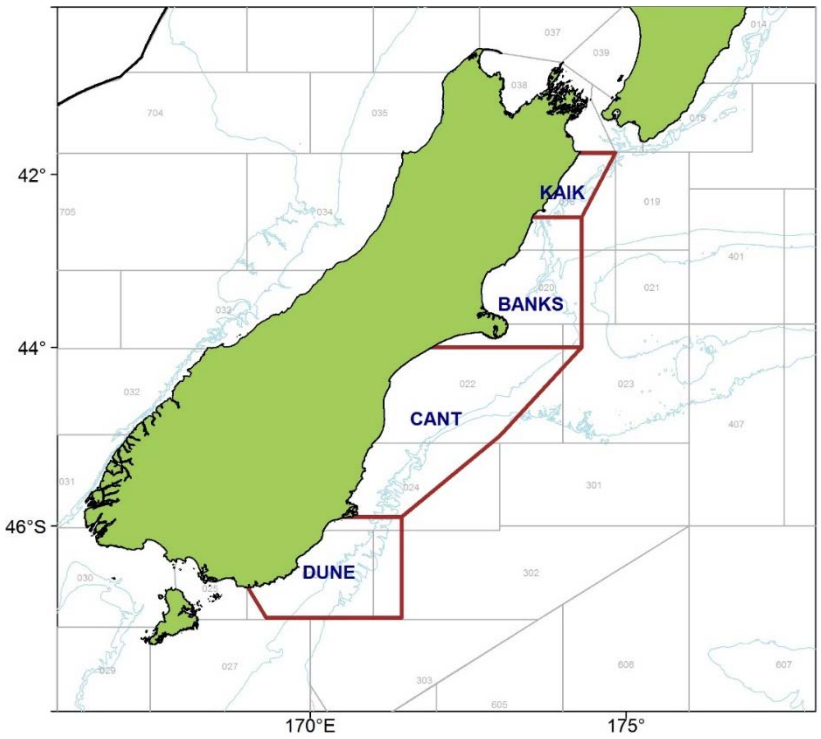


Figure 5: Areas used to analyse the barracouta catch from tow-by-tow TCER records, for 2008–14.

7.1 ECSI standardised CPUE models

(a) TCEPR mixed target bottom trawl (barracouta, red cod, and arrow squid)

The number of records, proportion of zeros, catch, effort and unstandardised CPUE are listed in Table D3. Standardised model results are shown in Tables D4–D5 and Figures D1–D7.

A total of 114 unique vessels (range 9–34 vessels each year) caught an estimated 66 748 t of barracouta during 1990–2014 from 57 583 bottom trawl tows (Table D3, Figure D1). The percentage of zero tows decreased over the time series, from 22–55% for 1990–2007 to 10–17% of tows during 2011–14 (Figure D2). Estimated barracouta catches ranged from 600 t (in 2008) to 4745 t (in 1996) annually, and the number of annual tows ranged between 169 (in 2008) and 4764 (in 1996). Twenty-six core vessels (range 7–22 per year) accounted for 81% of the bottom tows made by all vessels and caught an estimated 58 111 t of barracouta, representing 87% of the total catch for 1990–2014. About 7 vessels reported reasonably consistent catches when they were present in the fishery (see Figure D1).

For the tow-by-tow estimated core data analysis, six variables were selected into the lognormal model, resulting in a total r^2 of 23%, with *target* explaining 12.2% of the residual deviance (Table D4). The other variables selected were *vessel*, *tow depth*, *start time of tow*, *trawl region*, and *month*.

The CPUE series from the lognormal models is presented in Table D5 and Figure D3a. The tow-by-tow estimated catch index appears to decrease during the early to mid-2000s then increase after 2007 to a level slightly higher than seen in the indices for the mid to late-1990s, although the larger confidence intervals indicate less stability in this trend. The influence of the non-zero catches seen in the binomial model is reflected in the higher indices represented by the delta-lognormal model for 2010–14 (Figure D3b).

The effects of the addition of the selected variables on the unstandardised catch rate are shown in Figure D4, and the effects of the selected variables on the expected catch rates of barracouta are shown in Figure D5 and the influence plots (after Bentley et al. 2012) in Figures D6a–D6f. Catch rates were higher when: the target was barracouta, effort took place in December–June, tows started during daylight hours, and effort was in the two trawl regions NORTH or INSH. Twelve of the 26 vessels

had substantially higher expected catch rates. The influence of the higher catch rates from greater barracouta target effort is evident in Figure D6a, and the spike in catches in 2008 reflects the relatively larger amount of effort by a few vessels with higher catch rates (in a year of low effort overall). Conversely, in 2010, the index was influenced by the low effort by vessels with higher catch rates relative to the larger effort by vessels with low catch rates (see Figure D6b).

Larger numbers of tows in depths where barracouta catch rates were higher had a positive influence on the index (Figure D6c). Similarly, a positive influence on the index is evident when there was more effort started between 0500 h and 1350 h, in areas INSH and NORTH, or in the months January-June (Figures D6d–D6f). Model diagnostics are shown in Figure D7.

(b) TCER mixed target bottom trawl (barracouta, red cod, and tarakihi)

The number of records, proportion of zeros, catch, effort and unstandardised CPUE for the TCER data are listed in Table D3. Standardised model results are shown in Tables D4–D5 and Figures D8–D14. The catch data used in this analysis include the reported catch of the top eight species, as required on the form.

A total of 62 unique vessels (range 33–44 vessels each year) caught an estimated 15 771 t of barracouta during 2008–2014 from 23 926 bottom trawl tows (Table D3, Figure D8). The percentage of zero tows was fairly consistent each year, between 22 and 31% (Figure D9). Estimated barracouta catches ranged between 1748 t and 3111 t annually, and the number of annual tows ranged between 3059 and 3829. Twenty-one core vessels (range 18–21 per year) accounted for 84% of the bottom tows made by all vessels and caught an estimated 14 295 t of barracouta, representing 90% of the total catch for 2008–14.

Four variables were selected into the lognormal model, resulting in a total r^2 of 34.4%, with *vessel* explaining 23.9% of the residual deviance (see Table D4). The other variables selected were *start time of tow*, *target species*, and *bottom depth*.

A slightly increasing trend is shown by the lognormal indices for the 7 years of available data (Table D5, Figure D10a). The consistent trend in the proportion of non-zero tows is reflected in a lack of influence of the binomial on the lognormal seen in the delta-lognormal series (Figure D10b). The effect of the addition of the selected variables is shown in Figure D11, with the overall effect of increasing the indices before 2011 and lowering the indices after 2011. Figures D12 and D13a–D13d show the expected distributions and effects of the selected variables. Two vessels had substantially higher catch rates, and seven vessels had low catch rates relative to others. The catch rate from barracouta targeted tows is substantially higher than that for red cod and tarakihi. Higher catch rates were likely for tows in 50–150 m, in the middle of the day. For most variables the influences are relatively small. The vessel effect reflects the relative amounts of annual effort by one vessel with a lower catch coefficient, and an increase in effort by vessel with higher catch rates after 2011.

Model diagnostics are shown in Figure D14.

(c) CELR/TCER mixed target bottom trawl (barracouta, red cod, and tarakihi)

The number of records, proportion of zeros, catch, effort and unstandardised CPUE for the merged CELR/TCER data are listed in Table D3. Standardised model results are shown in Tables D4–D5 and Figures D15–D21.

A total of 188 unique vessels (range 32–71 vessels each year) landed 47 397 t of barracouta during 1990–2014 from 47 158 daily records (Table D3). The distribution of the daily data is shown in Figure D15. The percentage of zero tows ranged between 14 and 25%, with no apparent trend for all vessels or core vessels (Figure D16). Landed barracouta catches ranged between 853 t and 3148 t annually, and the number of daily records ranged between 1127 and 2924 per year. Thirty-four core vessels (range 9–23 per year) accounted for 76% of the daily records for vessels and caught an estimated

41 055 t of barracouta, representing 87% of the catch from all vessels. From 2008 on, the records in this dataset are based on TCER data and thus represent the daily catch from at least 10 vessels, based on the catch of the top five species per daily record, to match the daily CELR data.

Four variables were selected into the lognormal model, resulting in a total r^2 of 42.7%, with *vessel* explaining 35.5% of the residual deviance (see Table D4). The other variables selected were *target species*, *month*, and *fishing duration*.

Overall, a slightly increasing trend is indicated by the lognormal indices, particularly from the early 2000s (Table D5, Figure D17a). The higher indices from 1996–98 are similar to those for 2010–14; however, the earlier period represents more vessels with smaller catches than in the later period (see Figure D16). There is little influence from the non-zero records when the lognormal and binomial are combined for the delta-lognormal series (Figure D17b). The effect of the addition of the selected variables increases the indices in the earlier years up to 2000, and lowers the indices after 2006.

Figures D19 and D20a–D20d show the expected distributions and effects of the selected variables. The expected catch rates by vessel showed large differences; three vessels had substantially higher catch rates, and seventeen vessels had low catch rates relative to others. The catch rate from barracouta targeted tows was about twice the rate for red cod and tarakihi, and December–February had higher rates than other months, and expected rates for August and September were substantially lower than for any other month. Catch rates increased as the number of hours fished per day increased.

Figure D20a indicates the substantial influence of individual vessels, largely driven by the decrease in effort (or departure from the area) by vessels that fished before the 2000s and that generally had lower catch coefficients than vessels that fished throughout the series or arrived in the area in subsequent years. The positive influence of target species is also apparent in years when there was increased barracouta-targeted effort, and a negative effect when more effort was expended for tarakihi (Figure D20b). Month and fishing duration had relatively small, and variable, influences (Figures D20c and D20d). Model diagnostics are shown in Figure D21.

7.1.1 CPUE summary for BAR 1 ECSI

Barracouta catch in ECSI resulted from a range of target species in depths that overlapped the distribution of barracouta, generally less than 250 m. These targets varied by fleet. The larger TCEPR vessels (representing different nations and using bottom trawl and midwater trawl gear) mainly targeted barracouta, jack mackerels, and arrow squid. The catches from the bottom trawl effort were more consistent from year to year than the midwater effort catch; the latter showed large increases after 2008 and was representative of a large vessel fleet consisting of a small number of vessels with relatively small and inconsistent annual catches in the years prior to 2009. Thus the TCEPR CPUE analysis was restricted to bottom trawl effort only in the main months of fishing – October to June – and included a range of vessel sizes from New Zealand as well as Korean vessels. The larger New Zealand vessels and the Korean vessels operated mainly close to the shelf edge in Statistical Area 022 targeting mainly barracouta and arrow squid, whereas the smaller vessels fished more inshore targeting barracouta, red cod, and tarakihi. Although much of the catch was from bottom tows that targeted barracouta, the time series was characterised by a wide range in catch rates by vessel and the effect of vessels entering and departing the fishery area. Towards the end of the time series, a few vessels with high catch rates contributed most of the annual catch.

In comparison, the TCER vessel catch was from barracouta, red cod, and tarakihi targeted effort, mainly in January to June, by vessels that fished consistently in the area. Similar to the TCEPR vessels, there was increased targeting of barracouta after 2007–08 by TCER vessels.

A longer time series relevant to the small vessels (under 28 m) can only be analysed at the day level because of the resolution of the CELR data. Thus, there are some compromises in variables available for analysis where the location of effort is restricted to one Statistical Area and one target species for a fishing day for a vessel trip, and the fishing duration is the sum of hours fished during the day. The catch is determined from the top five species caught in a day. Thus, when the TCER are integrated

with the CELR to make the daily merged dataset, the TCER positive catch data are restricted to fishing days in which barracouta was reported in the top five species for the full day's effort. Other variables available in TCER data are defined by daily effort for the merged dataset; so each day is assigned a main Statistical Area and a main target species, and the fishing duration is summed across the tows in a day. Overall, the merged dataset has fewer variables available to describe the fishing activity than in the tow level datasets.

Fishing year (as represented by the season within each fishing year) was forced into every CPUE model; it rarely explained more than a few percent of the null model deviance. The overall r^2 values for each CPUE core model varied from low to moderate, with 23% for the TCEPR model, 34% for the TCER model over 7 years, and 43% for the merged CELR/TCER data. Some explanatory variables were consistent for all models, with *vessel* and *target* entering each model: *vessel* the primary influence for the small vessel models and *target* for the TCEPR model. The other variables retained in the models included *depth*, *tow start time*, *trawl region*, and *month* (TCEPR); *tow start time*, *target species*, and *depth* (TCER); *target species, month*, and *fishing duration* (CELR/TCER). Generally, these variables had small influence.

Broadly, the three CPUE models followed a similar trend (see Figures D3b, D10b, D17b), with an increase from 2008–14 (the only years where there are TCER data). The Southern Inshore Working Group (SINSWG) accepted the ECSI combined index series based on daily data from CELR and TCER forms (targeting barracouta, red cod, and tarakihi) as an index of abundance. An overlay of the ECSI trawl survey indices on this commercial series indicates a large increase in the barracouta abundance in the same years, although the index for 2012 is lower than the commercial indices and the index for 2014 is higher (Figure 6). This trawl survey is conducted in May-June using similar sized gear to that used by the smaller TCEPR vessels. The survey includes waters fished by both the smaller TCEPR vessels and the CELR/TCER vessels.

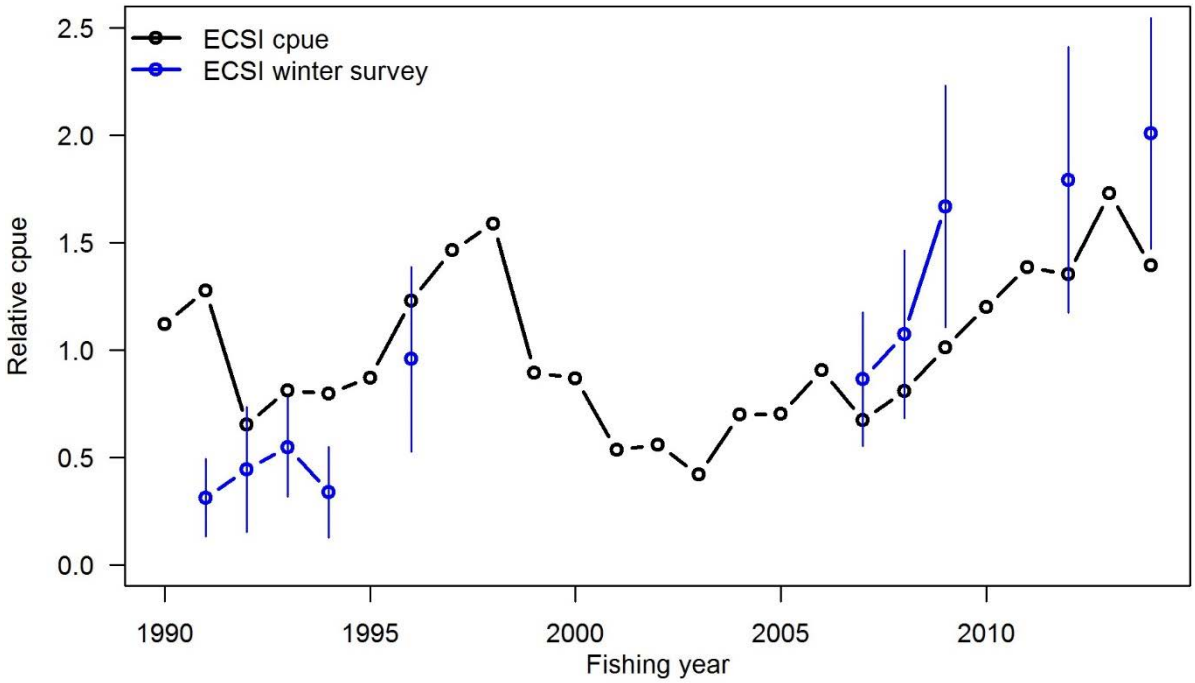


Figure 6: Comparison of the BAR 1 ECSI delta-lognormal indices for 1990–2014, based on the CELR and TCER daily data, and the recruited biomass (and associated variance) from the ECSI winter trawl survey series. The recruited biomass is based on fish over 60 cm fork length.

The mixed target bottom trawl TCEPR model accounted for about 58 000 t of barracouta compared with the 47 400 t of barracouta from the merged bottom trawl CELR/TCER model. Essentially these two datasets represent the catch of a mix of two fleets, i.e., vessels over 46 m that process and freeze

the catch, and small ice boats operating closer inshore. However, the effort and catch by TCEPR vessels was not as consistent as it was for the small CELR/TCER vessels. Coincidentally, the year (2008) in which the level of fishing activity reported on TCEPRs dropped markedly, and remained at a low level, was the year in which the TCER was introduced. Three vessels changed form types in these years: one used TCERs in 2008 and TCEPRs in 2009 and 2010; one used TCERs in 2008 and moved to TCEPRs for 2009–14; and one used TCEPRs in 2008 and changed to TCERs for 2009–11.

7.2 ECNI standardised CPUE models

An attempt was made to model the data from this area, following the specifications listed in Table D2b but, as the characterisation indicated, the data were too sparse and inconsistent to provide any useful information on catches over time in this area. However, for completeness, the CPUE analyses conducted on these data are presented below.

(a) TCEPR bottom trawl (barracouta and tarakihi)

The number of records, proportion of zeros, catch, effort and unstandardised CPUE for the TCEPR data are listed in Table D6. Standardised model results are shown in Tables D7–D8 and Figures D22–D28.

A total of 64 unique vessels (range 8–35 vessels each year) caught an estimated 3748.5 t of barracouta during 1994–2014 from 30 586 bottom trawl tows (Table D6). The distribution of the effort and catch by vessel each year is shown in Figure D22. The percentage of zero tows increased over the years, from 38% to about 55–60% for most years after 1999 (Figure D23). Estimated catches of barracouta ranged between 100 t and 411 t per year during 1994–2011 and 16–87 t for 2012–14. The effort expended each year ranged between 1097 and 2127 tows throughout the series except for 1994 and 2013 when about 600 tows were reported. Twenty-three core vessels (range 3–20 per year) accounted for 85% of the bottom tows made by all vessels and caught an estimated 2575 t of barracouta, representing 69% of the total catch for 1994–2014.

Four variables were selected into the lognormal model, resulting in a total r^2 of 32.8%, with *vessel* explaining 24.8% of the residual deviance (see Table D7). The other variables selected were *target species*, *month*, and *start time of tow*.

During the mid-late 1990s, the CPUE indices are substantially higher than for 2000–14, despite large confidence intervals (Table D8, Figure D24a). There is no trend in the CPUE for 2000–14, and little influence from the binomial in the delta-lognormal series (Figure D24b). The effect of the addition of the selected variables is shown in Figure D25, with the overall effect of decreasing the indices before 2002 and lowering the indices after 2004. Figures D26 and D27a–D27d show the expected distributions and effects of the selected variables. Higher catch rates were evident in December-January and July-September and when the target was barracouta. Tow start times between 0500 h and 1530 h had higher predicted rates. The vessel catch rates were stratified into three groups: one vessel had a substantially higher catch rate than all other vessels; another 13 vessels had moderate rates; and 8 vessels had relatively low rates.

The vessel effect reflects the relative amounts of annual effort by several vessels with higher catch coefficients, and an increase in effort by vessels with lower catch rates from the early 2000s (Figure D27a). The almost complete lack of barracouta-target tows from the mid-2000s, with the catch subsequently coming from tarakihi tows only, has resulted in the lower CPUE indices over the last decade (Figure D27b). Also at this time there has been a more even spread of effort across the months which lessens the effect of the higher catch rates during July-September (Figure D27c). The influence of tow start time reflected small changes in the proportions of effort when catch rates were higher or lower (Figure D27d). Model diagnostics are shown in Figure D28.

(b) TCER mixed target bottom trawl (barracouta, ghost shark, red gurnard, red cod, tarakihi, and blue warehou)

The number of records, proportion of zeros, catch, effort and unstandardised CPUE for the TCER data are listed in Table D6. Standardised model results are shown in Tables D7–D8 and Figures D29–D35.

A total of 71 unique vessels (range 40–49 vessels each year) caught an estimated 2362.1 t of barracouta during 2008–14 from 39 728 bottom trawl tows (Table D6). The distribution of the effort and catch by vessel each year is shown in Figure D29. The percentage of zero tows ranged from 50% to 59% (Figure D30). Between 4688 and 6178 tows were reported a year and the annual catch ranged between 264 t and 451 t. Twenty-four core vessels (range 17–22 per year) accounted for 85% of the bottom tows made by all vessels and caught an estimated 1990 t of barracouta, representing 84% of the total catch for 2008–14.

Three variables were selected into the lognormal model, resulting in a total r^2 of 38.0%, with *vessel* explaining 33.6% of the residual deviance (see Table D7). The other variables selected were *month* and *target species*.

No trend is discernible in the lognormal CPUE for this short time series, and the consistent level of non-zero tows each year means here is little difference between the lognormal and delta-lognormal indices (Table D8, Figures D31a, D31b). The effect of the addition of the selected variables is shown in Figure D32, with the overall effect of minor increases in the indices before 2011 and minor decreases after 2011. Figures D33 and D34a–D34d show the expected distributions and effects of the selected variables. Three vessels had substantially higher predicted catch rates, five vessels had moderate rates, and 15 vessels had low catch rates relative to others. The catch rate from barracouta targeted tows is substantially higher than the rates for the remaining species, which are very similar. Catch rates were highest in July and August. Prior to 2011, most effort was by vessels with low catch rates, but during 2011–14 the increased effort by two vessels with higher catch rates had a positive influence (Figure D34a). The influences of the other retained variables are very small (Figures D34b, D34c); the spread of effort across months is reasonably even across the years, as is the spread of effort by target species, with most effort aimed at tarakihi and red gurnard. Model diagnostics are shown in Figure D35.

(c) CELR/TCER bottom trawl (barracouta, red gurnard, snapper, and tarakihi)

The number of records, proportion of zeros, catch, effort and unstandardised CPUE for the CELR/TCER data are listed in Table D6. Standardised model results are shown in Tables D7–D8 and Figures D36–D42.

A total of 216 unique vessels (range 39–97 vessels each year) caught an estimated 10 232 t of barracouta during 1990–2014 from 53 631 bottom trawl tows (Table D6). The distribution of the effort and catch by vessel each year is shown in Figure D36. The percentage of zero tows varied little over the years, from 31% to 42% (Table D6, Figure D37). Between 215 t and 764 t of barracouta was landed each year, with the peak catches from 1992–95 when the numbers of daily records were the highest (2500–3000 days). For the remainder of the series, the number of daily records was about 1800–2200. Forty-two core vessels (range 11–24 per year) accounted for 71% of the daily records from all vessels and landed 6 984 t of barracouta, representing 68% of the total catch for 2008–14.

Five variables were selected into the lognormal model, resulting in a total r^2 of 41.5%, with *vessel* explaining 26.7% of the residual deviance (see Table D7). *Month ex*plained another 6.5%, and the other variables selected were *target species*, *fishing duration*, and *headline height*.

There is no real overall trend exhibited by the lognormal or delta-lognormal indices (Table D8, Figures D38a, D38b), apart from an increase apparent before 2000 followed by lower but variable indices. The effect of the addition of the selected variables is shown in Figure D39, with the overall effect of decreasing the indices before 2001 and increasing the indices after 2001. Figures D40 and D41a–D41d show the expected distributions and effects of the selected variables. About six vessels had higher

catch rates than the rest, and fourteen vessels had substantially lower catch rates relative to others. The winter months of July–September had substantially higher rates, as did the barracouta targeted tows. The rates for red gurnard, snapper, and tarakihi targets were similar. Higher catch rates were likely for days with more hours fished and for larger headline heights.

The vessel influence is evident in the increase in indices during the first decade of the series, after which some vessels with reasonable effort and high catch rates left the area or stopped targeting the species included in the model dataset (Figure D41a). More effort by low catch rate vessels was reported after 2000 and any fluctuations seen were largely due to changes in the effort distribution of high and low catch rate vessels; this was tempered by slight differences in the relative proportions of effort across months (Figure D41a, D41b) when more effort in July-September had a positive effect.

Tarakihi and red gurnard were the main target species throughout the time series and slight adjustments were evident depending on the relative amounts of effort targeted at barracouta (Figure D41c). The fishing duration influence plot (Figure D41d) indicates little influence of this variable but may highlight a difference in reporting duration between CELR and TCER with the distinct differences seen in the daily effort summary by duration and year before and after 2008. There is no such effect in the headline height data, where the CELR headline height is that reported on the form, but the TCER value represents a median for each vessel-trip-day for tows reported on TCERs. Model diagnostics are shown in Figure D42.

8. SUMMARY AND RECOMMENDATIONS

Barracouta occur on the continental shelf mainly in depths of 50–250 m. The current understanding of the distribution of barracouta stocks in New Zealand waters is based on tagging work, research trawl surveys, observer and commercial fisheries data, including length frequency data (Hurst 1988a, Hurst & Bagley 1989, Langley & Bentley 2002, Hurst et al. 2012). For the fish in BAR 1, barracouta from east coast South Island are thought to migrate north to the east coast North Island to spawn, and Langley & Bentley 2002 presented some evidence that the barracouta in the Southland area (on the Stewart-Snares shelf) may be part of this stock as well. However, Hurst et al. (2012), with a longer time series, found that the similarities between strong and weak year classes were not always consistent between the areas and these authors concluded that the current stock boundaries should remain in place.

Collection of length, weight, and gonad data by observers is required at appropriate spatial and temporal scales for the commercial effort by both the smaller and larger vessel fleets. Currently the observer information is limited by the location and timing of fisheries in which barracouta is targeted (or is caught as a bycatch species) by larger trawl vessels in ECSI only. Coverage of the catch by vessels fishing off the east coast of the North Island would provide biological data that could help describe the catch in ECNI and potentially add to the understanding of movement between areas within BAR 1. Any links with the barracoota in BAR 5 could be better informed by a joint analysis of these areas and maximised biological data collection by observers from BAR 5. The Southland trawl survey series in the mid-late 1990s provided a wealth of information on a variety of species, including barracouta, and re-commencement of this survey series could greatly increase understanding of barracouta stock in southern and southeastern waters.

Two sets of standardised CPUE indices were derived for BAR 1: one for the northern waters off the east coast North Island (ECNI) and one for the east coast South Island (ECSI). Each set had three CPUE series defined by form type: a merged CELR/TCER day-level model for 1990 to 2014; a TCER tow-level model for 2008 to 2014; and a TCEPR tow-level model for 1994–2014 (ECNI) or 1990 to 2014 (ECSI). All ECNI series were rejected by the Working Group because of shifts in targeting through time, high inter-annual variability, and unacceptably low levels of data. Three standardised CPUE series for the ECSI part of BAR 1 were prepared, as outlined above, with each series based on the catch of barracouta in bottom trawl fisheries defined by different target species, including barracouta. Two CPUE series were rejected by the SINSWG: the CPUE index based on the TCEPR

data (targeting barracouta, red cod, and arrow squid), primarily because of inter-annual inconsistencies in the underlying catch and effort data; and the short TCER series with only seven years of data.

The SINSWG accepted the combined index (delta lognormal model) series based on the daily data from CELR and TCER forms (targeting barracouta, red cod, and tarakihi) as an index of abundance for BAR 1. After a peak period during 1997 and 1998, there was a period of relatively lower CPUE from 1999 to 2009, followed by an increase up to 2013, to a level similar to the earlier peak. The most recent index (2014) showed a modest drop, but remained above the series mean. The TCER tow-level CPUE series, for which additional explanatory variables were incorporated into the model, was very similar to the CELR/TCER day-level series for the overlapping period (2008 to 2014). The increase in abundance measured by the trawl survey for 2007 onwards follows a similar trajectory to that for the ECSI CELR/TCER indices (see Figure 6).

8.1 Future data and research requirements

The use of TCER data in the ECSI fishery area should provide a more stable set of CPUE data in years to come as the dataset covers a longer time period. At a tow-by-tow level these data should provide a reasonable number of variables for CPUE analysis. However, any CPUE analysis, especially of a bycatch species such as barracouta, is hampered by the lack of data describing fishing strategy, fishing behaviour, and other factors that are not measureable or for which data are not currently collected — as indicated by the importance of *vessel*.

Gaps exist in the data available to increase understanding of the distribution of barracouta, spatially and temporally, as described above. These gaps currently limit any further clarification of the spawning and stock definitions. The ECSI trawl survey in core depths of 30–400 m provides a comparable dataset for the inshore barracouta catch, with surveys run every two years during May-June — at a time when reasonable catches were reported from barracouta effort, and also from red cod and tarakihi effort in some years. Added collection of barracouta biological data during the survey could be useful in further describing this catch. The survey catch covers a wide range of size classes, but there are no otolith data to create a complementary dataset to that used for ageing work based on the Southland (Stewart-Snares shelf) survey data. Consideration should also be given to the re-introduction of the "Southland" trawl survey series. This survey provided valuable information about a large variety of species that frequent depths shallower than 600 m, many of which are caught as bycatch in the main commercial target fisheries.

Improved observer coverage of both the small vessel and larger vessel fleets in both the ECSI and ECNI areas would potentially provide biological information through the collection of length, weight, sex, gonad data, and otoliths. Collection of length and reproductive stage data from fish caught throughout the year in both areas of BAR 1 would be useful, as well as from BAR 5, to enable a combined analysis of BAR 1 and BAR 5.

9. ACKNOWLEDGEMENTS

Thanks to my NIWA colleagues Mike Beentjes and Dan MacGibbon for useful comments and provision of several trawl survey plots. Thanks to Peter Horn and Rosie Hurst (NIWA) and Marc Griffiths (MPI) for helpful discussions and thorough reviews of this work; to Marc Griffiths (MPI), Paul Starr, and Adam Langley for direction in the data compilation; and to Marianne Vignaux (MPI) for final comments and edits. This work was completed under Project BAR201301 with funding from the Ministry for Primary Industries.

10. REFERENCES

Anderson, O.F.; Bagley, N.W.; Hurst, R.J.; Francis, M.P.; Clark, M.R.; McMillan, P.J. (1998). Atlas of New Zealand fish and squid distributions from research bottom trawls. *NIWA Technical Report 2*. 303 p.

Bagley, N.W.; Anderson, O.F.; Hurst, R.J.; Francis, M.P.; Taylor, P.R.; Clark, M.R.; Paul, L.J. (2000). Atlas of New Zealand fish and squid distributions from midwater trawls, tuna longline sets, and aerial sightings. *NIWA Technical Report 72*. 171 p.

Beentjes, M.P. (1995a). Inshore trawl survey of the Canterbury Bight and Pegasus Bay, May–June 1992 (KAH9205). *New Zealand Fisheries Data Report 55*. 58 p.

Beentjes, M.P. (1995b). Inshore trawl survey of the Canterbury Bight and Pegasus Bay, May–June 1993 (KAH9306). *New Zealand Fisheries Data Report 56*. 78 p.

Beentjes, M.P. (1998a). Inshore trawl survey of the Canterbury Bight and Pegasus Bay, May–June 1994 (KAH9406). *NIWA Technical Report 20.* 65 p.

Beentjes, M.P. (1998b). Inshore trawl survey of the Canterbury Bight and Pegasus Bay, May–June 1996 (KAH9606). *NIWA Technical Report 21*. 66 p.

Beentjes, M.P.; Lyon, W.S.; Stevenson, M.L. (2010). Inshore trawl survey of Canterbury Bight and Pegasus Bay, May–June 2009 (KAH0905). *New Zealand Fisheries Assessment Report 2010/29.*102 p.

Beentjes, M.P.; MacGibbon, D.J. (2013). Review of QMS species for inclusion in the east coast South Island winter trawl survey reports. *New Zealand Fisheries Assessment Report 2013/35*. 102 p.

Beentjes, M.P.; MacGibbon, D.J.; Lyon, W.S. (2013). Inshore trawl survey of Canterbury Bight and Pegasus Bay, April–June 2012 (KAH1207). *New Zealand Fisheries Assessment Report 2013/36.*135 p.

Beentjes, M.P.; MacGibbon, D.J.; Lyon, W.S. (2015). Inshore trawl survey of Canterbury Bight and Pegasus Bay, April–June 2014 (KAH1402). *New Zealand Fisheries Assessment Report 2015/14.* 136 p.

Beentjes, M.P.; Stevenson, M.L. (2000). Review of the east coast South Island winter trawl survey time series, 1991–96. *NIWA Technical Report 86*. 64 p.

Beentjes, M.P.; Stevenson, M.L. (2008). Inshore trawl survey of Canterbury Bight and Pegasus Bay, May–June 2007 (KAH0705). *New Zealand Fisheries Assessment Report 2008/38.* 95 p.

Beentjes, M.P.; Stevenson, M.L. (2009). Inshore trawl survey of Canterbury Bight and Pegasus Bay, May–June 2008 (KAH0806). *New Zealand Fisheries Assessment Report 2009/57.*105 p.

Beentjes, M.P.; Wass, R. (1994). Inshore trawl survey of the Canterbury Bight and Pegasus Bay, May–June 1991 (KAH9105). *New Zealand Fisheries Data Report 48*. 49 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.

Blackwell, R.G.; Manning, M.J.; Gilbert, D.J. (2005). Standardised CPUE analysis of the target rig (*Mustelus lenticulatus*) set net fishery in northern New Zealand (SPO 1 and SPO 8). Final Research Report for Ministry of Fisheries Project SPO2004-01, Objective 1. 37 p. (Unpublished report held by Ministry for Primary Industries, Wellington.)

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

Chambers, J.M.; Hastie, T.J. (1991). Statistical models in S. Wadsworth & Brooks-Cole, Pacific Grove, CA. 608 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. (2001). Orange roughy CPUE on the South and East Chatham Rise. *New Zealand Fisheries Assessment Report 2001/26*. 30 p.

Francis, R.I.C.C.; Fu, D. (2012). SurvCalc user manual v.1.2-2011-09-28. NIWA Technical Report No. 134. 54 p.

Harley, S.J.; Horn, P.L.; Hurst, R.J.; Bagley, N.W. (1999). Analysis of commercial catch and effort data and age determination and catch-at-age of barracouta in BAR 5. New Zealand Fisheries Assessment Research Document 99/39. 39 p. (Unpublished report held by NIWA library.)

Horn, P.L. (2002). Age estimation of barracouta (*Thyrsites atun*) off southern New Zealand. *Marine and Freshwater Research 53*: 1169–1178.

Horn, P.; Sutton, C.; Hulston, D.; Marriott, P. (2012). Routine age determination of hoki and middle depth species from commercial fisheries and trawl surveys. Final Research Report completed for MPI under project MID201001A, February 2012. [Unpublished report available from Ministry for Primary Industries.]

Hurst, R.J. (1988a). Barracouta. New Zealand Fisheries Assessment Research Document 88/8. 29 p. (Unpublished report held by NIWA library, Wellington.)

Hurst, R.J. (1988b). The barracouta, *Thyrsites atun*, fishery around New Zealand: historical trends to 1984. *New Zealand Fisheries Technical Report 5*. 43 p.

Hurst, R. J., and Bagley, N. W. (1987). Results of a trawl survey of barracouta and associated finfish near the Chatham Islands, New Zealand, December 1984. New Zealand Fisheries Technical Report No. 3. (Unpublished report held by NIWA library, Wellington.)

Hurst, R.J.; Bagley, N.W. (1989). Movements and possible stock relationships of the New Zealand barracouta, *Thrysites atun*, from tag returns. *New Zealand Journal of Marine and Freshwater Research 23(1)*: 105–111.

Hurst, R.J.; Bagley, N.W.; Anderson, O.F.; Francis, M.P.; Griggs, L.H.; Clark, M.R.; Paul, L.J.; Taylor, P.R. (2000a). Atlas of juvenile and adult fish and squid distributions from bottom and midwater trawl and tuna longlines in New Zealand waters. *NIWA Technical Report 84*. 167 p.

Hurst, R.J.; Ballara, S.L.; MacGibbon, D. (2012). Fishery characterisation and standardised CPUE analyse for barracouta, *Thyrsites atun* (Euphrasen, 1791) (Gempylidae), 1989–90 to 2007–08. *New Zealand Fisheries Assessment Report 2012/13*. 303 p.

Hurst, R.J.; Stevenson, M.L.; Bagley, N.W.; Griggs, L.H.; Morrison, M.A.; Francis, M.P. (2000b). Areas of importance for spawning, pupping or egg-laying, and juveniles of New Zealand coastal fish. Final Research Report for MPI project ENV1999-03. (Unpublished report held by Ministry for Primary Industries, Wellington.)

Langley, A.D. (2014). Updated CPUE analyses for selected South Island inshore finfish stocks. *New Zealand Fisheries Assessment Report 2014/40*. 120 p.

Langley, A.; Bentley, N. (2002). An examination of the stock structure of barracouta (*Thyrsites atun*) around the South Island of New Zealand. *New Zealand Fisheries Assessment Report 2001/*30. 57 p.

Langley A.D.; Walker, N. (2002a). CPUE analysis of the southeast South Island BAR 1 fishery, 1989–90 to 1999–2000. *New Zealand Fisheries Assessment Report 2002/11*. 28 p.

Langley, A.D.; Walker, N. (2002b). Characterisation of the barracouta (*Thyrsites atun*) fishery in BAR 1. *New Zealand Fisheries Assessment Report 2002/44*. 37 p.

Manning, M.J.; Hanchet, S.M.; Stevenson, M.L. (2004). A description and analysis of New Zealand's spiny dogfish (*Squalus acanthias*) fisheries and recommendations on appropriate methods to monitor the status of the stocks. *New Zealand Fisheries Assessment Report 2004/61*. 135 p.

Ministry for Primary Industries (2013). Annual review of Inshore Finfish Fisheries 2011/12. *MPI Technical Paper No. 2013/04*. 56 p.

Ministry for Primary Industries (2015). Fisheries Assessment Plenary, May 2015: stock assessments and stock status. Compiled by the Fisheries Science Group, Ministry for Primary Industries, Wellington, New Zealand. 1477 p.

Ministry of Fisheries (2011). Draft National Fisheries Plan for Inshore Finfish. Available online at: http://www.fish.govt.nz/NR/rdonlyres/2B56203E-052E-4D04-9236-D625AFBDD6D2/0/InshoreFinfishDraftNationalPlan2011.pdf. 61 p.

Phillips, N.L. (2001). Analysis of silver warehou (*Seriolella punctata*) catch-per-unit-effort (CPUE) data. *New Zealand Fisheries Assessment Report 2001/73*. 48 p.

R Development Core Team (2011). R: A language and environment for statistical computing. R Foundation for Statistical Computing. Vienna. http://www.R–project.org.

SeaFIC (Seafood Industry Council) (2007). Silver warehou: SWA 1 Adaptive Management Programme Full-term Review Report. AMPWG-2007/22. (Unpublished report held by the Ministry for Primary Industries, Wellington).

Starr, P.J. (2007). Procedure for merging MFish landing and effort data, V2.0. Working Group Document AMPWG/07/04. (Unpublished report held by Ministry for Primary Industries, Wellington).

Stevens, D.W.; Hurst, R.J.; Bagley, N.W. (2011). Feeding habits of New Zealand fishes: a literature review and summary of research trawl database records 1960 to 2000. *New Zealand Aquatic Environment and Biodiversity Report No. 85*. 136 p.

APPENDIX A: RELEVANT TRAWL SURVEY DATA SUMMARIES

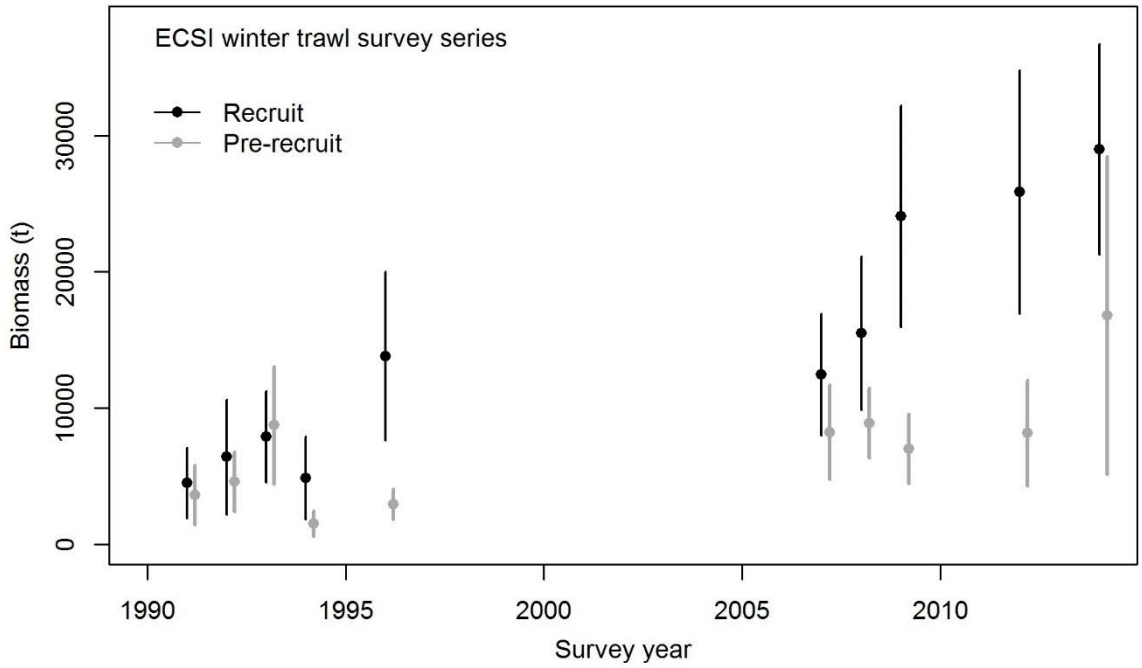


Figure A1: Barracouta pre-recruit and recruited biomass estimates and associated confidence intervals from the ECSI winter trawl survey core strata (30–400 m). Recruited fish were defined as fish over 60 cm fork length.

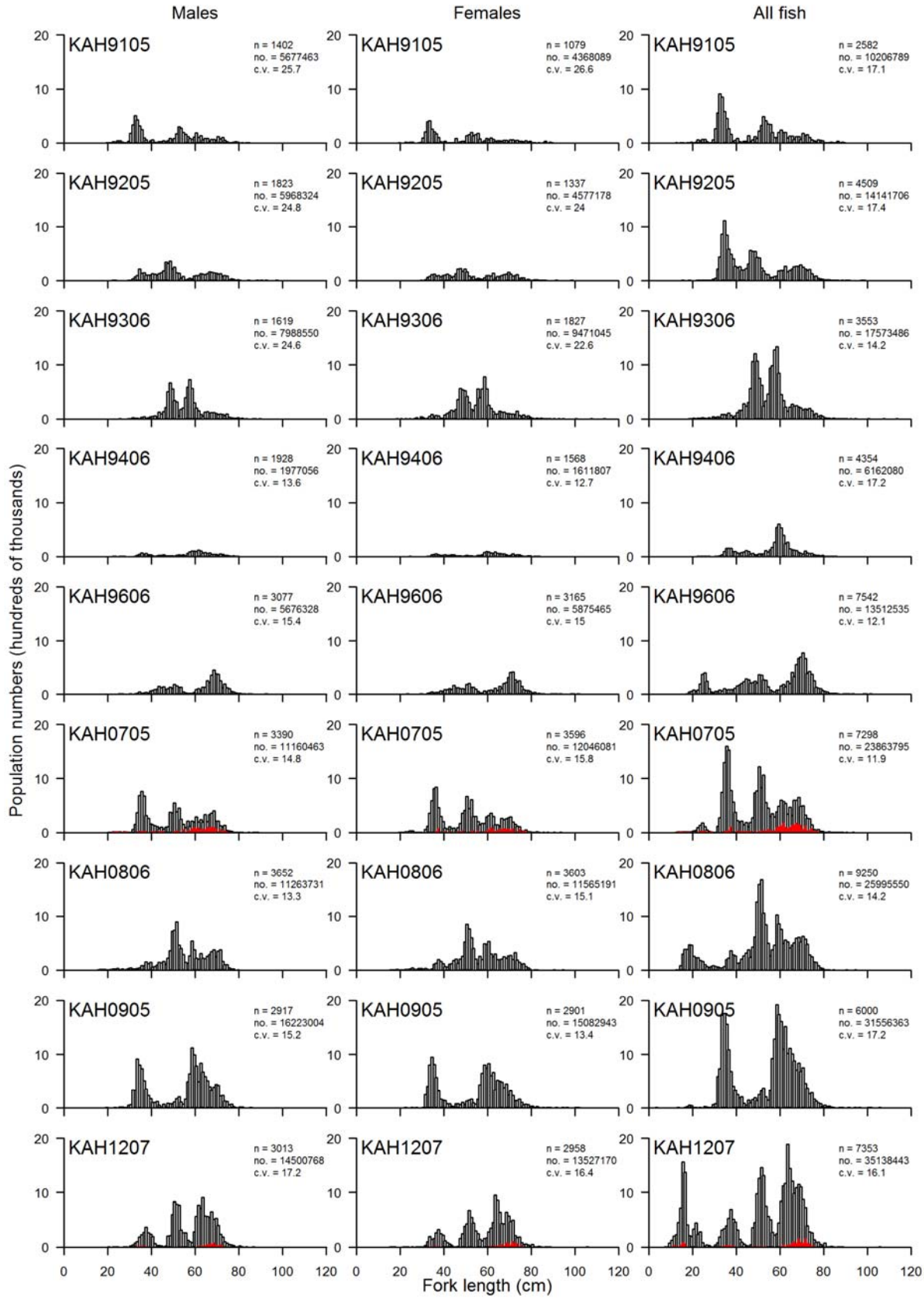


Figure A2: Scaled length frequency distributions for barracouta in core strata (30–400 m) for the ECSI winter surveys listed in Table 3, except for KAH1402. Where possible, data from the 10–30 m stratum were also included and are shown in red for 2007 and 2012. n, number of fish measured; no., core strata population estimates; c.v., coefficient of variation. This plot is from figure 4 from Beentjes & MacGibbon (2013) (see continuation on next page for KAH1402).

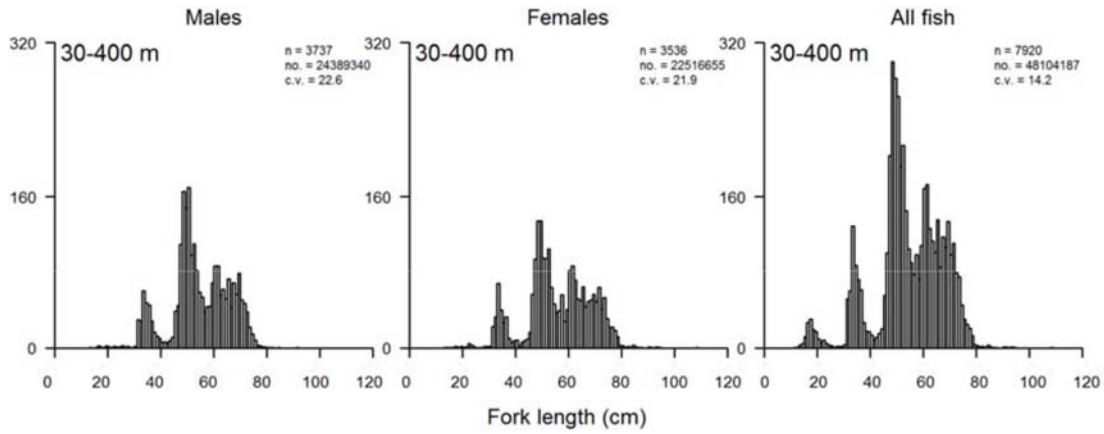


Figure A2: *continued.* Scaled length frequency distributions showing population numbers (tens of thousands) of barracouta in core strata (30–400 m) for the KAH1402 ECSI winter survey (from Beentjes et al. 2015).

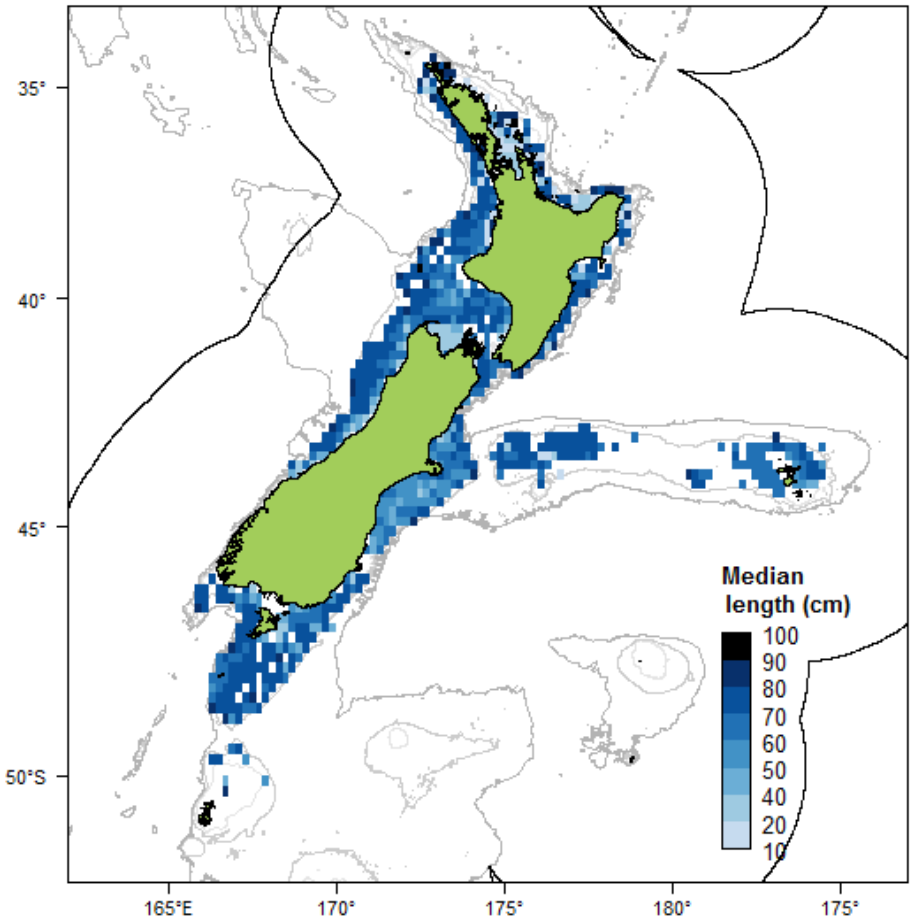


Figure A3: Distribution of median lengths of all barracouta measured during trawl surveys (*n* = 641 594 fish).

APPENDIX B: OBSERVER DATA SUMMARIES FOR BAR 1, 1990–2014

Table B1: Number of observed trips and observed tows in BAR 1 (ECNI and ECSI), including the number where barracouta catch was observed and sampled for barracouta length and sex, for fishing years 1990–2014.

(a) BAR 1 ECNI

Fishing year	Total observed trips	Trips with BAR	Total observed tows	Tows with BAR	Observed BAR catch (t)	Trips with LF data	Tows with LF data	Total BAR sampled	No. females sampled
1990	8	3	120	4	0.3	0	–	–	–
1991	8	0	401	0	<0.1	0	–	–	–
1992	4	1	148	4	<0.1	0	–	–	–
1993	7	1	142	1	<0.1	0	–	–	–
1994	17	2	317	6	<0.1	0	–	–	–
1995	12	1	451	1	<0.1	0	–	–	–
1996	19	2	495	2	<0.1	0	–	–	–
1997	12	0	343	0	<0.1	0	–	–	–
1998	20	8	501	36	4.5	1	1	20	15
1999	30	9	1 016	59	12.3	1	1	1	1
2000	27	7	1 048	44	2.8	1	1	1	1
2001	20	7	537	51	2.2	3	8	94	56
2002	19	4	608	7	<0.1	0	–	–	–
2003	18	6	495	35	1.4	0	–	–	–
2004	16	3	312	10	<0.1	0	–	–	–
2005	20	5	287	42	5.6	2	9	47	23
2006	15	4	453	18	3.0	1	1	1	0
2007	26	8	736	65	1.1	2	3	30	18
2008	23	6	913	33	0.6	2	4	24	16
2009	20	6	741	29	0.5	1	2	27	14
2010	24	7	754	36	2.7	0	–	–	–
2011	30	4	1 167	13	<0.1	0	–	–	–
2012	17	7	691	55	2.1	0	–	–	–
2013	12	5	239	44	2.5	0	–	–	–
2014	38	28	1 556	423	33.7	1	4	260	0
All	456	40	14 471	1 018	75.9	15	34	505	143

(b) BAR 1 ECSI

Fishing year	Total observed trips	Trips with BAR	Total observed tows	Tows with BAR	Observed BAR catch (t)	Trips with LF data	Tows with LF data	Total BAR sampled	No. females
1990	18	10	562	77	365.6	0	–	–	–
1991	17	9	830	164	282.2	1	1	77	51
1992	20	10	351	48	35.7	1	1	102	53
1993	18	8	384	194	236.8	3	14	497	235
1994	33	11	980	254	170.2	2	12	214	114
1995	23	6	459	71	198.6	1	7	757	364
1996	24	8	924	80	53.2	2	5	24	13
1997	25	9	452	50	163.1	2	3	326	161
1998	34	13	1 177	52	65.3	1	2	22	12
1999	47	16	1 042	180	518.1	5	19	1 101	534
2000	90	13	1 941	145	402.7	5	22	1 067	583
2001	137	33	2 759	325	1 027.0	15	71	3 818	1 700
2002	111	12	2 409	162	564.6	6	33	1 639	810
2003	102	21	1 616	143	338.8	10	33	1 311	679
2004	56	12	1 230	41	56.0	4	8	173	91
2005	48	12	940	63	24.2	3	18	184	83
2006	27	12	762	88	337.8	7	19	1 480	807
2007	37	23	693	109	558.3	4	14	1 298	669
2008	37	15	818	125	1 357.0	3	38	3 346	1 793
2009	56	17	1 649	44	305.3	6	11	974	416
2010	44	15	1 329	173	2 232.8	6	44	3 286	1 811
2011	41	27	973	219	1 386.8	12	53	3 610	1 775
2012	57	31	895	224	2 015.8	17	95	6 348	3 238
2013	92	63	1 843	646	4 008.4	28	217	12 060	5 705
2014	96	73	1 691	867	6 340.7	44	238	15 961	7 870
All	1 244	470	28 709	4 544	23 044.9	186	978	59 675	29 567

Table B2: Number of observed tows and the number of observed tows with barracouta catch, by main target species for 1990 to 2014, for BAR 1 ECNI and ECSI. BAR, barracouta; BYX, alfonsino; CDL, cardinal fish; HOK, hoki; JDO, John dory; JMA, jack mackerel species; LIN, ling; OEO, oreo species; ORH, orange roughy; RBT, redbait; RBY, rubyfish; SCI, scampi; SKI. gemfish; SNA, snapper; SQU, arrow squid species; SWA, silver warehou; TAR, tarakihi, TRE, trevally. [Scientific names of target species are given in Table C10.]

(a) BAR 1 ECNI

All observed tows

Fishing year	BYX	CDL	HOK	JDO	ORH	RBY	SCI	SKI	SNA	TAR	TRE	Other	All
1990	0	0	6	0	91	0	0	4	0	0	0	19	101
1991	1	0	0	0	44	0	350	0	0	0	0	6	395
1992	0	0	0	0	0	0	147	0	0	0	0	1	147
1993	0	0	14	0	21	0	107	0	0	0	0	0	142
1994	0	10	39	0	69	0	199	0	0	0	0	0	317
1995	3	8	0	0	188	1	196	55	0	0	0	0	451
1996	0	109	46	0	187	0	149	0	0	0	0	4	491
1997	1	4	6	0	225	2	95	3	0	0	0	7	336
1998	0	0	269	0	149	1	59	20	0	0	0	3	498
1999	9	11	297	0	230	3	363	82	0	7	6	8	1 008
2000	32	69	177	0	463	0	253	37	0	10	0	7	1 041
2001	6	6	281	0	21	6	146	29	0	41	0	1	536
2002	8	25	146	0	126	0	299	0	0	1	1	2	606
2003	1	80	154	0	199	0	32	15	0	1	0	13	482
2004	40	64	132	1	68	0	5	0	0	0	1	1	311
2005	20	9	141	0	33	0	66	0	0	13	0	5	282
2006	88	35	66	0	126	1	114	0	4	14	0	5	448
2007	21	45	227	62	178	2	136	0	8	21	29	7	729
2008	33	145	203	0	234	3	247	0	24	7	13	4	909
2009	46	43	172	0	90	25	130	0	21	0	0	214	527
2010	96	17	321	0	89	0	150	0	0	0	0	81	673
2011	128	89	92	0	195	18	213	0	5	24	0	403	764
2012	24	26	193	2	98	45	239	1	23	20	14	6	685
2013	0	5	182	0	19	0	16	1	16	0	0	0	239
2014	1	2	254	201	21	14	106	5	332	303	189	128	1 428
All	558	802	3 418	266	3 164	121	3 817	252	433	462	253	925	13 546

ECNI observed tows with barracouta

Fishing year	BYX	CDL	HOK	JDO	ORH	RBY	SCI	SKI	SNA	TAR	TRE	Other	All
1990	–	–	0	–	1	–	–	1	–	–	–	2	4
1991	0	–	–	–	0	–	0	–	–	–	–	0	0
1992	–	–	–	–	–	–	4	–	–	–	–	0	4
1993	–	–	0	–	0	–	1	–	–	–	–	–	1
1994	–	0	6	–	0	–	0	–	–	–	–	–	6
1995	0	0	–	–	0	0	1	0	–	–	–	–	1
1996	–	0	0	–	0	–	2	–	–	–	–	0	2
1997	0	0	0	–	0	0	0	0	–	–	–	0	0
1998	–	0	28	–	0	0	1	7	–	–	–	0	36
1999	0	0	18	–	0	0	0	31	–	5	4	1	59
2000	0	0	15	–	0	–	2	14	–	9	–	4	44
2001	0	0	8	–	0	1	0	8	–	34	–	0	51
2002	0	0	3	–	0	–	2	–	–	1	1	0	7
2003	0	0	22	–	0	–	0	12	–	0	–	1	35
2004	0	0	7	1	0	–	0	–	–	–	1	1	10
2005	0	0	27	–	0	–	0	–	–	11	–	4	42
2006	5	0	0	–	0	0	0	–	2	11	–	0	18
2007	0	0	41	10	0	0	0	–	2	7	5	0	65
2008	0	0	16	–	0	0	0	–	9	4	3	1	33
2009	0	0	16	–	0	0	2	–	11	–	–	0	29
2010	1	0	33	–	0	–	2	–	–	–	–	0	36
2011	2	0	2	–	2	0	0	–	4	1	–	2	13
2012	0	0	34	0	0	0	2	0	7	9	3	0	55
2013	–	0	38	–	0	–	0	0	6	–	–	–	44
2014	0	0	28	91	0	3	0	0	69	150	55	27	423
All	8	0	342	102	3	4	19	73	110	242	72	43	1 018

(b) BAR 1 ECSI

All observed tows

Fishing year	BAR	HOK	JMA	LIN	OEO	ORH	RBT	SCI	SQU	SWA	Other	All
1990	44	302	0	7	85	55	0	0	0	27	42	562
1991	82	277	2	133	253	31	0	3	0	14	35	830
1992	25	259	0	1	17	7	0	8	7	15	12	351
1993	38	108	161	0	0	1	0	1	30	13	32	384
1994	0	361	39	0	47	129	0	133	267	4	0	980
1995	41	217	5	0	123	4	0	60	3	6	0	459
1996	0	691	94	0	53	28	0	46	12	0	0	924
1997	36	268	5	0	80	53	0	0	7	1	2	452
1998	11	993	15	0	104	19	0	29	6	0	0	1 177
1999	41	755	24	0	59	35	0	51	72	1	4	1 042
2000	60	1 291	11	0	488	32	0	21	23	2	13	1 941
2001	65	1 842	36	0	474	63	0	18	232	12	17	2 759
2002	27	1 793	68	0	314	29	0	83	64	11	20	2 409
2003	20	1 305	32	0	89	5	0	72	78	12	3	1 616
2004	7	1 009	0	0	105	0	0	64	34	7	4	1 230
2005	5	754	4	0	88	2	0	0	68	8	11	940
2006	17	548	56	1	81	4	0	0	16	35	4	762
2007	37	397	16	0	140	0	0	0	38	26	39	693
2008	93	543	15	2	118	4	0	5	2	17	19	818
2009	22	508	4	16	196	17	0	1	9	71	805	1 649
2010	102	589	14	13	110	3	0	0	5	43	450	1 329
2011	64	572	23	4	112	23	0	1	63	104	7	973
2012	146	382	52	1	56	0	3	0	18	31	206	895
2013	291	895	209	12	46	15	23	0	48	149	155	1 843
2014	353	602	263	7	61	0	81	0	70	205	49	1 691
All	1627	17 261	1 148	197	3 299	559	107	596	1 172	814	1 929	28 709

ECSI observed tows with barracouta

Fishing year	BAR	HOK	JMA	LIN	OEO	ORH	RBT	SCI	SQU	SWA	Other	All
1990	43	13	–	0	0	0	–	–	–	13	8	77
1991	73	46	2	5	1	0	–	0	–	7	30	164
1992	23	7	0	0	0	0	–	0	1	7	10	48
1993	37	2	96	0	0	0	–	0	26	6	27	194
1994	–	10	30	–	0	0	–	0	213	1	0	254
1995	39	23	2	–	0	0	–	0	3	4	0	71
1996	–	11	58	–	0	0	–	0	11	0	–	80
1997	36	1	5	–	0	0	–	0	6	0	2	50
1998	9	22	15	–	0	0	–	0	6	0	–	52
1999	39	59	17	–	0	0	–	0	63	0	2	180
2000	60	47	11	–	0	0	–	0	15	0	12	145
2001	64	19	36	–	0	0	–	0	190	2	14	325
2002	27	2	58	–	0	0	–	0	57	5	13	162
2003	18	30	31	–	0	0	–	0	55	9	–	143
2004	7	5	0	–	0	–	–	–	24	1	4	41
2005	4	5	2	–	0	0	–	–	50	2	–	63
2006	17	9	49	0	0	0	–	–	10	2	1	88
2007	36	3	13	–	0	–	–	–	22	8	27	109
2008	90	8	10	0	0	0	–	0	1	4	12	125
2009	21	6	4	0	0	0	–	0	8	5	–	44
2010	101	27	10	0	0	0	–	–	2	24	9	173
2011	63	12	23	1	0	0	–	0	55	65	–	219
2012	143	9	39	0	0	–	0	–	17	14	2	224
2013	283	28	188	0	0	0	9	–	43	94	1	646
2014	350	18	244	0	0	–	68	–	60	115	12	867
All	1 583	422	943	6	1	0	77	0	938	338	186	4 544

Table B3: Total observed barracouta catch, by main target species and month, for BAR 1 subareas ECNI and ECSI, for the fishing years 1990 to 2014 combined. BAR, barracouta; BYX, alfonsino; HOK, hoki; JDO, John dory; JMA, jack mackerel species; LIN, ling; ORH, orange roughy; RBT, redbait; RBY, rubyfish; SCI, scampi; SKI, gemfish; SNA, snapper; SQU, arrow squid species; SWA, silver warehou; TAR, tarakihi; TRE, trevally. [Scientific names of target species are given in Table C10.]

(a) BAR 1 ECNI – catches in table in kilograms. For observed tows with barracouta, catch weight per tow ranged from 1 kg to 8988 kg (median of 10 kg, mean of 74.5 kg, 1st quartile of 3 kg, 3rd quartile of 35 kg).

Target species	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total catch (kg)
BYX	0	48	0	0	0	–	0	0	0	0	3	–	51
HOK	0	716	3 339	2 239	414	0	10	2 164	631	409	602	3 819	14 343
JDO	15	–	2 962	247	634	4	186	2	–	–	–	–	4 050
ORH	0	0	0	0	0	2	0	0	20	0	0	0	22
RBY	30	0	0	0	0	0	5	–	35	0	0	0	70
SCI	5	9	9	0	0	2	0	0	64	7	2	6	104
SKI	378	7003	781	66	1 735	0	735	45	0	–	0	–	10 743
SNA	361	5	524	43	55	0	78	973	666	975	88	274	4 042
TAR	1 801	0	16	974	2 542	139	1 405	2 698	990	2 985	3 576	1 049	18 175
TRE	–	–	76	147	929	65	51	24	267	–	8	30	1 597
Other*	60	0	2 649	1 176	682	250	519	1 107	0	50	10 699	5 456	22 648
Total catch (kg)	2 650	7 781	10 356	4 892	6 991	462	2 989	7 013	2 673	4 426	14 978	10 634	75 845

* The observed catches in August and September were from observed tows that targeted silver warehou in 2014.

(b) BAR 1 ECSI – catches in table in tonnes. For observed tows with barracouta, catch weight per tow ranged from 1 kg to 65 000 kg (median of 1000 kg, mean of 5072 kg, 1st quartile of 67 kg, 3rd quartile of 6329 kg).

Target species	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total catch (t)
BAR	3 474.7	109.3	98.3	333.3	4 891.0	3 071.5	1 277.2	287.1	827.7	874.7	883.1	1 251.3	17 379.2
HOK	2.8	0.8	11.7	6.0	6.3	3.9	12.4	44.6	5.0	0.0	0.2	18.1	111.9
JMA	129.1	2.7	6.6	21.3	1 050.0	1 145.1	1 120.0	120.9	14.0	NA	18.6	24.8	3 653.1
LIN	1.1	0.0	0.2	0.1	–	–	–	–	–	–	–	0.01	1.4
RBT	108.7	–	–	–	1.0	–	0.2	–	–	–	–	–	109.9
SQU	–	1.6	5.4	130.6	401.5	114.1	192.4	134.9	16.6	0	0	0.4	997.6
SWA	460.7	58.1	87.3	15.5	9.3	9.2	3.3	0.2	0.2	0	17.9	10.2	671.8
Other	19.0	4.2	32.7	5.8	8.7	5.3	23.3	1.9	0.0	2.3	6.8	10.1	120.1
Total catch (t)	4 196.0	176.7	242.2	512.7	6 367.9	4 349.1	2 628.7	589.6	863.5	877.0	926.7	1 314.9	23 044.9

Table B4: Number of observer tows sampled for length and sex measurements by month for each fishing year, for BAR 1 ECNI (1998–2014) and ECSI (1991–2014).
Note: no sampling occurred in ECNI for fishing years 1990–97 and 2011–13 or in ECSI in 1990.

(a) BAR 1 ECNI

Fishing year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1998	0	0	1	0	0	0	0	0	0	0	0	0	1
1999	0	0	0	0	0	0	0	0	0	0	0	0	1
2000	0	0	0	0	0	0	0	0	0	0	1	0	1
2001	5	0	0	0	0	0	0	0	0	0	1	2	8
2002	0	0	0	0	0	0	0	0	0	0	0	0	3
2003	0	0	0	0	0	0	0	0	0	0	0	0	7
2004	0	0	0	0	0	0	0	0	0	0	0	0	1
2005	0	0	0	0	0	0	0	0	0	0	1	0	1
2006	0	0	0	0	0	0	0	0	0	0	1	0	1
2007	0	0	2	0	0	0	0	0	0	0	1	0	3
2008	0	0	0	0	0	0	0	0	0	0	1	3	4
2009	0	0	0	0	0	0	0	0	0	2	0	0	2
2010	0	0	0	0	0	0	0	0	0	–	–	0	10
2014	0	0	0	0	0	0	0	0	0	0	3	1	4
Total	5	0	3	0	0	0	0	0	0	2	9	15	34

(b) BAR 1 ECSI

Fishing year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1991	0	0	1	0	0	0	0	0	0	0	0	0	1
1992	0	0	0	0	0	0	0	0	0	1	0	0	1
1993	0	0	0	0	0	0	9	0	0	5	0	0	14
1994	0	0	0	0	0	0	4	8	0	0	0	0	12
1995	0	0	0	0	0	0	7	0	0	0	0	0	7
1996	0	0	4	0	0	0	0	1	0	0	0	0	5
1997	0	0	0	0	0	0	1	2	0	0	0	0	3
1998	0	2	0	0	0	0	0	0	0	0	0	0	2
1999	0	0	6	1	0	1	11	0	0	0	0	0	19
2000	0	0	0	4	0	12	0	6	0	0	0	0	22
2001	8	0	0	0	39	13	7	3	0	0	0	1	71
2002	9	0	0	0	0	3	19	2	0	0	0	0	33
2003	0	0	0	1	0	2	18	6	0	0	0	6	33
2004	1	0	0	0	1	1	5	0	0	0	0	0	8
2005	0	0	0	0	0	0	0	15	1	0	1	1	18
2006	0	0	0	0	0	6	0	3	0	0	9	1	19
2007	1	0	1	0	0	0	2	0	4	6	0	0	14
2008	0	0	0	0	0	0	0	0	3	10	11	14	38
2009	0	0	0	0	0	6	3	0	0	0	1	1	11
2010	6	1	0	0	14	21	2	0	0	0	0	0	44
2011	5	2	5	0	30	0	10	0	1	0	0	0	53
2012	10	0	0	0	10	13	23	10	15	6	2	6	95
2013	36	5	2	0	89	49	27	0	4	3	0	2	217
2014	71	2	4	14	74	55	5	7	2	0	0	4	238
Total	147	12	23	20	257	182	153	63	30	31	24	36	978

Table B5: Number of barracouta sampled for length and sex measurements by month for each fishing year, for BAR 1 ECNI (1998–2014) and ECSI (1991–2014).
Note no sampling occurred in ECNI for fishing years 1990–97 and 2011–13 or in ECSI in 1990.

(a) BAR 1 ECNI

Fishing year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1998	0	0	20	0	0	0	0	0	0	0	0	0	20
1999	0	0	0	0	0	0	0	0	0	0	0	1	1
2000	0	0	0	0	0	0	0	0	0	0	1	0	1
2001	84	0	0	0	0	0	0	0	0	0	1	9	94
2002	–	–	–	–	–	–	–	–	–	–	–	–	–
2003	–	–	–	–	–	–	–	–	–	–	–	–	–
2004	–	–	–	–	–	–	–	–	–	–	–	–	–
2005	0	0	0	0	0	0	0	0	0	0	2	45	47
2006	0	0	0	0	0	0	0	0	0	0	1	0	1
2007	0	0	10	0	0	0	0	0	0	0	20	0	30
2008	0	0	0	0	0	0	0	0	0	0	20	4	24
2009	0	0	0	0	0	0	0	0	0	27	0	0	27
2010	–	–	–	–	–	–	–	–	–	–	–	–	–
2014	0	0	0	0	0	0	0	0	0	0	180	80	260
Total	84	0	30	0	0	0	0	0	0	27	225	139	505

(b) BAR 1 ECSI

Fishing year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1991	0	0	77	0	0	0	0	0	0	0	0	0	77
1992	0	0	0	0	0	0	0	0	0	102	0	0	102
1993	0	0	0	0	0	0	44	0	0	453	0	0	497
1994	0	0	0	0	0	0	104	110	0	0	0	0	214
1995	0	0	0	0	0	0	757	0	0	0	0	0	757
1996	0	0	22	0	0	0	0	2	0	0	0	0	24
1997	0	0	0	0	0	0	110	216	0	0	0	0	326
1998	0	22	0	0	0	0	0	0	0	0	0	0	22
1999	0	0	28	1	0	27	1045	0	0	0	0	0	1 101
2000	0	0	0	172	0	547	0	348	0	0	0	0	1 067
2001	832	0	0	0	1 956	530	188	305	0	0	0	7	3 818
2002	929	0	0	0	0	135	402	173	0	0	0	0	1 639
2003	0	0	0	98	0	132	795	52	0	0	0	234	1 311
2004	10	0	0	0	8	5	150	0	0	0	0	0	173
2005	0	0	0	0	0	0	0	180	2	0	1	1	184
2006	0	0	0	0	0	315	0	206	0	0	869	90	1 480
2007	100	0	10	0	0	0	191	0	416	581	0	0	1 298
2008	0	0	0	0	0	0	0	0	250	819	977	1 300	3 346
2009	0	0	0	0	0	480	285	0	0	0	110	99	974
2010	386	20	0	0	1 098	1 604	178	0	0	0	0	0	3 286
2011	440	203	132	0	2 073	0	670	0	92	0	0	0	3 610
2012	747	0	0	0	834	783	815	776	1 323	448	161	461	6 348
2013	2 614	320	105	0	4 592	2 670	1 220	0	320	59	0	160	12 060
2014	5 013	90	209	1 017	4 675	3 829	300	320	160	0	0	348	15 961
Total	11 071	655	583	1 288	15 236	11 057	7 254	2 688	2 563	2 462	2 118	2 700	59 675

Table B6: Total numbers of sampled barracouta and percentage of sampled barracouta that were females, by month for each fishing year, 1991–2014, for BAR 1 ECSI. Note there were no observer data for the 1990 fishing year.

Fishing year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total fish	All
1991	–	–	66.2	–	–	–	–	–	–	–	–	–	77	66.2
1992	–	–	–	–	–	–	–	–	–	52.0	–	–	102	52.0
1993	–	–	–	–	–	–	36.4	–	–	48.3	–	–	497	47.3
1994	–	–	–	–	–	–	59.6	47.3	–	–	–	–	214	53.3
1995	–	–	–	–	–	–	48.1	–	–	–	–	–	757	48.1
1996	–	–	50.0	–	–	–		100.0	–	–	–	–	24	54.2
1997	–	–	–	–	–	–	51.8	48.1	–	–	–	–	326	49.4
1998	–	54.5	–	–	–	–		–	–	–	–	–	22	54.5
1999	–	–	25.0	0.0	–	51.9	49.1	–	–	–	–	–	1 101	48.5
2000	–	–	–	59.3	–	51.2		57.8	–	–	–	–	1 067	54.6
2001	18.3	–	–	–	53.4	51.3	61.2	38.0	–	–	–	14.3	3 818	44.5
2002	46.7	–	–	–	–	51.1	55.2	49.1	–	–	–	–	1 639	49.4
2003		–	–	58.2	–	31.1	52.6	73.1	–	–	–	53.4	1 311	51.8
2004	70.0	–	–	–	37.5	20.0	53.3	–	–	–	–	–	173	52.6
2005	–	–	–	–	–	–	–	45.0	50.0	–	0.0	100.0	184	45.1
2006	–	–	–	–	–	51.7	–	52.9	–	–	56.7	46.7	1 480	54.5
2007	50.0	–	40.0	–	–	–	44.0	–	54.6	52.3	–	–	1 298	51.5
2008	–	–	–	–	–	–		–	37.6	53.6	56.8	54.2	3 346	53.6
2009	–	–	–	–	–	46.9	44.9	–	–	–	18.2	43.4	974	42.7
2010	35.2	25.0	–	–	61.1	55.0	65.2	–	–	–	–	–	3 286	55.1
2011	54.1	27.6	59.8	–	48.6	–	50.7	–	58.7	–	–	–	3 610	49.2
2012	38.8	–	–	–	57.1	52.1	50.9	56.7	55.0	43.1	49.7	45.1	6 348	51.0
2013	40.9	35.6	52.4	–	50.4	50.4	46.1	–	49.7	0.0	–	53.1	12 060	47.3
2014	50.3	48.9	30.1	60.3	51.4	45.8	53.3	41.9	33.1	–	–	34.8	15 961	49.3
Total	44.3	35.3	46.3	59.9	52.0	49.3	50.4	50.7	51.3	49.1	54.2	49.3	59 675	49.5

Table B7: Number of female barracouta that were staged, by month for each fishing year, 1991–2014, for BAR 1 ECSI

Fishing year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1991	0	0	51	0	0	0	0	0	0	0	0	0	51
1992	0	0	0	0	0	0	0	0	0	53	0	0	53
1993	0	0	0	0	0	0	16	0	0	219	0	0	235
1994	0	0	0	0	0	0	62	52	0	0	0	0	114
1995	0	0	0	0	0	0	364	0	0	0	0	0	364
1996	0	0	11	0	0	0	0	2	0	0	0	0	13
1997	0	0	0	0	0	0	57	104	0	0	0	0	161
1998	0	12	0	0	0	0	0	0	0	0	0	0	12
1999	0	0	7	0	0	14	513	0	0	0	0	0	534
2000	0	0	0	102	0	279	0	201	0	0	0	0	582
2001	152	0	0	0	1 044	272	115	116	0	0	0	1	1 700
2002	434	0	0	0	0	69	221	85	0	0	0	0	809
2003	0	0	0	57	0	41	418	38	0	0	0	125	679
2004	7	0	0	0	3	1	80	0	0	0	0	0	91
2005	0	0	0	0	0	0	0	81	1	0	0	1	83
2006	0	0	0	0	0	163	0	109	0	0	493	42	807
2007	50	0	4	0	0	0	84	0	227	242	0	0	607
2008	0	0	0	0	0	0	0	0	94	437	555	705	1 791
2009	0	0	0	0	0	225	128	0	0	0	20	43	416
2010	136	5	0	0	671	883	116	0	0	0	0	0	1 811
2011	238	56	79	0	1 008	0	340	0	54	0	0	0	1 775
2012	290	0	0	0	476	408	415	440	685	193	80	208	3 195
2013	1 068	114	55	0	2 316	1 345	563	0	159	0	0	85	5 705
2014	2 524	44	63	613	2 405	1 753	160	134	53	0	0	121	7 870
Total	4 899	231	270	772	7 923	5 453	3 652	1 362	1 273	1 144	1 148	1 331	29 458

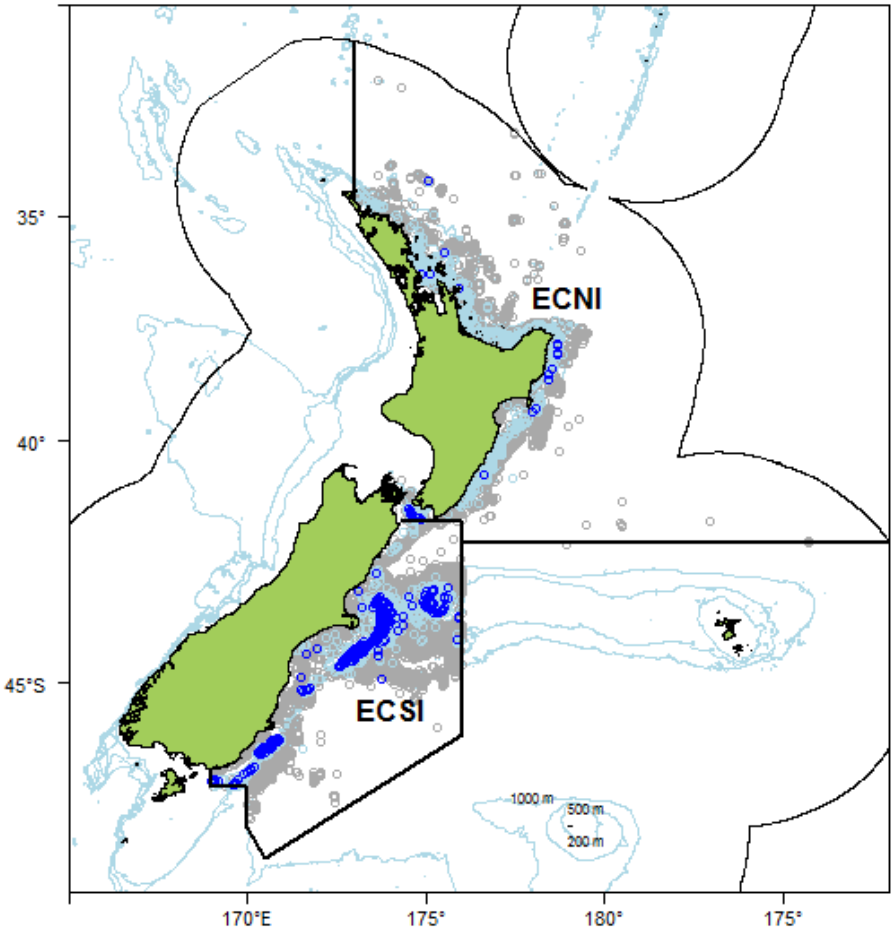
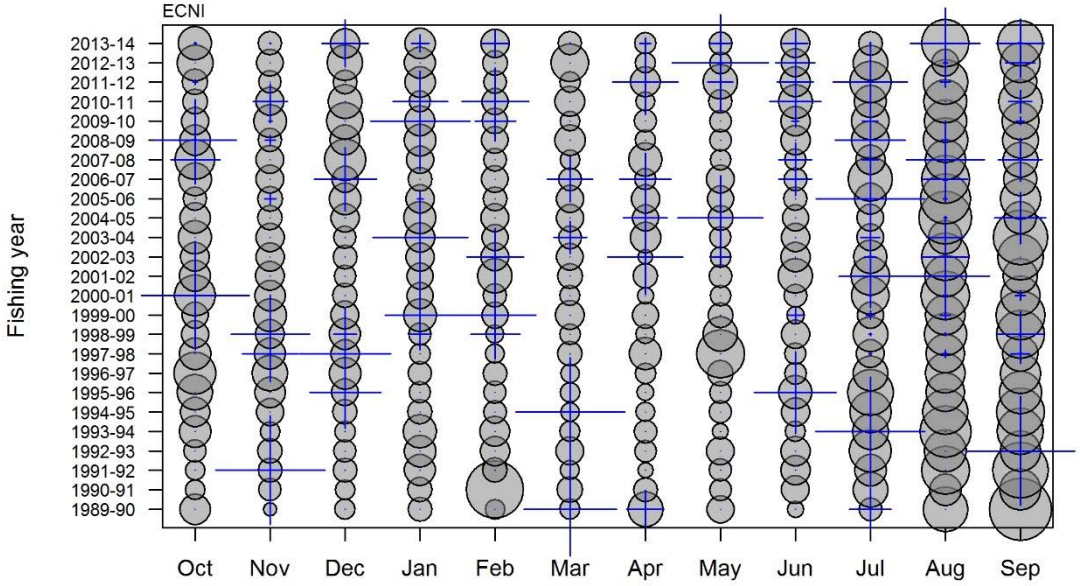


Figure B1: Distribution of observed tows, where grey circles represent observed tows in the ECNI and ECSI subareas of BAR 1, light blue circles indicate observed tows with barracouta catch, and blue circles are observed tows for which the barracouta catch was sampled for length and sex data, for fishing years 1991–2014.

a. BAR 1 ECNI



b. BAR 1 ECSI

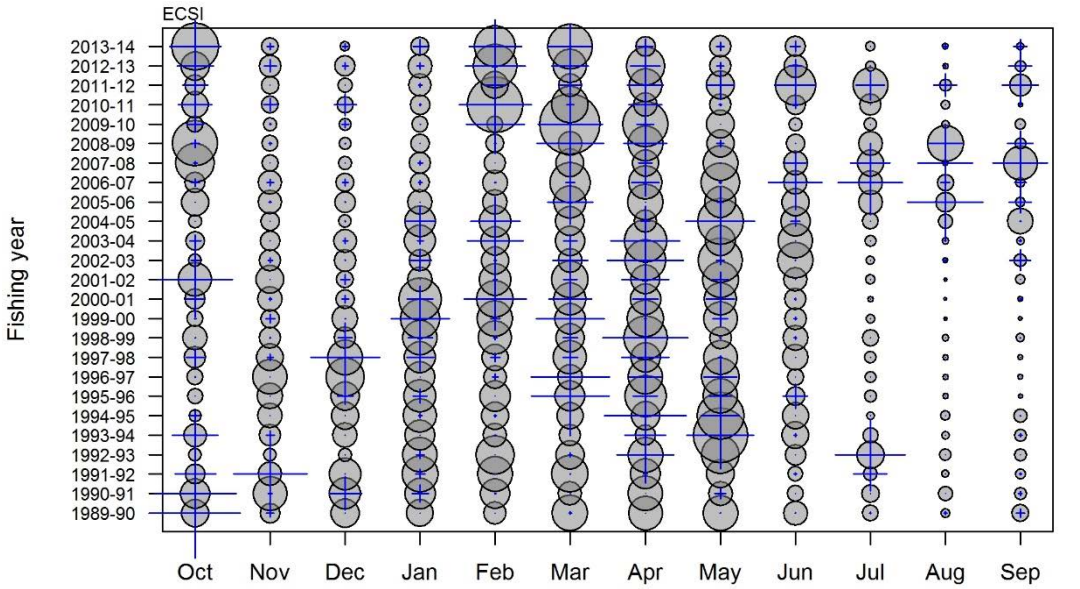


Figure B2: Proportions of the annual commercial barracouta catch (○) and the observed barracouta catch (+) in each month, for the ENCI and ECSI areas of BAR 1.

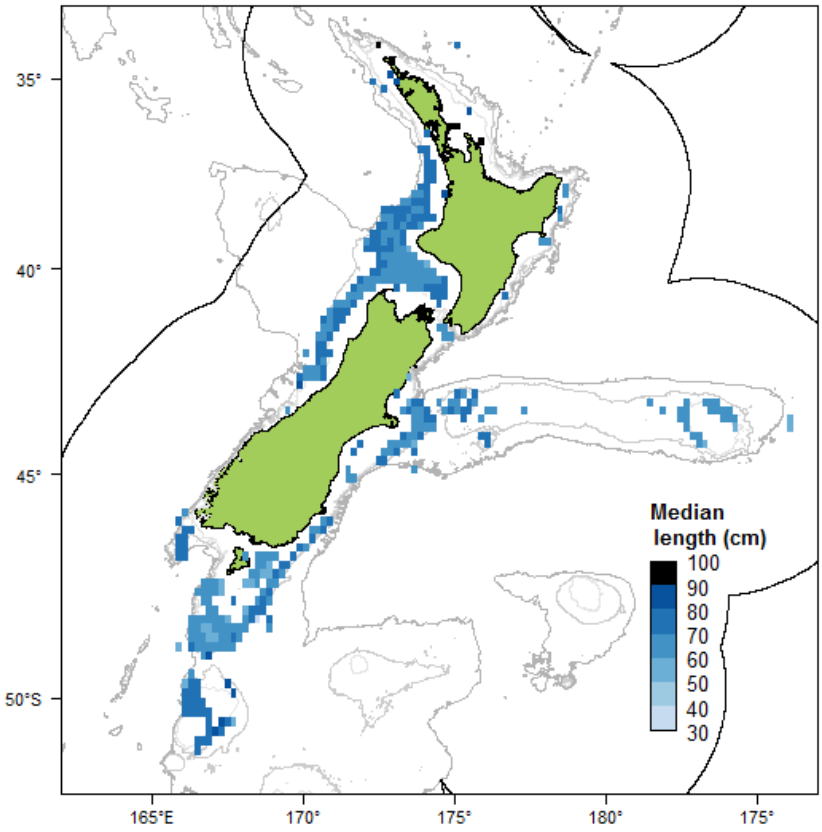


Figure B3: Distribution of median lengths of all barracouta measured by observers (*n* = 326 472 fish) (upper), for fishing years 1991–2014.

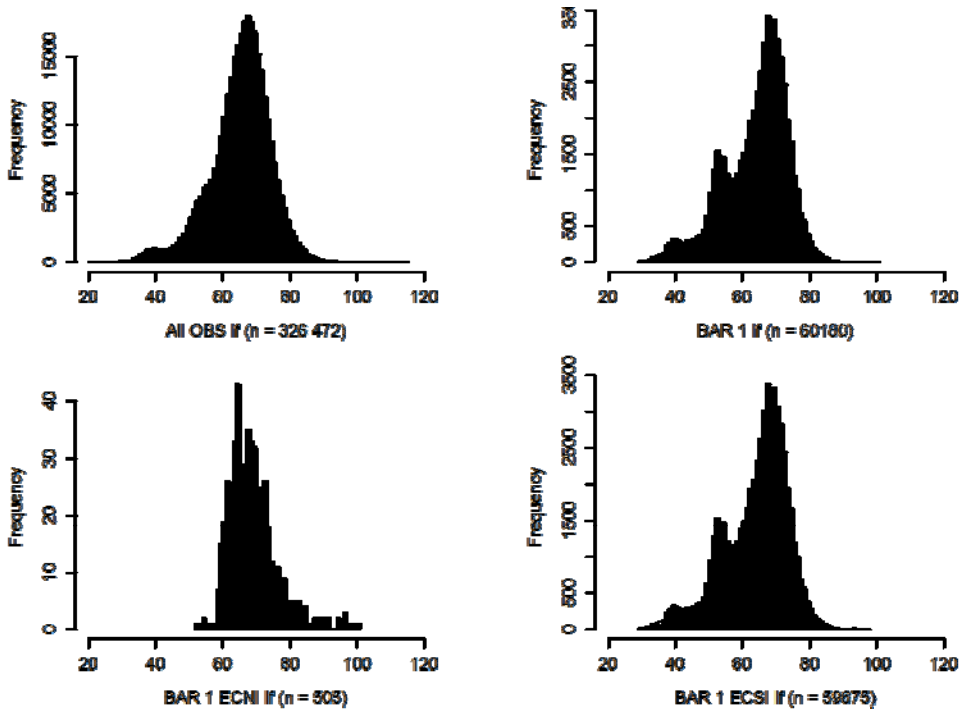


Figure B4a: Distribution of barracouta length data for all barracouta measured by observers (upper left), for BAR 1 barracouta (upper right), for ECNI (lower left), and for ECSI (lower right), for fishing years 1991–2014 combined.

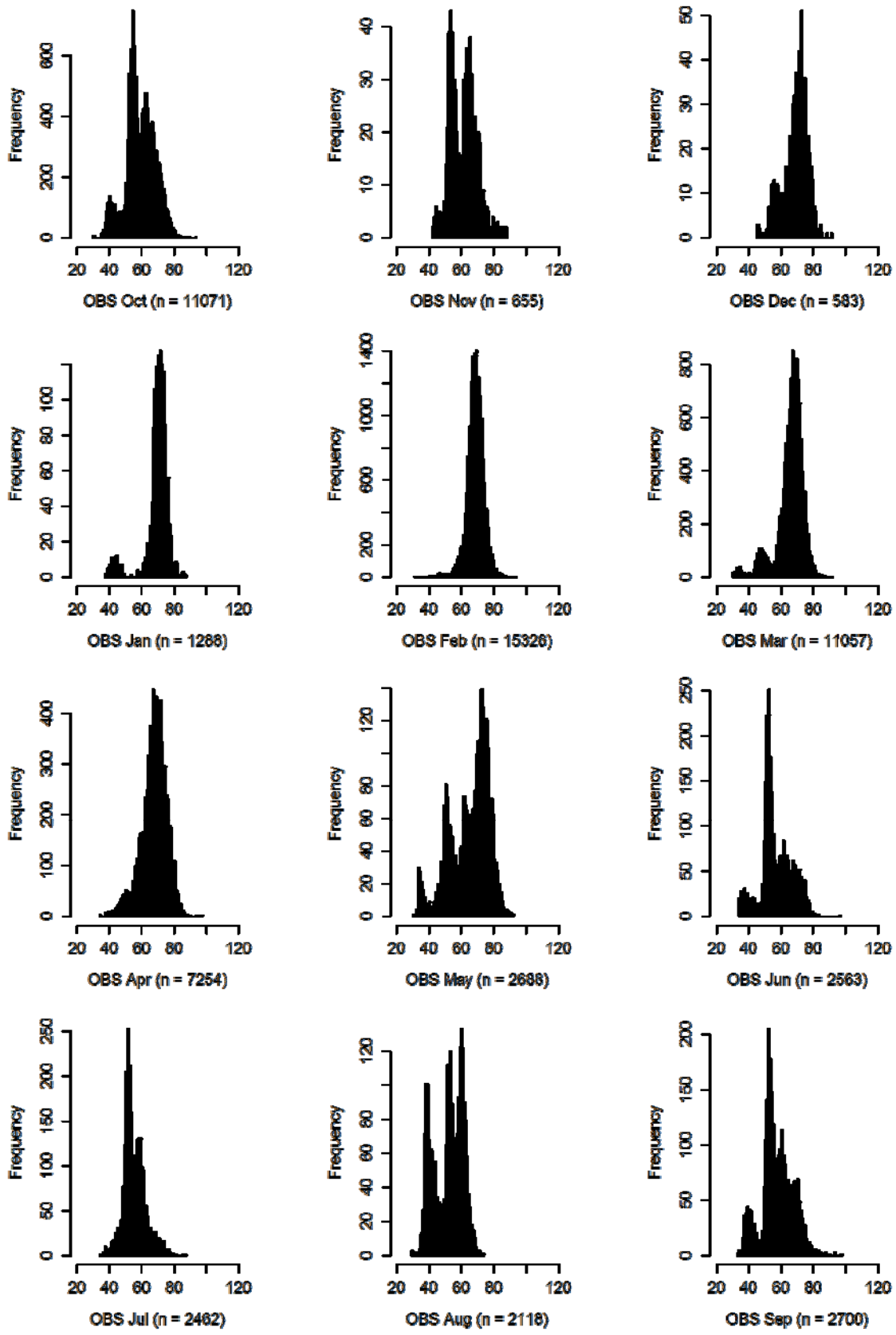


Figure B4b: Distribution of barracouta length data for all ECSI barracouta measured by observers, by month (October-September), for fishing years 1991–2014 combined.

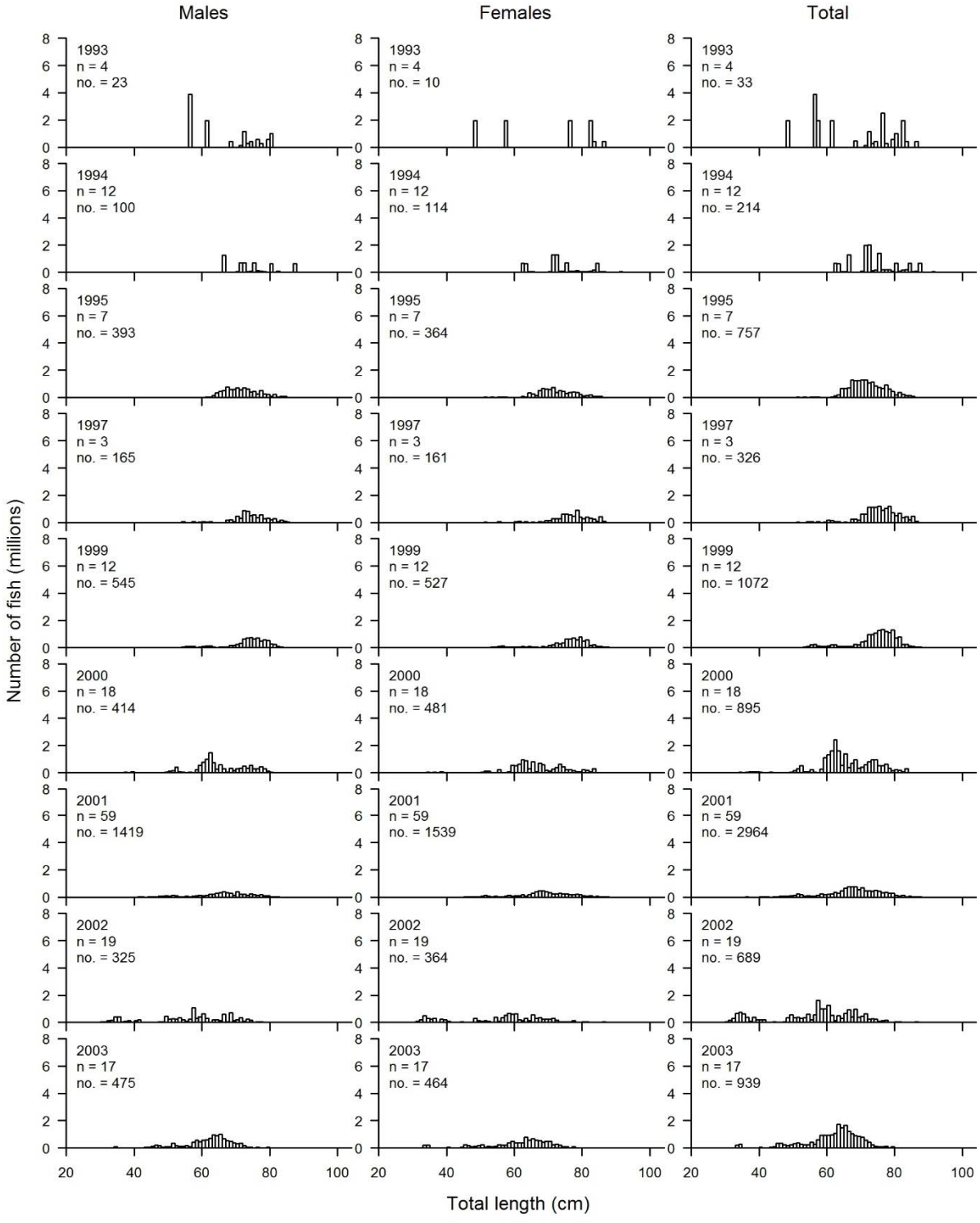


Figure B5: Scaled length frequency of barracouta sampled by observers from commercial catches from the ECSI area, where there were more than 5 barracouta per tow, for the main months of observer coverage (February-May) for fishing years 1993-95, 1997, 1999–2007, 2009–14. n, number of tows sampled with more than 5 barracouta; no., number of barracouta sample.

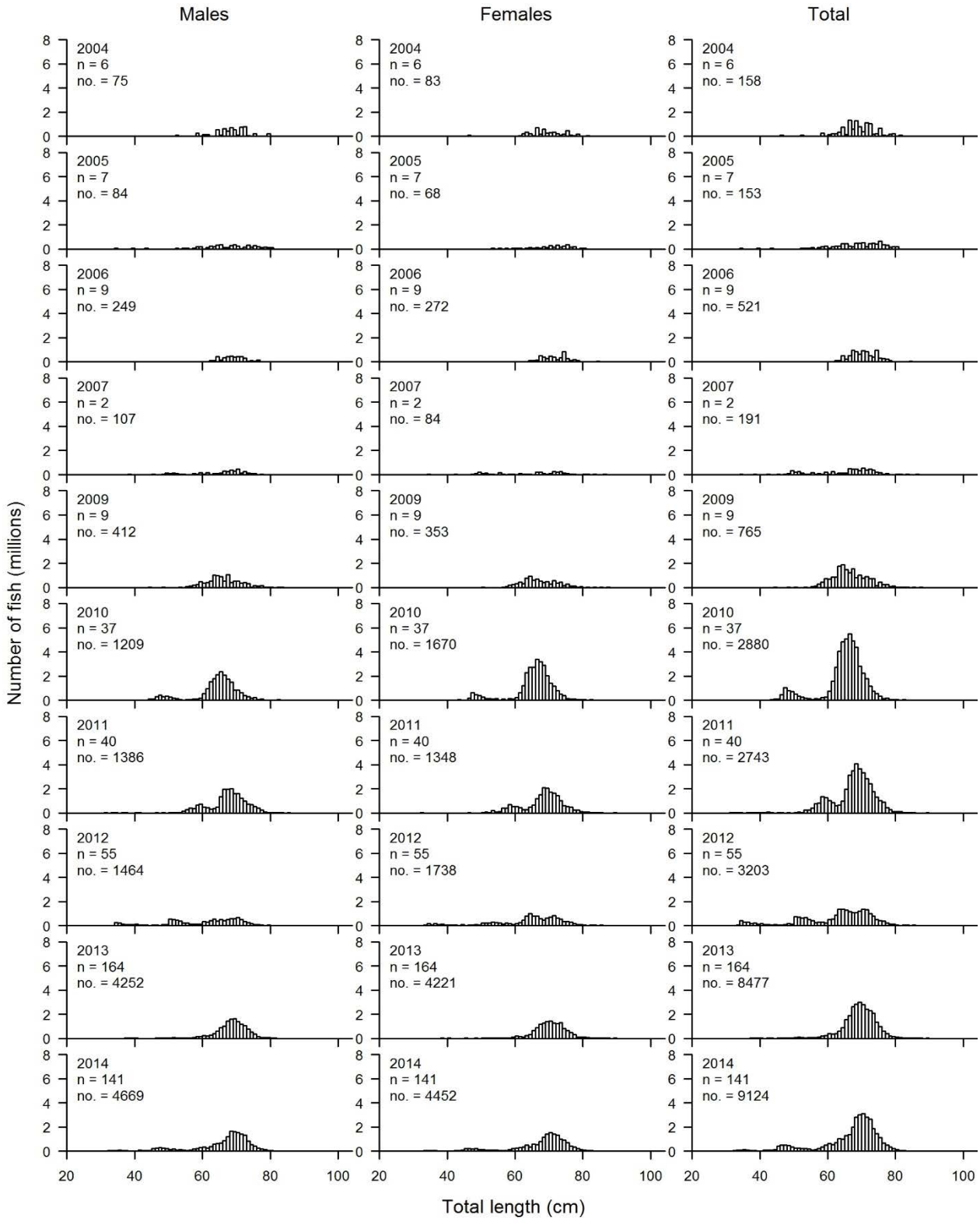


Figure B5: ***continued.***

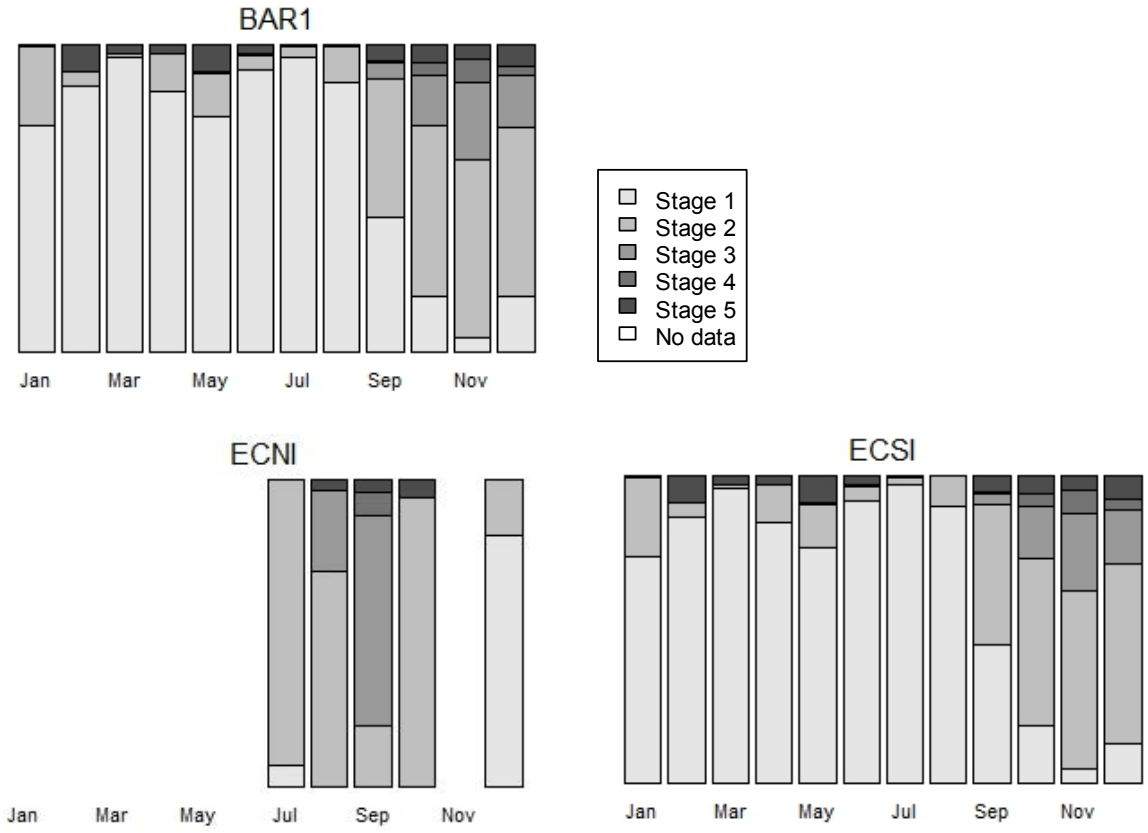


Figure B6: Percent of female reproductive stage by month, where the lightest grey indicates stage 1 and black is stage 5, for both areas combined and for each BAR 1 area, from fishing years 1990–2014. Female reproductive stage 1 is immature/resting, stage 2 is ripening, stage 3 is ripe, stage 4 is running ripe, and stage 5 is spent.

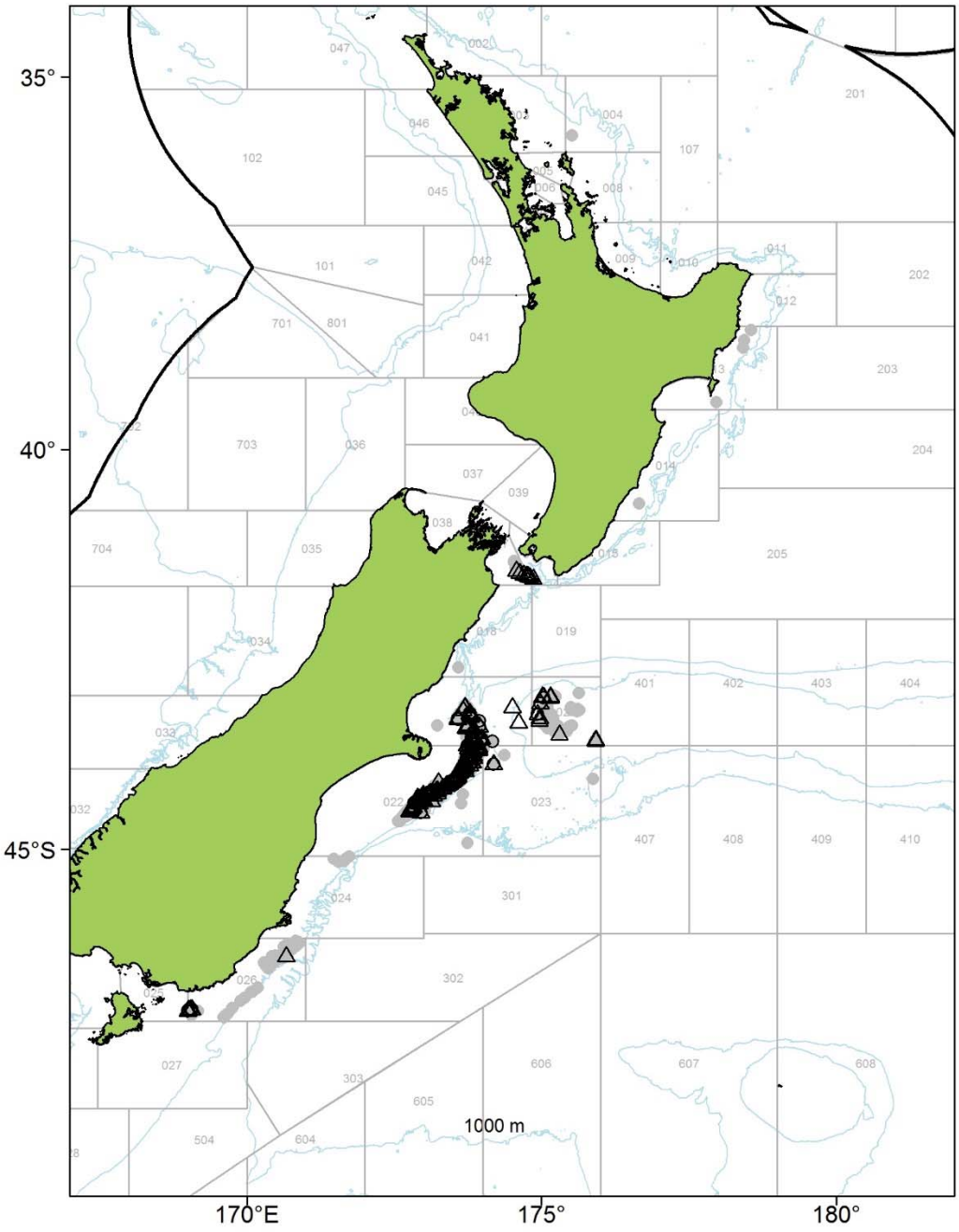


Figure B7a: Distribution of BAR 1 female barracouta reproductive stage data from observer data, by month, where grey circles represent immature females, △ are ripe, and ○ are running ripe.

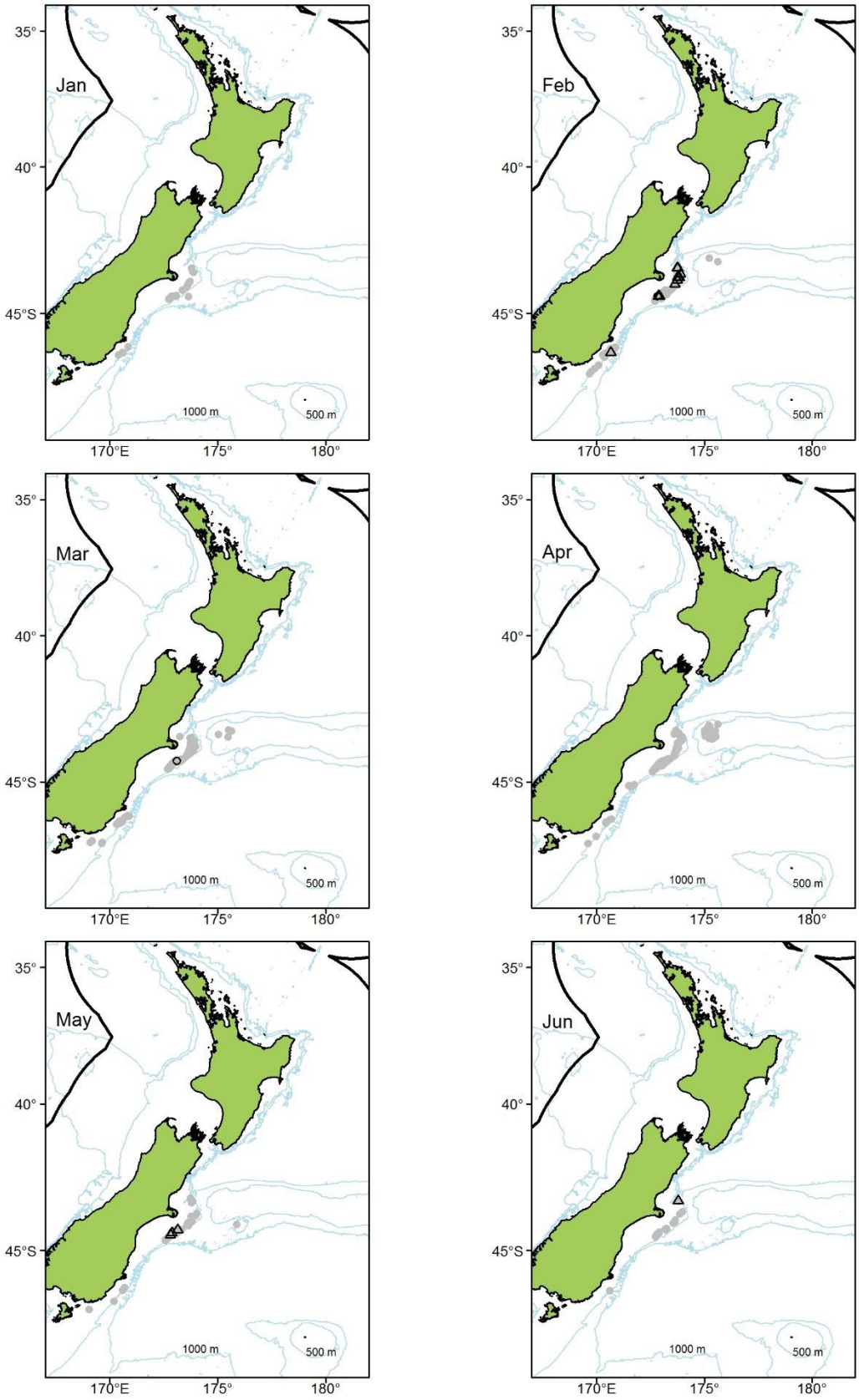


Figure B7b: Distribution of female barracouta reproductive stage data from observer data, by month, where grey circles represent immature females, △ are ripe, and ○ are running ripe. *n* = 23 in ECNI and *n* = 956 in ECSI.

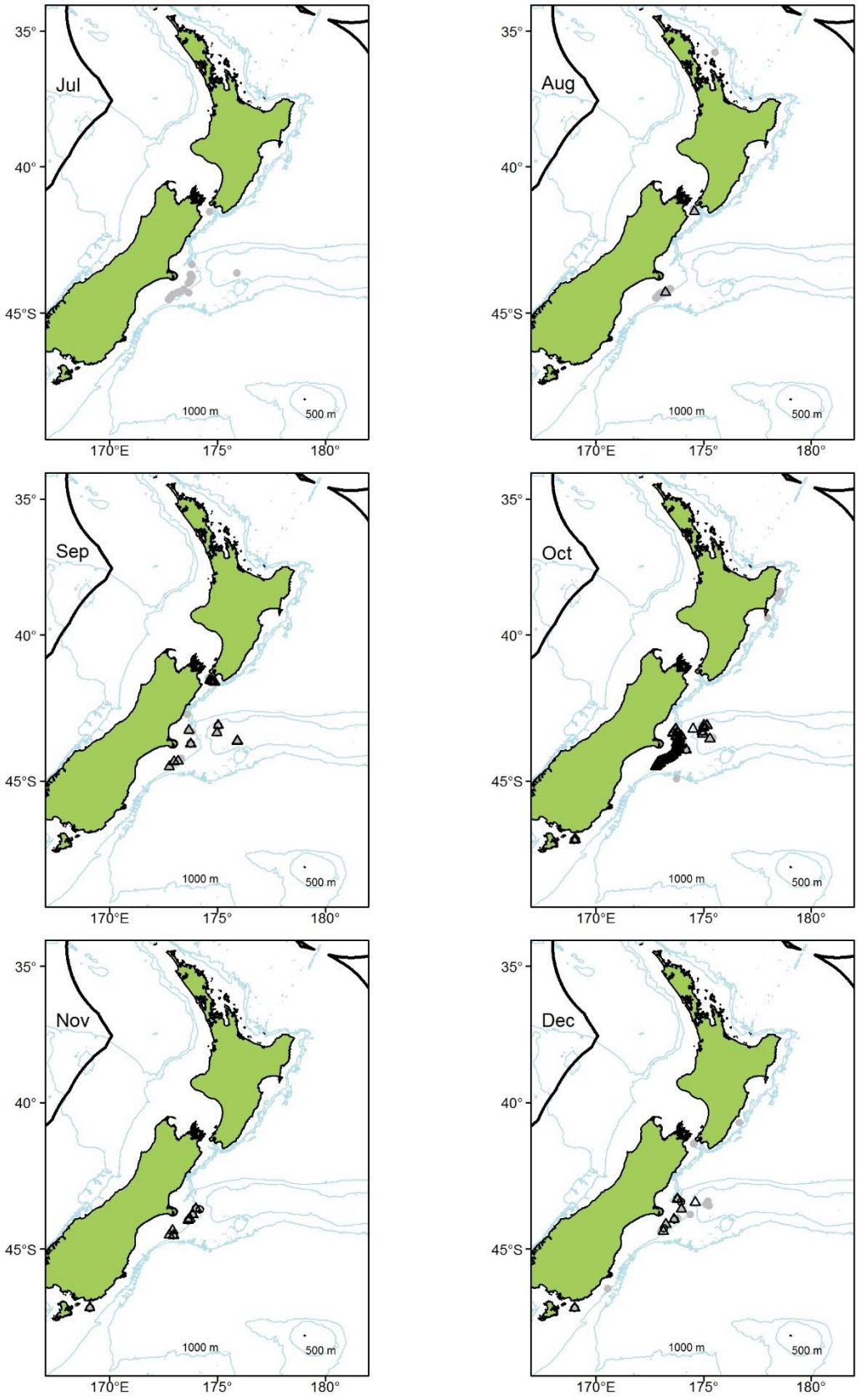


Figure B7b – *continued.*

APPENDIX C: CHARACTERISATION

Table C1: List of tables and fields requested in the Ministry for Primary Industries extract 9934.

Fishing_events table

Event_Key	Effort_total_num	Column_a
Version_seqno	Effort_width	Column_b
DCF_key	Effort_speed	Column_c
Start_datetime	Total_net_length	Column_d
End_datetime	Total_hook_num	Display_fishyear
Primary_method	Set_end_datetime	Start_stats_area_code
Target_species	Haul_start_datetime	Vessel_key
Fishing_duration	Start_latitude (full accuracy)	Form_type
Catch_weight	Start_longitude (full accuracy)	Trip
Effort_depth	End_latitude (full accuracy)	Literal_yn
Effort_height	End_longitude (full accuracy)	Interp_yn
Effort_num	Pair_trawl_yn	Resrch_yn
Effort_num_2	Bottom_depth	
Effort_seqno		

Landing_events table

Event_Key	Destination_type	Trip_key
Version_seqno	Unit_type	Trip_start_datetime
DCF_key	Unit_num	Trip_end_datetime
Landing_datetime	Unit_weight	Vessel_key
Landing_name	Conv_factor	Form_type
Species_code	Green_weight	Literal_yn
Species_name	Green_weight_type	Interp_yn
Fishstock_code (ALL fish stocks)	Processed_weight	Resrch_yn
State_code	Processed_weight_type	
	Form_type	

Estimated subcatch table

Event_Key	Species_code (ALL species for each fishing event)	Literal_yn
Version_seqno	Catch_weight	Interp_yn
DCF_key		Resrch_yn

Process data table

Event_Key	Unit_type	Processed_weight_type
Version_seqno	Unit_num	Vessel_key
DCF_key	Unit_weight	Form_type
Spec_prod_action_type	Conv_factor	Trip_key
Processed_datatime	Green_weight	Literal_yn
Species_code	Green_weight_type	Interp_yn
State_code	Processed_weight	Resrch_yn

Vessel_history table

Vessel_key
Flag_nationality_code
Built_year
Engine_kilowatts
Gross_tonnes
Overall_length_metres
History_start_datetime
History_end_datetime

Table C2: Number of landing events by major destination code and form type for BAR 1 fishstock for fishing years 1990–2014. CELR is Catch Effort Landing Return; NCELR is Netting Catch Effort Landing Return; CLR is Catch Landing Return. Destination codes are defined in Table C3. Note: the last Total column does not include data where "C" was reported (124 records from CELR and 5 records from CLR).

	CELR/NCELR				CLR				All					
	L	C	R	Total	L	T	R	Total	L	T	R	A	O	Total
1990	3 194	92	18	3304	526	62	14	602	3 720	62	32	2	4	3 820
1991	4 169	5	23	4197	455	72	17	544	4 624	72	40	3	3	4 742
1992	4 611	23	14	4648	614	49	31	694	5 225	49	45	4	4	5 327
1993	5 354	4	25	5383	717	72	9	798	6 071	73	34	–	2	6 180
1994	4 868	–	28	4896	889	42	23	954	5 757	42	51	2	2	5 854
1995	5 354	–	27	5381	1 000	80	34	1114	6 354	80	61	4	–	6 499
1996	5 267	–	21	5288	1 526	90	19	1635	6 793	93	40	2	–	6 928
1997	4 872	–	18	4890	1 491	35	15	1541	6 363	35	33	1	1	6 433
1998	4 719	–	33	4752	1 512	9	27	1548	6 231	9	60	–	1	6 301
1999	4 071	–	23	4094	1 384	–	20	1404	5 455	3	43	3	1	5 505
2000	3 627	–	10	3637	1 188	–	17	1205	4 815	–	27	5	–	4 847
2001	2 957	–	7	2964	1 113	–	12	1125	4 070	–	19	10	–	4 099
2002	2 523	–	26	2549	1 087	–	11	1098	3 610	–	37	2	–	3 649
2003	2 445	–	5	2450	1 155	–	23	1178	3 600	–	28	3	–	3 631
2004	2 647	–	15	2662	1 120	–	23	1143	3 767	–	38	3	–	3 808
2005	2 877	–	18	2895	956	–	28	984	3 833	–	46	10	–	3 889
2006	2 903	–	6	2909	891	–	14	905	3 794	–	20	8	–	3 822
2007	2 335	–	4	2339	862	–	11	873	3 197	8	15	10	–	3 230
2008	329	–	5	334	2 507	–	41	2548	2 836	–	46	13	1	2 896
2009	389	–	6	395	2 635	–	35	2670	3 024	–	41	17	–	3 082
2010	434	–	5	439	2 784	–	37	2821	3 218	–	42	14	–	3 274
2011	463	–	1	464	2 615	–	25	2640	3 078	–	26	16	–	3 120
2012	555	–	–	555	2 738	–	15	2753	3 293	–	15	13	–	3 321
2013	563	–	5	568	2 723	–	28	2751	3 286	–	33	33	–	3 352
2014	513	–	2	515	2 979	–	18	2997	3 492	–	20	39	1	3 552
Total	72 039	124	345	72 508	37 467	511	547	38 525	109 506	526	892	217	20	111 161

Table C3: Destination codes, total landing weight, number of landings, and whether the records were kept or dropped, for all barracouta catch reported for 1990–2014, for BAR 1.

Destination code	Greenweight (t)	No. records	Description	Action
L	209 796.9	109 506	Landed in New Zealand to a Licensed Fish Receiver	Keep
T	7 036.1	526	Transferred to another vessel	Keep
A	226.3	217	Accidental loss	Keep
O	157.9	20	Conveyed outside New Zealand	Keep
C	102.8	129	Disposed to the Crown	Keep
U	34.9	689	Used as bait	Keep
D	7.0	30	Discarded	Keep
E	3.4	196	Eaten	Keep
W	1.3	150	Sold at wharf	Keep
F	1.1	140	Recreational catch	Keep
S	0.4	6	Seized by the Crown	Keep
H	0.3	3	Loss from holding pot	Keep
R	3 425.3	892	Retained on board	Drop
Q	51.7	530	Holding receptacle on land	Drop
Null	41.7	70	Missing destination type code	Drop
Invalid	34.2	29	Invalid destination type code recorded	Drop
B	20.5	579	Stored as bait	Drop

Table C4: The reported Quota Management Report (QMR) or Monthly Harvest Return (MHR) catch, annual retained landings in the groomed and unmerged dataset, and retained landings in the groomed and merged dataset, and estimated catches in the groomed and merged dataset for BAR 1, for fishing years 1990–2014.

BAR 1

	Landings (t)			Merged estimated (t)	
Fishing	**MHR**	**Unmerged**	**Merged**	**Catch**	**% of MHR**
1990	9 209	7 120	7 497	7 489	81.3
1991	9 401	8 074	7 991	8 168	86.9
1992	6 733	6 461	6 384	6 293	93.5
1993	9 032	8 984	8 817	8 273	91.6
1994	7 299	7 108	6 940	6 702	91.8
1995	10 023	9 765	9 714	9 254	92.3
1996	11 252	10 781	10 509	10 669	94.8
1997	11 873	11 902	11 851	11 660	98.2
1998	11 543	11 118	11 038	11 357	98.4
1999	9 229	9 306	9 257	9 113	98.7
2000	10 032	9 958	9 877	9 812	97.8
2001	7 118	7 131	7 050	7 268	102.1
2002	6 900	6 900	6 923	7 070	102.5
2003	7 595	7 503	7 382	7 146	94.1
2004	5 949	5 968	5 367	5 875	98.8
2005	6 085	5 537	5 581	5 371	88.3
2006	7 030	7 508	7 503	7 071	100.6
2007	5 351	3 916	3 895	3 621	67.7
2008	5 987	5 886	5 883	5 388	90.0
2009	8 861	9 506	9 598	8 884	100.3
2010	10 635	10 580	11 151	9 849	92.6
2011	11 420	11 386	11 511	10 902	95.5
2012	9 305	9 250	9 186	8 760	94.1
2013	9 740	9 377	9 462	8 981	92.2
2014	11 309	11 459	11 521	11 051	97.7

Table C5: Total number of trips, number of trips with zero estimated catch, and proportion of trips with zero estimated catch, by form type for BAR 1 for fishing years 1990–2014. CELR is Catch Effort Landing Return; TCER is Trawl Catch Effort Return, and TCEPR is Trawl Catch Effort Processing Return.

	CELR			TCEPR			TCER		
Fishing year	Total trips	Zero trips	Proportion	Total trips	Zero trips	Proportion	Total trips	Zero trips	Proportion
1990	3 189	1 006	0.32	394	15	0.04	–	–	–
1991	4 074	1 349	0.33	392	28	0.07	–	–	–
1992	4 561	1 800	0.39	571	62	0.11	–	–	–
1993	5 229	1 954	0.37	701	86	0.12	–	–	–
1994	4 755	1 785	0.38	819	119	0.15	–	–	–
1995	5 138	1 826	0.36	953	154	0.16	–	–	–
1996	4 997	1 533	0.31	1 339	233	0.17	–	–	–
1997	4 701	1 397	0.30	1 354	254	0.19	–	–	–
1998	4 515	1 270	0.28	1 422	244	0.17	–	–	–
1999	3 942	1 140	0.29	1 230	224	0.18	–	–	–
2000	3 514	1 064	0.30	1 026	240	0.23	–	–	–
2001	2 912	846	0.29	969	221	0.23	–	–	–
2002	2 481	748	0.30	973	233	0.24	–	–	–
2003	2 394	728	0.30	987	231	0.23	–	–	–
2004	2 644	824	0.31	967	193	0.20	–	–	–
2005	2 862	993	0.35	845	150	0.18	–	–	–
2006	2 889	1 015	0.35	745	103	0.14	–	–	–
2007	2 213	746	0.34	685	89	0.13	–	–	–
2008	223	79	0.35	435	78	0.18	1 744	182	0.10
2009	240	88	0.37	501	38	0.08	1 875	179	0.10
2010	345	124	0.36	459	58	0.13	2 051	226	0.11
2011	377	165	0.44	475	43	0.09	1 761	242	0.14
2012	412	197	0.48	461	60	0.13	1 945	205	0.11
2013	430	205	0.48	378	69	0.18	2 082	253	0.12
2014	402	175	0.44	462	92	0.20	2 225	327	0.15

Table C6: Total landed catch from groomed and merged data for BAR 1, by main statistical area, by east coast North Island (ECNI) and east coast South Island (ECSI), for fishing years 1990–2014 combined.

Sub area	Statistical Area	Catch (t)	Sub area	Statistical Area	Catch (t)
ECNI	001	203.4	ECSI	018	5 935.5
ECNI	002	1 173.1	ECSI	019	57.2
ECNI	003	1 243.7	ECSI	020	24 572.2
ECNI	004	95.8	ECSI	021	2 392.7
ECNI	005	592.5	ECSI	022	127 137.6
ECNI	006	206.7	ECSI	023	678.3
ECNI	007	26.6	ECSI	024	17 504.7
ECNI	008	743.8	ECSI	026	4 646.9
ECNI	009	3 459.7	ECSI	301	35.8
ECNI	010	1 592.2	ECSI	302	6.4
ECNI	011	1 063.4	ECSI	303	0.4
ECNI	012	1 607.3			
ECNI	013	4 723.9			
ECNI	014	5 695.5			
ECNI	015	2 022.4			
ECNI	016	2 559.2			
ECNI	017	1 777.2			
ECNI	105	14.0			
ECNI	106	25.8			
ECNI	107	0.6			
ECNI	201	5.4			
ECNI	202	7.2			
ECNI	203	1.1			
ECNI	204	20.8			
ECNI	205	57.2			

Table C7: Total landed catch (t) for BAR 1 subareas ECNI and ECSI and all BAR 1, from the groomed and merged data, for fishing years 1990–2014.

Fishing year	ECNI	ECSI	Total catch (t)
1990	1 546.8	5 949.8	7 496.6
1991	835.4	7 155.2	7 990.6
1992	1 284.9	5 099.2	6 384.1
1993	1 414.3	7 402.3	8 816.6
1994	1 781.0	5 158.9	6 939.9
1995	2 372.2	7 341.6	9 713.8
1996	2 301.3	8 208.1	10 509.4
1997	2 127.7	9 722.8	11 850.5
1998	1 934.5	9 104.0	11 038.5
1999	1 324.5	7 932.6	9 257.1
2000	967.3	8 909.9	9 877.2
2001	1 061.4	5 988.6	7 050.0
2002	752.7	6 170.2	6 922.9
2003	946.5	6 435.7	7 382.2
2004	838.6	4 528.3	5 366.9
2005	917.3	4 664.0	5 581.3
2006	816.9	6 685.6	7 502.5
2007	935.9	2 959.4	3 895.3
2008	695.7	5 186.9	5 882.6
2009	744.9	8 852.9	9 597.8
2010	711.0	10 439.9	11 150.9
2011	631.5	10 879.4	11 510.9
2012	571.8	8 613.9	9 185.7
2013	621.2	8 841.1	9 462.3
2014	783.5	10 737.3	11 520.8
Total catch (t)	28 918.7	182 967.7	211 886.4

Table C8a: Total barracouta catch (t) by vessel nationality from groomed and merged data for BAR 1 ECNI, for fishing years 1990–2014.

Fishing year	Korea	New Zealand	Russia	Ukraine	Total catch (t)
1990	–	1 546.8	–	–	1546.8
1991	–	815.7	19.7	–	835.4
1992	0.0	1 284.9	–	–	1 284.9
1993	–	1 413.7	–	0.6	1 414.3
1994	–	1 768.9	12.1	–	1 781.0
1995	21.0	2 351.2	0.0	–	2 372.2
1996	5.0	2 296.3	–	–	2 301.3
1997	8.1	2 119.5	–	0.0	2 127.7
1998	0.1	1 934.4	–	0.0	1 934.5
1999	6.1	1 318.4	–	–	1 324.5
2000	–	967.3	0.0	0.0	967.3
2001	–	1 061.4	–	–	1 061.4
2002	0.0	752.7	–	–	752.7
2003	–	946.5	–	–	946.5
2004	–	838.6	–	–	838.6
2005	–	917.3	–	–	917.3
2006	–	816.9	–	–	816.9
2007	–	935.9	–	–	935.9
2008	–	695.6	–	0.0	695.7
2009	–	744.9	–	–	744.9
2010	–	711.0	–	–	711.0
2011	–	631.5	–	–	631.5
2012	–	571.8	–	–	571.8
2013	–	621.2	–	–	621.2
2014	–	783.5	–	–	783.5
Total catch (t)	40.3	28 846.0	31.8	0.6	28 918.7

Table C8b: Total barracouta catch reported from the ECNI of BAR 1, by form type, for fishing years 1990 to 2014. CELR is Catch Effort Landing Return; TCER is Trawl Catch Effort Return; TCEPR is Trawl Catch Effort Processing Return.

Fishing year	CELR	TCER	TCEPR	Total catch (t)
1990	778.8	NA	767.9	1 546.8
1991	676.0	NA	159.4	835.4
1992	1 159.1	NA	125.9	1 284.9
1993	1 199.2	NA	215.1	1 414.3
1994	1 022.2	NA	758.8	1 781.0
1995	1 397.6	NA	974.6	2 372.2
1996	1 040.5	NA	1 260.8	2 301.3
1997	934.5	NA	1 193.1	2 127.7
1998	598.0	NA	1 336.5	1 934.5
1999	573.0	NA	751.5	1 324.5
2000	480.9	NA	486.4	967.3
2001	514.6	NA	546.8	1 061.4
2002	330.7	NA	422.0	752.7
2003	358.6	NA	587.9	946.5
2004	336.1	NA	502.4	838.6
2005	388.2	NA	529.2	917.3
2006	392.1	NA	424.8	816.9
2007	409.1	NA	526.9	935.9
2008	2.3	352.8	340.5	695.7
2009	0.0	396.2	348.8	744.9
2010	NA	392.0	319.0	711.0
2011	NA	296.9	334.6	631.5
2012	NA	384.6	187.2	571.8
2013	NA	456.5	164.8	621.2
2014	NA	564.7	218.8	783.5
Total catch (t)	12 591.5	2 843.6	13 483.6	28 918.7

Table C8c: Total barracouta catch and percentage reported from the ECNI of BAR 1, by primary method, for fishing years 1990 to 2014. BPT is paired bottom trawl; BT is bottom trawl; DS is Danish seine net; MW is midwater trawl.

Fishing year	BPT	BT	DS	MW	Total catch (t)
1990	1.0	1 544.4	–	1.3	1 546.8
1991	0.1	815.3	–	19.9	835.4
1992	–	1 258.5	–	26.4	1 284.9
1993	0.0	1 382.3	–	32.0	1 414.3
1994	6.4	1 717.2	–	57.4	1 781.0
1995	43.3	2 240.0	–	88.8	2 372.2
1996	4.1	2 255.3	0.0	41.9	2 301.3
1997	4.0	1 997.1	0.2	126.3	2 127.7
1998	3.4	1 888.5	–	42.5	1 934.5
1999	4.7	1 301.0	–	18.8	1 324.5
2000	66.8	895.1	–	5.3	967.3
2001	23.3	1 032.4	–	5.7	1 061.4
2002	5.3	738.7	–	8.8	752.7
2003	52.8	849.7	–	44.0	946.5
2004	19.6	808.7	–	10.3	838.6
2005	27.0	868.1	–	22.2	917.3
2006	2.4	807.7	–	6.8	816.9
2007	0.5	914.0	–	21.5	935.9
2008	–	688.6	–	7.0	695.7
2009	–	733.1	–	11.8	744.9
2010	–	704.7	–	6.3	711.0
2011	–	614.3	–	17.3	631.5
2012	–	554.2	–	17.6	571.8
2013	–	601.9	–	19.3	621.2
2014	–	776.8	–	6.7	783.5
Total catch (t)	264.7	27 987.7	0.3	666.0	28 918.7

Table C8d: Total barracouta landed catch and percentage reported from the ECNI of BAR 1, by month, for fishing years 1990–2014.

Fishing year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total catch (t)
1990	8.4	1.6	3.8	5.0	3.8	3.7	10.8	6.8	2.4	4.5	17.8	31.5	1 546.8
1991	8.4	4.2	3.3	5.1	25.8	6.2	4.8	4.0	4.7	9.6	10.4	13.5	835.4
1992	3.6	5.1	5.1	8.4	5.4	2.9	2.4	4.3	7.5	8.5	18.9	27.9	1 284.9
1993	4.4	4.9	4.8	8.3	7.7	7.0	4.3	6.4	8.3	15.3	15.1	13.4	1 414.3
1994	9.7	3.3	3.9	9.5	7.3	4.0	4.6	2.3	3.5	9.9	23.1	19.0	1 781.0
1995	7.6	6.4	5.7	5.0	4.9	3.0	3.3	3.9	7.8	15.1	17.6	19.7	2 372.2
1996	11.8	7.6	6.6	4.0	4.2	3.5	2.6	4.2	9.4	17.4	13.2	15.3	2 301.3
1997	15.0	11.2	8.6	4.7	5.2	2.8	3.8	6.0	3.6	11.0	11.5	16.6	2 127.7
1998	8.6	8.2	7.3	3.8	3.2	4.2	9.7	20.1	3.2	7.6	11.7	12.3	1 934.5
1999	6.6	7.4	8.5	4.3	2.7	3.8	3.4	10.0	7.2	10.8	14.9	20.4	1 324.5
2000	5.9	9.4	6.9	9.2	5.9	7.6	5.7	5.7	2.9	6.1	14.0	20.9	967.3
2001	13.8	9.1	5.4	5.6	5.1	3.9	2.5	3.9	4.5	12.4	20.1	13.8	1 061.4
2002	8.5	7.4	4.5	5.6	10.7	4.7	6.2	4.6	9.0	13.7	14.9	10.3	752.7
2003	7.0	7.2	5.1	6.7	7.1	5.9	2.1	3.8	7.1	10.0	19.0	18.9	946.5
2004	9.9	6.7	4.9	7.6	5.9	4.9	8.3	4.1	7.1	6.2	9.8	24.5	838.6
2005	9.4	5.3	7.1	8.4	7.0	6.7	5.5	5.8	5.8	6.3	21.8	10.8	917.3
2006	4.5	5.2	9.4	7.0	4.4	7.4	6.9	5.6	5.4	8.6	21.8	13.8	816.9
2007	9.3	6.8	6.0	4.9	6.1	4.6	4.3	6.6	4.7	17.0	19.7	9.8	935.9
2008	14.0	6.8	14.7	6.6	4.6	3.0	9.7	3.8	4.4	7.6	12.7	12.1	695.7
2009	8.3	4.7	8.1	8.7	6.1	8.0	4.0	4.2	7.5	12.1	17.2	11.1	744.9
2010	6.5	9.3	11.6	7.8	5.7	3.4	4.3	4.1	7.6	11.2	16.6	11.9	711.0
2011	5.5	7.0	10.0	3.3	6.6	7.7	3.5	4.6	10.2	8.1	16.9	16.8	631.5
2012	5.7	4.3	5.3	7.8	4.7	4.1	6.4	11.6	8.0	14.9	16.2	10.8	571.8
2013	11.3	6.6	11.2	8.5	5.7	10.8	5.3	4.2	6.6	10.8	6.7	12.3	621.2
2014	10.6	4.8	7.5	7.7	7.2	4.5	4.1	4.8	7.1	3.5	18.5	19.7	783.5
Total catch (t)	2 560.8	1 891.8	1 928.2	1 795.6	1 748.5	1 351.6	1 449.9	1 774.1	1 747.8	3 115.2	4 624.7	4 930.4	28 918.7

Table C8e: Total barracouta catch reported from the ECNI part of BAR 1, by main target species, for 1989–90 (1990) to 2013–14 (2014). Target species code definitions are given in Table C10.

Fishing year	BAR	GUR	HOK	JDO	RCO	SKI	SNA	TAR	TRE	WAR	Other	Total catch (t)
1990	989.9	7.0	18.1	13.1	25.3	54.3	156.1	146.9	12.9	52.1	71.1	1 546.8
1991	438.3	25.0	30.7	18.0	5.6	25.4	86.6	144.8	7.0	26.9	26.9	835.4
1992	534.4	58.6	25.6	18.8	1.1	165.2	93.5	260.4	12.5	93.4	21.3	1 284.9
1993	421.8	113.7	36.4	18.5	11.7	229.0	70.7	297.1	46.4	106.5	62.5	1 414.3
1994	572.1	89.4	116.9	25.0	7.4	199.4	109.5	482.4	48.7	65.5	64.7	1 781.0
1995	405.9	153.4	102.5	35.5	22.4	333.2	131.9	766.5	53.5	263.1	104.3	2 372.2
1996	469.6	170.9	136.2	56.0	73.1	289.0	167.0	619.2	31.5	226.9	62.0	2 301.3
1997	581.3	168.8	223.8	69.7	23.1	213.2	110.0	460.4	48.8	174.4	54.3	2 127.7
1998	365.9	77.1	247.8	84.5	50.5	245.3	203.7	446.3	111.1	52.3	49.9	1 934.5
1999	358.1	50.6	47.1	43.4	3.7	46.6	154.9	476.9	86.7	35.2	21.4	1 324.5
2000	181.6	93.2	29.4	34.3	0.2	48.7	108.1	336.8	63.1	44.3	27.5	967.3
2001	302.8	167.0	19.7	14.6	4.8	21.3	92.6	277.6	57.9	74.8	28.3	1 061.4
2002	116.9	115.5	14.8	12.3	51.6	17.5	56.7	193.9	32.9	119.0	21.5	752.7
2003	219.5	102.9	46.0	9.0	9.8	27.1	70.8	311.3	31.9	91.3	26.8	946.5
2004	107.9	75.3	106.1	8.2	0.1	16.6	87.4	377.4	26.2	23.3	10.0	838.6
2005	34.2	100.8	56.1	15.4	5.9	7.9	87.7	509.2	35.8	57.5	6.8	917.3
2006	41.6	106.0	41.4	14.7	1.1	2.6	65.9	463.4	23.5	53.1	3.6	816.9
2007	28.2	100.3	24.2	39.2	6.5	3.6	86.9	566.7	32.2	35.1	13.1	935.9
2008	66.9	103.7	11.2	41.2	0.9	0.0	27.8	373.9	21.9	42.3	5.7	695.7
2009	35.3	103.9	25.5	28.0	5.8	1.4	68.2	389.8	28.2	35.3	23.7	744.9
2010	5.2	175.3	16.4	35.4	0.7	2.6	56.4	349.2	20.2	28.3	21.0	711.0
2011	15.7	93.2	22.3	21.3	16.3	4.1	28.2	353.1	17.3	16.8	43.2	631.5
2012	35.5	71.4	23.3	10.4	31.0	1.5	34.1	296.6	11.8	42.3	14.0	571.8
2013	55.5	85.9	22.2	11.9	45.5	10.3	41.6	258.9	44.6	27.6	17.0	621.2
2014	26.0	129.3	10.1	24.1	2.8	5.1	67.0	416.4	18.6	32.2	51.7	783.5
Total catch (t)	6 410.0	2 538.7	1 453.8	702.7	406.9	1 971.0	2 263.3	9 575.0	925.3	1 819.7	852.4	28 918.7

Table C8f: Total barracouta landed catch and percentage reported from the ECNI of BAR 1, by Statistical Area, for fishing years 1990–2014.

Fishing year	Statistical area															Total catch (t)
	001	002	003	004-007	008	009	010	011	012	013	014	015	016	017	other	
1990	1.2	6.3	7.9	4.0	1.9	7.5	6.6	0.6	1.8	7.3	9.2	16.1	1.0	28.3	0.1	1 546.8
1991	0.6	5.3	23.3	2.9	3.4	14.3	4.1	1.2	6.3	8.6	3.5	11.2	4.5	4.2	6.5	835.4
1992	0.4	1.1	3.7	2.0	2.1	37.6	3.2	1.4	1.8	13.1	16.2	3.3	10.8	3.1	0.2	1 284.9
1993	1.4	2.4	3.2	2.5	3.6	14.7	4.8	1.5	1.6	20.1	28.8	6.1	6.3	2.3	0.6	1 414.3
1994	1.5	2.6	1.0	1.4	2.2	13.6	5.4	2.1	4.2	15.6	28.8	8.5	7.4	5.0	0.7	1 781.0
1995	0.6	4.5	2.4	1.5	1.7	9.6	5.5	3.6	6.2	15.8	26.5	7.0	12.1	2.4	0.6	2 372.2
1996	1.8	6.3	2.9	2.7	1.1	7.4	7.2	4.2	4.8	17.5	23.6	9.1	7.4	3.7	0.4	2 301.3
1997	1.9	5.8	2.2	3.1	1.0	9.5	5.2	3.9	3.6	15.3	23.9	4.0	16.6	3.9	0.3	2 127.7
1998	1.5	5.9	6.3	1.6	2.5	31.0	4.3	3.5	4.3	9.7	14.2	5.2	3.1	5.8	0.9	1 934.5
1999	0.2	2.6	4.4	1.7	5.5	26.4	7.2	6.6	4.9	11.6	13.1	6.1	6.8	2.7	0.1	1 324.5
2000	0.0	11.0	5.7	3.6	4.8	10.2	3.9	6.5	7.3	22.0	12.5	2.4	5.4	4.5	0.0	967.3
2001	0.0	8.7	5.8	2.3	2.1	9.8	11.6	3.7	6.2	22.7	14.1	3.6	5.0	4.3	0.1	1 061.4
2002	0.0	1.9	10.6	2.5	2.3	7.3	7.3	2.9	4.5	15.9	19.4	7.1	12.1	6.1	0.0	752.7
2003	0.0	1.9	3.9	0.8	3.4	10.2	6.5	3.9	7.7	22.1	18.6	5.0	10.1	5.6	0.2	946.5
2004	0.0	1.4	3.2	2.1	1.6	7.2	8.6	4.7	10.4	22.9	12.4	6.0	12.0	7.5	0.0	838.6
2005	0.0	7.4	3.6	1.3	3.8	5.5	5.8	5.0	7.4	20.0	14.8	8.3	10.5	6.6	0.0	917.3
2006	0.1	3.8	5.0	2.5	2.4	6.8	5.7	7.2	8.8	17.7	17.4	9.8	9.3	3.4	0.1	816.9
2007	0.0	3.0	3.8	5.9	2.8	4.1	4.1	4.1	6.2	23.6	28.5	4.7	7.3	1.9	0.0	935.9
2008	0.0	1.2	2.6	5.7	2.9	8.6	2.9	4.3	3.9	16.1	25.3	9.7	11.7	5.0	0.1	695.7
2009	0.0	2.1	3.7	9.1	4.1	3.8	3.9	3.4	9.4	17.7	25.6	6.3	8.3	2.6	0.0	744.9
2010	0.0	0.8	2.9	8.9	4.4	2.9	3.9	6.1	9.1	17.9	21.6	9.0	9.6	2.8	0.0	711.0
2011	0.0	0.2	1.5	6.4	2.9	2.7	3.2	3.6	7.4	13.0	28.8	8.6	10.2	11.5	0.0	631.5
2012	0.0	0.2	1.4	6.0	3.9	3.9	4.5	5.7	6.6	13.6	21.6	5.1	19.9	7.5	0.0	571.8
2013	0.0	0.8	0.6	8.0	1.9	2.0	1.8	1.8	4.6	19.4	12.9	8.8	12.5	24.8	0.0	621.2
2014	0.0	0.9	0.9	5.5	1.7	2.5	6.0	4.8	15.6	23.8	15.2	3.4	10.7	9.0	0.0	783.5
Total catch (t)	203.4	1 173.1	1 243.7	921.6	743.8	3 459.7	1 592.2	1 063.4	1 607.3	4 723.9	5 695.5	2 022.4	2 559.2	1 777.2	132.1	28 918.7

Table C9a: Total barracouta catch (t) by vessel nationality from groomed and merged data for BAR 1 ECSI, for fishing years 1990–2014. Other includes vessels from Australia, China, Cyprus, and Norway.

Fishing year	Japan	Korea	New Zealand	Poland	Russia	Ukraine	Other	Total catch (t)
1990	199.6	806.4	4 943.8	–	0.0	–	0.0	5 949.8
1991	131.3	1 613.6	5 317.7	–	66.0	13.5	13.2	7 155.2
1992	16.6	937.0	4 143.0	–	2.6	0.0	0.0	5 099.2
1993	25.1	1 870.8	4 502.2	2.4	738.3	217.9	45.6	7 402.3
1994	24.2	759.7	2 358.9	283.0	605.2	1 127.7	0.3	5 158.9
1995	9.3	1 022.3	4 742.3	40.0	807.5	682.5	37.8	7 341.6
1996	0.5	1 541.9	5 500.5	16.6	492.0	567.6	88.9	8 208.1
1997	0.2	1 314.9	7 197.0	2.1	659.2	549.4	0.0	9 722.8
1998	0.1	1 358.5	6 722.6	0.0	523.0	499.6	0.1	9 104.0
1999	8.4	1 532.8	5 235.0	0.3	306.2	848.2	1.7	7 932.6
2000	19.3	1 959.9	4 743.0	5.8	1 179.1	1 001.8	0.9	8 909.9
2001	21.7	2 116.5	3 205.1	0.0	380.9	264.3	0.2	5 988.6
2002	23.4	664.7	3 999.5	0.0	478.5	1 004.0	0.0	6 170.2
2003	6.7	674.3	4 556.4	0.1	453.4	695.4	49.5	6 435.7
2004	0.1	194.9	4 241.8	22.7	41.8	25.6	1.5	4 528.3
2005	32.3	79.7	3 348.3	5.9	477.7	663.8	56.3	4 664.0
2006	4.5	149.8	4 564.5	22.1	1 078.5	861.7	4.5	6 685.6
2007	19.0	279.0	2 106.1	0.7	272.0	282.5	0.0	2 959.4
2008	0.4	1 983.1	2 322.0	0.0	371.2	510.2	0.0	5 186.9
2009	0.1	3 185.4	3 366.9	–	928.5	1 372.0	0.0	8 852.9
2010	0.0	148.5	2 986.8	–	2 010.4	5 294.3	0.0	10 439.9
2011	9.7	1 280.2	4 136.1	–	1 209.5	4 215.9	28.0	10 879.4
2012	4.7	2 454.5	4 322.8	–	490.5	1 341.4	0.0	8 613.9
2013	1.4	770.8	4 849.2	–	659.5	2 560.1	0.0	8 841.1
2014	–	486.7	3 647.0	–	1 473.3	5 130.3	0.0	10 737.3
Total catch (t)	558.5	29 186.0	107 058.4	401.7	15 704.9	29 729.7	328.6	182 967.7

Table C9b: Total barracouta catch reported from the ECSI of BAR 1, by form type, for fishing years 1990 to 2014. CEL is Catch Effort Landing Return; TCER is Trawl Catch Effort Return; TCEPR is Trawl Catch Effort Processing Return.

Fishing year	CELR	TCER	TCEPR	Total catch (t)
1990	1 496.5	–	4 453.3	5 949.8
1991	2 816.9	–	4 338.3	7 155.2
1992	1 233.7	–	3 865.5	5 099.2
1993	1 255.3	–	6 147.0	7 402.3
1994	1 019.8	–	4 139.1	5 158.9
1995	1 842.1	–	5 499.5	7 341.6
1996	1 922.3	–	6 285.7	8 208.1
1997	2 880.8	–	6 842.0	9 722.8
1998	3 080.1	–	6 023.9	9 104.0
1999	2 201.3	–	5 731.4	7 932.6
2000	2 120.3	–	6 789.6	8 909.9
2001	1 976.2	–	4 012.4	5 988.6
2002	1 842.0	–	4 328.2	6 170.2
2003	2 087.1	–	4 348.6	6 435.7
2004	1 950.5	–	2 577.7	4 528.3
2005	2 030.6	–	2 633.4	4 664.0
2006	2 846.1	–	3 839.6	6 685.6
2007	1 410.2	–	1 549.2	2 959.4
2008	2.9	2 232.8	2 951.3	5 186.9
2009	0.2	2 095.3	6 757.4	8 852.9
2010	–	2 129.6	8 310.3	10 439.9
2011	–	2 493.9	8 385.5	10 879.4
2012	–	3 237.8	5 376.1	8 613.9
2013	0.0	3 836.1	5 005.0	8 841.1
2014	–	3 000.8	7 736.5	10 737.3
Total catch (t)	36 014.9	19 026.3	127 926.5	182 967.7

Table C9c: Total barracouta catch and percentage reported from the ECSI of BAR 1, by primary method, for fishing years 1990 to 2014. BT is bottom trawl; MW is midwater trawl.

Fishing year	BT	MW	Total catch (t)
1990	5 949.8	0.0	5 949.8
1991	7 086.3	68.9	7 155.2
1992	5 091.0	8.2	5 099.2
1993	6 398.1	1 004.1	7 402.3
1994	3 130.6	2 028.3	5 158.9
1995	5 807.0	1 534.7	7 341.6
1996	6 964.4	1 243.7	8 208.1
1997	8 422.2	1 300.6	9 722.8
1998	8 070.6	1 033.4	9 104.0
1999	6 769.3	1 163.3	7 932.6
2000	6 751.6	2 158.3	8 909.9
2001	5 333.8	654.8	5 988.6
2002	4 683.8	1 486.4	6 170.2
2003	5 048.6	1 387.1	6 435.7
2004	4 340.0	188.2	4 528.3
2005	3 426.3	1 237.7	4 664.0
2006	4 705.4	1 980.2	6 685.6
2007	2 237.8	721.5	2 959.4
2008	3 107.7	2 079.2	5 186.9
2009	3 960.4	4 892.5	8 852.9
2010	3 073.7	7 366.2	10 439.9
2011	5 254.7	5 624.7	10 879.4
2012	6 771.1	1 842.9	8 613.9
2013	5 612.1	3 229.1	8 841.1
2014	4 098.3	6 639.0	10 737.3
All	132 094.6	50 873.1	182 967.7

Table C9d: Total barracouta landed catch and percentage reported from the ECSI of BAR 1, by month, for fishing years 1990–2014.

Fishing year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total catch (t)
1990	9.2	5.0	10.0	9.0	6.2	15.6	14.3	15.4	7.1	3.3	1.1	3.7	5 949.8
1991	10.8	14.2	11.9	11.8	10.9	6.9	14.6	7.1	3.2	3.9	2.7	1.8	7 155.2
1992	4.8	6.8	12.7	16.1	15.0	16.5	11.1	9.5	2.9	2.5	0.7	1.4	5 099.2
1993	2.1	2.1	2.3	14.6	17.8	10.0	15.1	17.6	5.5	9.3	1.7	1.9	7 402.3
1994	6.6	5.8	7.5	11.1	7.0	5.7	5.2	36.5	8.9	3.0	0.8	2.0	5 158.9
1995	1.9	7.7	9.4	13.6	9.2	8.7	10.0	27.0	8.5	0.8	1.1	2.2	7 341.6
1996	2.9	8.1	10.1	12.8	11.8	11.3	21.2	14.8	4.3	1.9	0.5	0.3	8 208.1
1997	3.3	14.7	17.9	11.4	6.7	7.8	14.6	17.6	3.5	1.6	0.4	0.3	9 722.8
1998	5.8	8.9	15.2	12.0	8.8	13.8	10.8	14.1	8.1	1.8	0.4	0.4	9 104.0
1999	7.6	5.6	5.7	14.8	13.7	10.1	23.5	6.1	8.0	3.4	0.6	0.9	7 932.6
2000	3.2	4.3	8.1	18.9	15.8	11.5	16.5	14.1	6.1	1.1	0.2	0.2	8 909.9
2001	5.1	7.5	4.3	22.1	16.8	12.9	11.8	12.8	5.8	0.4	0.1	0.3	5 988.6
2002	14.0	9.8	3.7	7.4	12.4	16.8	10.6	15.9	6.8	1.1	0.2	1.2	6 170.2
2003	2.1	5.8	6.0	5.6	9.2	7.2	20.7	24.3	15.5	1.0	0.4	2.0	6 435.7
2004	4.3	5.0	6.5	12.2	10.1	10.8	22.5	11.2	14.5	1.6	0.6	0.8	4 528.3
2005	2.2	4.4	2.1	11.5	12.6	10.3	6.3	25.8	10.8	3.1	2.6	8.2	4 664.0
2006	9.4	6.9	5.3	7.5	7.6	13.0	15.8	11.9	9.5	7.2	4.8	1.2	6 685.6
2007	5.1	7.0	4.1	4.6	8.0	20.3	13.6	18.7	6.8	7.2	3.5	1.2	2 959.4
2008	18.7	3.4	2.3	5.7	5.7	9.5	8.7	15.0	7.3	8.7	0.5	14.4	5 186.9
2009	25.5	3.3	1.9	4.3	4.2	7.1	15.2	9.3	4.5	7.2	15.9	1.6	8 852.9
2010	3.2	2.3	1.8	3.1	3.3	44.7	25.5	9.6	2.2	2.0	0.8	1.4	10 439.9
2011	8.7	3.6	3.5	5.0	37.9	16.6	7.1	5.6	4.9	5.7	1.1	0.3	10 879.4
2012	5.2	3.8	2.5	6.3	9.1	6.6	13.5	9.6	20.2	15.3	1.9	5.9	8 613.9
2013	9.9	6.0	5.1	7.2	23.8	13.9	18.3	5.9	6.6	1.3	0.4	1.5	8 841.1
2014	27.2	3.8	1.1	4.1	20.8	24.9	4.8	5.7	5.3	1.2	0.5	0.7	10 737.3
Total catch (t)	15 305.1	11 322.8	11 862.4	18 003.6	23 611.5	25 477.3	26 054.9	24 576.8	13 085.0	6 890.2	3 233.4	3 544.9	182 967.7

Table C9e: Total barracouta catch reported from ECSI of BAR 1, by target species, for fishing years 1990–2014. Target species code definitions are given in Table C10.

Fishing year	BAR	ELE	FLA	HOK	JMA	RCO	SQU	SWA	TAR	WAR	Other	Total catch (t)
1990	3 939.0	23.8	56.3	37.2	2.5	1 391.8	175.0	46.1	58.8	46.3	173.0	5 949.8
1991	4 773.4	17.1	60.8	145.5	116.4	1 460.0	190.5	38.9	56.7	69.2	226.7	7 155.2
1992	2 983.0	6.1	54.4	99.3	2.6	1 245.4	487.1	57.0	45.0	31.0	88.2	5 099.2
1993	4 028.3	6.5	112.3	123.1	125.8	2 205.1	412.8	90.7	17.0	8.5	272.3	7 402.3
1994	1 330.2	5.2	47.3	166.7	119.6	1 339.2	1 876.8	91.2	55.0	29.9	97.9	5 158.9
1995	2 895.0	12.6	39.7	112.8	599.6	2 243.7	1 278.2	42.3	37.3	15.5	65.0	7 341.6
1996	2 708.0	2.4	124.8	126.5	265.1	3 220.3	1 467.7	85.9	74.4	9.6	123.5	8 208.1
1997	3 443.1	7.2	130.1	131.2	329.2	4 569.5	918.5	50.1	59.9	17.0	67.1	9 722.8
1998	2 488.1	0.3	227.7	133.8	592.2	4 239.0	1 161.6	8.1	22.0	14.9	216.3	9 104.0
1999	3 051.1	2.7	255.3	77.2	801.7	2 133.4	1 445.8	25.3	61.4	37.5	41.3	7 932.6
2000	3 286.8	3.1	100.2	111.7	910.1	2 313.4	2 068.3	7.2	23.3	60.4	25.4	8 909.9
2001	2 062.3	3.7	114.4	44.6	338.3	1 138.4	2 216.9	2.8	23.4	21.6	22.3	5 988.6
2002	2 918.5	9.1	46.8	34.1	670.4	1 229.0	1 105.3	55.9	30.7	29.3	41.3	6 170.2
2003	3 334.7	40.4	18.7	174.2	784.0	1 144.5	806.1	8.4	39.1	37.4	48.3	6 435.7
2004	2 005.4	162.5	47.3	137.3	6.6	1 442.9	603.1	1.6	44.5	32.7	44.5	4 528.3
2005	2 074.8	51.5	34.4	106.1	70.9	1 577.5	398.8	5.0	214.3	90.2	40.4	4 664.0
2006	2 434.4	11.8	17.8	44.3	1 053.3	1 730.8	728.9	11.4	268.3	100.6	178.0	6 685.6
2007	1 217.8	34.5	25.3	22.1	165.8	616.3	464.0	53.7	234.2	60.5	65.1	2 959.4
2008	3 047.5	68.4	32.5	28.5	398.4	585.4	367.4	262.3	282.0	65.8	48.8	5 186.9
2009	6 759.3	88.1	32.1	32.0	292.7	779.8	213.1	78.6	413.6	77.2	86.4	8 852.9
2010	8 162.5	49.0	44.5	15.1	430.8	689.0	63.8	53.1	487.3	288.9	156.0	10 439.9
2011	7 240.9	62.3	23.0	92.0	818.4	843.1	715.3	214.2	502.3	203.5	164.4	10 879.4
2012	5 937.5	168.0	36.7	52.3	399.5	798.6	177.8	195.3	355.0	388.5	104.8	8 613.9
2013	5 294.0	83.6	100.5	40.5	568.5	1 173.9	98.4	344.0	533.1	258.9	345.7	8 841.1
2014	6 381.5	65.0	64.0	64.4	1 800.0	998.2	91.7	220.3	569.9	76.3	406.0	10 737.3
Total (t)	93 796.9	1 091.0	1 846.6	2 152.2	11 662.3	41 108.2	19 532.9	2 049.2	4 508.5	2 071.0	3 148.7	182 967.7

Table C9f: Total barracouta landed catch and percentage reported from the ECNI of BAR 1, by Statistical Area, for fishing years 1990–2014.

Fishing year	018	020	021	022	023	024	026	Other	Total catch (t)
1990	7.0	17.3	0.8	72.1	0.0	1.5	0.9	0.4	5 949.8
1991	7.5	12.7	2.3	60.4	1.5	12.4	3.0	0.2	7 155.2
1992	4.0	16.4	0.7	52.0	0.3	24.2	2.4	0.0	5 099.2
1993	4.1	6.8	2.8	64.2	0.2	15.1	6.7	0.1	7 402.3
1994	6.9	13.8	4.3	66.8	0.5	5.7	2.0	0.0	5 158.9
1995	3.3	14.8	4.6	64.8	0.1	11.6	0.7	0.2	7 341.6
1996	4.5	15.1	1.2	67.8	0.7	6.4	4.3	0.0	8 208.1
1997	3.8	13.5	0.8	72.2	0.7	7.0	1.8	0.1	9 722.8
1998	3.0	23.7	0.8	63.1	0.2	5.4	3.8	0.0	9 104.0
1999	5.4	14.3	0.1	66.9	0.5	10.7	2.1	0.1	7 932.6
2000	2.4	11.2	0.2	76.1	0.8	8.0	1.3	0.0	8 909.9
2001	6.0	14.1	0.4	65.5	0.7	5.6	7.6	0.0	5 988.6
2002	4.6	18.1	0.2	63.4	0.4	12.0	1.3	0.0	6 170.2
2003	3.1	10.0	1.9	77.2	0.0	5.7	2.1	0.0	6 435.7
2004	3.2	13.4	0.1	51.8	0.1	27.6	3.7	0.0	4 528.3
2005	2.9	21.3	0.0	68.9	0.1	5.6	1.2	0.0	4 664.0
2006	1.2	10.3	2.5	74.6	0.4	8.9	2.2	0.0	6 685.6
2007	2.1	20.4	0.8	61.3	0.1	14.8	0.5	0.0	2 959.4
2008	2.5	12.4	3.3	62.7	0.0	16.8	2.3	0.0	5 186.9
2009	0.7	5.4	0.8	76.9	0.1	14.1	1.9	0.1	8 852.9
2010	0.6	10.9	0.4	79.3	0.1	7.0	1.7	0.0	10 439.9
2011	1.2	17.1	0.1	65.7	0.6	12.0	3.2	0.0	10 879.4
2012	1.1	11.3	0.2	78.3	0.2	6.9	2.0	0.0	8 613.9
2013	3.3	8.6	2.2	76.4	0.2	7.0	2.4	0.0	8 841.1
2014	1.8	12.1	2.4	77.7	0.4	3.8	1.9	0.0	10 737.3
Total catch (t)	5 935.5	24 572.2	2 392.7	127 137.6	678.3	17 504.7	4 646.9	99.8	182 967.7

Table C10: Species codes used in the report.

Code	Common name	Scientific name
BAR	Barracouta	*Thyrsites atun*
ELE	Elephant fish	*Callorhynchus milii*
FLA	Flatfish species	*Rhombosolea leporina, R. plebeia, R. retiaria, R. tapirina, Pelotretis flavilatus, Peltorhamphus novaezeelandiae, Colistium guntheri, C. nudipinnis*
GSH	Dark ghost shark	*Hydrolagus novaezealandiae*
GUR	Red gurnard	*Chelidonichthys kumu*
HOK	Hoki	*Macruronus novaezelandiae*
JMA	Jack mackerels	*Trachurus declivis*, *T. novaezelandiae*, *T. murphyi*
JDO	John dory	*Zeus faber*
RCO	Red cod	*Pseudophycis bachus*
SKI	Gemfish	*Rexea solandri*
SNA	Snapper	*Pagrus auratus*
SQU	Arrow squid	*Nototodarus gouldi*, *N. sloanii*
SWA	Silver warehou	*Seriolella punctata*
TAR	Tarakihi	*Nemadactylus macropterus*
TRE	Trevally	*Pseudocaranx georgianus*
WAR	Blue warehou	*Seriolella brama*

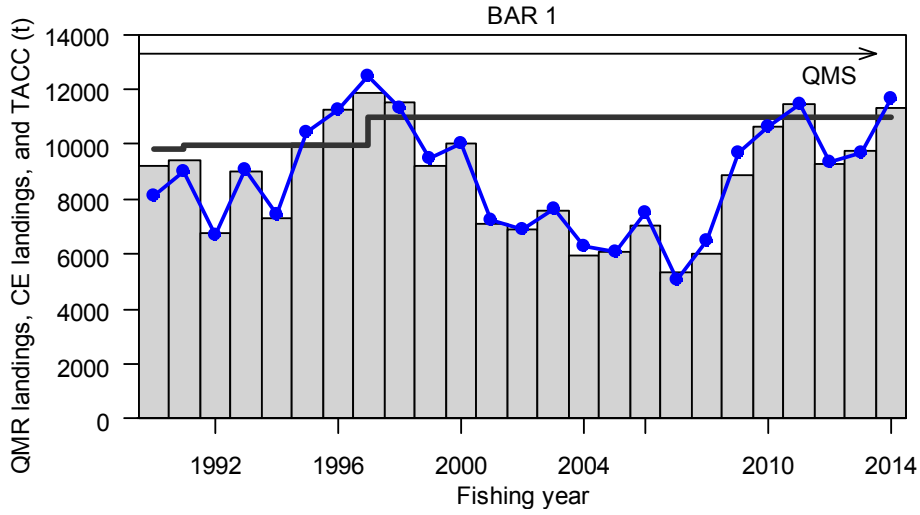


Figure C1: The QMR/MHR landings (grey bars), un-groomed catch effort landings (blue line), and TACC (black line) in tonnes for BAR 1 for the fishing years 1990 to 2014.

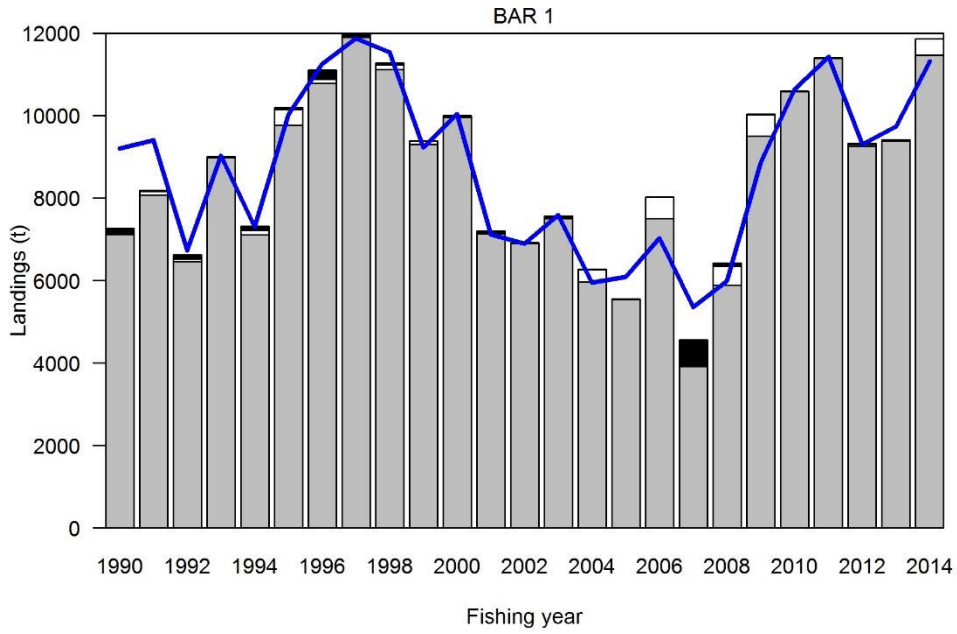


Figure C2: The retained landings (grey bars), interim landings (white bars), and landings dropped during data grooming (black bars), and MHR landings (blue line) in tonnes for BAR 1 for the fishing years 1990 to 2014.

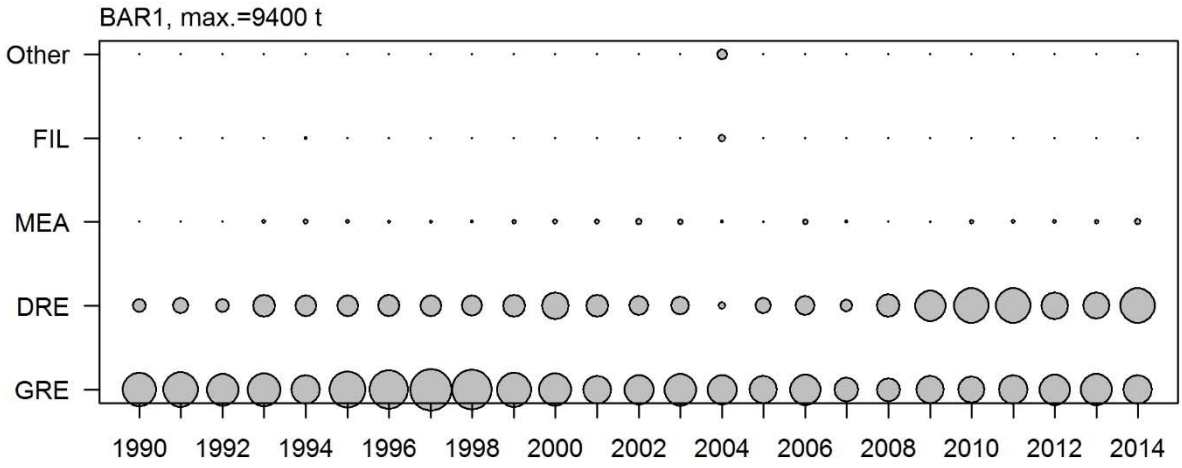


Figure C3: Retained landings (greenweight) by processed state for the BAR 1 stock for fishing years 1990–2014. GRE is Green; DRE is dressed; MEA is mealed; and FIL is filleted or skin off filleted.

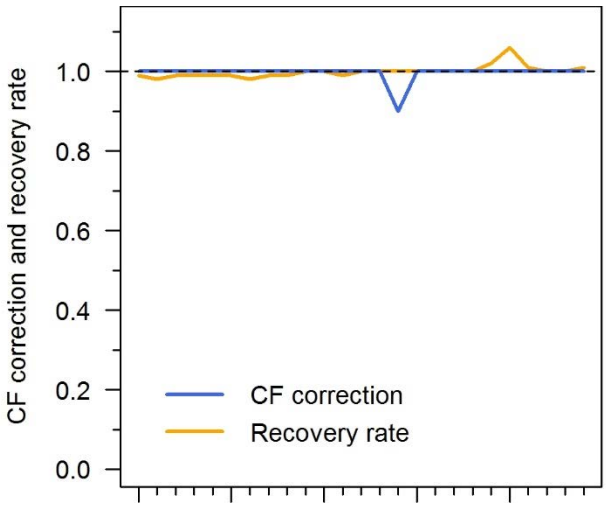


Figure C4: Conversion factor (CF) corrections (by the centroid method), defined as the ratio of annual green weight recalculated using the most recent correction factors for each processed state to the reported green weight, and the recovery rate, defined as the ratio of annual landings in the groomed and merged dataset to those in the groomed and unmerged dataset, for BAR 1, for the fishing years 1990–2014.

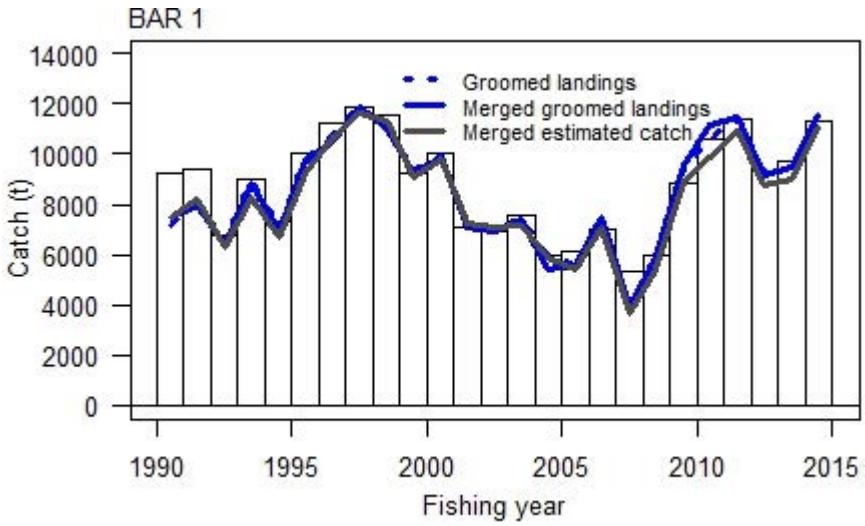


Figure C5: The QMR/MHR landings (white bars), retained landings in the groomed and unmerged dataset (blue dashed line), retained landings in groomed and merged dataset (blue solid line), and estimated catch in the groomed and merged dataset (grey solid line), for BAR 1, for the fishing years 1990–2014.

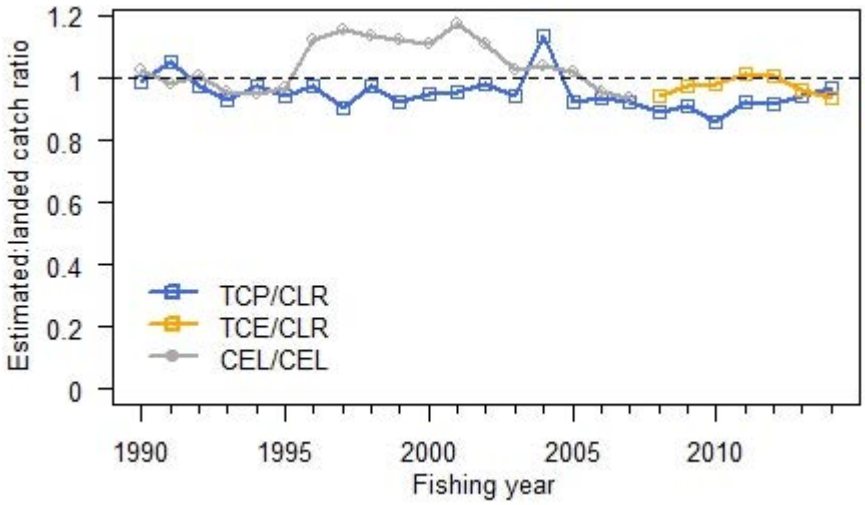


Figure C6: The reporting rate, defined as the ratio of the estimated catch as a proportion of retained landings in the groomed and merged BAR 1 dataset, by form type, for the fishing years 1990–2014.

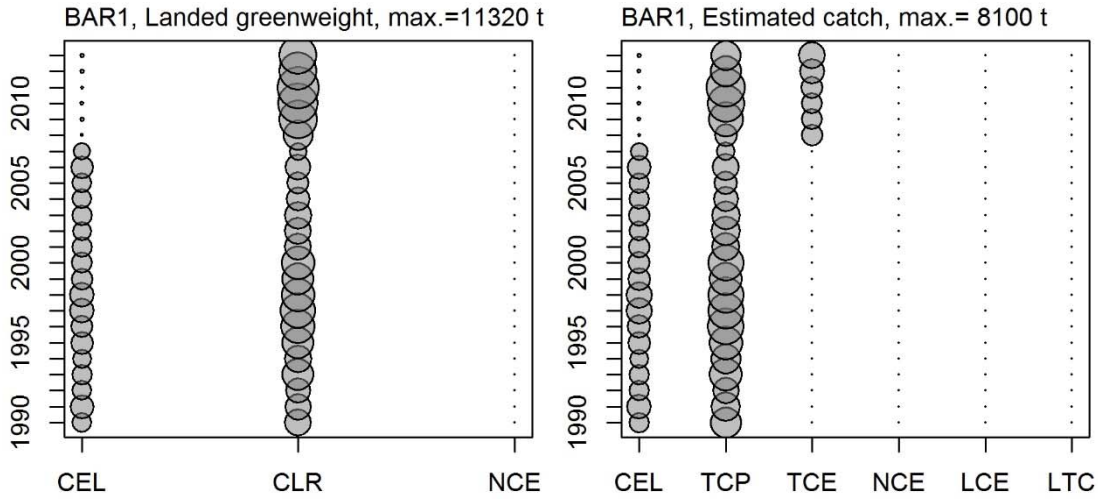


Figure C7: Proportion of landings and estimated catch by form type in the groomed and unmerged dataset, for BAR 1, for the fishing years 1990–2014. The area of the circle is proportional to the annual catches (only comparable within each panel). CEL is Catch Effort Landing Return, CLR is Catch Landing Return, NCE is Netting Catch Effort and Landing Return, TCP is Trawl Catch Effort Processing Return, TCE is Trawl Catch Effort Return, LCE is Lining Catch Effort Return, and LTC is Lining Trip Catch Effort Return.

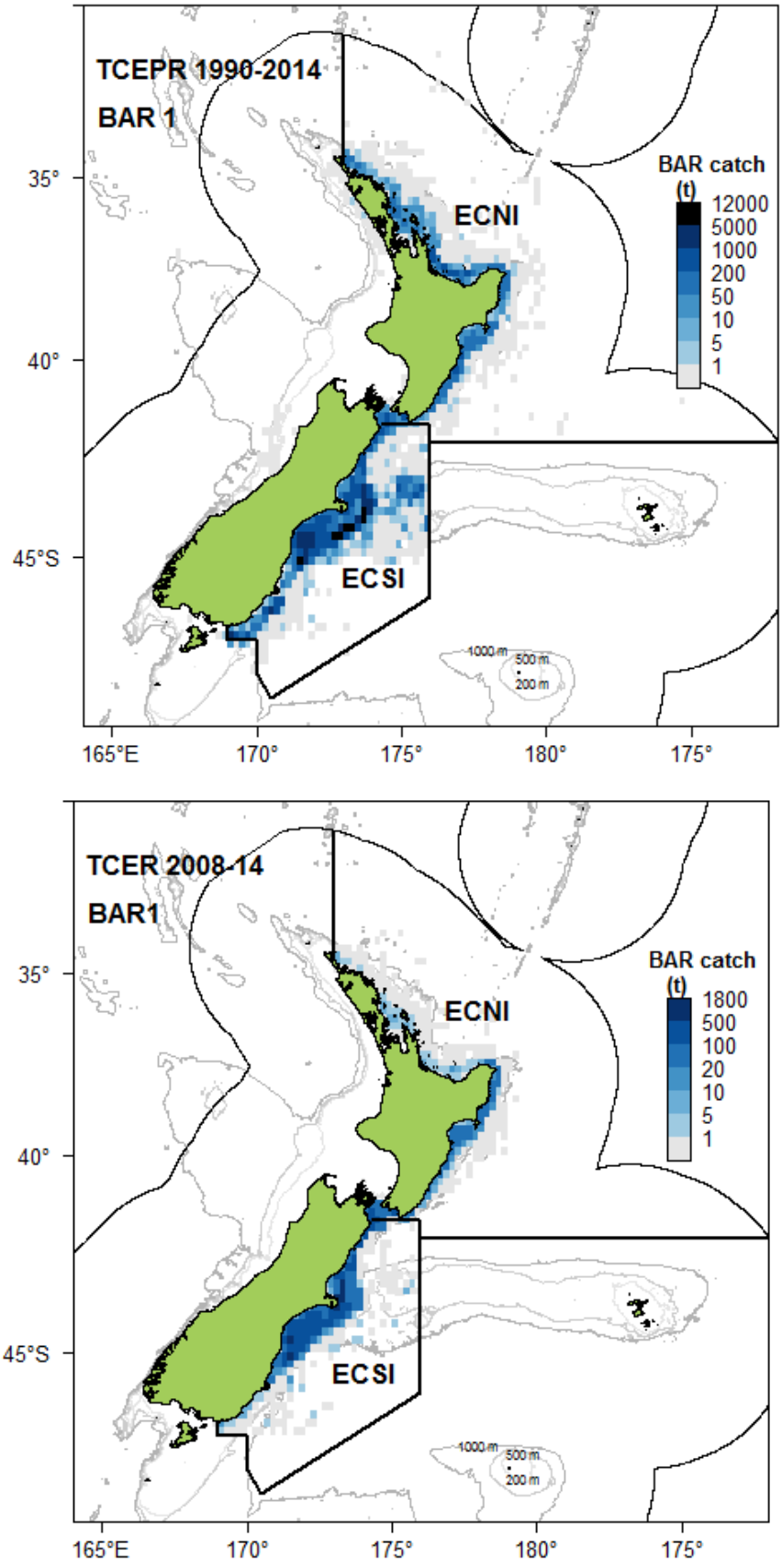


Figure C8: Total estimated barracouta catch (t) from Trawl Catch Effort and Processing Return (TCEPR) records (upper) and for Trawl Catch Effort Return (TCER) (lower), for ECNI and ECSI of BAR 1.

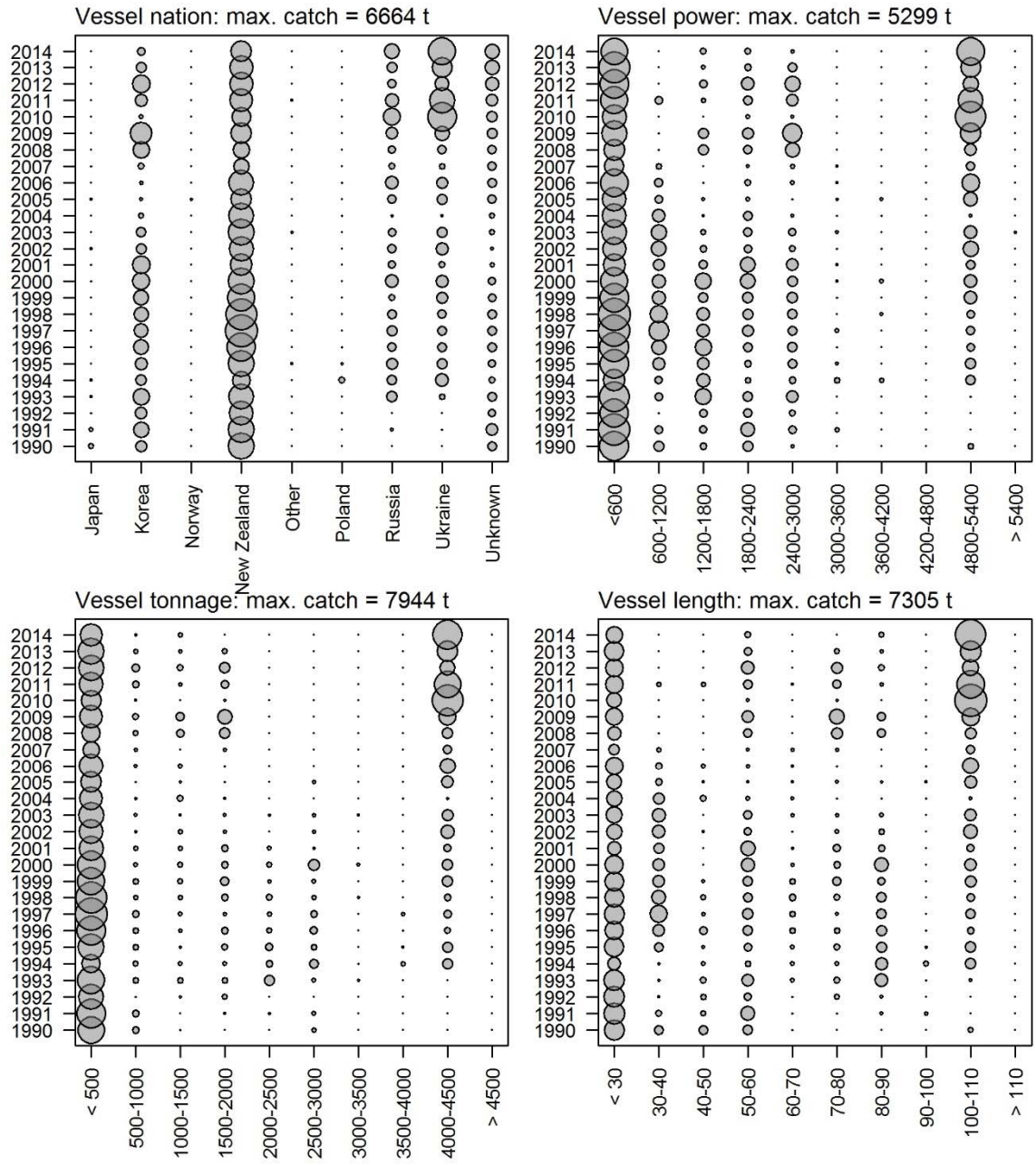


Figure C9: Distribution of annual barracouta catch (t) by vessel nationality, power, tonnage, and length for all groomed merged data in BAR 1, by fishing year from 1990–2014. Circle size is proportional to catch; maximum circle size is indicated on top left hand corner of each plot.

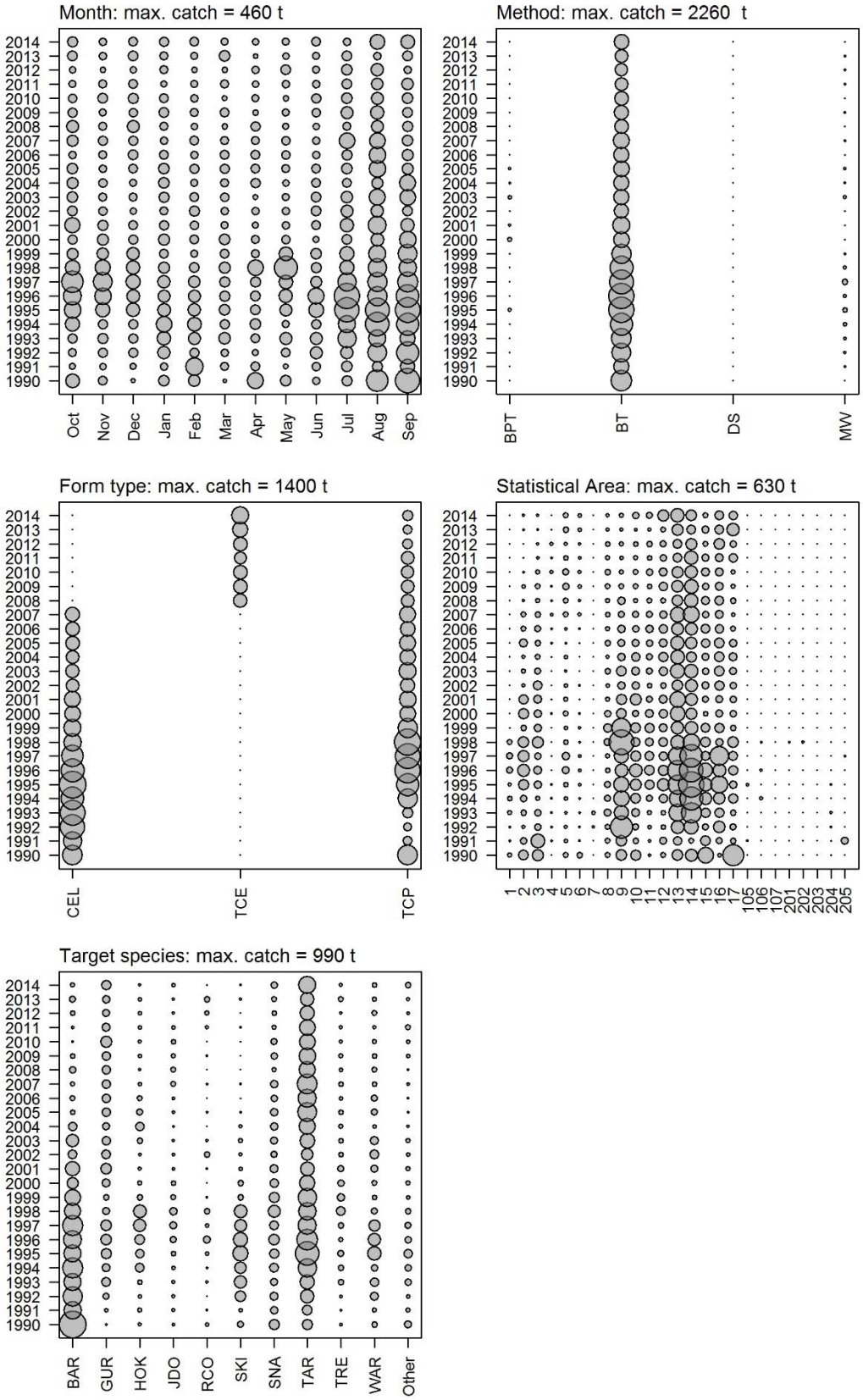


Figure C10: Distribution of annual catch (t) by month, method, form type, statistical area, and target species for ECNI merged data. Circle size is proportional to catch; maximum circle size is indicated on the top left hand corner of each plot. BT is bottom trawl, BPT is bottom paired trawl, MW is midwater trawl, and DS is Danish seine. Form types are defined in Figure C7. Target species codes are given in Table C10. Statistical Areas are shown in Figure 1.

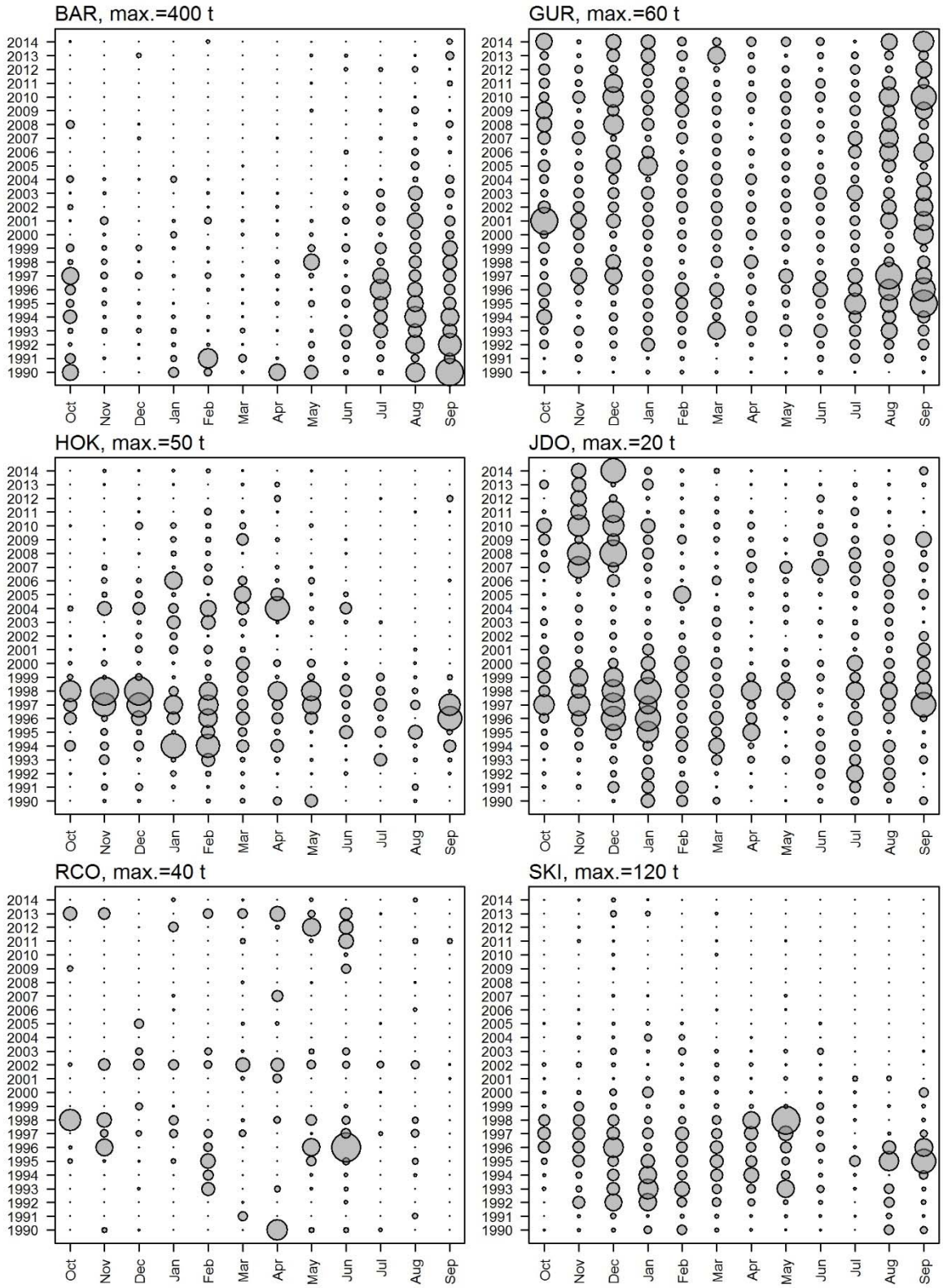


Figure C11a: Distribution of annual catch (t) by month and target species for ECNI merged data. Circle size is proportional to catch; maximum circle size is indicated on the top left hand corner of each plot. See Table C10 for definition of target species codes.

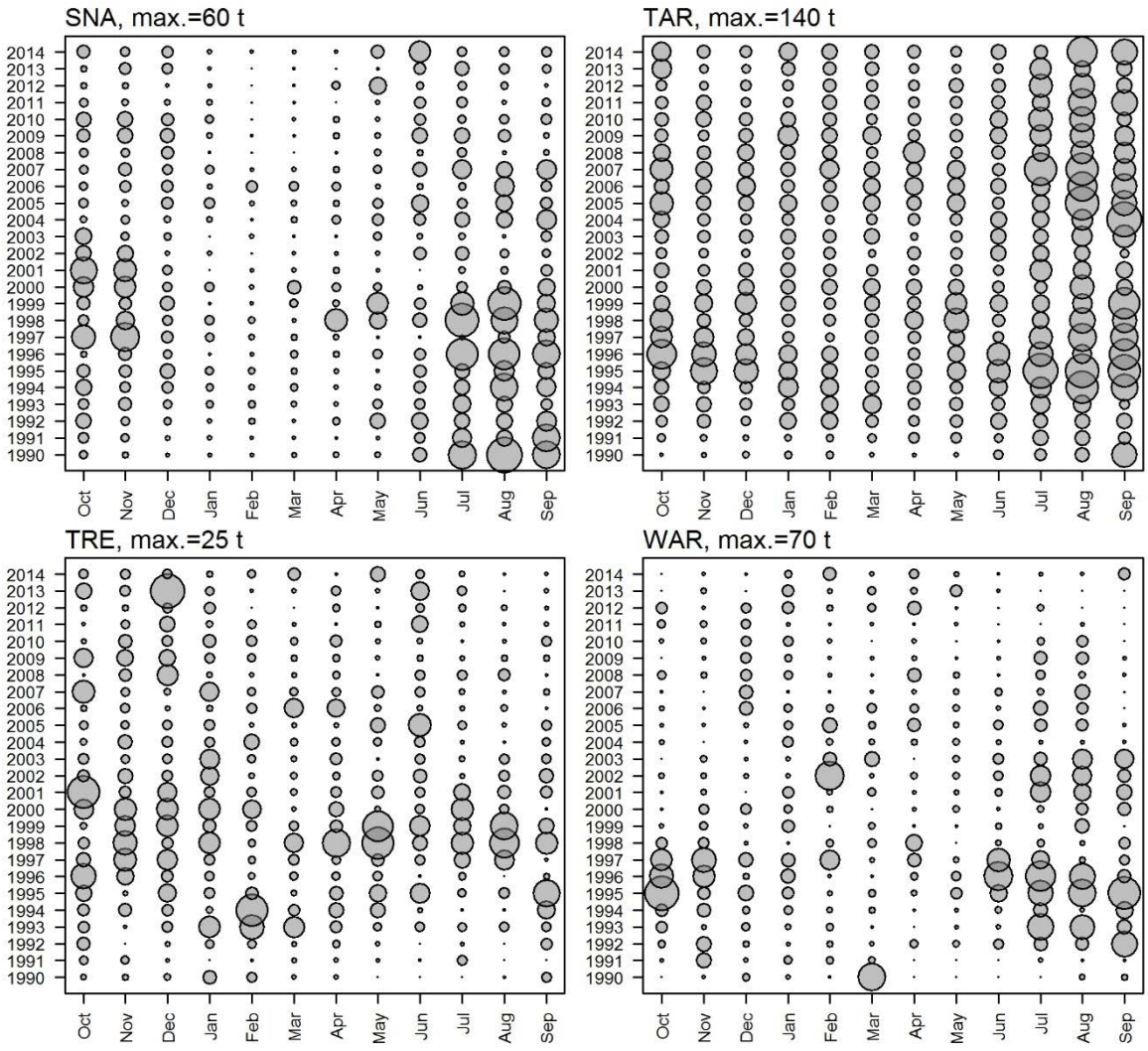


Figure C11a *continued.*

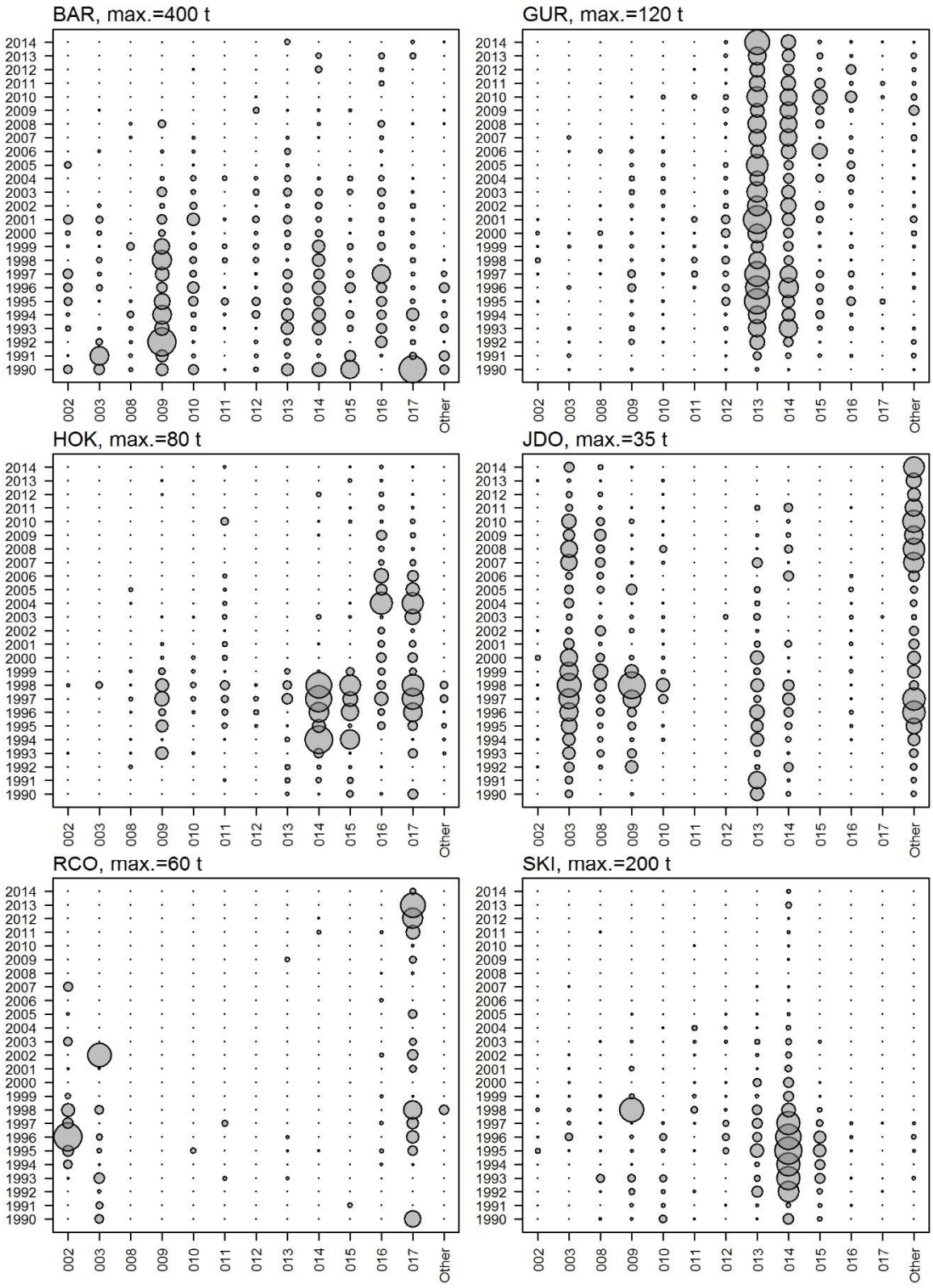


Figure C11b: Distribution of annual catch (t) by statistical area for the main target species for ECNI merged data. Circle size is proportional to catch; maximum circle size is indicated on the top left hand corner of each plot. See Table C10 for definition of target species codes and Figure 1 for statistical areas.

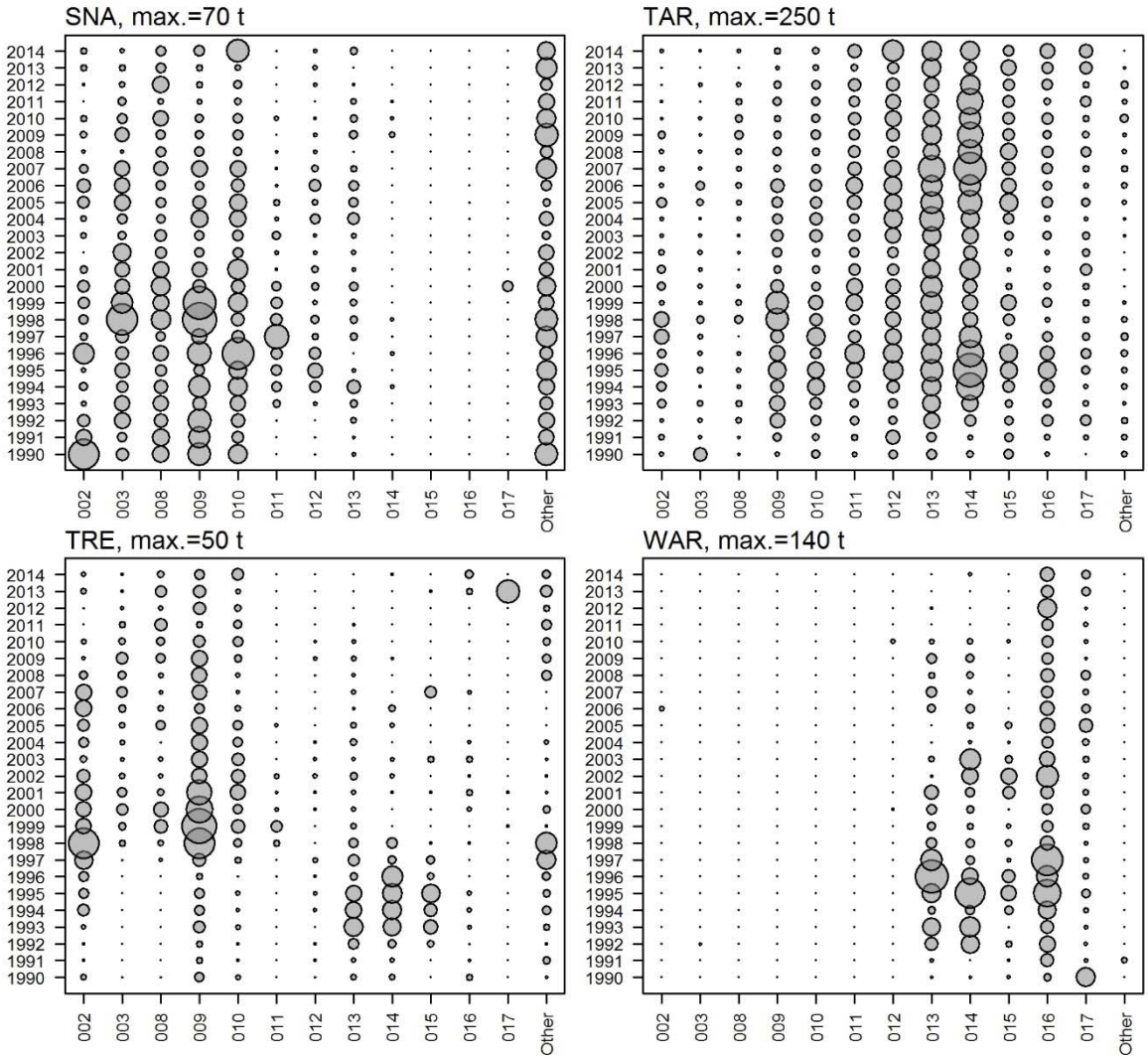


Figure C11b *continued.*

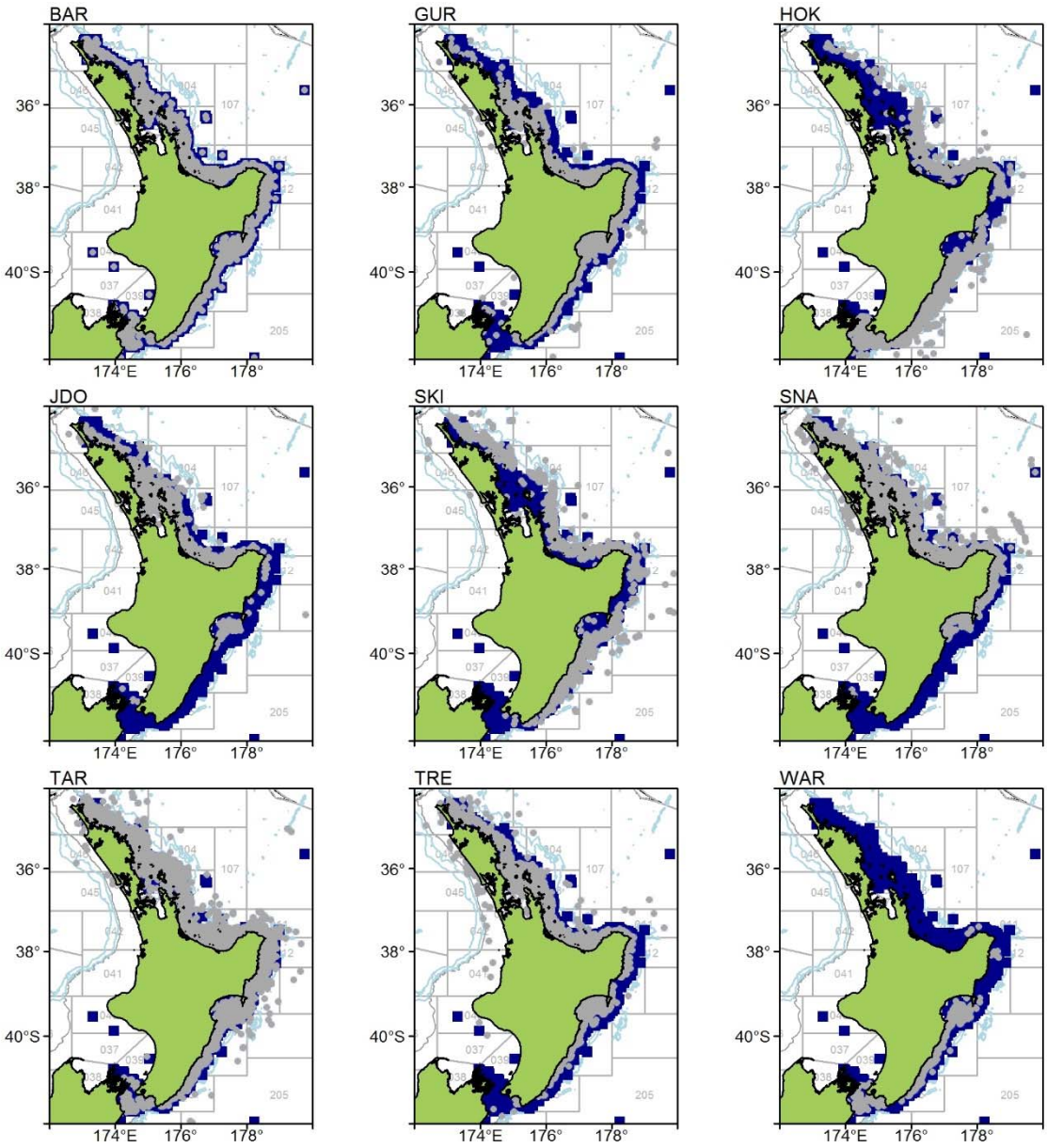


Figure C12a: Distribution of TCEPR effort for barracouta (■), for the main target species (■), and for the main target species where barracouta was caught (●), for the BAR 1 ECNI fishery, 1990–2014. Target species codes are defined in Table C10.

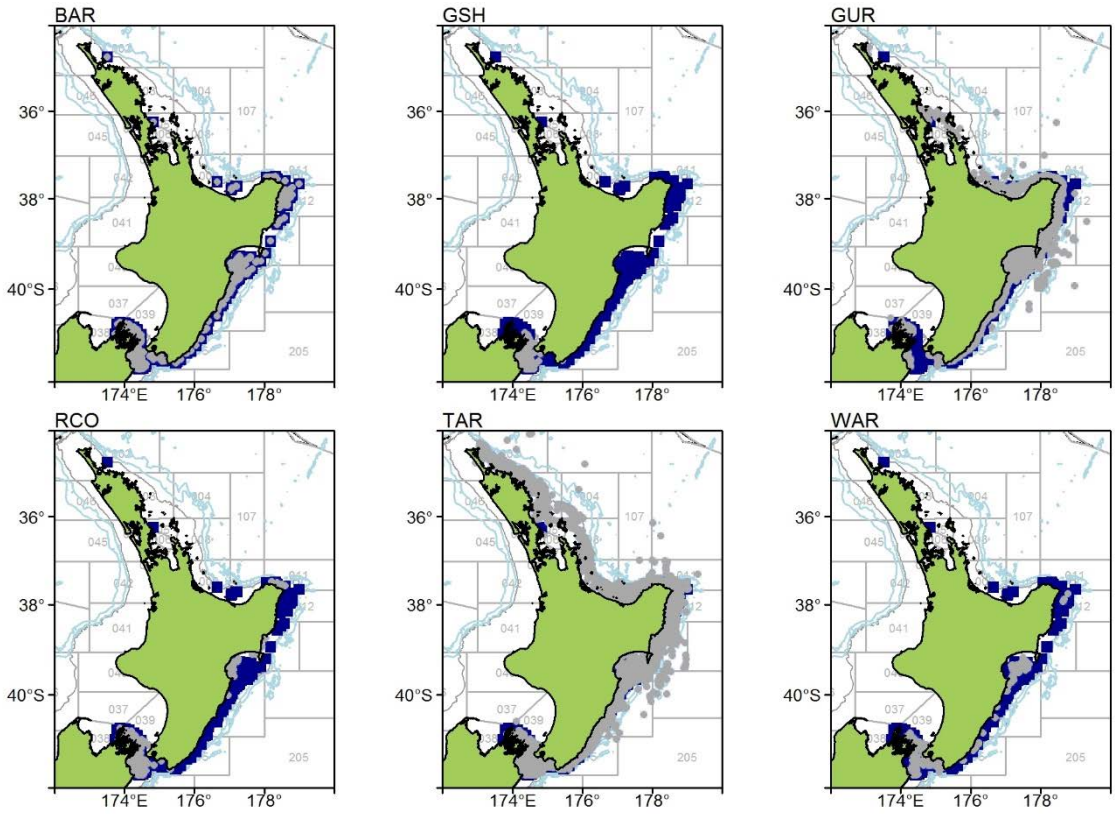


Figure C12b: Distribution of TCER effort for barracouta (■), for the main target species (■), and for the main target species where barracouta was caught (●), for the BAR 1 ECNI fishery, 2008–14. Target species codes are defined in Table C10.

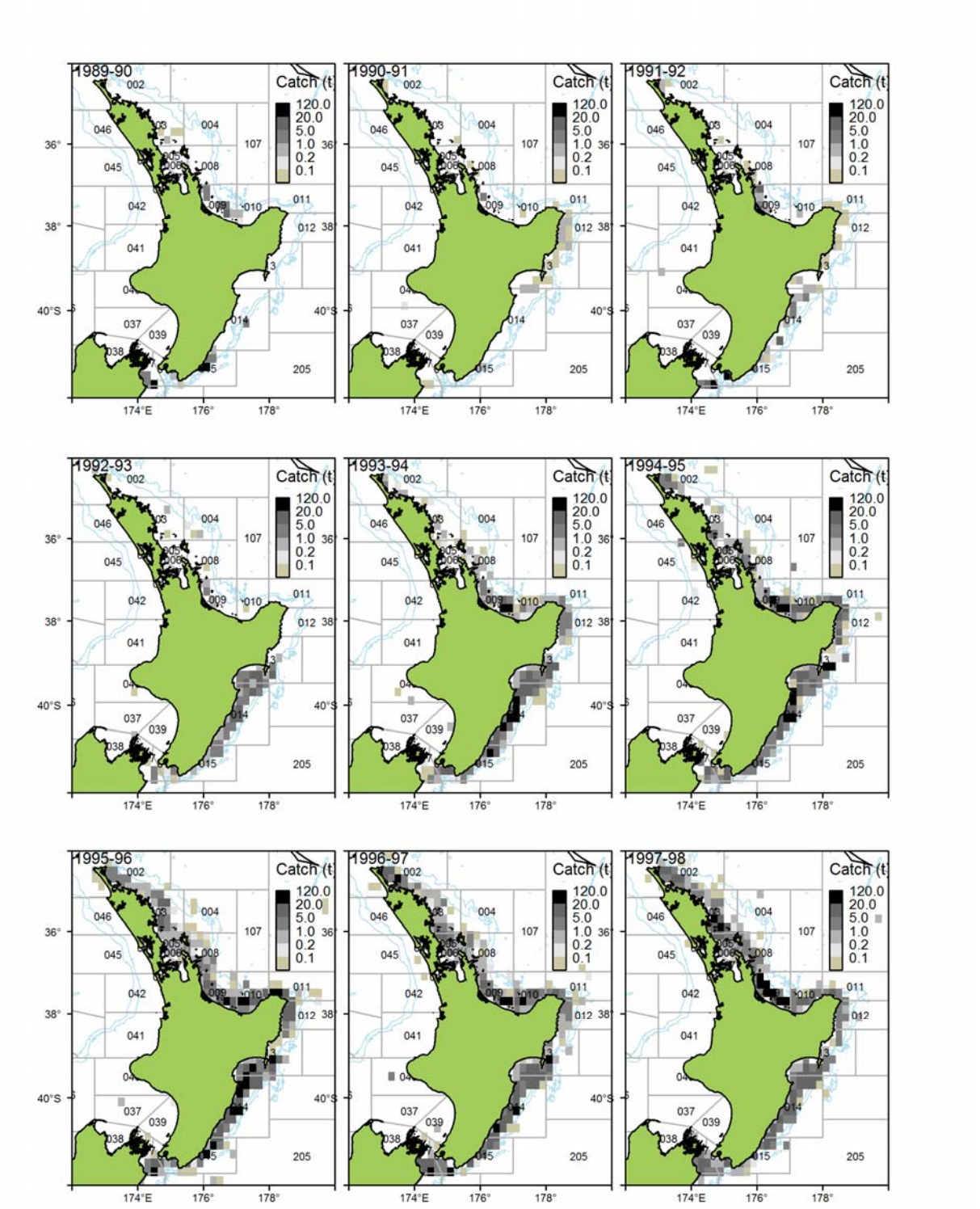


Figure C13a: Distribution of TCEPR bottom trawl barracouta catch aggregated into 0.2° cells within the BAR 1 ECNI area, 1989–90 to 2013–14. Blue lines show the 500 m and 1000 m depth contours.

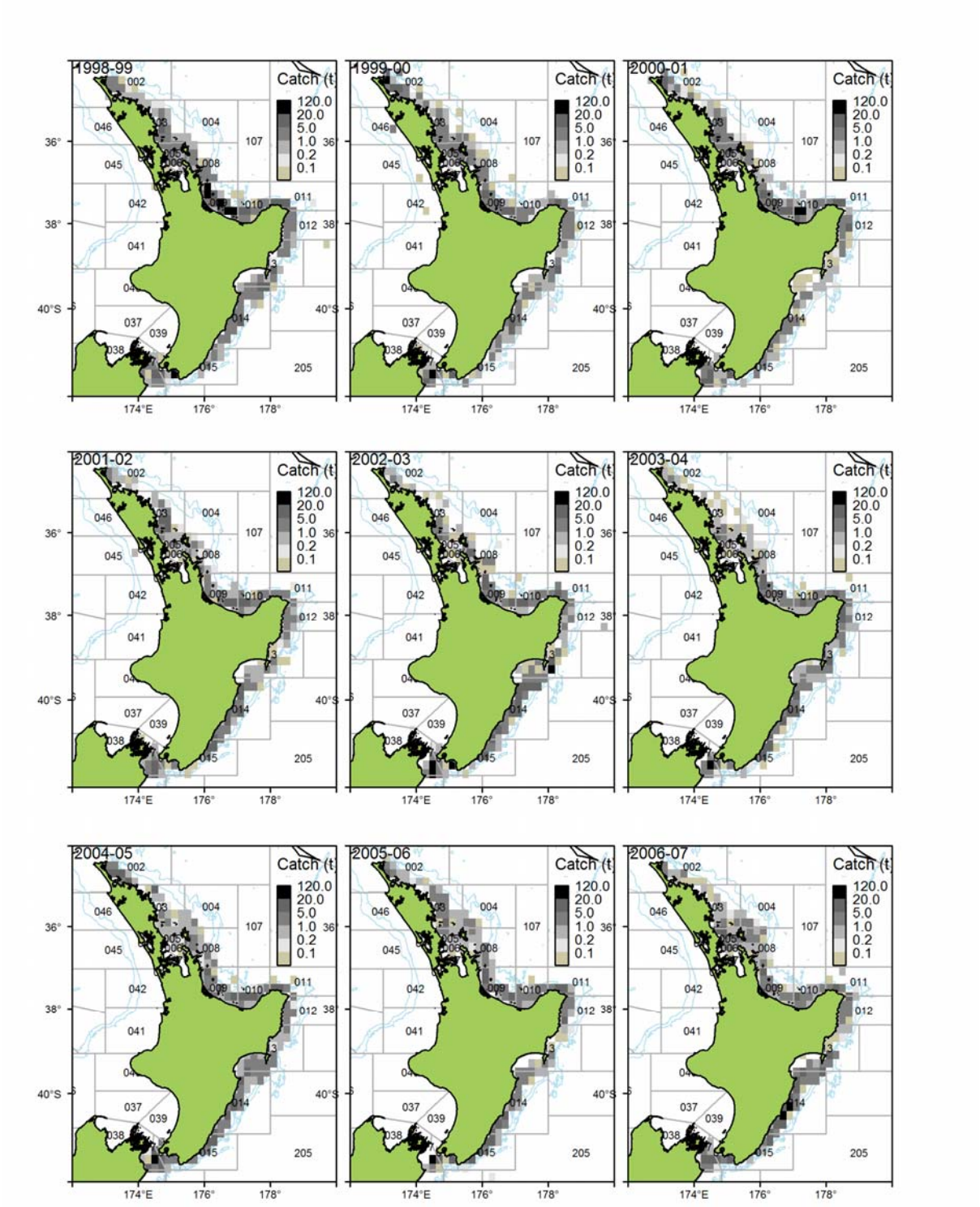


Figure C13a *continued.*

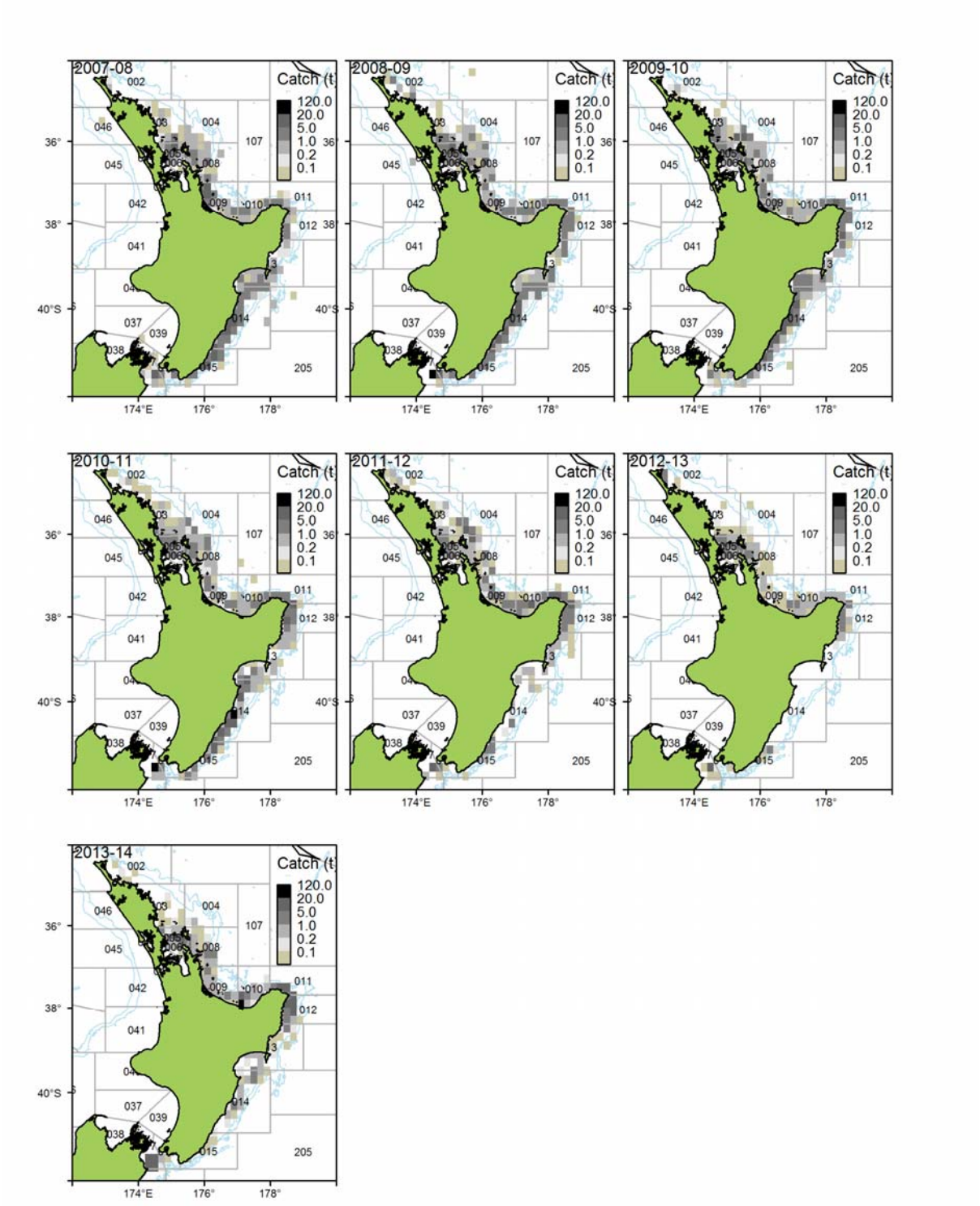


Figure C13a *continued.*

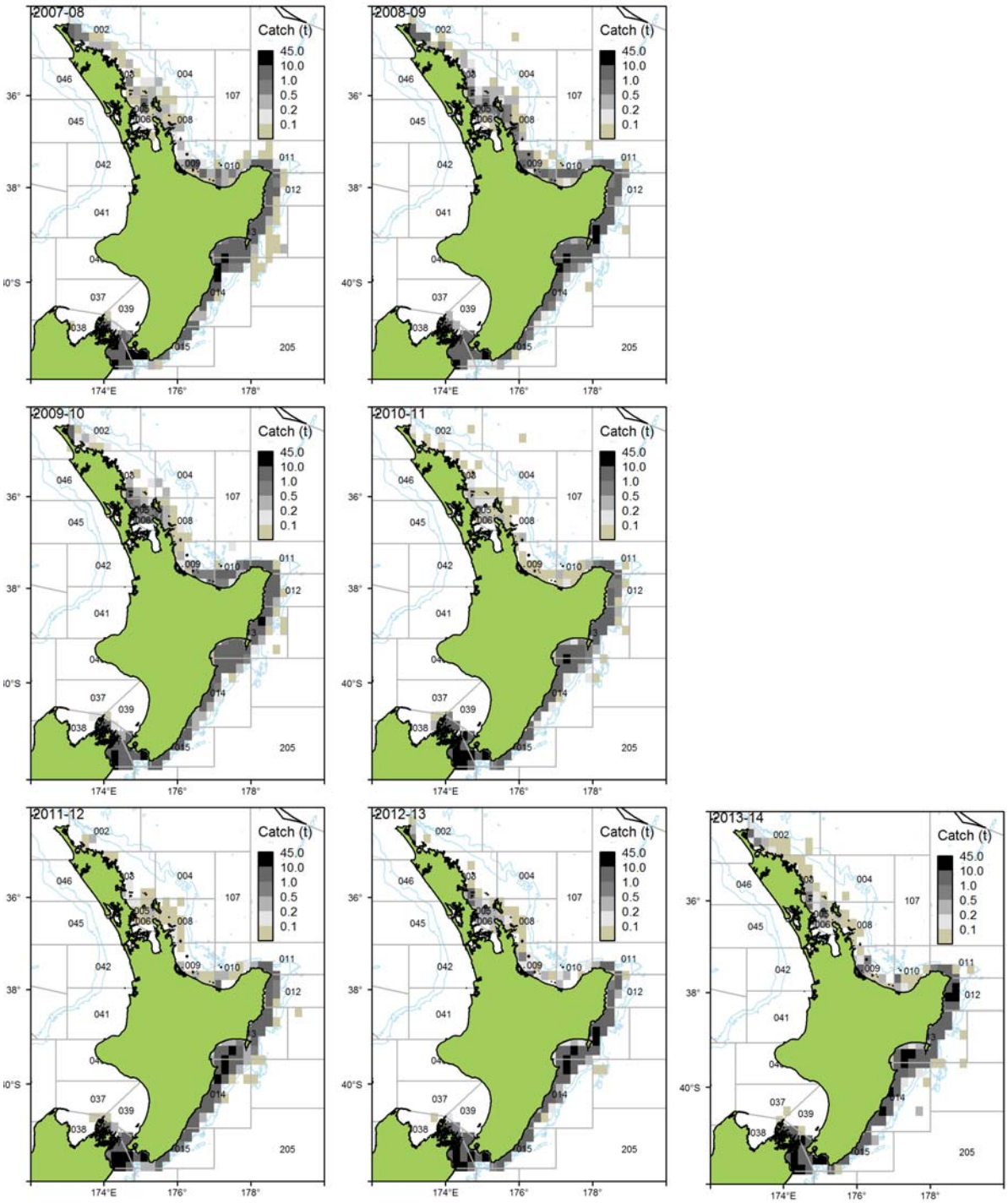


Figure C13b: Distribution of TCER bottom trawl barracouta catch aggregated into 0.2° cells within the BAR 1 ECNI area, 2007–08 to 2013–14. Blue lines show the 500 m and 1000 m depth contours.

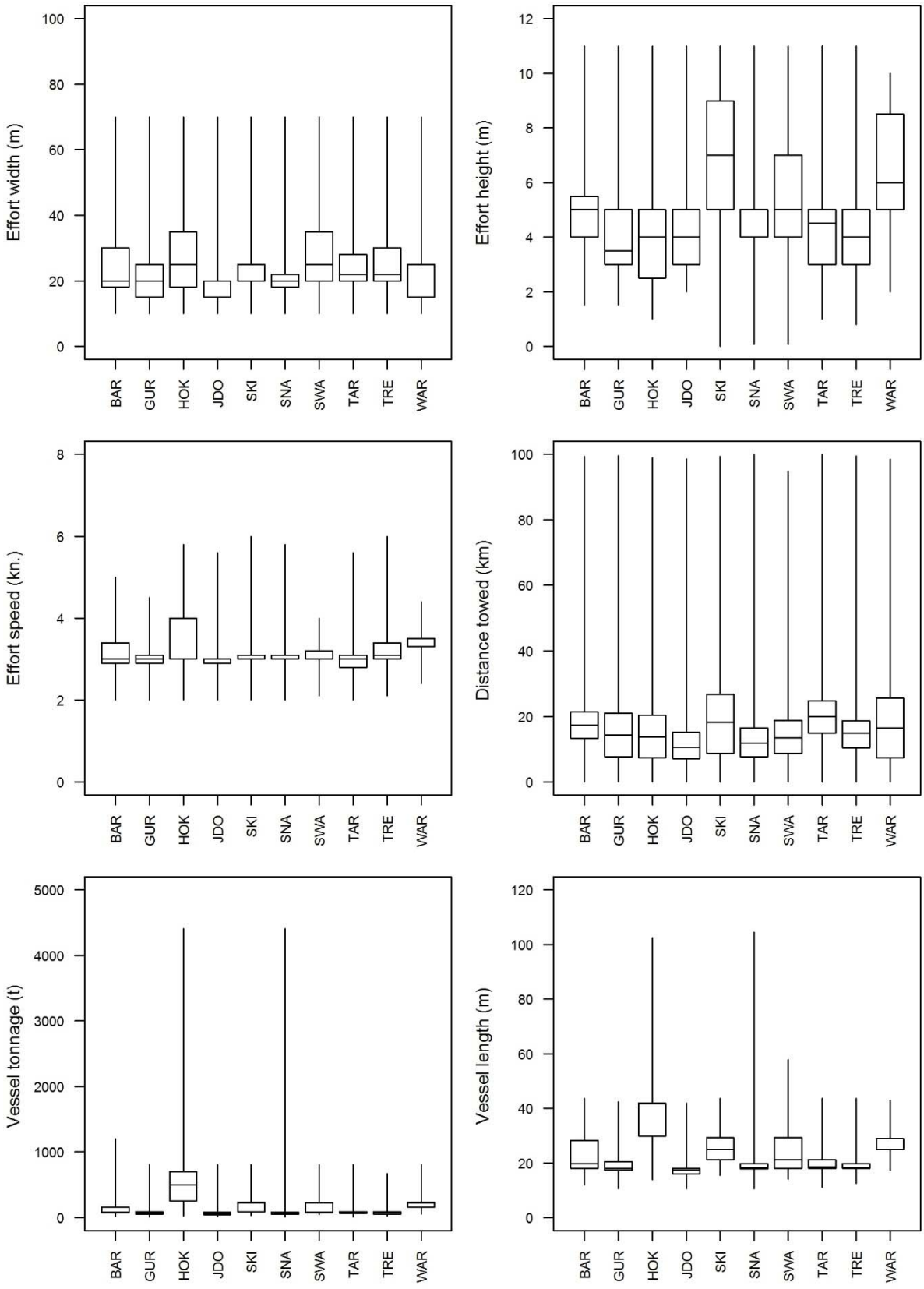


Figure C14a: Annual median (horizontal line), inter-quartile range (box), and range (vertical lines) of TCEPR bottom trawl variables reported for major target species effort with barracouta catch in the BAR 1 ECNI fishery area, based on the groomed unmerged data. Target species codes are defined in Table C10.

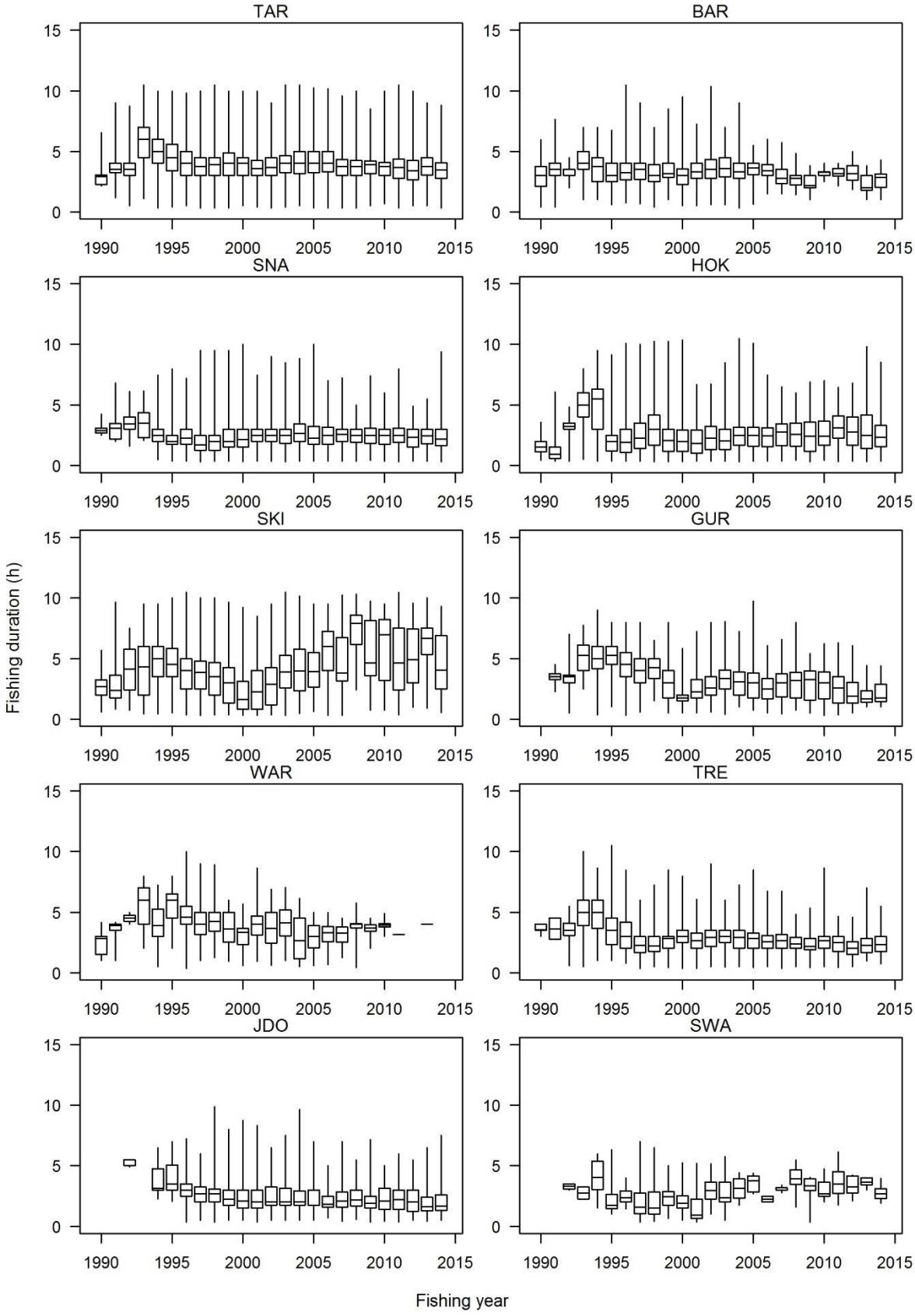


Figure C14b: Annual median (horizontal line), inter-quartile range (box), and range (vertical lines) of TCEPR bottom trawl tow durations reported for major target species effort with barracouta catch in the BAR 1 ECNI fishery area, based on the groomed unmerged data. Target species codes are defined in Table C10.

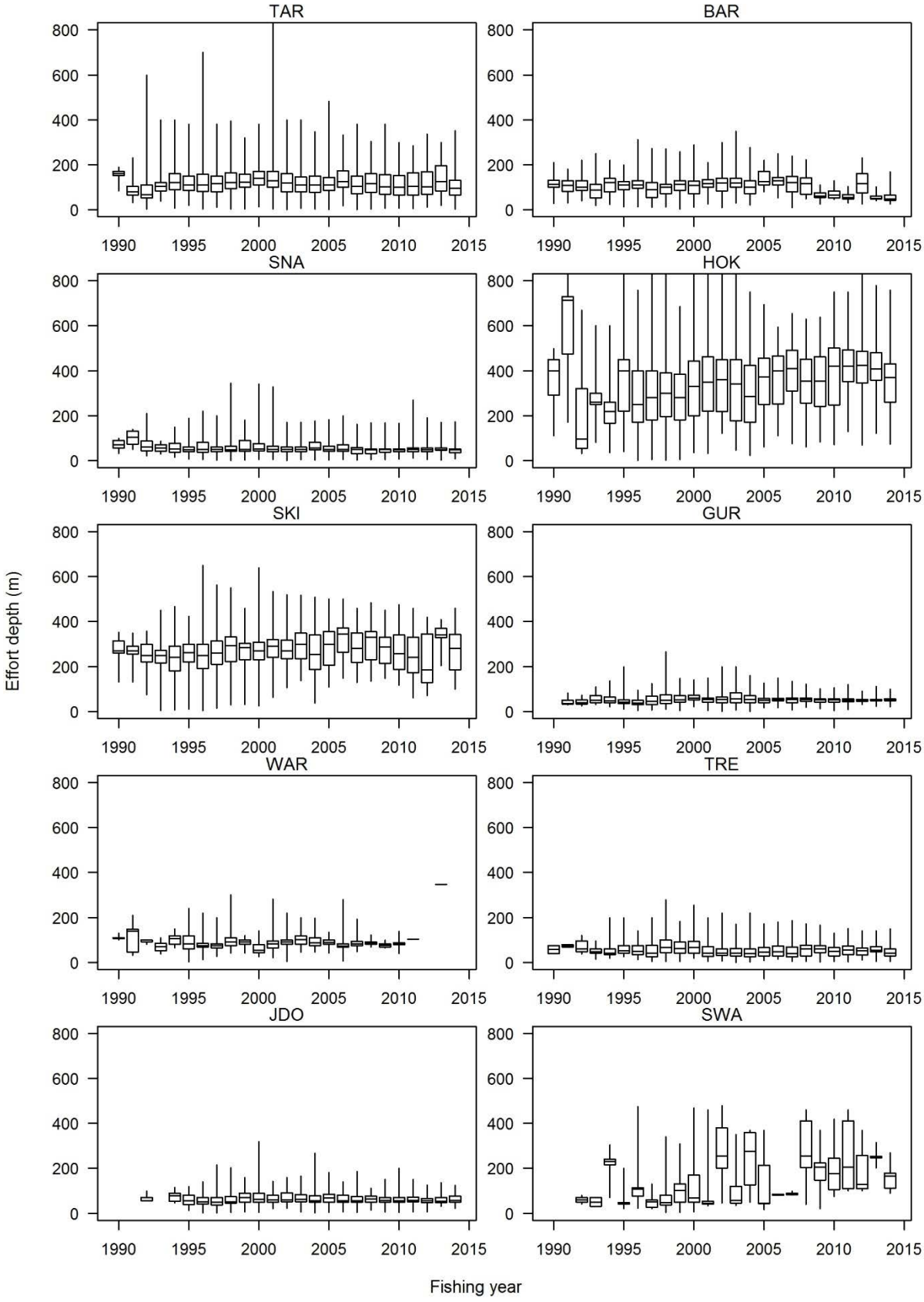


Figure C14c: Annual median (horizontal line), inter-quartile range (box), and range (vertical lines) of TCEPR bottom trawl effort depths reported for major target species effort with barracouta catch in the BAR 1 ECNI fishery area, based on the groomed unmerged data. Target species codes are defined in Table C10.

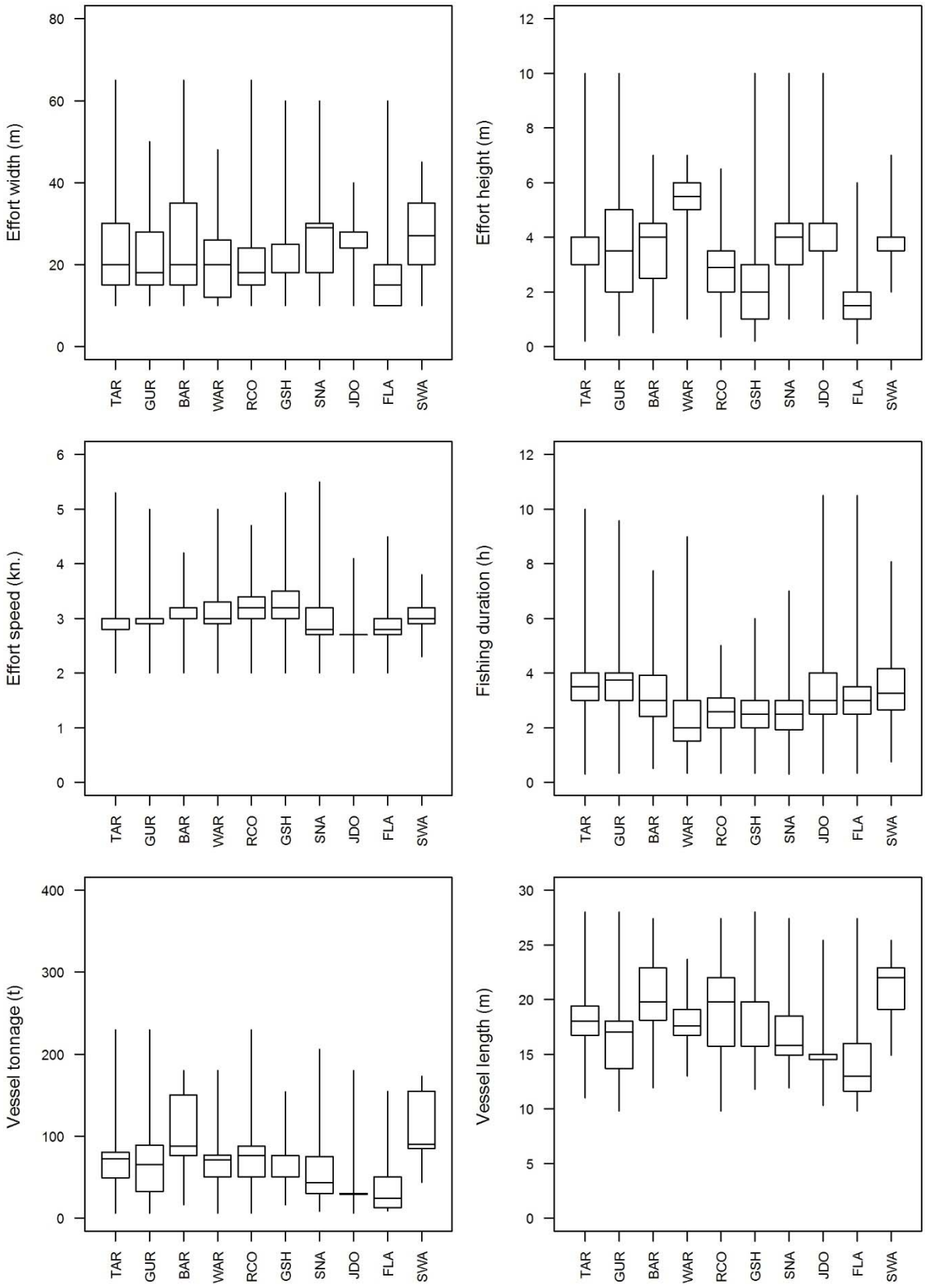


Figure C15a: Annual median (horizontal line), inter-quartile range (box), and range (vertical lines) of TCER bottom trawl variables reported for major target species effort with barracouta catch in the BAR 1 ECNI fishery area, based on the groomed unmerged data. Target species codes are defined in Table C10.

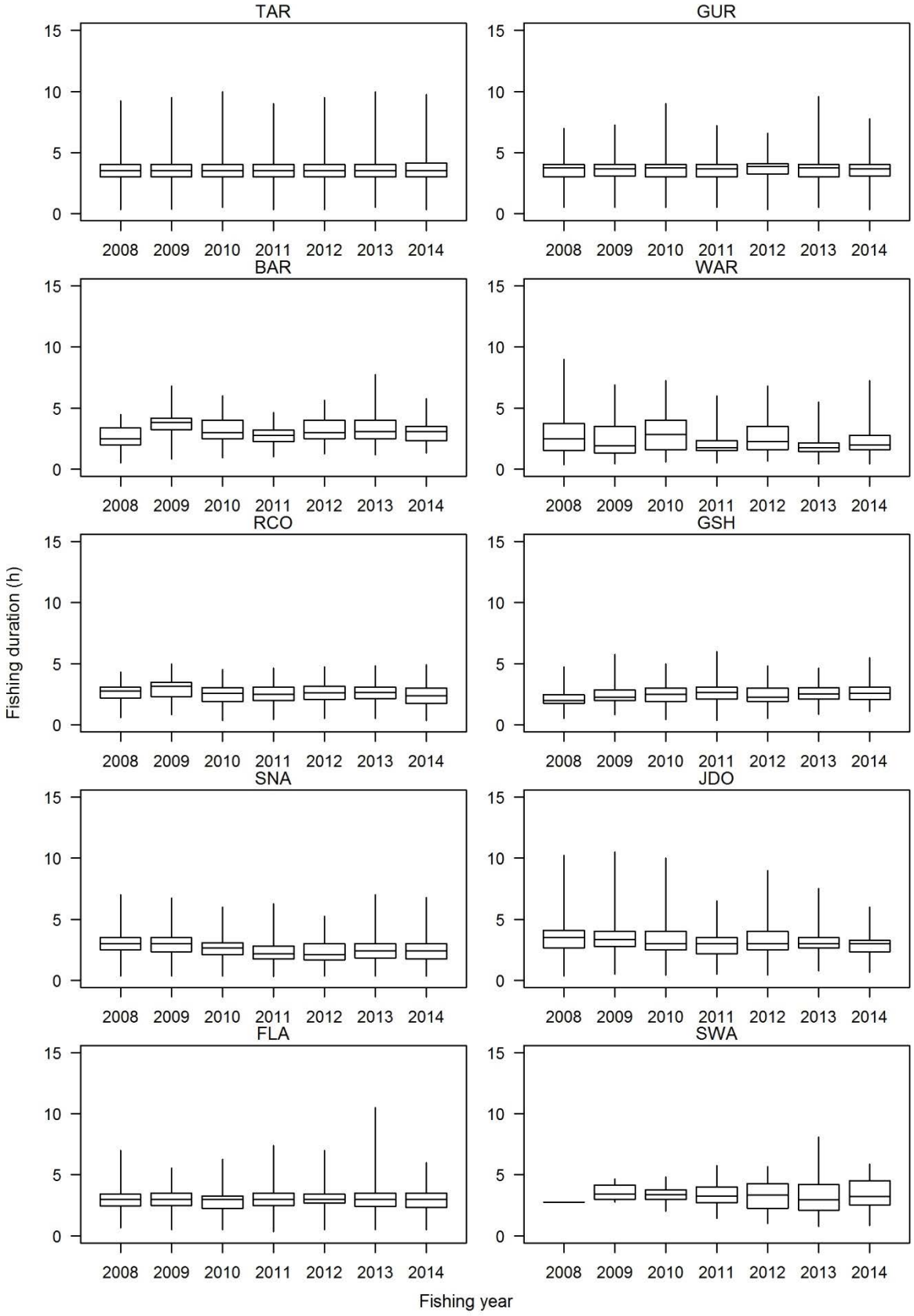


Figure C15b: Annual median (horizontal line), inter-quartile range (box), and range (vertical lines) of TCER bottom trawl tow durations reported for major target species effort with barracouta catch in the BAR 1 ECNI fishery area, based on the groomed unmerged data. Target species codes are defined in Table C10.

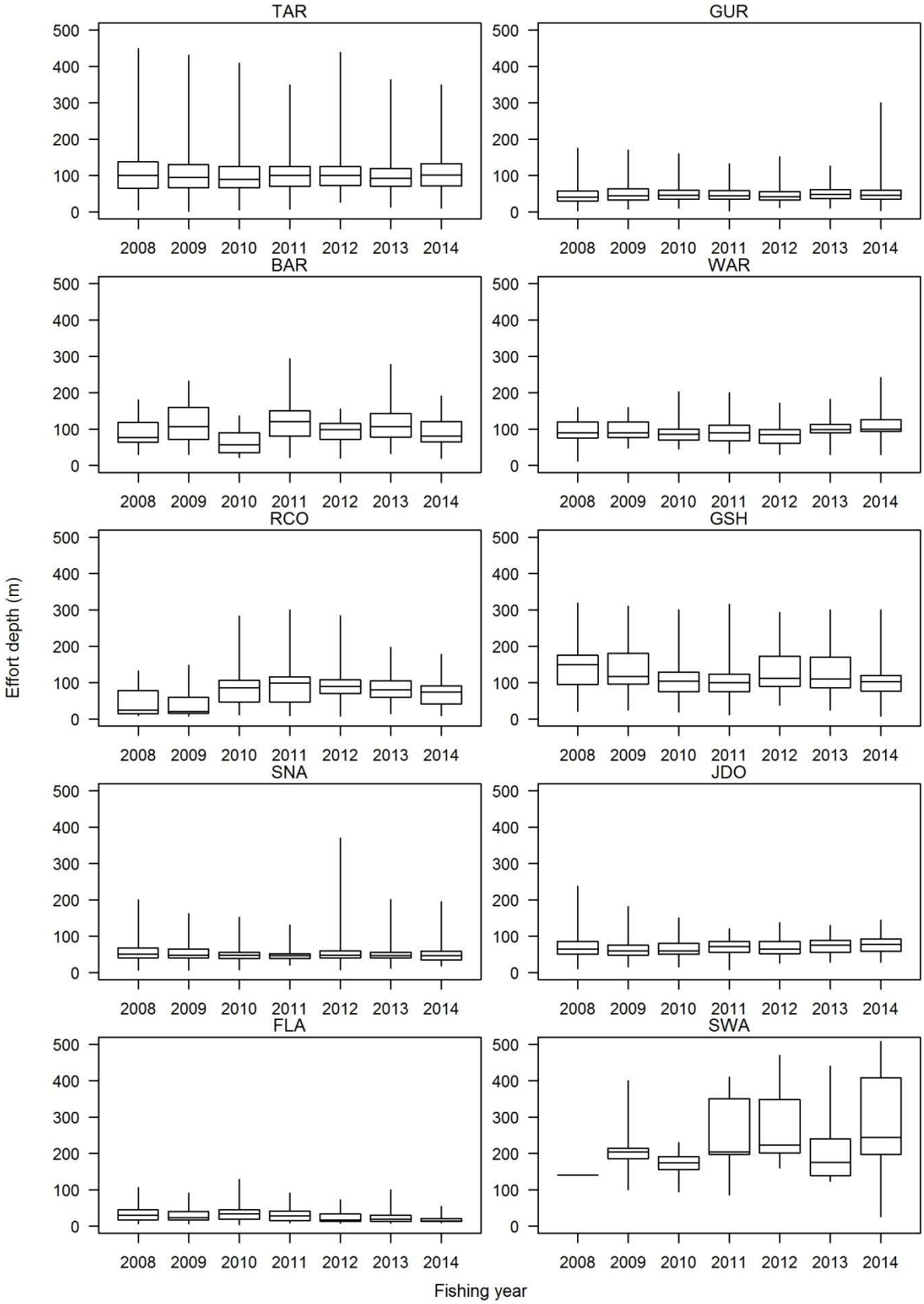


Figure C15c: Annual median (horizontal line), inter-quartile range (box), and range (vertical lines) of TCER bottom trawl effort depths reported for major target species effort with barracouta catch in the BAR 1 ECNI fishery area, based on the groomed unmerged data. Target species codes are defined in Table C10.

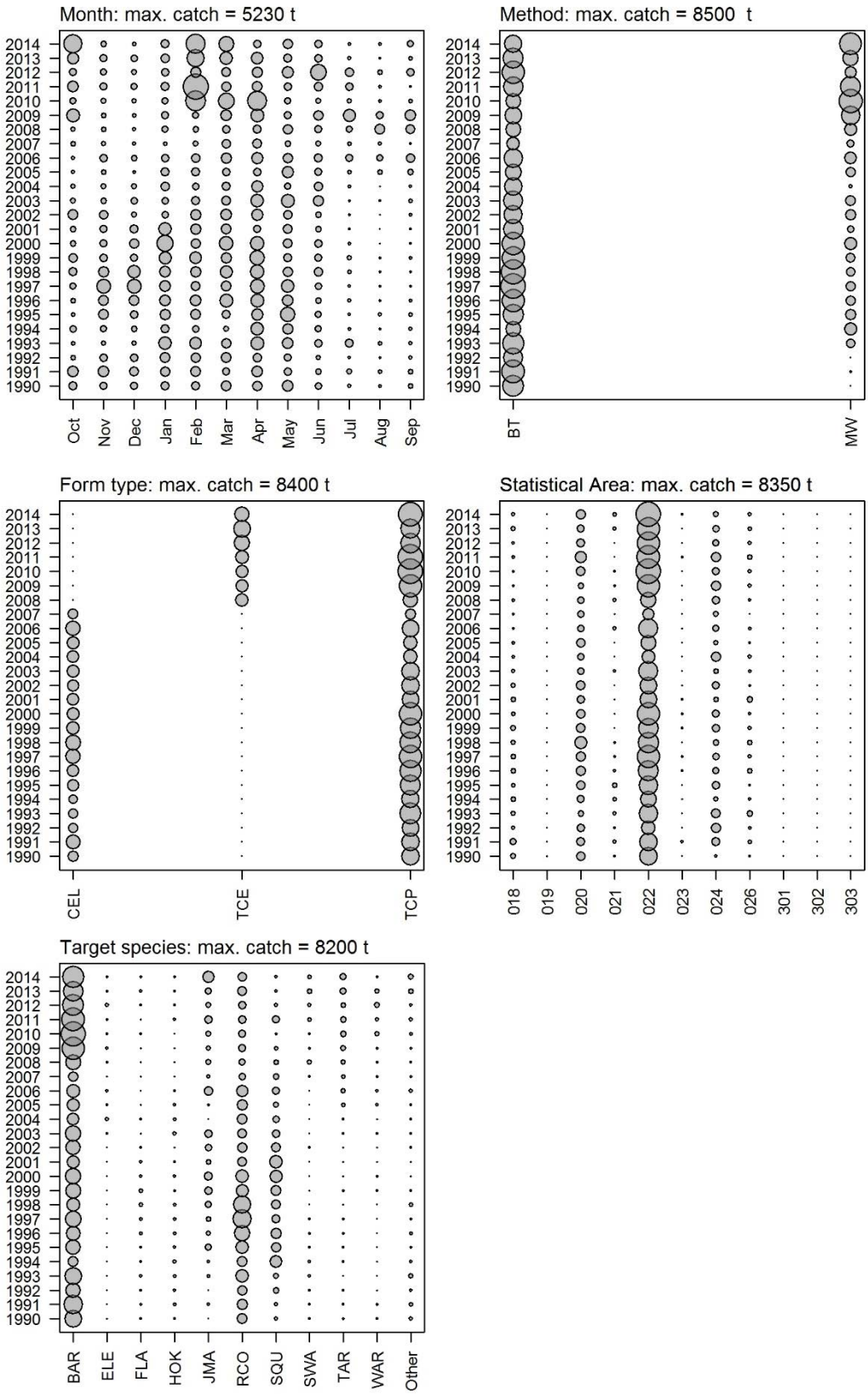


Figure C16: Distribution of annual catch (t) by month, method, form type, statistical area, and target species for ECSI BAR 1 merged trawl data. Circle size is proportional to catch; maximum circle size is indicated on the top left hand corner of each plot. Statistical areas are shown in Figure 1. Form types are CEL for CELR, TCE for TCER, and TCP for TCEPR as defined in Section 6.1. Fishing methods are BT for bottom trawl and MW for midwater trawl. Target species codes are given in Table C10.

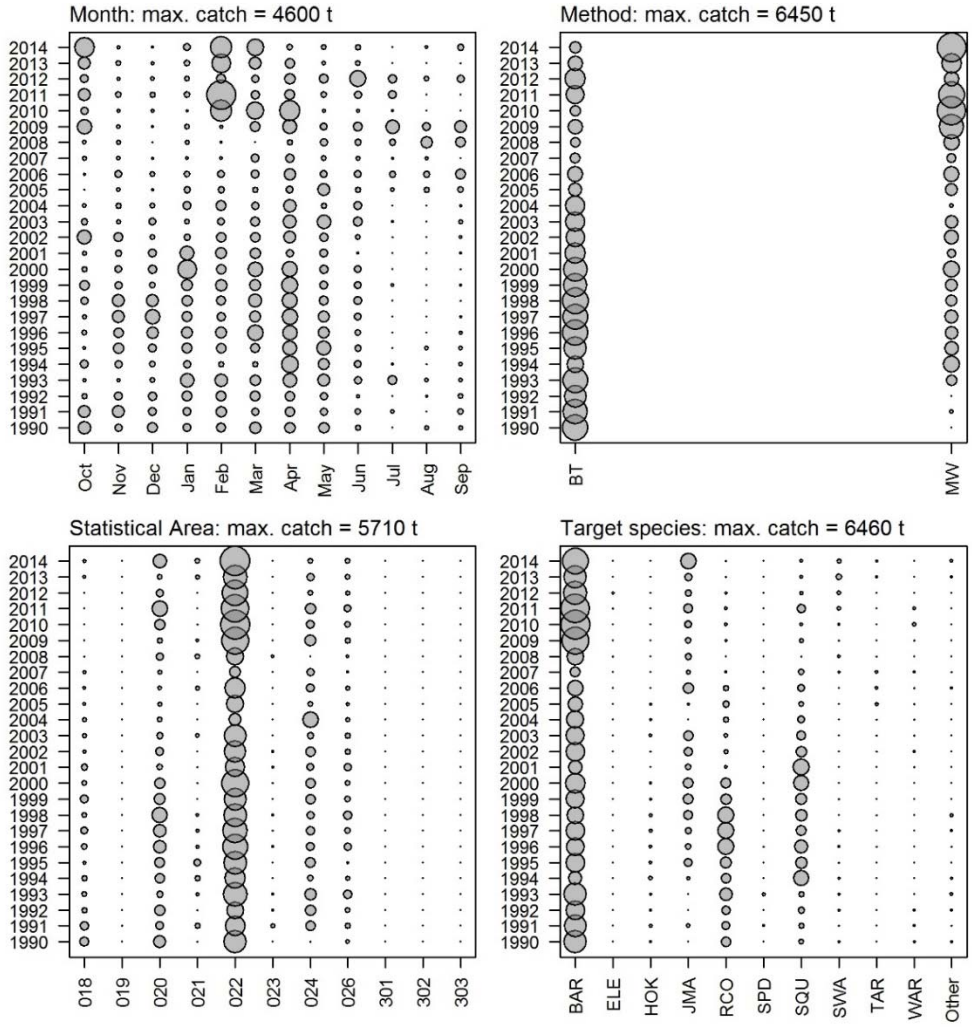


Figure C17a: Distribution of annual estimated catch (t) by month, method, Statistical Area (see Figure 1), and target species for ECSI BAR 1 unmerged TCEPR data. Circle size is proportional to catch; maximum circle size is indicated on the top left hand corner of each plot. Statistical areas are shown in Figure 1. Fishing methods are BT for bottom trawl and MW for midwater trawl. Target species codes are given in Table C10.

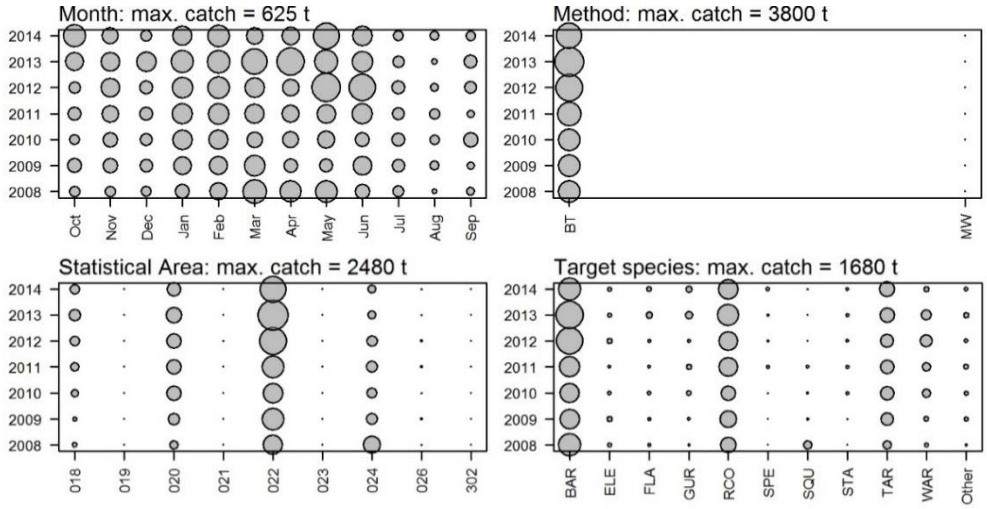


Figure C17b: Distribution of annual estimated catch (t) by month, method, statistical area, and target species for ECSI BAR 1 unmerged TCER data. See Figure C17a caption for code descriptions.

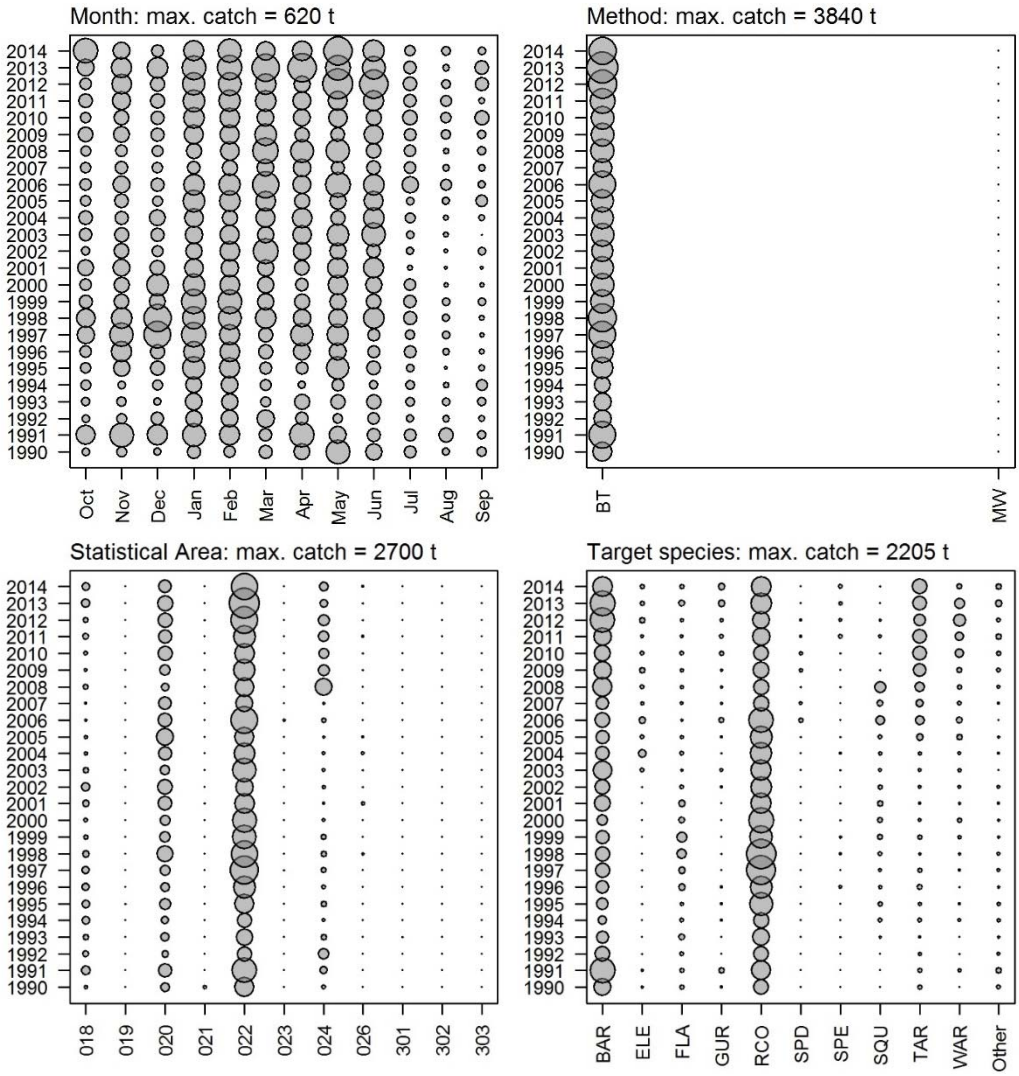


Figure C17c: Distribution of annual landed catch (t) by month, method, statistical area, and target species for ECSI BAR 1 merged CELR (1990–2007) and TCER data (2008–14). See Figure C17a caption for code descriptions.

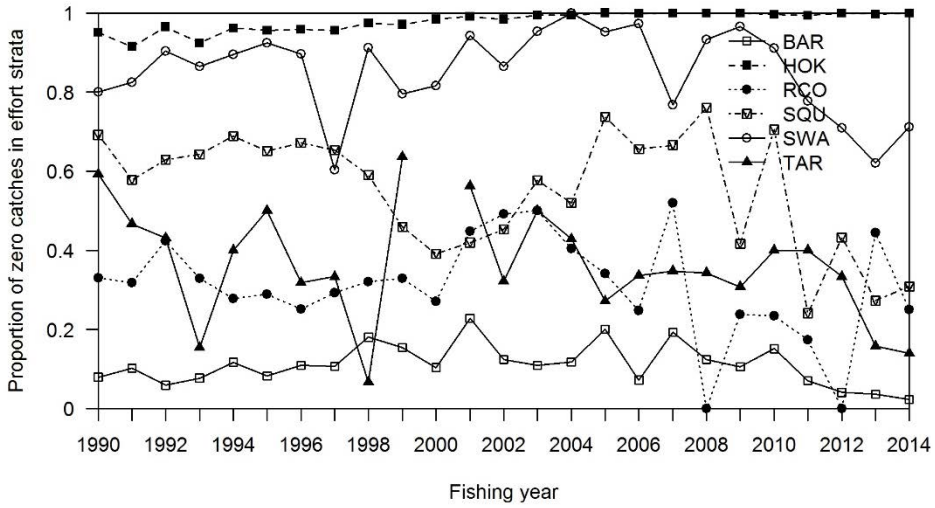


Figure C18a: Proportion of zero catches by main target species for the ECSI subarea of BAR 1 for TCEPR bottom trawl unmerged estimated catch data, 1990–2014 fishing years.

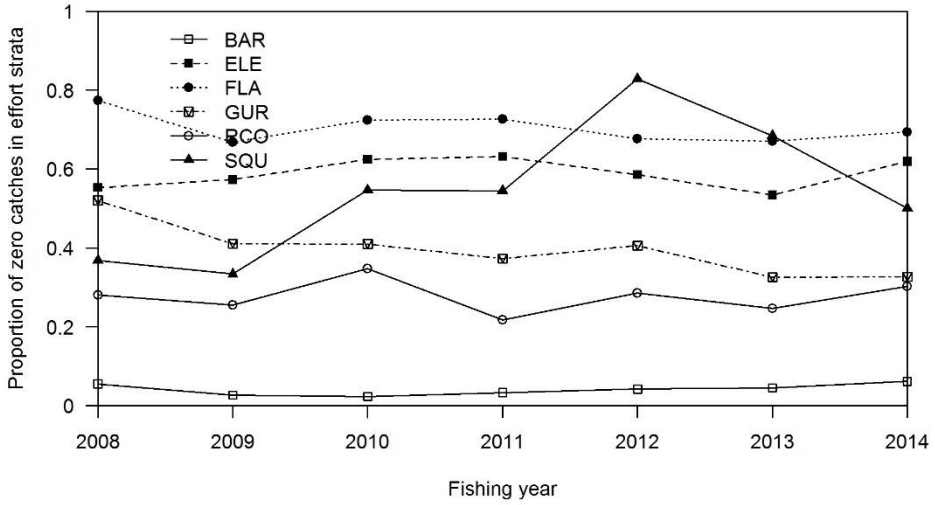


Figure C18b: Proportion of zeros by main target species for the ECSI subarea of BAR 1 for TCER bottom trawl unmerged estimated catch data, 2008–14 fishing years.

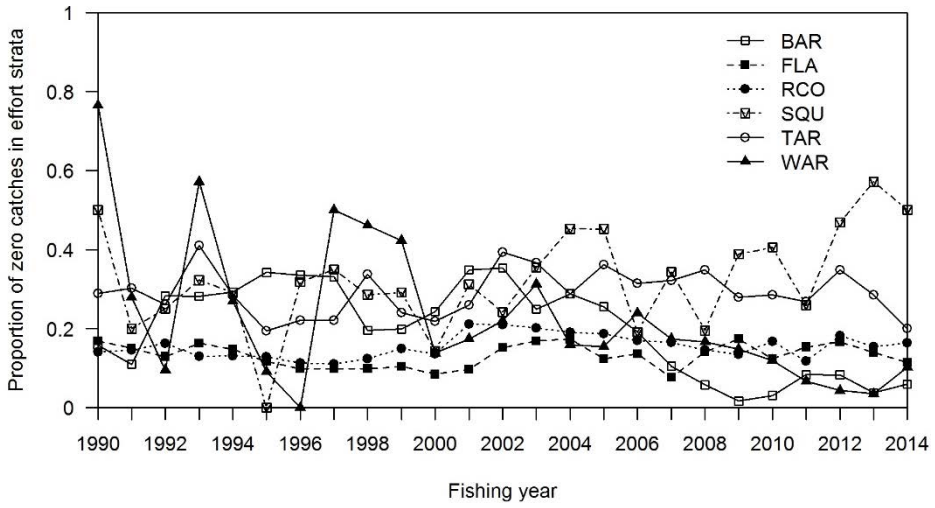


Figure C18c: Proportion of zeros by main target species for the ECSI subarea of BAR 1 for merged daily CELR (1990–2007) and TCER (2008–14) bottom trawl landed catch data.

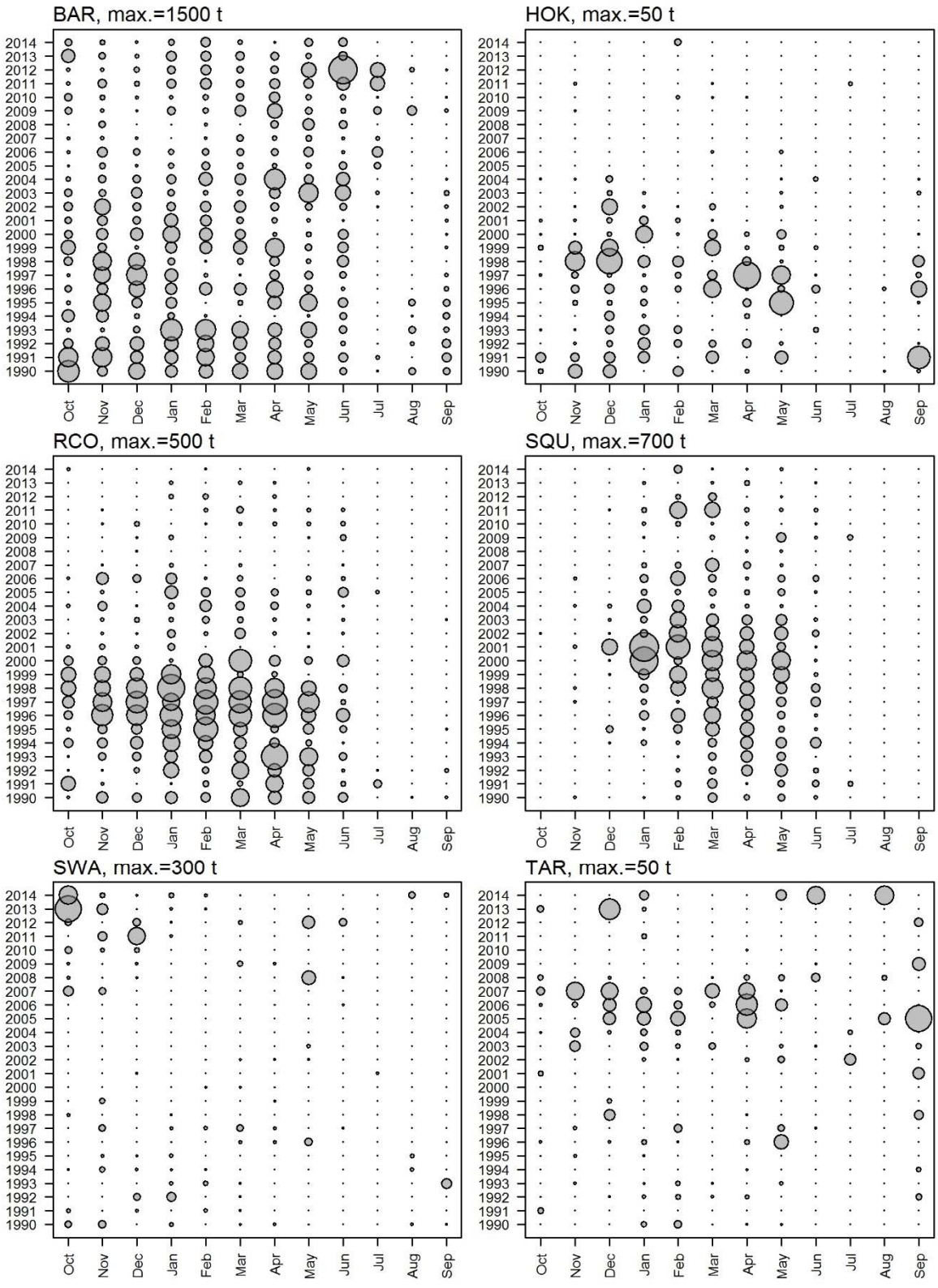


Figure C19a: Distribution of annual estimated catch (t) from the unmerged TCEPR data for the ECSI fishery area by month and fishing year for the main bottom trawl target species reported on TCEPRs. Circle size is proportional to the catch for each species stratum; maximum circle size is indicated on the top left hand corner of each plot.

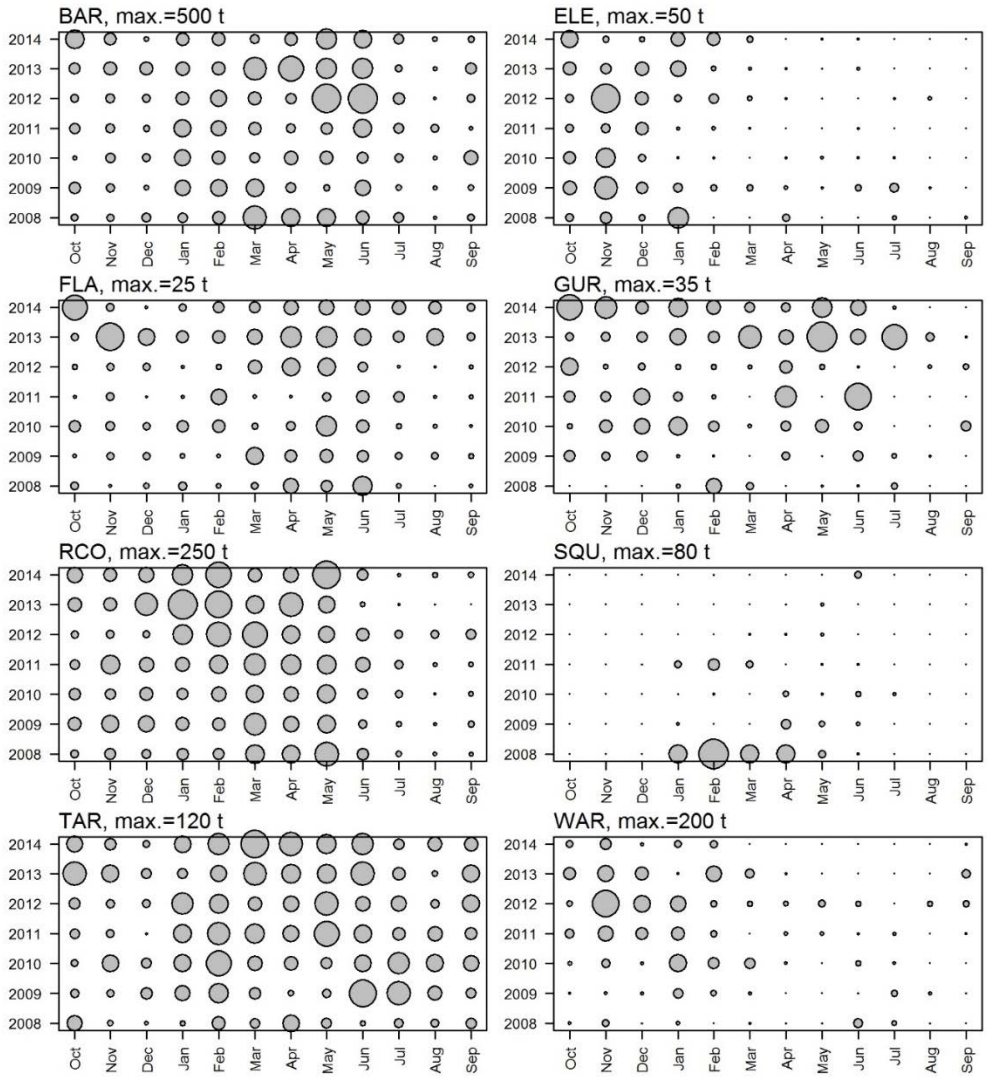


Figure C19b: Distribution of annual estimated catch (t) from the unmerged TCER data for the ECSI fishery area by month and fishing year for the main bottom trawl target species reported on TCERs. Circle size is proportional to the catch for each species stratum; maximum circle size is indicated on the top left hand corner of each plot.

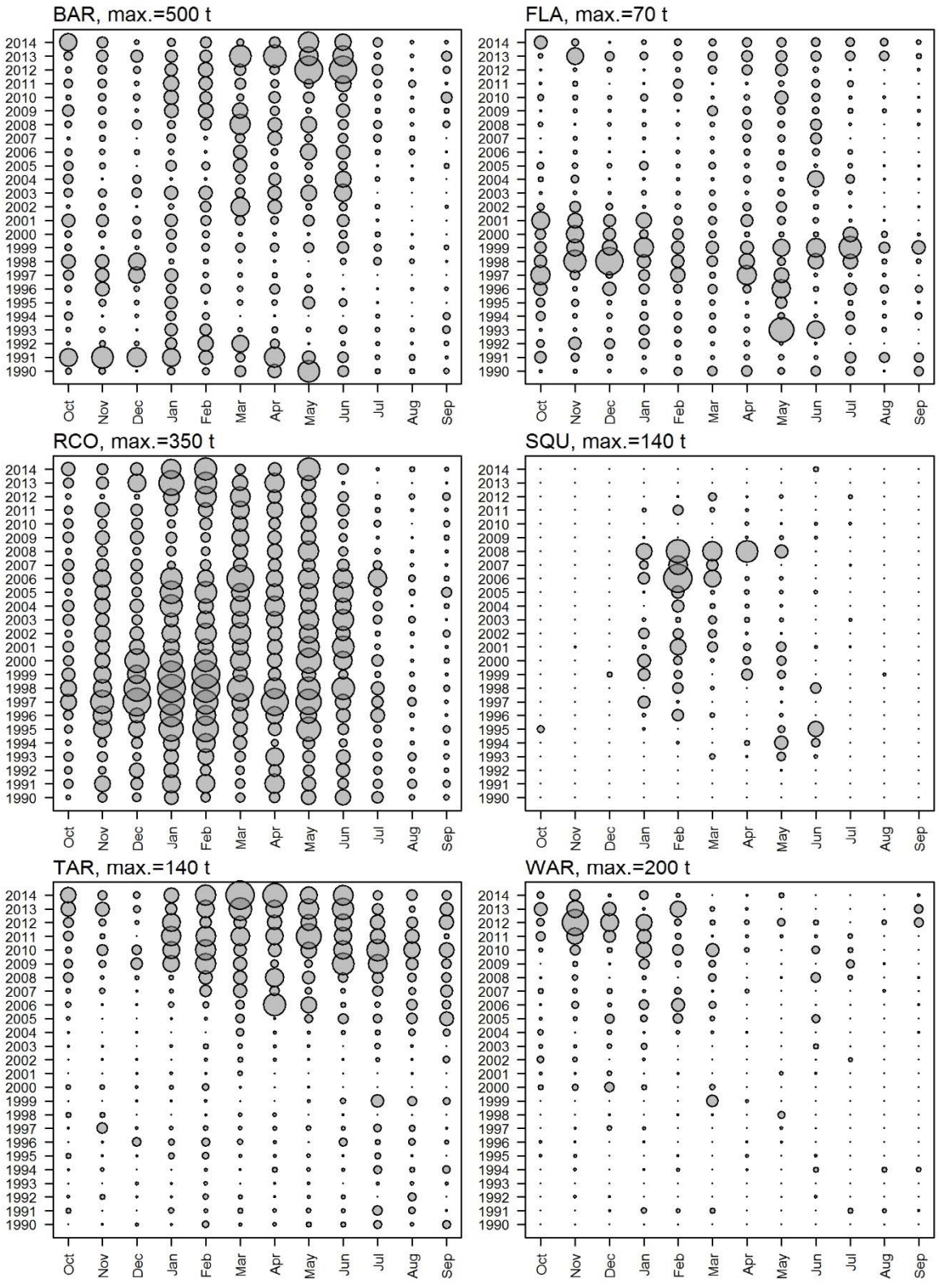


Figure C19c: Distribution of annual landed catch (t) from the merged CELR (1990–2007) and TCER data for the ECSI fishery area by month and fishing year for the main bottom trawl target species reported on CELRs and TCERs. Circle size is proportional to the catch for each species stratum; maximum circle size is indicated on the top left hand corner of each plot.

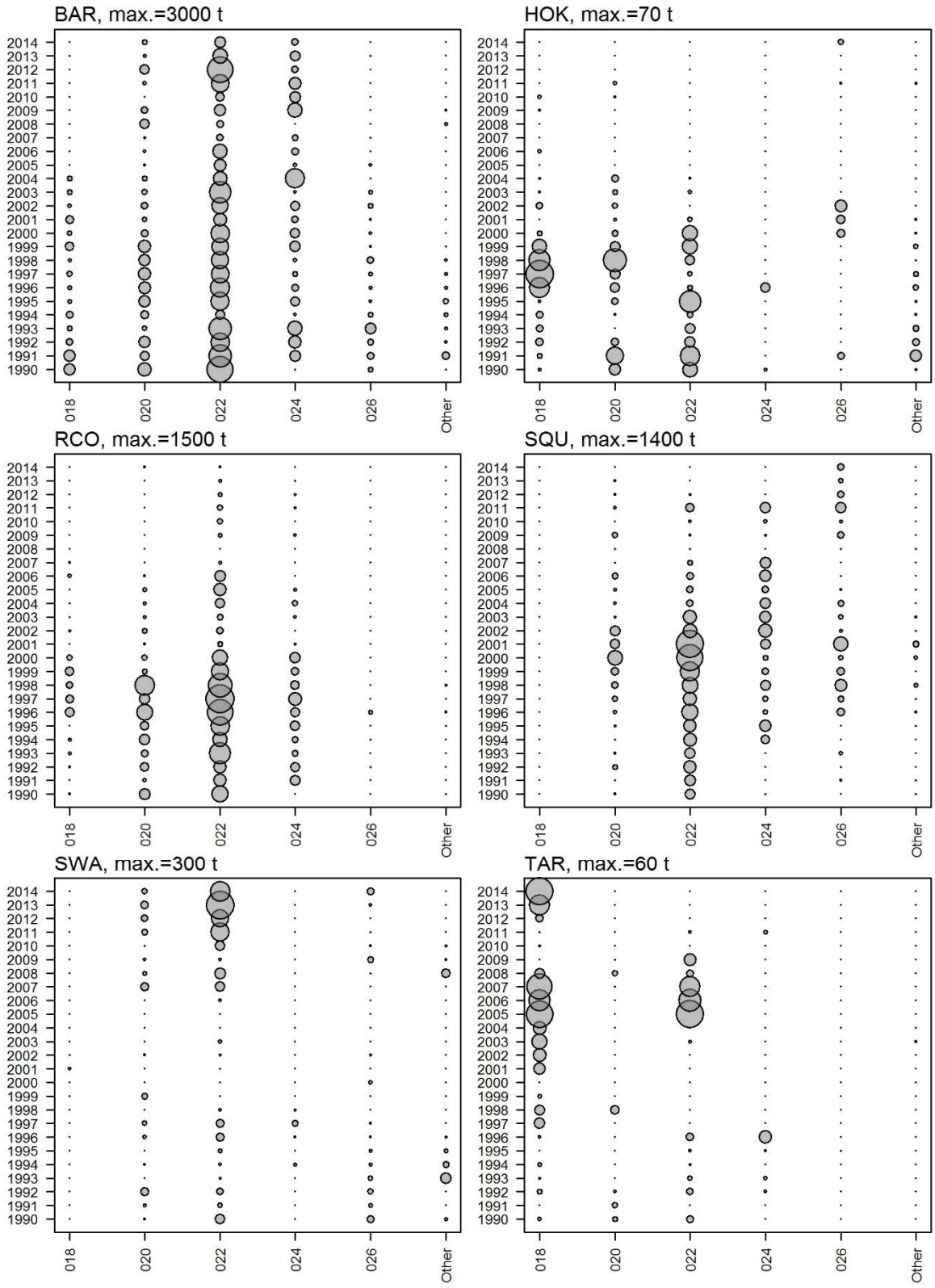


Figure C20a: Distribution of annual estimated catch (t) from the unmerged TCEPR data for the ECSI fishery area by Statistical Area and fishing year for the main bottom trawl target species reported on TCEPRs. Circle size is proportional to the catch for each species stratum; maximum circle size is indicated on the top left hand corner of each plot.

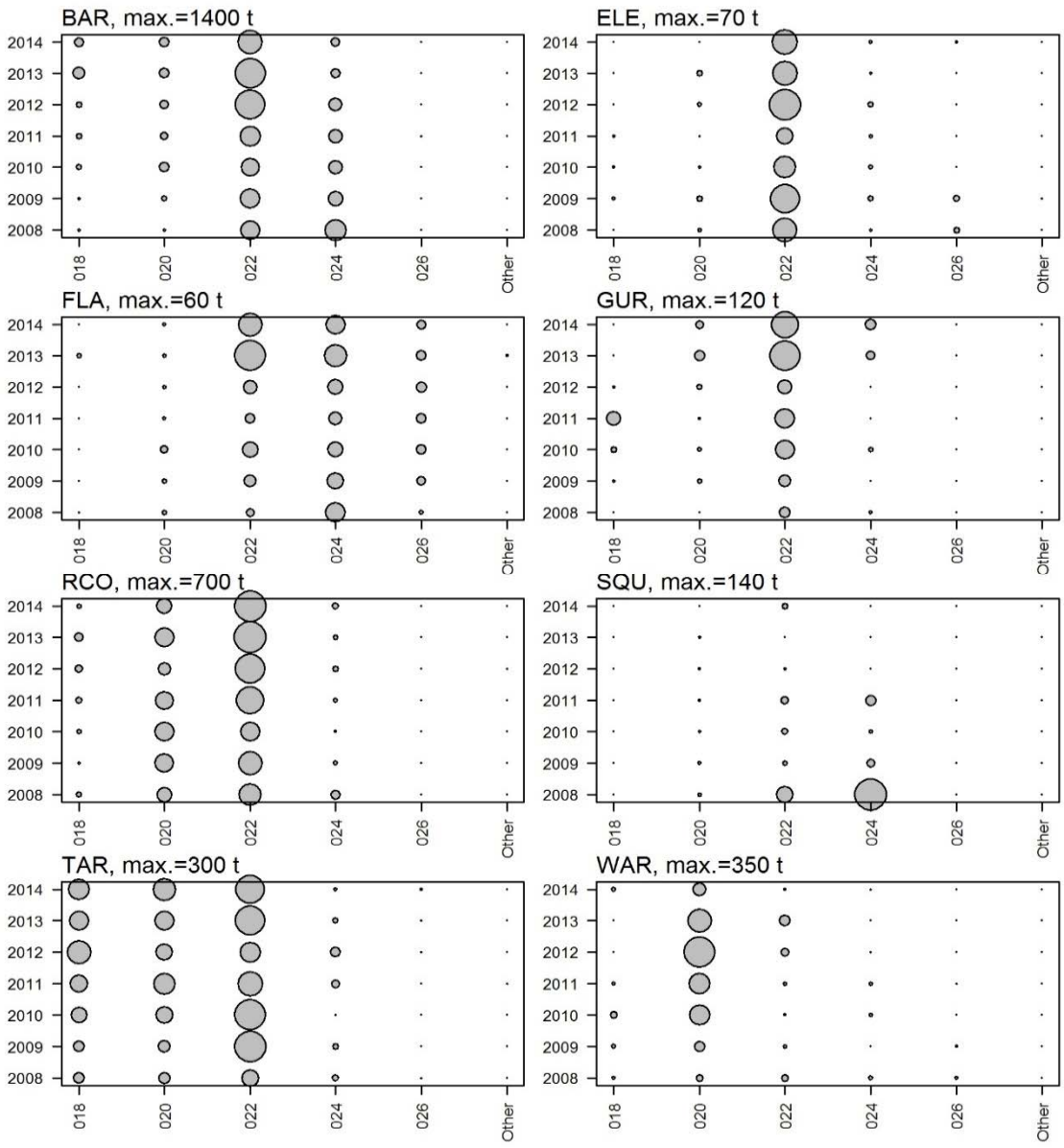


Figure C20b: Distribution of annual estimated catch (t) from the unmerged TCER data for the ECSI fishery area by Statistical Area and fishing year for the main bottom trawl target species reported on TCERs. Circle size is proportional to the catch for each species stratum; maximum circle size is indicated on the top left hand corner of each plot.

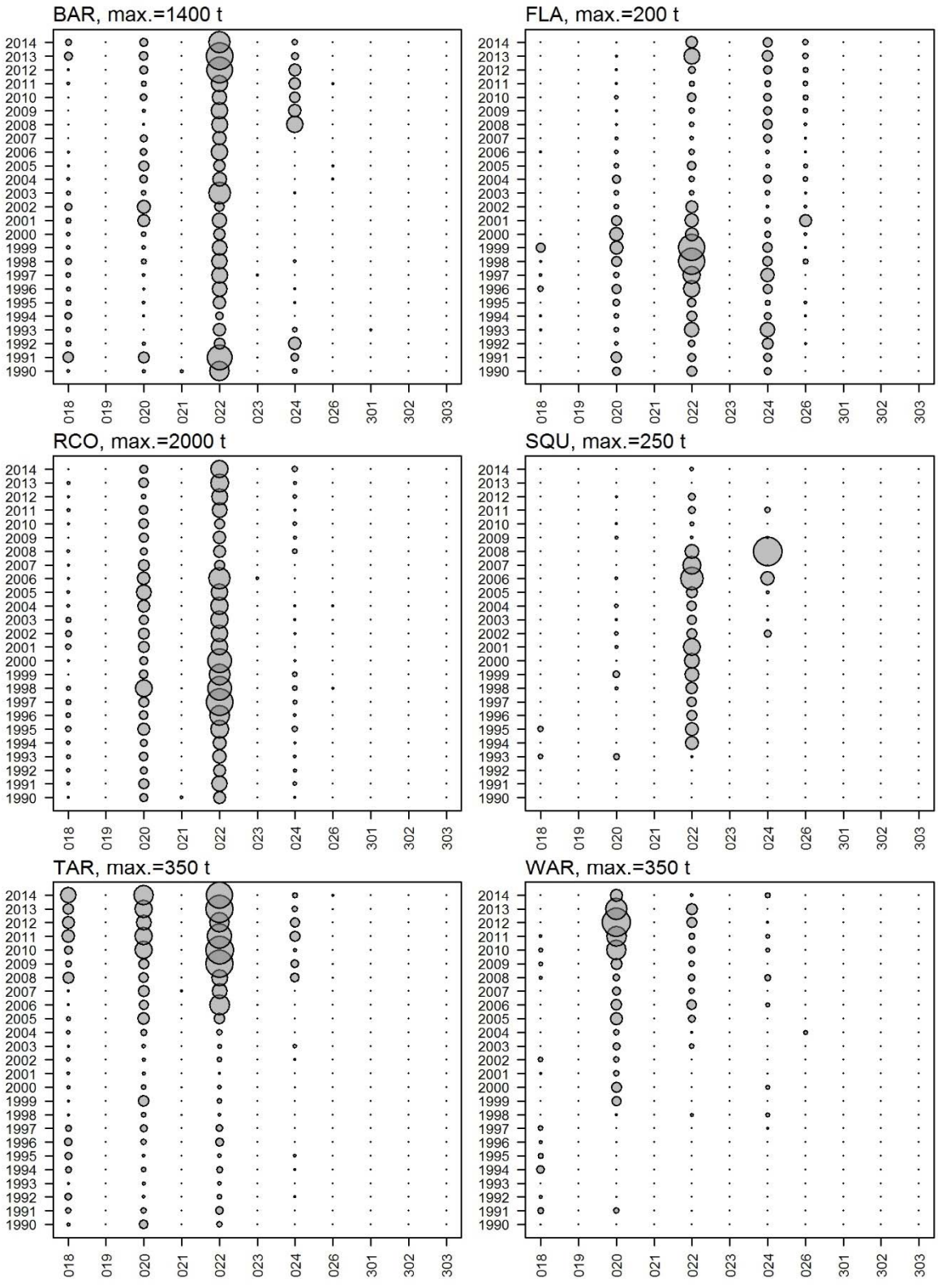


Figure C20c: Distribution of annual landed catch (t) from the merged CELR and TCER data for the ECSI fishery area by Statistical Area and fishing year for the main bottom trawl target species reported on CELRs and TCERs. Circle size is proportional to the catch for each species stratum; maximum circle size is indicated on the top left hand corner of each plot.

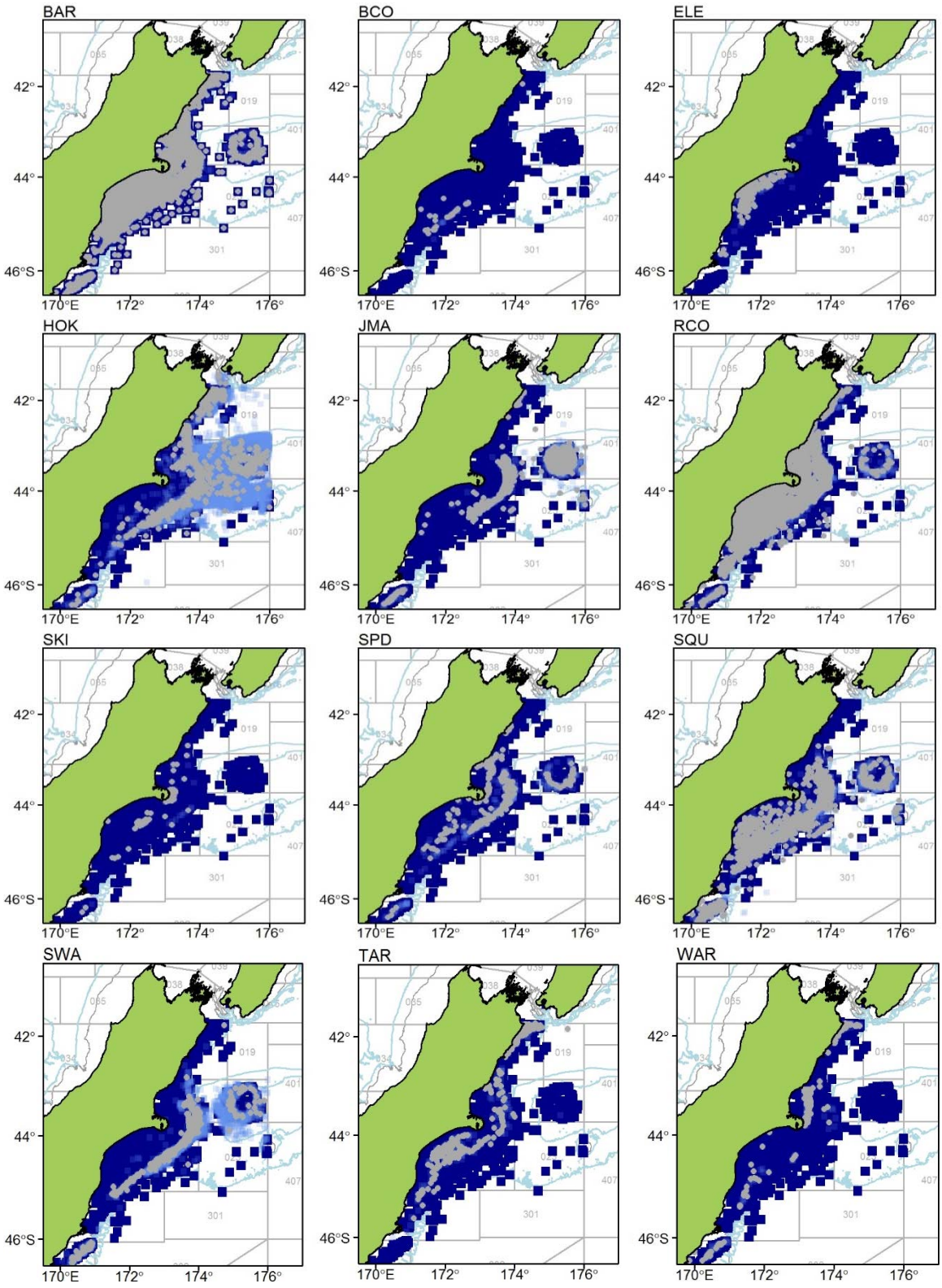


Figure C21a: Distribution of TCEPR effort for barracouta (■), for the main target species (■), and for the main target species where barracouta was caught (●), for the BAR 1 ECSI fishery, 1990–2014. Target species codes are defined in Table C10.

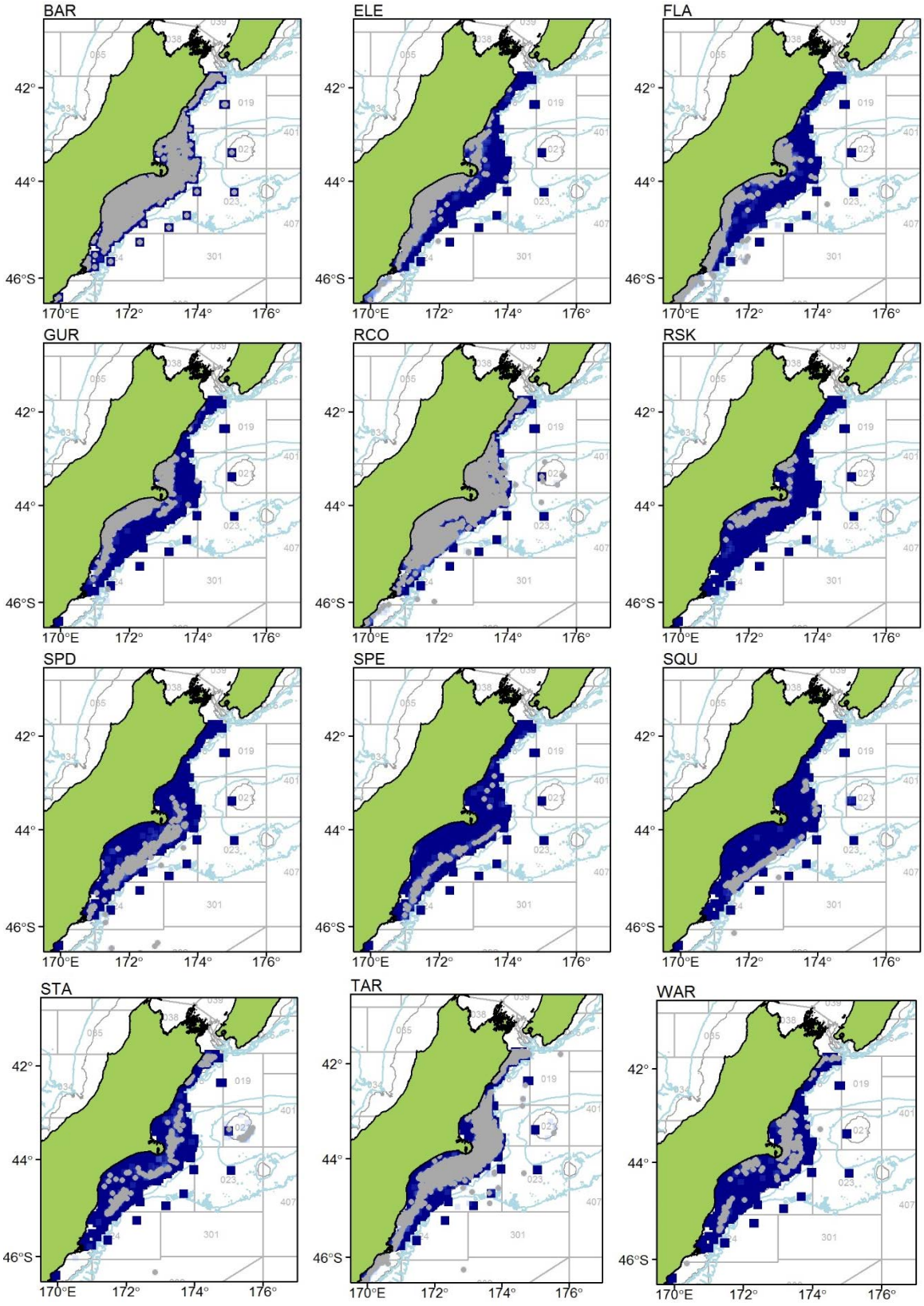


Figure C21b: Distribution of TCER effort for barracouta (■), for the main target species (■), and for the main target species where barracouta was caught (●), for the BAR 1 ECSI fishery area, 2008 to 2014 combined. Target species codes are defined in Table C10.

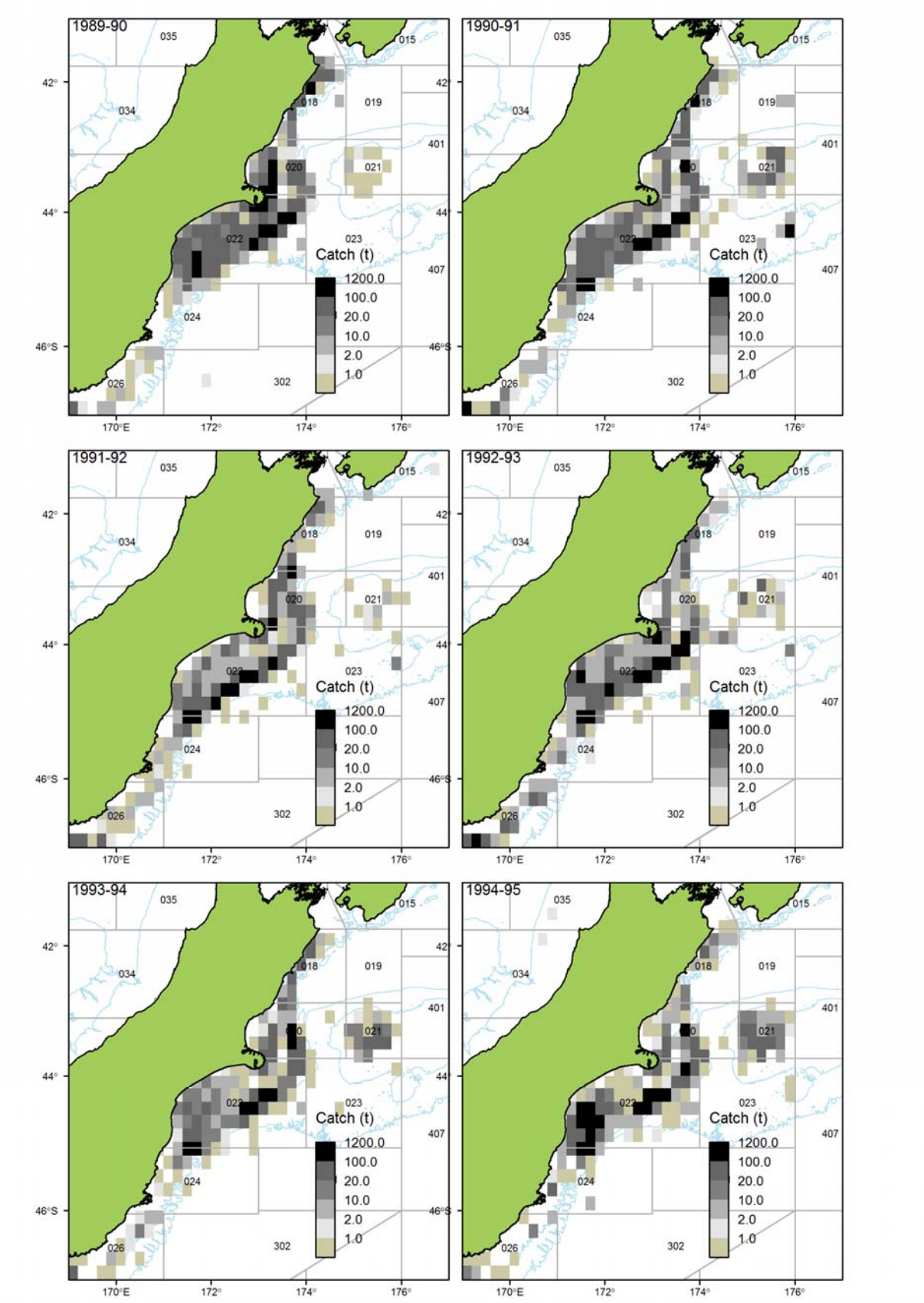


Figure C22a: Distribution of TCEPR bottom trawl barracouta catch aggregated into 0.2° cells within the BAR 1 ECSI area, 1989–90 to 1994–95. Blue lines show the 500 m and 1000 m depth contours.

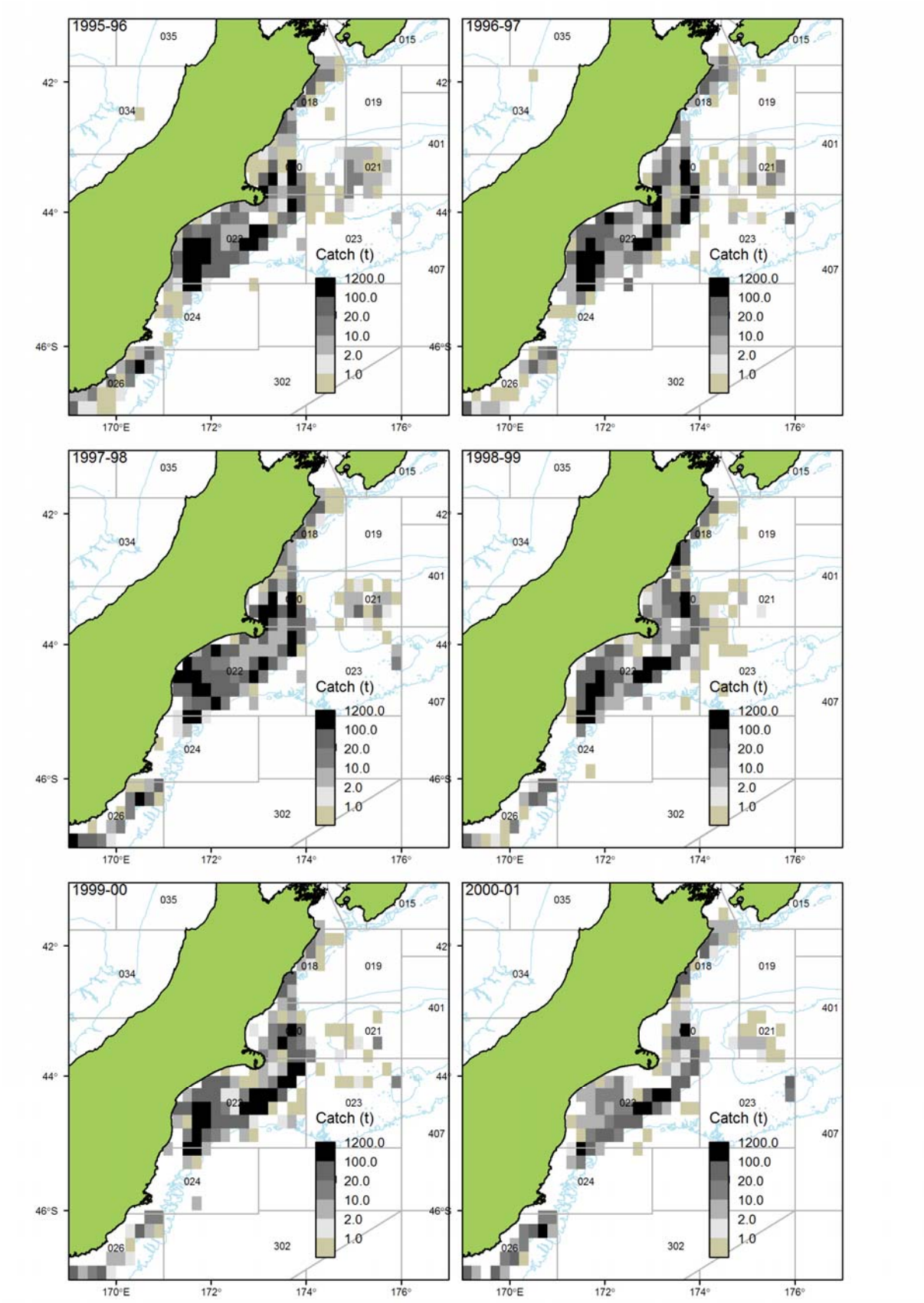


Figure C22a *continued*: Distribution of TCEPR bottom trawl barracouta catch aggregated into 0.2° cells within the BAR 1 ECSI area, 1995–96 to 2000–01. Blue lines show the 500 m and 1000 m depth contours.

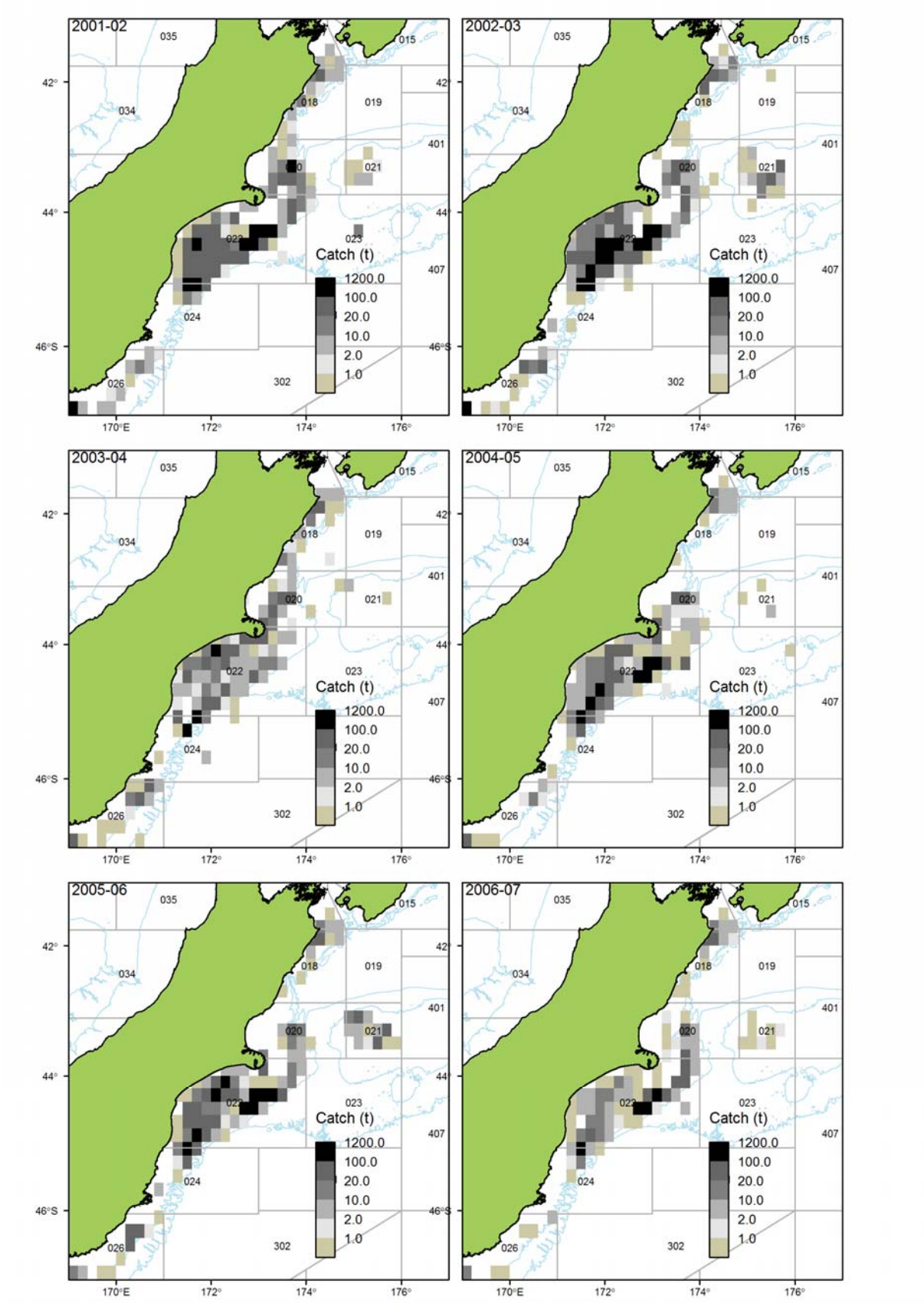


Figure C22a *continued*: Distribution of TCEPR bottom trawl barracouta catch aggregated into 0.2° cells within the BAR 1 ECSI area, 2001–02 to 2006–07. Blue lines show the 500 m and 1000 m depth contours.

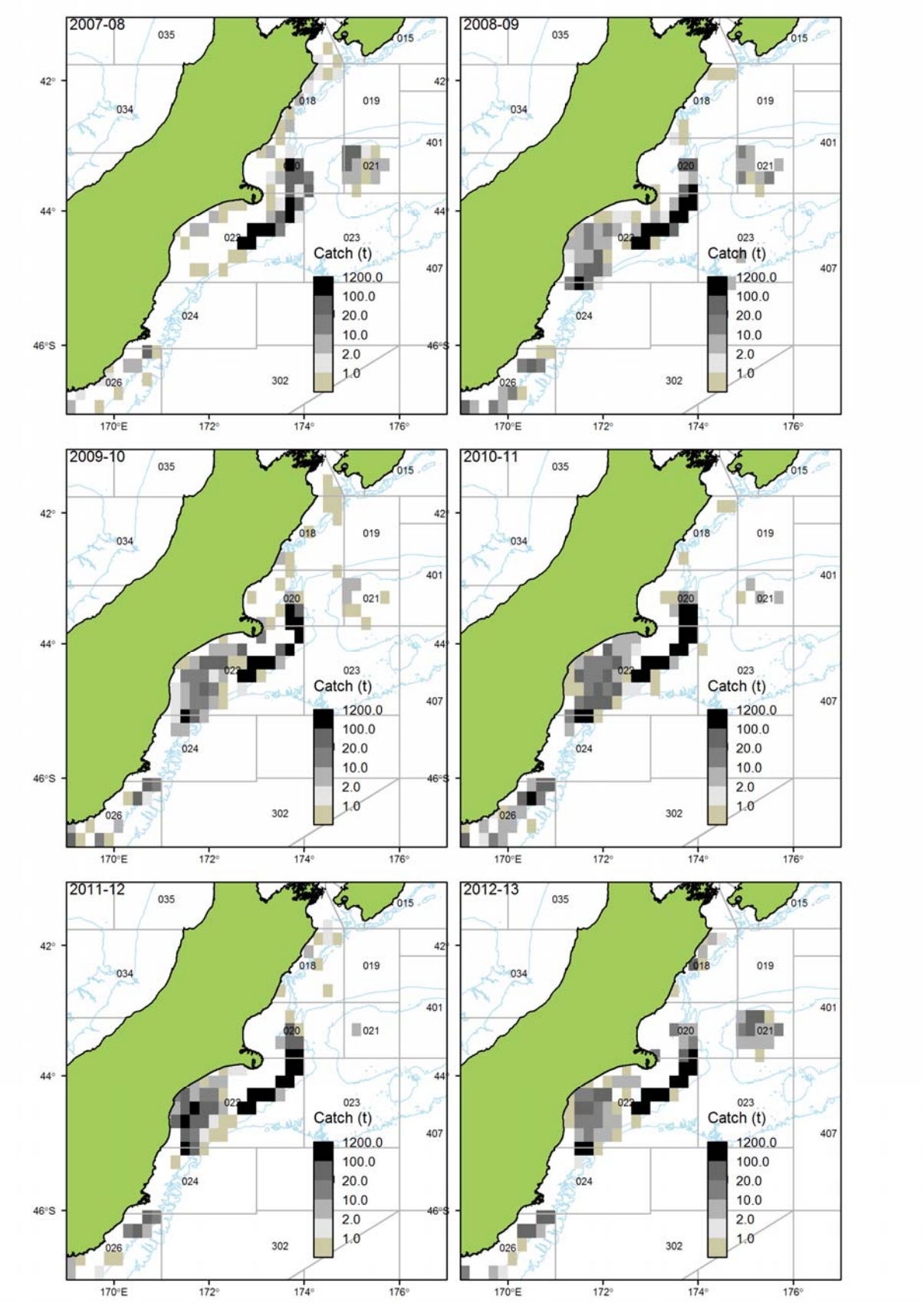


Figure C22a *continued*: Distribution of TCEPR bottom trawl barracouta catch aggregated into 0.2° cells within the BAR 1 ECSI area, 2007–08 to 2012–13. Blue lines show the 500 m and 1000 m depth contours.

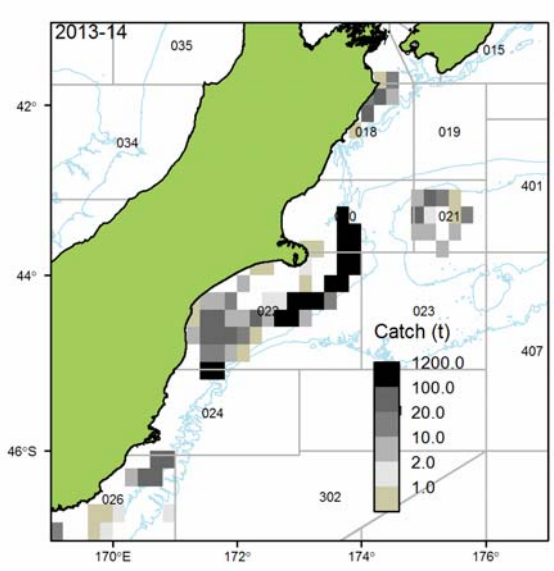


Figure C22a *continued*: Distribution of TCEPR bottom trawl barracouta catch aggregated into 0.2° cells within the BAR 1 ECSI area, 2013–14. Blue lines show the 500 m and 1000 m depth contours.

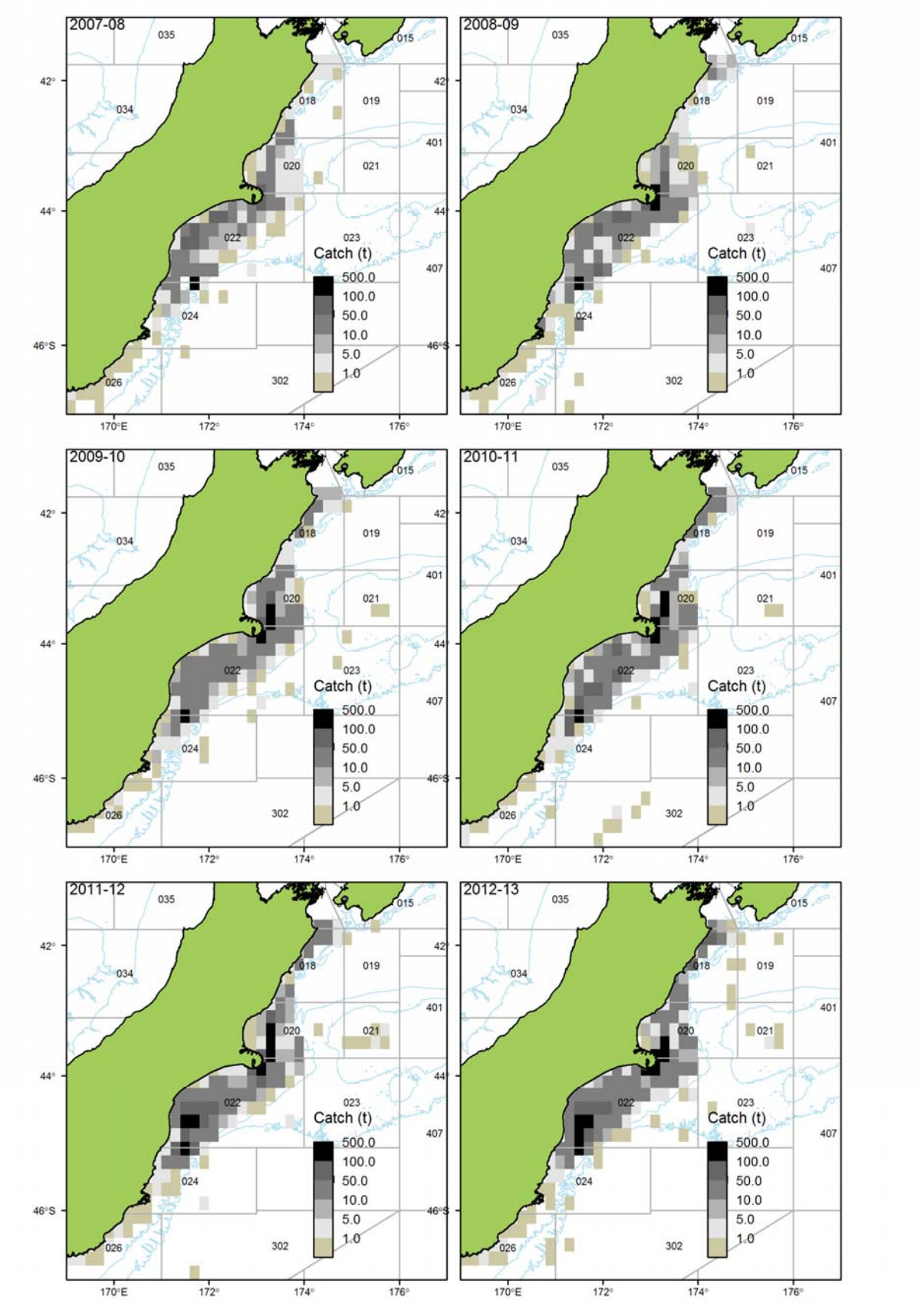


Figure C22b *continued*: Distribution of TCER bottom trawl barracouta catch aggregated into 0.2° cells within the BAR 1 ECSI area, 2007–08 to 2012–13. Blue lines show the 500 m and 1000 m depth contours.

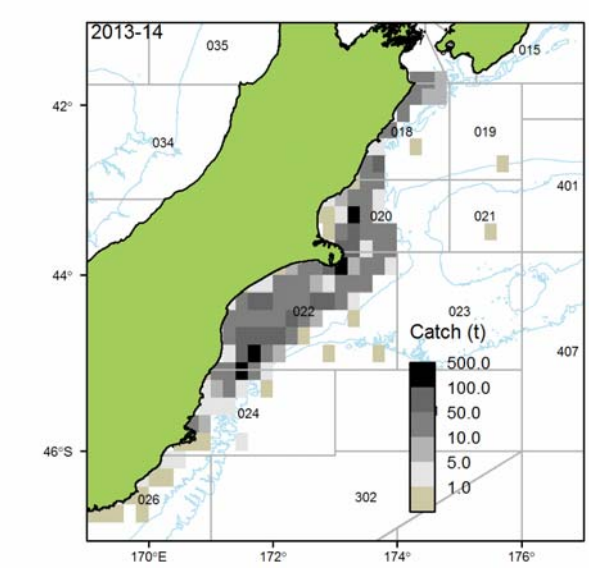


Figure C22b *continued*: Distribution of TCER bottom trawl barracouta catch aggregated into 0.2° cells within the BAR 1 ECSI area, 2013–14. Blue lines show the 500 m and 1000 m depth contours.

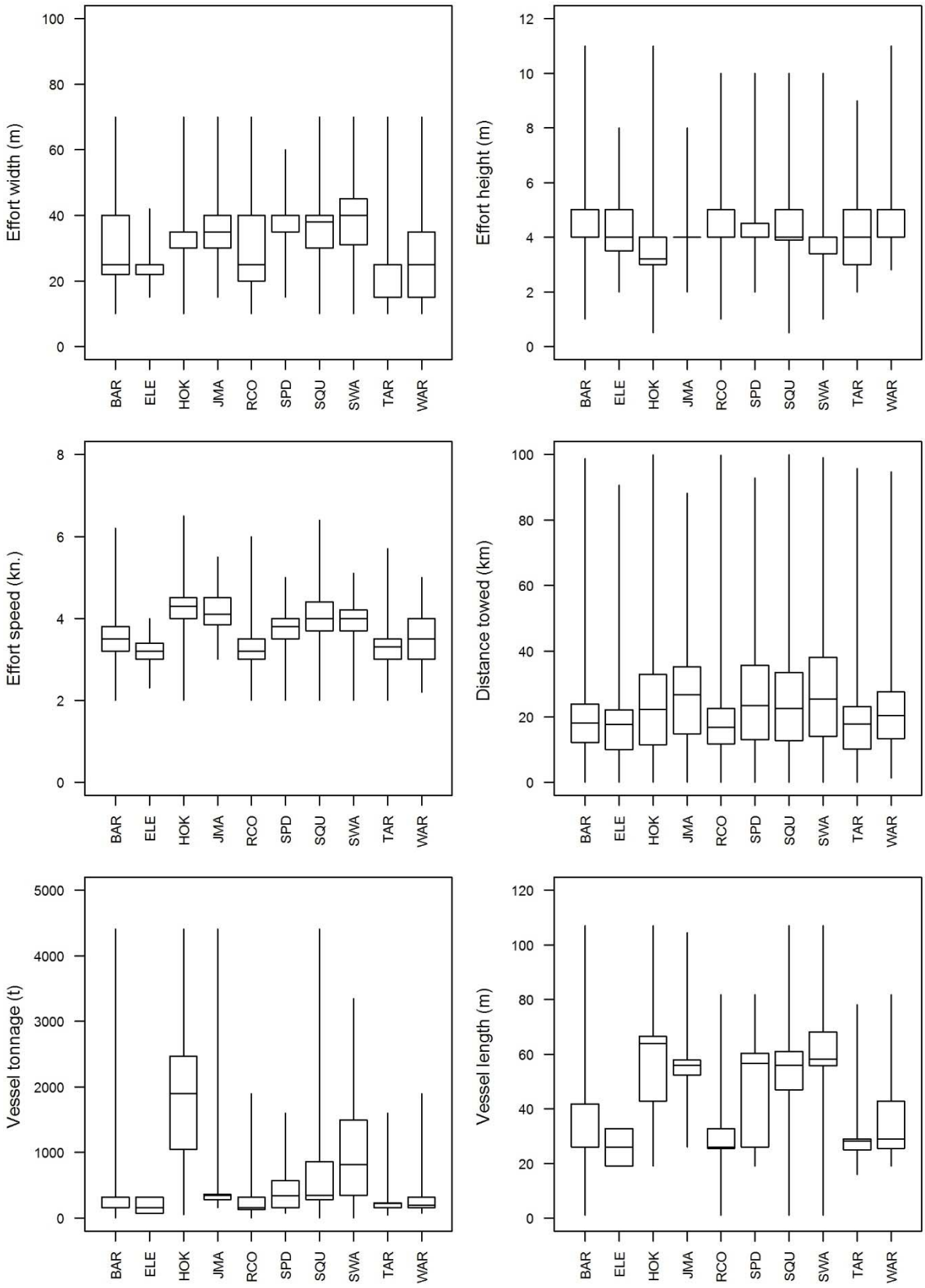


Figure C23a: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) of TCEPR bottom trawl tow variables reported for major target species effort with barracouta catch in the BAR 1 ECSI fishery area, based on the groomed unmerged data. Target species codes are given in Table C10.

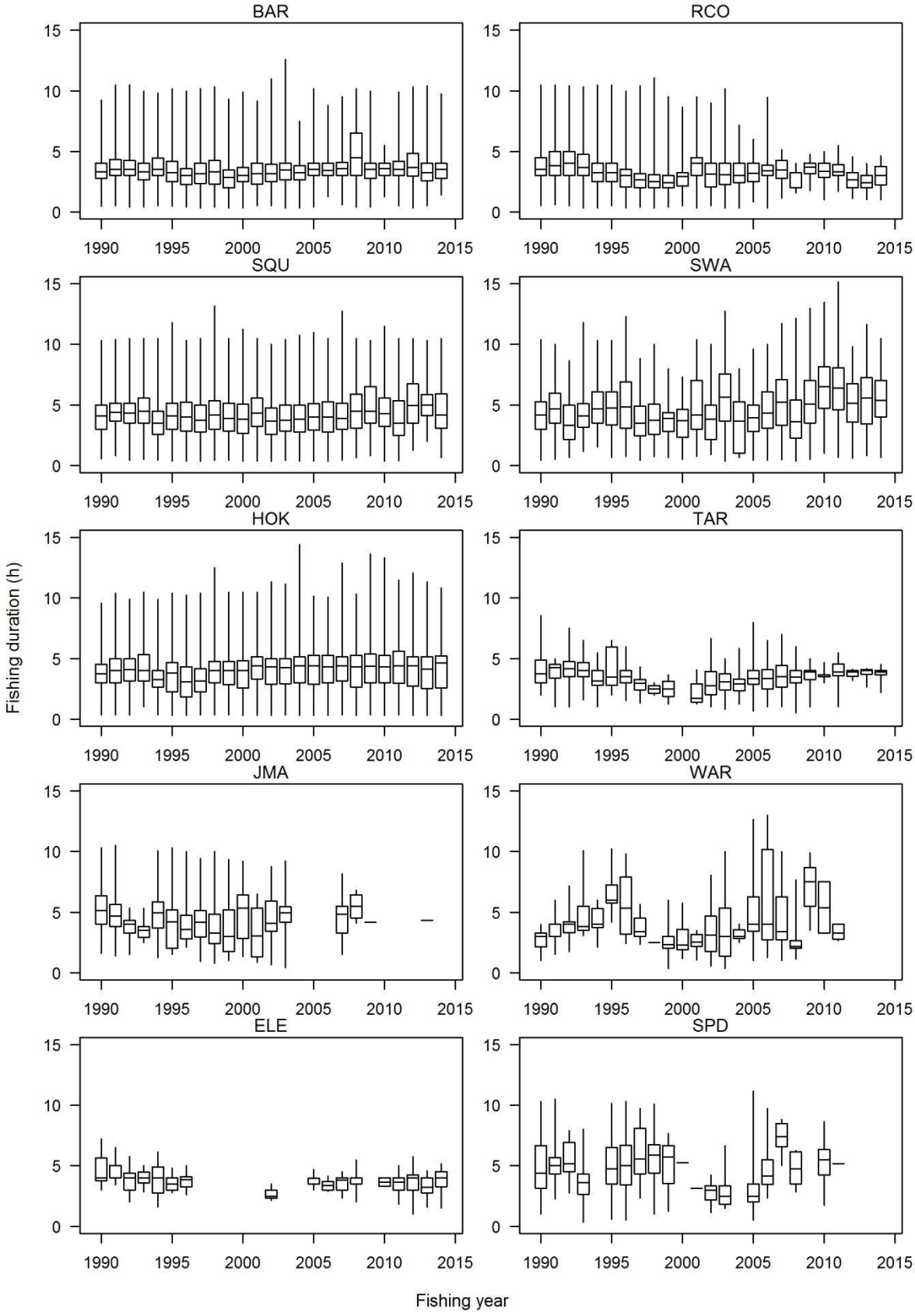


Figure C23b: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) of TCEPR bottom trawl tow durations reported for major target species effort with barracouta catch in the BAR 1 ECSI fishery area, based on the groomed unmerged data. Target species codes are given in Table C10.

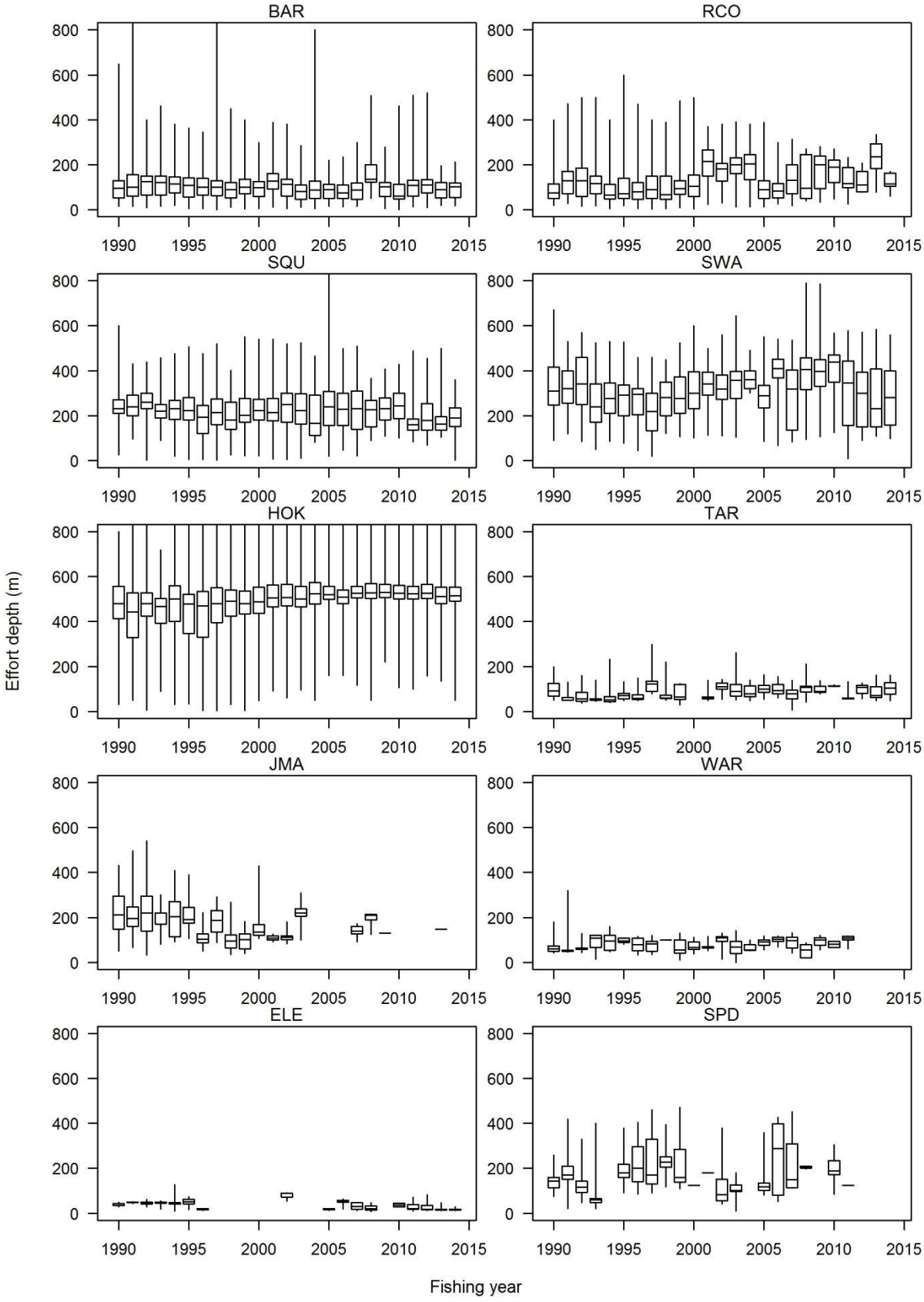


Figure C23c: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) of TCEPR bottom trawl tow durations reported for major target species effort with barracouta catch in the BAR 1 ECSI fishery area, based on the groomed unmerged data. Target species codes are given in Table C10.

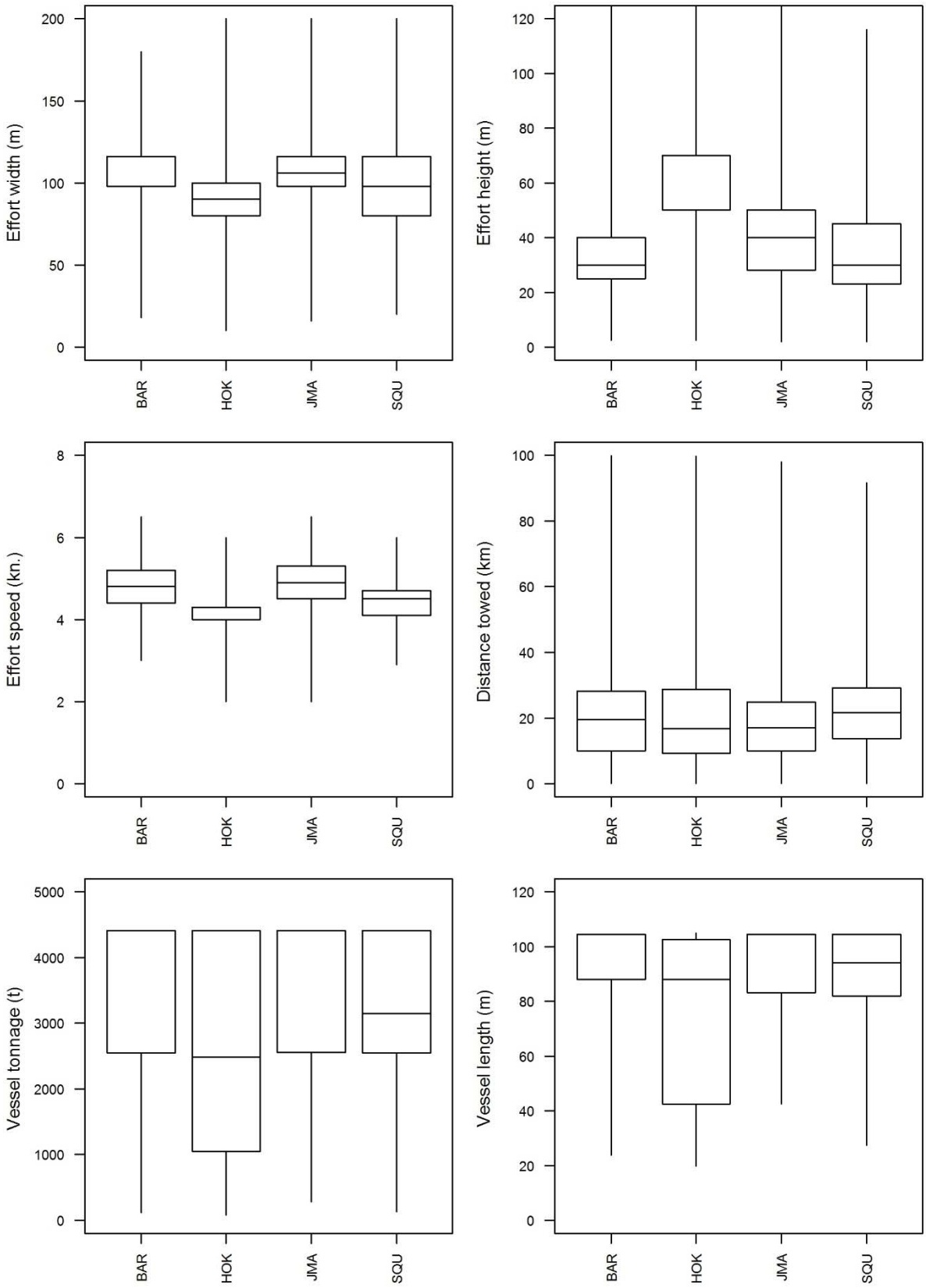


Figure C23d: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) of TCEPR midwater trawl tow variables reported for major target species effort with barracouta catch in the BAR 1 ECSI fishery area, based on the groomed unmerged data. Target species codes are given in Table C10.

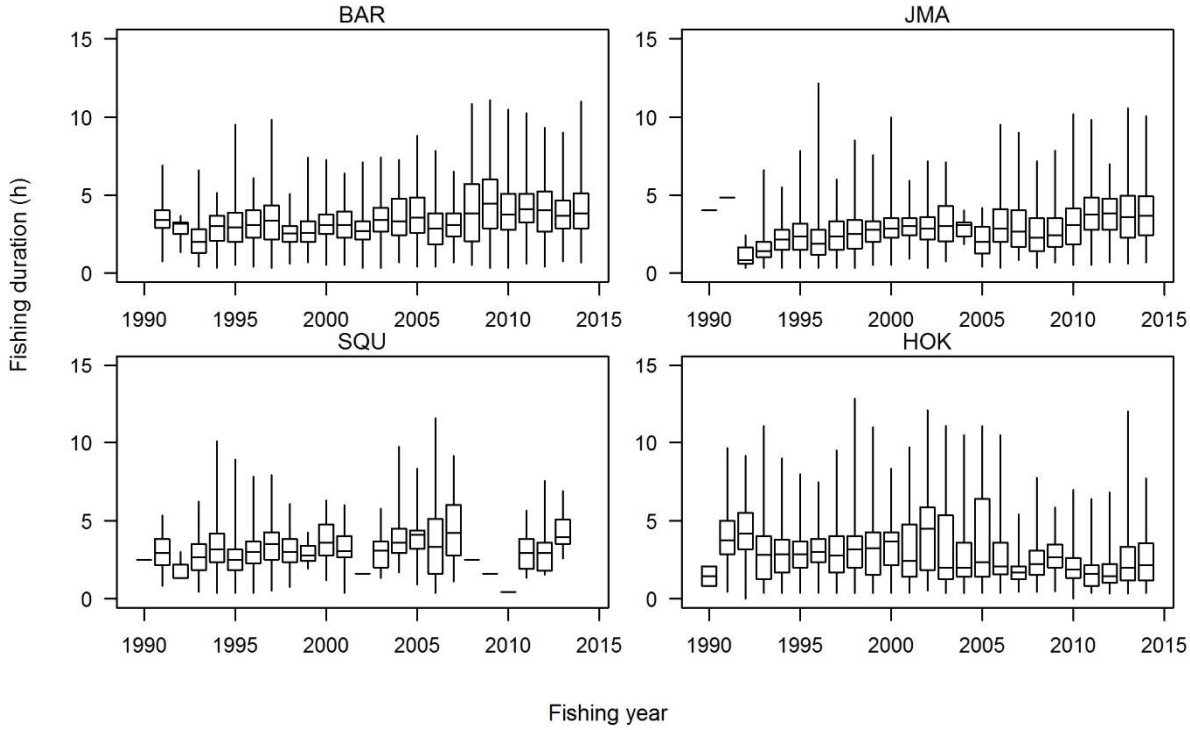


Figure C23e: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) of TCEPR midwater trawl tow durations reported for major target species effort with barracouta catch in the BAR 1 ECSI fishery area, based on the groomed unmerged data. Target species codes are given in Table C10.

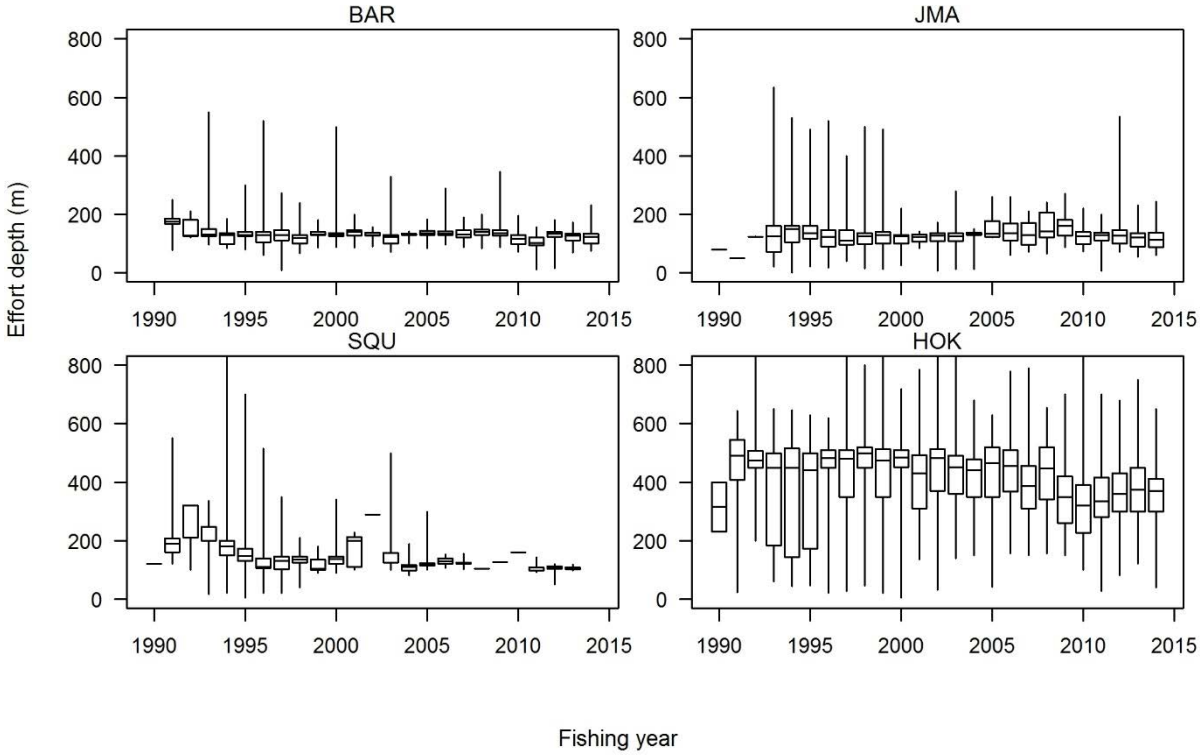


Figure C23f: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) of TCEPR midwater trawl fishing depth reported for major target species effort with barracouta catch in the BAR 1 ECSI fishery area, based on the groomed unmerged data. Target species codes are given in Table C10.

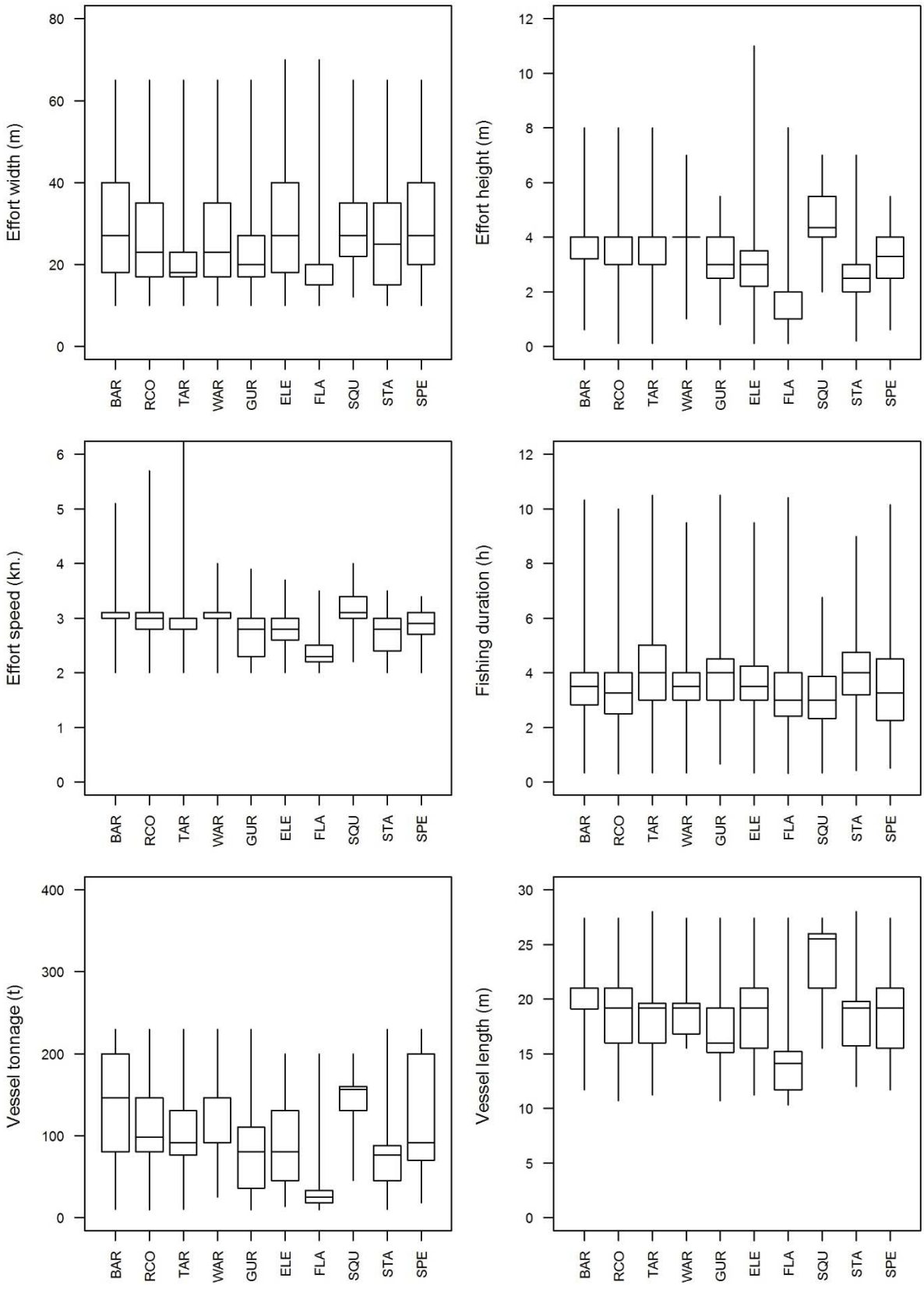


Figure C24a: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) of TCER bottom trawl variables reported for major target species effort with barracouta catch in the BAR 1 ECSI fishery area, based on the groomed unmerged data. Target species codes are defined in Table C10.

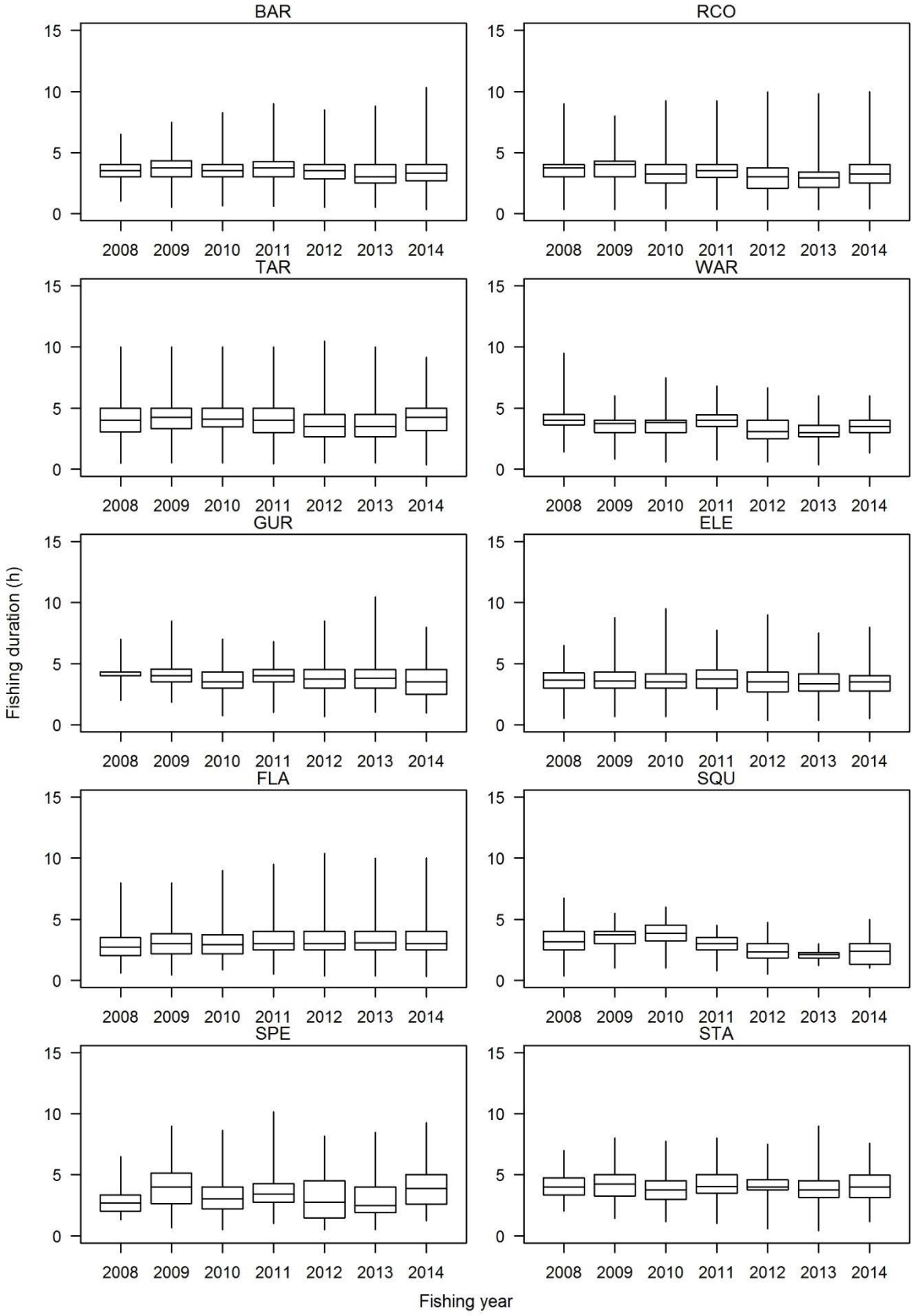


Figure C24b: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) of TCER bottom trawl fishing duration reported for major target species effort with barracouta catch in the BAR 1 ECSI fishery area, based on the groomed unmerged data. Target species codes are defined in Table C10.

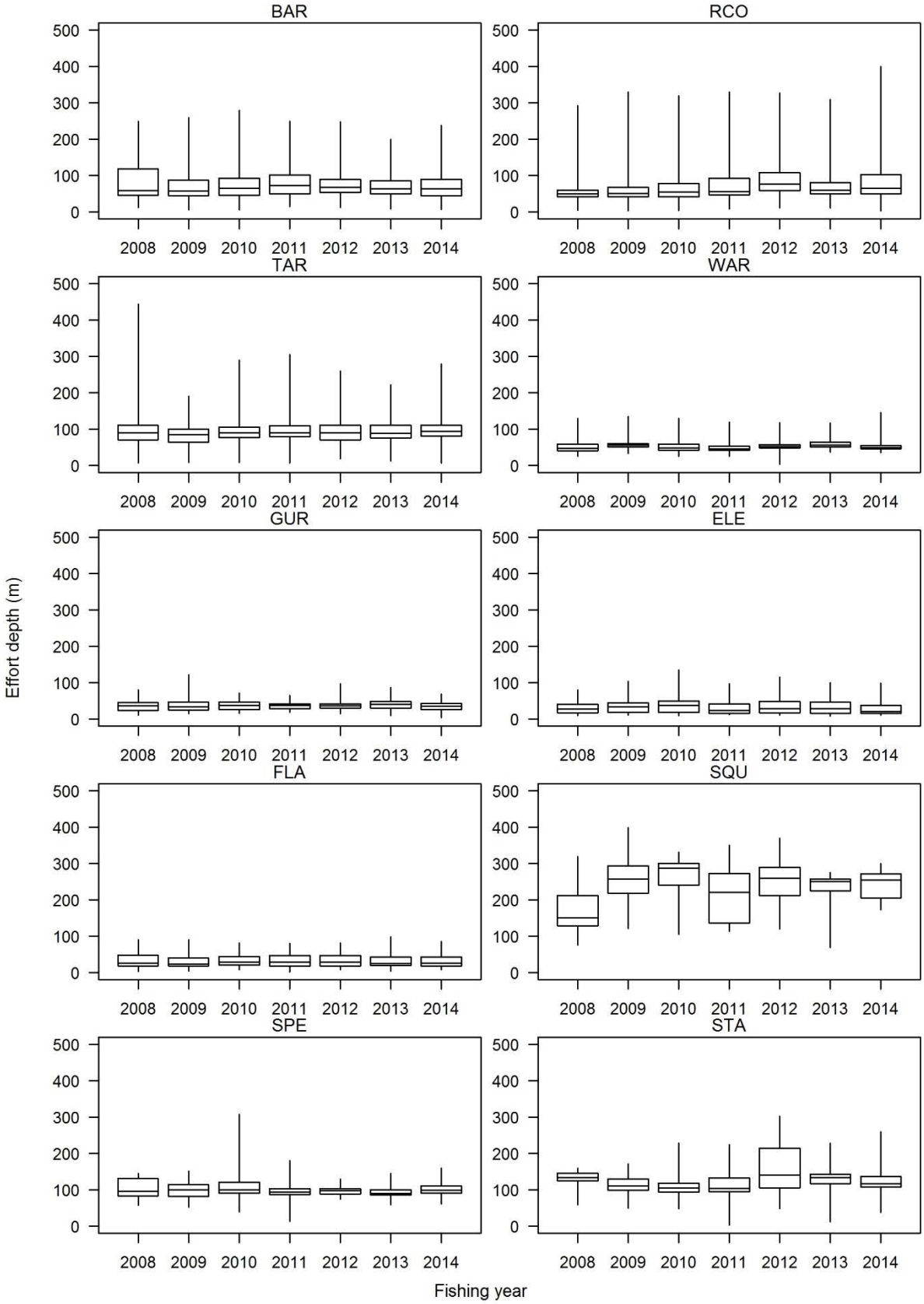


Figure C24c: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) of TCER bottom trawl fishing depth reported for major target species effort with barracouta catch in the BAR 1 ECSI fishery area, based on the groomed unmerged data. Target species codes are defined in Table C10.

APPENDIX D: CATCH-PER-UNIT-EFFORT ANALYSIS

Table D1: Description of variables and their type used in the CPUE analysis for the TCEPR estimated tow-by-tow catch; TCER estimated tow-by-tow catch; and the CELR/TCER merged data. Continuous variables were fitted as third order polynomials except for tow duration which was offered as both third and fourth order polynomials.

(a) BAR 1 ECNI and ECSI TCEPR and TCER bottom trawl tow-by-tow data

Variable	Type	Description
Year	Categorical	Fishing year (1 Oct–30 Sep)
Vessel	Categorical	Unique (encrypted) vessel identification number
Statistical area	Categorical	Statistical area
Trawl region	Categorical	Allocated trawl region based on catch distribution
Tow duration	Continuous	Duration of tow (h)
Tow distance	Continuous	Distance of tow (km) (TCEPR only)
Distance2	Continuous	Distance (as speed * duration) of tow (km)
Headline height	Continuous	Headline height (m) of the net for a tow
Bottom depth	Continuous	Seabed depth (m) for a tow
Effort depth	Continuous	Depth of trawl gear (m)
Speed	Continuous	Vessel speed (kn.) for a tow
Wingspread	Continuous	Wingspread (m) of the net for a tow
Vessel experience	Continuous	Number of years the vessel has been involved in the fishery
Catch	Continuous	Estimated greenweight (t) of barracouta caught from a tow
Longitude	Continuous	Start longitude of the vessel for a tow
Latitude	Continuous	Start latitude of the vessel for a tow
Target species	Categorical	Target species of tow
Date	Continuous	Date of the tow
Month	Categorical	Month of the fishing year
Fday	Continuous	Day of the year
Time start	Continuous	Start time of tow
Time mid	Continuous	Mid time of tow

(b) BAR 1 ECNI and ECSI CELR/TCER bottom trawl day-by-day landed catch data

Variable	Type	Description
Year	Categorical	Fishing year (1 Oct–30 Sep)
Vessel	Categorical	Unique (encrypted) vessel identification number
Statistical area	Categorical	Statistical area
Target species	Categorical	Main daily target species
Month	Categorical	Month of fishing year
Fishing duration	Continuous	Duration of daily effort (h)
Headline height	Continuous	Headline height (m) of the net for a tow
Bottom depth	Continuous	Seabed depth (m) for a tow
Effort depth	Continuous	Depth of trawl gear (m)
Speed	Continuous	Vessel speed (kn.) for a tow
Wingspread	Continuous	Wingspread (m) of the net for a tow
Vessel experience	Continuous	Number of years the vessel has been involved in the fishery
Catch	Continuous	Estimated greenweight (t) of barracouta caught from a tow
Fday	Continuous	Day of the year

Table D2a: CPUE data constraints for core datasets in the BAR 1 ECSI area.

(1) BAR1 ECSI: TCEPR bottom trawl tow-by-tow data mixed target tows – estimated catch

Data source	TCEPR tow-by-tow
Fishing year range	1990–2014
Season definition	October-June
Method	BT
Target species	BAR, RCO, SQU
Trawl region	NORTH, INSH, DEEP, SOUTH
Core vessel selection	> 80% of catch, ≥ 7 years vessel participation, all tows per vessel-year
Depth	20–500 m
Barracouta catch	All catches < 30 t per tow

(2) BAR 1 ECSI: TCER bottom trawl tow-by-tow data mixed target tows – estimated catch

Data source	TCER tow-by-tow
Fishing year range	2008–2014
Season definition	October-September
Method	BT
Target species	BAR, RCO, TAR
Trawl region	KAIK, BANKS, CANT, DUNE
Core vessel selection	90% of catch, ≥ 6 years vessel participation, all tows per vessel-year
Depth	20–250 m

(3) BAR 1 ECSI: CELR/TCER daily data mixed target bottom tows – landed catch

Data source	CELR and TCER data merged to day level
Year range	1990–2014
Season definition	October–September
Method	BT
Target species	BAR, RCO, TAR
Statistical areas	018, 020, 022, 034
Core vessel selection	≥ 6 years vessel participation and ≥ 80% catch

Table D2b: CPUE data constraints for core datasets in the BAR 1 ECNI area.

(4) BAR1 ECNI: TCEPR bottom trawl tow-by-tow data mixed target tows – estimated catch

Data source	TCEPR tow-by-tow
Fishing year range	1994–2014
Season definition	October-December, January-March, April-June, July-September
Method	BT
Target species	BAR, TAR
Statistical Area	009–014
Core vessel selection	> 80% of catch, ≥ 7 years vessel participation, all tows per vessel-year
Depth	20–500 m
Barracouta catch	All catches < 30 t per tow

(5) BAR 1 ECNI: TCER bottom trawl tow-by-tow data mixed target tows – estimated catch

Data source	TCER tow-by-tow
Fishing year range	2008–2014
Season definition	October-June
Statistical areas	012–017
Method	BT
Target species	BAR, GSH, GUR, RCO, TAR, WAR
Core vessel selection	80% of catch, at least 20 tows per vessel-year
Depth	20–250 m

(6) BAR 1 ECNI: CELR/TCER daily data mixed target bottom tows – landed catch

Data source	CELR and TCER data merged to day level
Year range	1990–2014
Season definition	October-December, January-March, April-June, July-September
Statistical areas	009–017
Method	BT
Target species	BAR, GUR, SNA, TAR
Core vessel selection	≥ 6 years vessel participation and ≥ 80% catch
Depth	20–250 m

Table D3: Summary of BAR 1 ECSI TCEPR data used in the analyses of estimated catch for all vessels and for core vessels. Vess, number of unique vessels fishing; tows, number of tow records; records, number of daily records. Zero tows are those with no barracouta catch; CPUE, unstandardised CPUE from the tow-by-tow data (estimated catch).

(1) Estimated TCEPR mixed target bottom trawl catch data, October–June, for each fishing year during 1990–2014. Mixed target species were: barracouta, red code, and arrow squid.

	All vessels						Core vessels					
Fish year	Vess	Tows	Prop. zero tows	Catch (t)	No. non-zero tows	CPUE	Vess	Tows	Prop. zero tows	Catch (t)	No. non-zero tows	CPUE
1990	31	3 319	0.32	4 486.5	2 260	1.99	9	1 618	0.24	2 125.3	1 233	1.72
1991	29	2 473	0.22	3 754.0	1 932	1.94	10	1 398	0.15	2 156.6	1 192	1.81
1992	30	3 645	0.37	3 325.1	2 309	1.44	14	2 075	0.39	2 224.0	1 267	1.76
1993	29	3 777	0.32	4 339.7	2 576	1.68	15	2 492	0.33	3 548.0	1 658	2.14
1994	26	3 066	0.46	1 802.1	1 662	1.08	15	2 330	0.46	1 466.2	1 250	1.17
1995	28	2 850	0.38	3 531.7	1 754	2.01	18	2 385	0.37	3 379.1	1 513	2.23
1996	31	4 764	0.42	4 745.2	2 752	1.72	20	3 701	0.43	3 927.4	2 099	1.87
1997	34	4 162	0.43	4 369.7	2 389	1.83	22	3 473	0.39	4 152.8	2 129	1.95
1998	30	4 473	0.41	4 615.2	2 639	1.75	21	3 936	0.38	4 313.4	2 445	1.76
1999	27	3 167	0.33	3 915.3	2 118	1.85	22	3 067	0.32	3 848.4	2 076	1.85
2000	25	3 020	0.25	4 279.9	2 269	1.89	19	2 977	0.25	4 257.1	2 239	1.9
2001	27	3 169	0.33	3 039.8	2 115	1.44	19	3 022	0.33	3 001.9	2 027	1.48
2002	23	2 585	0.34	2 531.1	1 715	1.48	18	2 546	0.34	2 507.8	1 688	1.49
2003	23	2 894	0.45	2 566.5	1 587	1.62	18	2 690	0.46	2 482.6	1 463	1.7
2004	23	2 261	0.35	2 858.0	1 459	1.96	18	2 225	0.36	2 843.8	1 432	1.99
2005	27	1 806	0.55	1 067.5	812	1.31	14	1 508	0.5	942	747	1.26
2006	26	1 672	0.46	1 467.5	911	1.61	15	1 412	0.38	1 379.0	871	1.58
2007	19	1 141	0.52	612.4	543	1.13	14	1 021	0.49	596.2	519	1.15
2008	16	169	0.25	600.4	127	4.73	10	137	0.25	565.5	103	5.49
2009	13	465	0.17	1 272.1	384	3.31	12	461	0.18	1 265.1	380	3.33
2010	16	486	0.28	834.6	351	2.38	9	464	0.25	821.1	347	2.37
2011	20	866	0.15	1 946.5	735	2.65	12	662	0.12	1 692.2	582	2.91
2012	15	621	0.17	2 620.7	515	5.09	11	570	0.17	2 476.9	471	5.26
2013	16	426	0.14	1 343.0	368	3.65	9	405	0.13	1 319.0	351	3.76
2014	9	306	0.10	823.8	276	2.98	7	295	0.09	819.8	268	3.06
	114	57 583		66 748.2	36 558		26	46 870		58 111.4	30 350	

(2) Estimated TCER catch data, October–September in 018, 020, 022, and 024, for barracouta, red cod, and tarakihi, 2008 to 2014

	All vessels						Core vessels					
Fish year	Vess	Tows	Prop. zero tows	Catch (t)	No. non-zero tows	CPUE	Vess	Tows	Prop. zero tows	Catch (t)	No. non-zero tows	CPUE
2008	35	3 059	0.29	1 825.1	2 168	0.84	18	2 490	0.31	1 347.0	1 730	0.78
2009	33	3 372	0.28	1 848.5	2 434	0.76	20	3 107	0.26	1 821.9	2 302	0.79
2010	41	3 395	0.31	1 747.6	2 334	0.75	21	3 034	0.29	1 668.2	2 154	0.77
2011	44	3 377	0.27	2 090.3	2 459	0.85	21	3 130	0.26	2 053.0	2 322	0.88
2012	43	3 271	0.28	2 681.1	2 367	1.13	21	2 700	0.25	2 497.2	2 015	1.24
2013	41	3 623	0.22	3 110.7	2 824	1.10	20	2 786	0.20	2 678.8	2 216	1.21
2014	39	3 829	0.27	2 467.9	2 802	0.88	21	2 842	0.24	2 229.2	2 152	1.04
Total	62	23 926		15 771.2	17 388		21	20 089		14 295.2	14 891	

(3) Landed barracouta catch data from BAR 1 ECSI merged daily CELR and TCER forms where barracouta, red code and tarakihi were targeted using bottom trawl gear, October-September in 018, 020, 022, and 024, for all effort and core effort, by fishing year 1990 to 2014.

	All vessels						Core vessels					
Fish year	Vess	Records	Prop. zero records	Catch (t)	No. non-zero records	CPUE	Vess	Records	Prop. zero records	Catch (t)	No. non-zero records	CPUE
1990	56	1 929	0.17	1 366.7	1 608	0.85	12	875	0.14	677.0	755	0.90
1991	71	2 399	0.15	2 551.0	2 043	1.25	16	1 279	0.12	1 188.9	1 131	1.05
1992	61	2 286	0.19	1 149.5	1 854	0.62	17	1 576	0.18	639.8	1 296	0.49
1993	58	2 334	0.16	1 102.7	1 962	0.56	18	1 647	0.14	777.1	1 417	0.55
1994	63	2 163	0.16	852.6	1 823	0.47	18	1 632	0.13	749.0	1 423	0.53
1995	62	2 924	0.15	1 698.0	2 482	0.68	21	2 110	0.13	1 467.9	1 842	0.80
1996	58	2 544	0.15	1 804.9	2 174	0.83	20	1 974	0.11	1 647.0	1 765	0.93
1997	54	2 647	0.14	2 712.1	2 274	1.19	23	2 195	0.11	2 549.0	1 962	1.30
1998	48	2 632	0.14	2 751.8	2 273	1.21	21	2 203	0.11	2 555.4	1 950	1.31
1999	44	2 164	0.16	1 808.1	1 812	1.00	18	1 894	0.14	1 752.2	1 629	1.08
2000	50	1 965	0.16	1 884.9	1 654	1.14	20	1 736	0.12	1 809.9	1 528	1.18
2001	46	2 148	0.24	1 735.2	1 629	1.07	21	1 868	0.18	1 692.5	1 532	1.10
2002	42	1 818	0.25	1 676.9	1 372	1.22	15	1 517	0.19	1 602.8	1 223	1.31
2003	35	1 860	0.22	1 935.5	1 445	1.34	17	1 654	0.18	1 887.1	1 362	1.39
2004	47	1 743	0.21	1 655.7	1 372	1.21	18	1 457	0.16	1 539.5	1 228	1.25
2005	42	1 798	0.23	1 780.9	1 377	1.29	18	1 544	0.19	1 751.1	1 253	1.40
2006	40	1 773	0.21	2 252.2	1 409	1.60	16	1 506	0.17	2 199.0	1 252	1.76
2007	34	1 248	0.20	1 153.7	995	1.16	13	1 048	0.17	1 138.2	872	1.31
2008	36	1 137	0.19	1 729.5	921	1.88	9	827	0.16	1 251.7	693	1.81
2009	32	1 246	0.17	1 795.5	1 034	1.84	10	1 039	0.12	1 732.0	916	1.89
2010	40	1 270	0.21	1 681.3	1 007	1.67	10	918	0.14	1 564.5	790	1.98
2011	45	1 276	0.18	2 036.2	1 043	1.95	9	957	0.11	1 900.8	856	2.22
2012	39	1 201	0.23	2 593.4	924	2.81	10	815	0.15	2 343.0	690	3.40
2013	39	1 306	0.17	3 148.0	1 082	2.91	9	810	0.09	2 548.0	734	3.47
2014	39	1 347	0.16	2 540.8	1 130	2.25	9	873	0.12	2 091.6	772	2.71
Total	188	47 158		47 397.1	38 699		34	35 954		41 055.1	30 871	

Table D4: Variables retained in order of decreasing explanatory value by each BAR 1 ECSI lognormal model and the corresponding total r^2 value.

Dataset	Variable	r^2
TCEPR tow-by-tow estimated mixed target, bottom tows		
Lognormal	Year	3.7
For 1990–14 fishing years	Target	12.2
	Vessel	15.6
	Tow depth	19.1
	Start time of tow	20.6
	Trawl region	21.9
	Month	23.1
TCER tow-by-tow estimated bottom trawl catch from mixed targets		
Lognormal	Year	1.6
For 2008–14 fishing years	Vessel	23.9
	Tow start time	28.9
	Target species	32.2
	Bottom depth	34.4
CELR and TCER daily bottom trawl data for BAR, RCO, and TAR.		
Lognormal	Year	9.7
For 1990–2014 fishing years	Vessel	35.5
	Target species	38.9
	Month	41.2
	Fishing duration	42.7

Table D5: ECSI lognormal CPUE core indices by fishing year, with 95% confidence intervals and CVs.

(a) TCEPR

	Core vessels: BT target BAR, RCO, SQU						
Fishing year	Index	95% CI	CV	Fishing year	Index	95% CI	CV
1990	0.87	0.82–0.93	0.03	2003	0.76	0.72–0.81	0.03
1991	0.98	0.92–1.04	0.03	2004	0.74	0.70–0.18	0.03
1992	0.93	0.88–0.99	0.03	2005	0.51	0.48–0.55	0.04
1993	0.98	0.93–1.03	0.03	2006	0.82	0.77–0.88	0.03
1994	0.89	0.84–0.94	0.03	2007	0.5	0.45–0.54	0.04
1995	1.13	1.07–1.19	0.03	2008	1.47	1.21–1.79	0.10
1996	1.15	1.10–1.21	0.02	2009	1.18	1.07–1.31	0.05
1997	1.27	1.22–0.33	0.02	2010	0.85	0.76–0.94	0.05
1998	1.21	1.16–0.27	0.02	2011	1.31	1.21–1.43	0.04
1999	1.13	1.08–0.19	0.02	2012	1.29	1.18–1.42	0.05
2000	1.32	1.26–1.38	0.02	2013	1.31	1.18–1.46	0.05
2001	0.94	0.90–0.99	0.02	2014	1.51	1.34–1.70	0.06
2002	0.87	0.83–0.92	0.03				

(b) TCER

	Mixed target core vessels		
Fishing year	Index	95% CI	CV
2008	0.70	0.67–0.73	0.02
2009	0.91	0.87–0.94	0.02
2010	1.04	1.00–1.08	0.02
2011	1.06	1.02–1.10	0.02
2012	1.14	1.09–1.19	0.02
2013	1.22	1.17–1.27	0.02
2014	1.04	0.99–1.08	0.02

(c) CELR and TCER

	Core vessels: BT target BAR, RCO, TAR						
Fishing year	Index	95% CI	CV	Fishing year	Index	95% CI	CV
1990	1.18	1.09–1.27	0.04	2003	0.52	0.49–0.55	0.03
1991	1.29	1.21–1.37	0.03	2004	0.77	0.73–0.82	0.03
1992	0.73	0.69–0.78	0.03	2005	0.83	0.78–0.88	0.03
1993	0.84	0.80–0.89	0.03	2006	1.01	0.95–1.07	0.03
1994	0.84	0.80–0.89	0.03	2007	0.77	0.72–0.82	0.03
1995	0.90	0.86–0.95	0.03	2008	0.87	0.80–0.94	0.04
1996	1.21	1.15–1.28	0.03	2009	1.01	0.94–1.08	0.03
1997	1.46	1.39–1.54	0.02	2010	1.22	1.14–1.32	0.04
1998	1.62	1.54–1.70	0.02	2011	1.29	1.20–1.38	0.04
1999	0.94	0.89–0.99	0.03	2012	1.49	1.38–1.61	0.04
2000	0.91	1.86–0.96	0.03	2013	1.67	1.55–1.81	0.04
2001	0.66	0.63–0.70	0.03	2014	1.40	1.30–1.51	0.04
2002	0.69	0.65–0.73	0.03				

Table D6: Summary of BAR 1 ECNI TCEPR data used in the analyses of estimated catch for all vessels and for core vessels. Vess, number of unique vessels fishing; tows, number of tow records; records, number of daily records. Zero tows are those with no barracouta catch; CPUE, unstandardised CPUE from the tow-by-tow data (estimated catch).

(1) Estimated TCEPR mixed target bottom trawl catch data, October–September, for each fishing year during 1994–2014. Mixed target species were: barracouta and tarakihi.

	All vessels						Core vessels					
Fish year	Vess	Tows	Prop. zero tows	Catch (t)	No. non-zero tows	CPUE	Vess	Tows	Prop. zero tows	Catch (t)	No. non-zero tows	CPUE
1994	18	567	0.38	244.2	353	0.69	6	187	0.34	83.1	123	0.68
1995	19	1 097	0.39	351.7	672	0.52	8	298	0.42	110.9	173	0.64
1996	32	1 302	0.41	411.6	764	0.54	11	321	0.36	117.9	207	0.57
1997	30	1 268	0.53	291.4	594	0.49	8	537	0.57	89.9	230	0.39
1998	35	1 445	0.55	321	655	0.49	17	793	0.57	147.9	340	0.44
1999	25	1 686	0.48	313.9	874	0.36	17	1 148	0.45	243.4	631	0.39
2000	20	1 081	0.56	111.2	475	0.23	15	957	0.56	88.1	421	0.21
2001	22	1 352	0.55	212.8	607	0.35	19	1 305	0.54	212.6	600	0.35
2002	17	1 459	0.59	102.6	594	0.17	14	1 444	0.59	102.6	594	0.17
2003	22	1 680	0.67	141.4	556	0.25	19	1 662	0.67	141.1	554	0.25
2004	22	1 917	0.55	156.0	856	0.18	20	1 911	0.55	155.4	851	0.18
2005	20	1 846	0.59	122.3	766	0.16	17	1 836	0.58	122.3	765	0.16
2006	19	1 803	0.51	127.7	875	0.15	16	1 794	0.51	127.2	871	0.15
2007	17	2 127	0.55	209.6	966	0.22	13	2 084	0.54	208.2	957	0.22
2008	12	1 518	0.62	101.7	572	0.18	10	1 488	0.62	100.8	570	0.18
2009	9	1 624	0.52	105.7	787	0.13	7	1 621	0.51	105.7	787	0.13
2010	10	1 712	0.55	109.8	765	0.14	7	1 685	0.55	109.5	761	0.14
2011	10	1 567	0.57	144.1	679	0.21	5	1 544	0.56	143.5	672	0.21
2012	11	1 452	0.59	67.4	600	0.11	6	1 429	0.59	62.7	591	0.11
2013	8	632	0.63	15.8	235	0.07	3	580	0.60	15.8	232	0.07
2014	9	1 451	0.60	86.6	578	0.15	5	1 426	0.60	86.5	574	0.15
All	64	30 586		3 748.5	13 823		23	26 050		2575.0	11504	

(2) Estimated TCER catch data, October–September in Statistical Areas 012–017, for barracouta, ghost shark, red gurnard, red cod, tarakihi, and blue warehou, 2008 to 2014.

	All vessels						Core vessels					
Fish year	Vess	Tows	Prop. zero tows	Catch (t)	No. non-zero tows	CPUE	Vess	Tows	Prop. zero tows	Catch (t)	No. non-zero tows	CPUE
2008	40	4 688	0.55	263.6	2 104	0.13	17	3 318	0.52	186.9	1 608	0.12
2009	41	5 202	0.54	275.6	2 385	0.12	20	4 384	0.52	216.3	2 085	0.1
2010	49	6 178	0.52	279.1	2 991	0.09	22	5 407	0.51	241.6	2 676	0.09
2011	47	6 175	0.59	309.4	2 536	0.12	19	5 417	0.57	258.7	2 317	0.11
2012	46	5 757	0.51	422.3	2 849	0.15	21	5 140	0.49	360.3	2 598	0.14
2013	43	5 860	0.54	360.7	2 684	0.13	18	4 953	0.52	329.7	2 367	0.14
2014	42	5 868	0.50	451.4	2 936	0.15	20	5 113	0.49	396.7	2 616	0.15
Total	62	39 728		2 362.1	18 485		24	33 732		1 990.2	16 267	

(3) Landed barracouta catch data from BAR 1 ECNI merged daily CELR and TCER forms where barracouta, red gurnard, snapper, and tarakihi were targeted using bottom trawl gear, October-September in Statistical Areas 009–017, for all effort and core effort, by fishing year 1990 to 2014.

	All vessels						Core vessels					
Fish year	Vess	Records	Prop. zero records	Catch (t)	No. non-zero records	CPUE	Vess	Records	Prop. zero records	Catch (t)	No. non-zero records	CPUE
1990	77	1 605	0.35	465.6	1 039	0.45	12	773	0.24	167.9	587	0.29
1991	83	2 324	0.34	316.6	1 534	0.21	17	1 341	0.28	135.0	967	0.14
1992	97	2 947	0.29	764.1	2 095	0.36	23	1 650	0.25	359.2	1 245	0.29
1993	92	3 119	0.32	702.8	2 136	0.33	24	1 944	0.28	392.3	1 391	0.28
1994	84	2 733	0.32	687.8	1 869	0.37	20	1 654	0.28	370.3	1 183	0.31
1995	77	2 458	0.31	690.8	1 695	0.41	20	1 667	0.26	467.2	1 233	0.38
1996	53	1 908	0.36	499.4	1 230	0.41	15	1 346	0.27	339.6	978	0.35
1997	49	1 997	0.43	526.8	1 139	0.46	15	1 238	0.28	284.0	887	0.32
1998	46	1 647	0.39	389.2	1 008	0.39	12	1 133	0.29	303.8	799	0.38
1999	54	1 784	0.42	430.1	1 036	0.42	11	1 100	0.31	288.1	758	0.38
2000	54	2 240	0.41	364.5	1 328	0.27	12	1 326	0.33	244.8	895	0.27
2001	50	2 033	0.37	372.3	1 271	0.29	17	1 382	0.31	285.8	947	0.30
2002	49	1 823	0.38	238.7	1 133	0.21	12	1 285	0.28	170.7	926	0.18
2003	42	1 915	0.36	311.8	1 219	0.26	14	1 387	0.32	214.4	940	0.23
2004	48	1 805	0.40	292.4	1 074	0.27	15	1 440	0.34	262.3	949	0.28
2005	40	2 126	0.32	327.2	1 437	0.23	19	1 843	0.28	297.2	1 325	0.22
2006	39	2 077	0.32	331.8	1 416	0.23	16	1 688	0.29	272.4	1 206	0.23
2007	39	2 032	0.34	332.4	1 335	0.25	17	1 765	0.31	285.9	1 218	0.23
2008	41	2 055	0.36	285.7	1 310	0.22	16	1 523	0.29	222.1	1 078	0.21
2009	41	2 105	0.35	293.8	1 370	0.21	18	1 675	0.29	246.9	1 184	0.21
2010	46	2 538	0.36	302.3	1 618	0.19	19	2 177	0.33	248.9	1 451	0.17
2011	45	2 152	0.40	214.9	1 293	0.17	16	1 817	0.35	177.7	1 190	0.15
2012	45	2 065	0.34	290.1	1 356	0.21	16	1 740	0.27	268.0	1 269	0.21
2013	44	1 981	0.33	335.5	1 318	0.25	15	1 467	0.23	280.0	1 123	0.25
2014	44	2 162	0.40	465.1	1 308	0.36	17	1 745	0.34	402.2	1 149	0.35
Total	216	53 631		10 231.7	34 567		42	38 106		6 984.5	26 878	

Table D7: Variables retained in order of decreasing explanatory value by each BAR 1 ECNI lognormal model and the corresponding total r^2 value.

Dataset	Variable	r^2
TCEPR tow-by-tow estimated mixed target, bottom tows		
Lognormal	Year	8.6
For 1994–14 fishing years	Vessel	24.8
	Target	29.6
	Month	31.8
	Start time of tow	32.8
TCER tow-by-tow estimated bottom trawl catch from mixed targets		
Lognormal	Year	0.7
For 2008–14 fishing years	Vessel	33.6
	Month	36.9
	Target species	38.0
CELR and TCER daily bottom trawl data from mixed targets.		
Lognormal	Year	3.8
For 1990–2014 fishing years	Vessel	26.7
	Month	33.2
	Target	37.6
	Fishing duration	40.5
	Headline height	41.5

Table D8: ECNI lognormal CPUE core indices by fishing year, with 95% confidence intervals and CVs.

(a) TCEPR

	Core vessels: BT target BAR and TAR						
Fishing year	Index	95% CI	CV	Fishing year	Index	95% CI	CV
1994	1.67	1.37–2.04	0.10	2005	0.89	0.83–0.97	0.04
1995	1.86	1.57–2.21	0.08	2006	0.86	0.80–0.92	0.04
1996	2.00	1.72–2.32	0.07	2007	0.94	0.88–1.02	0.04
1997	1.24	1.08–1.43	0.07	2008	0.69	0.63–0.76	0.05
1998	1.61	1.43–1.82	0.06	2009	0.68	0.63–0.74	0.04
1999	1.11	1.02–1.21	0.04	2010	0.75	0.69–0.82	0.04
2000	0.83	0.75–0.92	0.05	2011	0.97	0.89–1.05	0.04
2001	0.85	0.78–0.93	0.04	2012	0.81	0.74–0.89	0.05
2002	0.82	0.75–0.90	0.04	2013	0.81	0.71–0.92	0.07
2003	0.90	0.83–0.99	0.04	2014	1.05	0.96–1.15	0.05
2004	0.80	0.74–0.86	0.04				

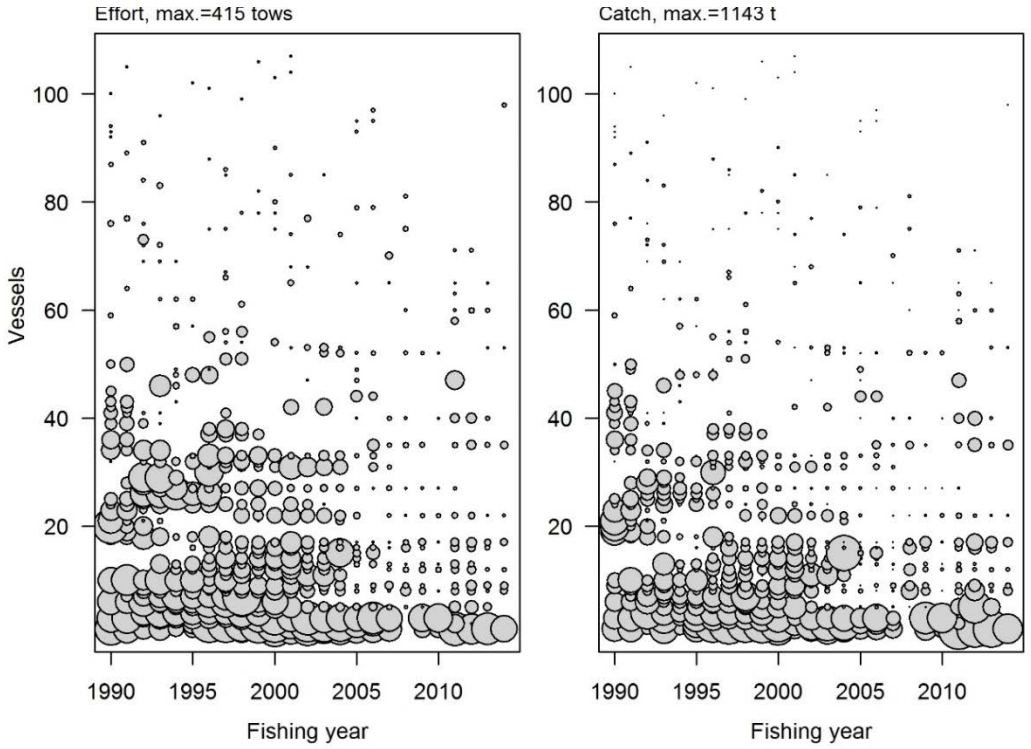
(b) TCER

	Mixed target core vessels		
Fishing year	Index	95% CI	CV
2008	1.08	1.03–1.13	0.02
2009	1.09	1.04–0.13	0.02
2010	0.94	0.91–0.98	0.02
2011	0.87	0.83–0.90	0.02
2012	1.01	0.98–1.05	0.02
2013	1.03	0.99–1.07	0.02
2014	1.00	0.96–1.04	0.02

(c) CELR and TCER

	Core vessels: BT target BAR, RCO, TAR						
Fishing year	Index	95% CI	CV	Fishing year	Index	95% CI	CV
1990	0.77	0.70–0.84	0.04	2003	0.94	0.88–1.01	0.03
1991	0.48	0.45–0.51	0.03	2004	1.28	1.20–1.37	0.03
1992	0.69	0.65–0.73	0.03	2005	1.10	1.04–0.16	0.03
1993	0.87	0.82–0.92	0.03	2006	1.21	1.14–1.29	0.03
1994	0.87	0.82–0.92	0.03	2007	1.11	1.04–1.18	0.03
1995	1.08	1.02–1.14	0.03	2008	0.91	0.86–0.97	0.03
1996	1.36	1.27–1.45	0.03	2009	0.92	0.87–0.97	0.03
1997	1.48	1.38–1.58	0.03	2010	1.03	0.98–1.09	0.03
1998	1.58	1.47–1.70	0.04	2011	0.62	0.59–0.66	0.03
1999	1.64	1.52–1.76	0.04	2012	0.74	0.69–0.78	0.03
2000	1.16	1.09–1.24	0.03	2013	0.85	0.80–0.91	0.03
2001	1.23	1.15–0.32	0.03	2014	1.25	1.18–1.33	0.03
2002	0.86	0.81–0.93	0.03				

(a) All vessels



(b) Core vessels

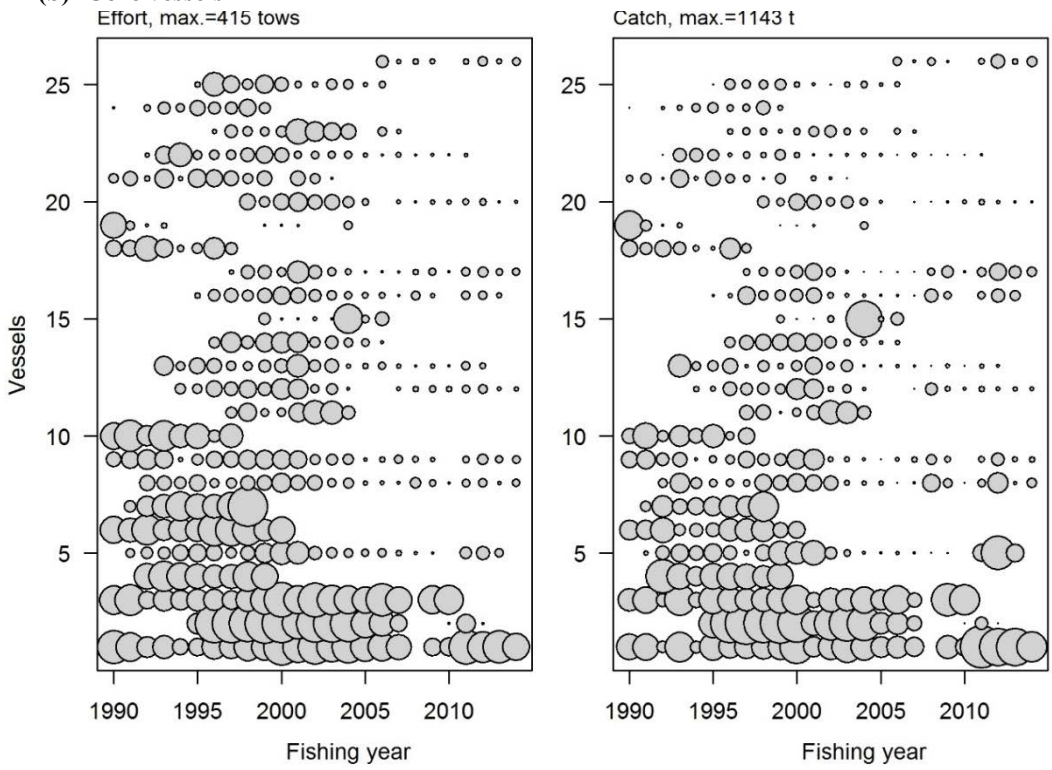


Figure D1: ECSI TCEPR summary of effort (number of bottom trawls) and landed barracouta catch (t) by fishing year for 1990–2014, for all vessels and core vessels. The symbol area is proportional to either the number of records or the annual catch, and the maximum circle size is shown in the label on the plot.

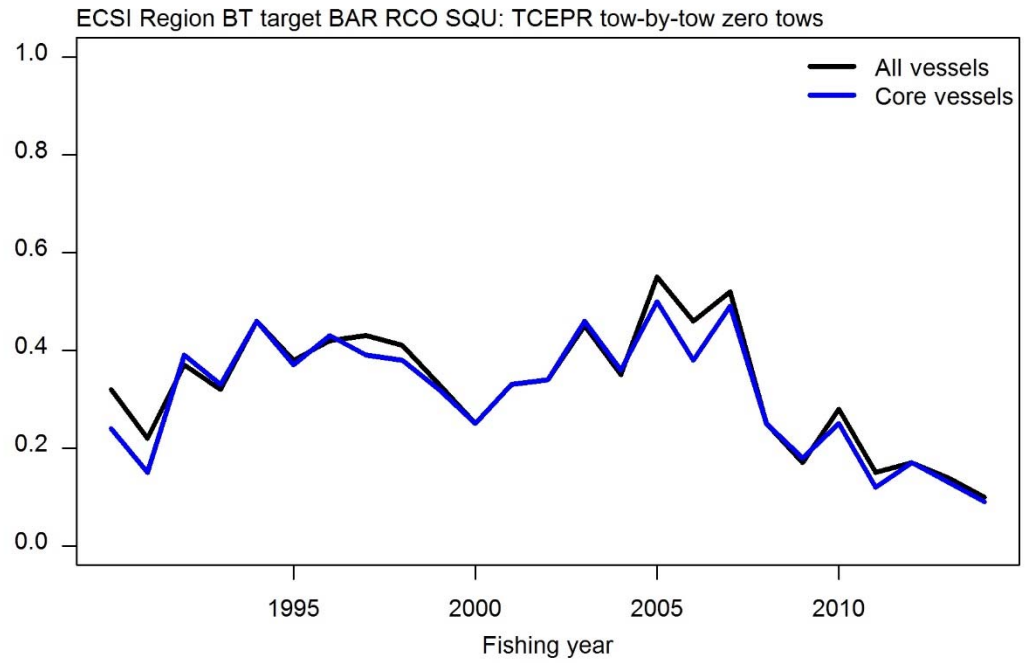


Figure D2: Proportion of zero barracouta catches in the ECSI TCEPR tow-by-tow bottom trawl, mixed target data for all vessels and for core vessels, 1990–2014.

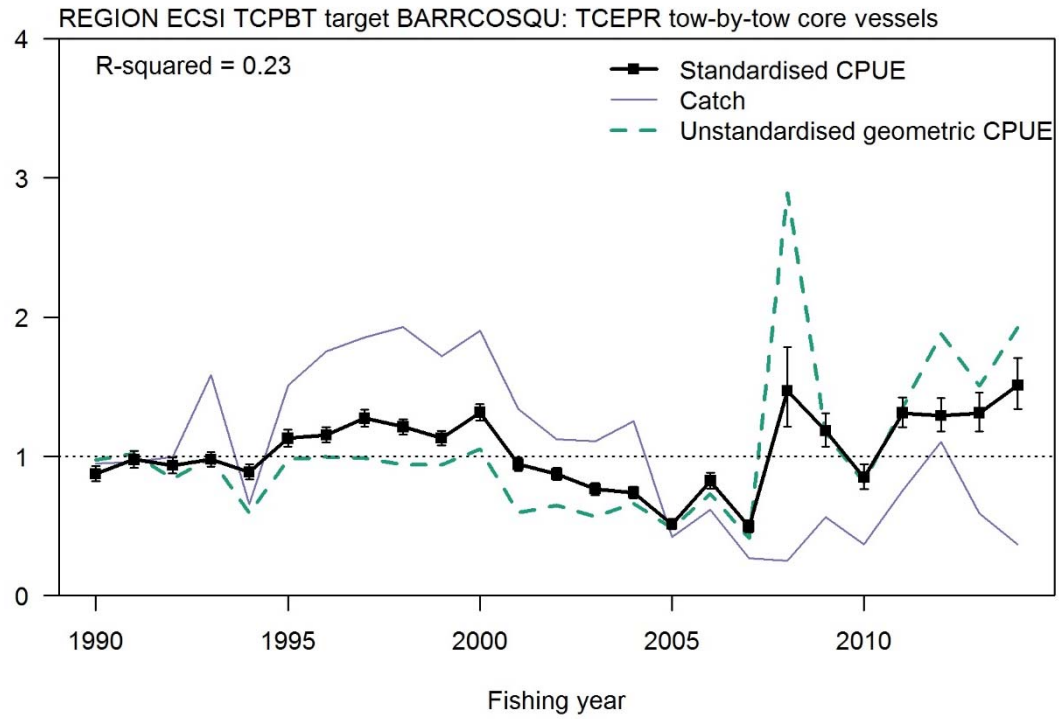


Figure D3a: CPUE lognormal indices for ECSI TCEPR bottom trawl, mixed target data, showing catches (scaled to same mean as indices), and lognormal standardised and unstandardised indices. Bars indicate 95% confidence intervals.

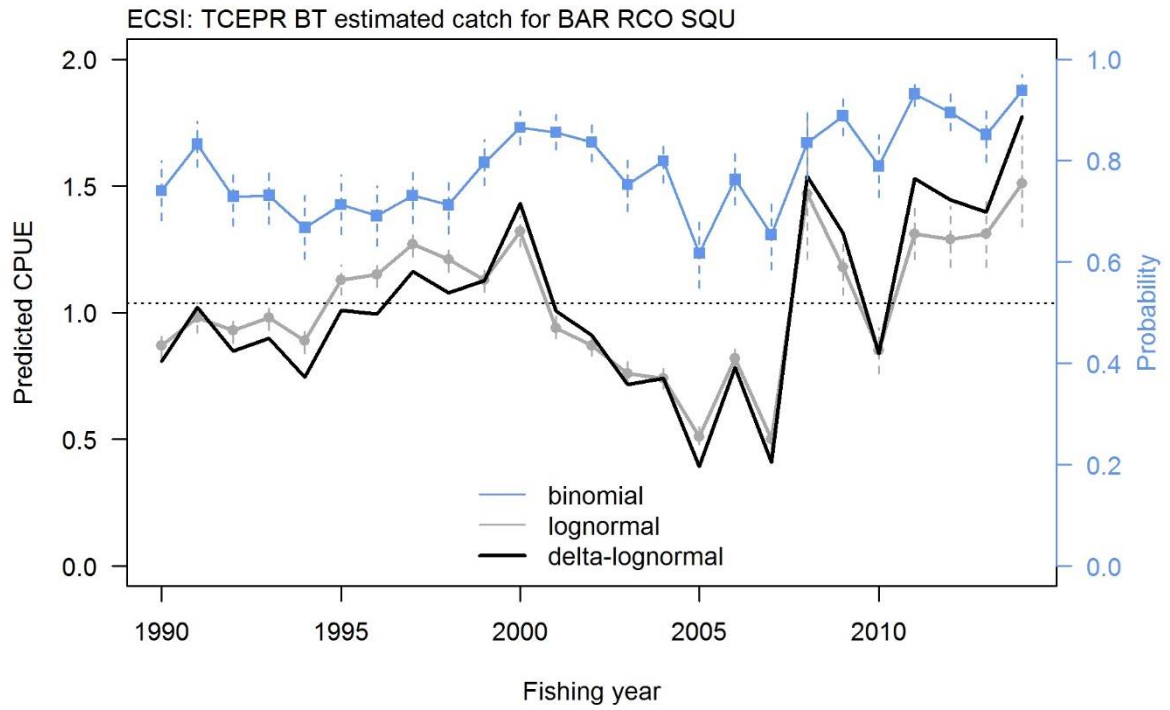


Figure D3b: ECSI TCEPR CPUE from the lognormal, binomial, and delta–lognormal (combined) core vessel mixed target, bottom trawl estimated catch model, for October–June, 1990–2014. Bars indicate 95% confidence intervals.

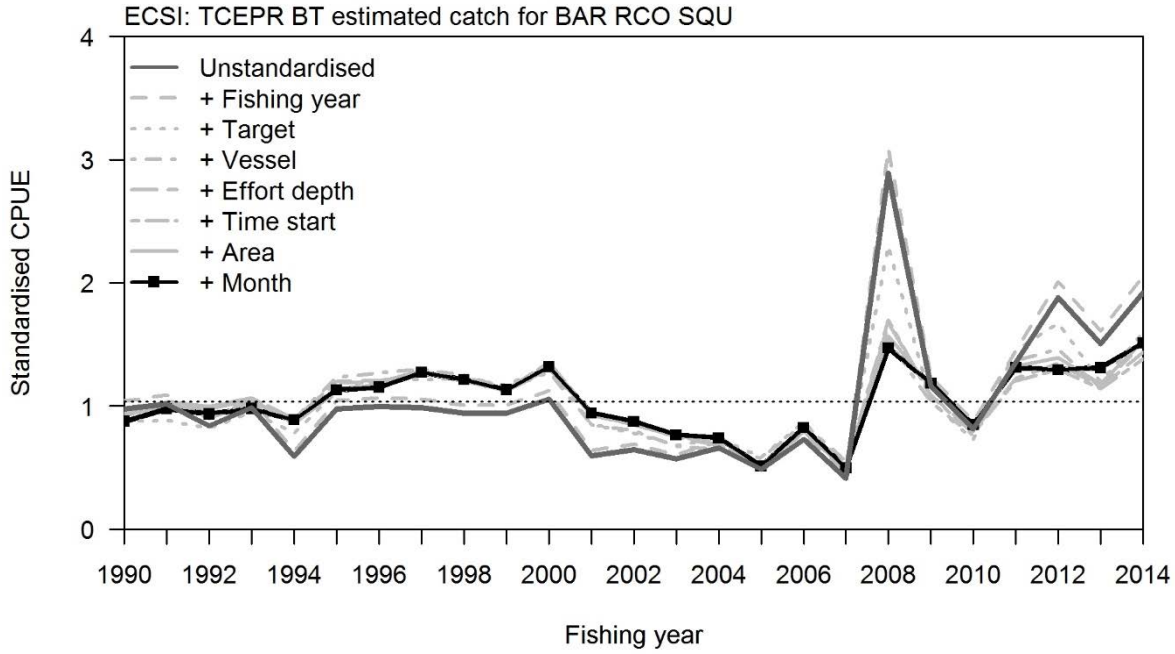


Figure D4: Addition of variables into the lognormal CPUE from the lognormal model for the ECSI TCEPR trawl fishery using bottom trawls to target barracouta, red cod, and arrow squid in Statistical Areas 018, 020, 022, and 024, during October–June of each fishing year, 1990–2014.

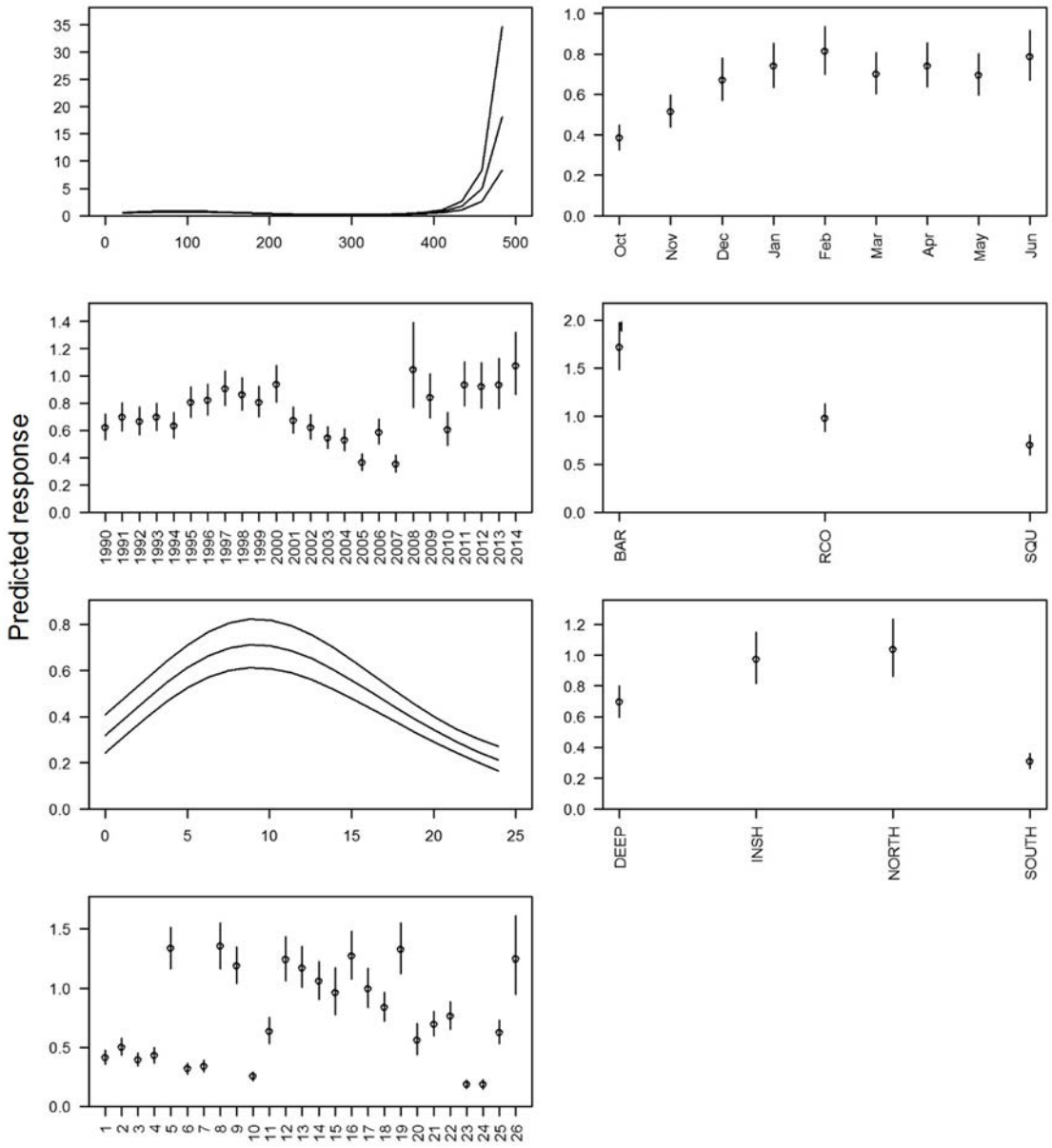


Figure D5: Effects of selected variables in the lognormal model for the ECSI TCEPR BT estimated catch for core mixed target vessels, 1990–2014. Bars indicate 95% confidence intervals. Top: fishing year, target; middle: start time of tow, trawl region; bottom: core vessel.

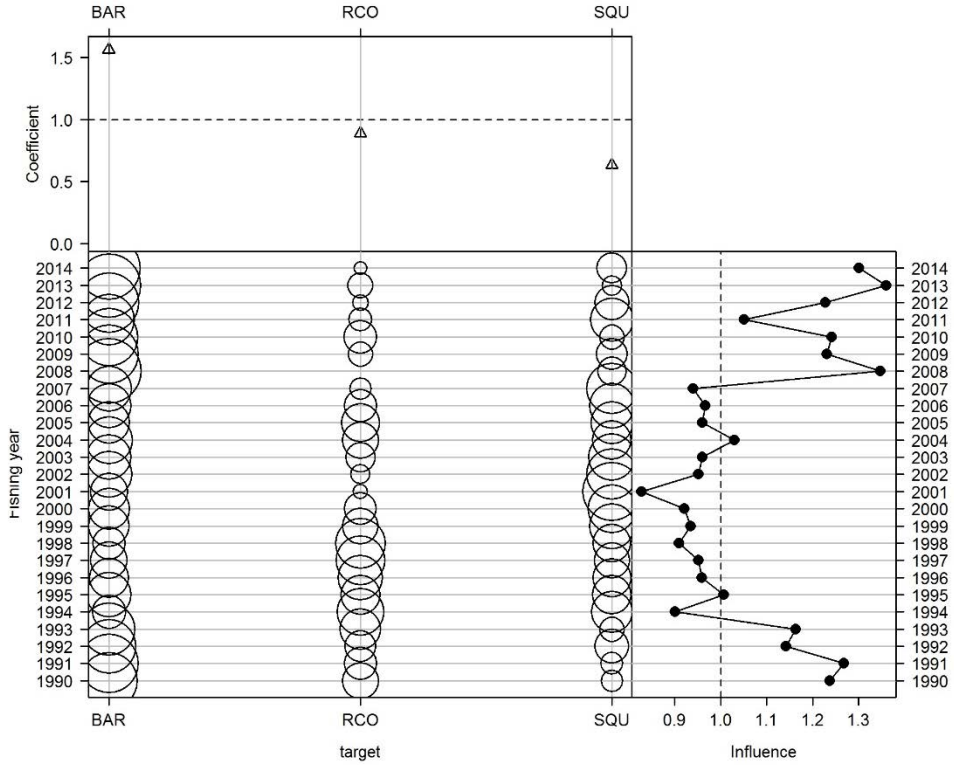


Figure D6a: Effect and influence of target species in the ECSI TCEPR tow-by-tow core vessel mixed target BT lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of the effort by variable and fishing year. Bottom right: influence of variable (target) on unstandardised CPUE by fishing year.

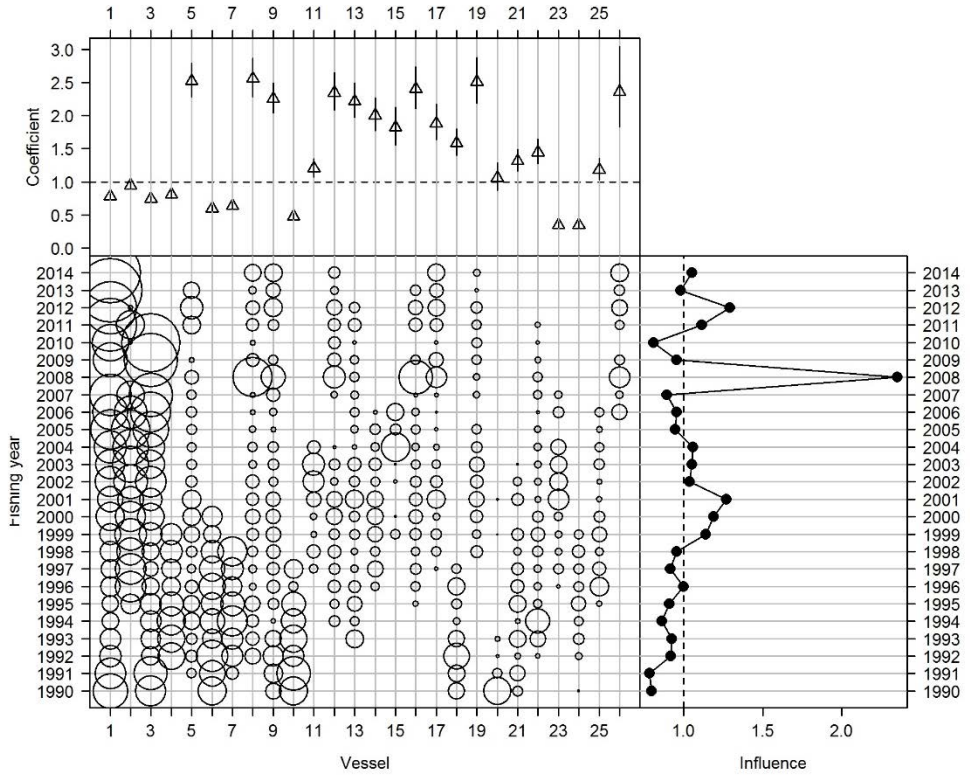


Figure D6b: Effect and influence of vessel in the ECSI TCEPR tow-by-tow core vessel mixed target BT lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of the effort by variable and fishing year. Bottom right: influence of variable on unstandardised CPUE by fishing year.

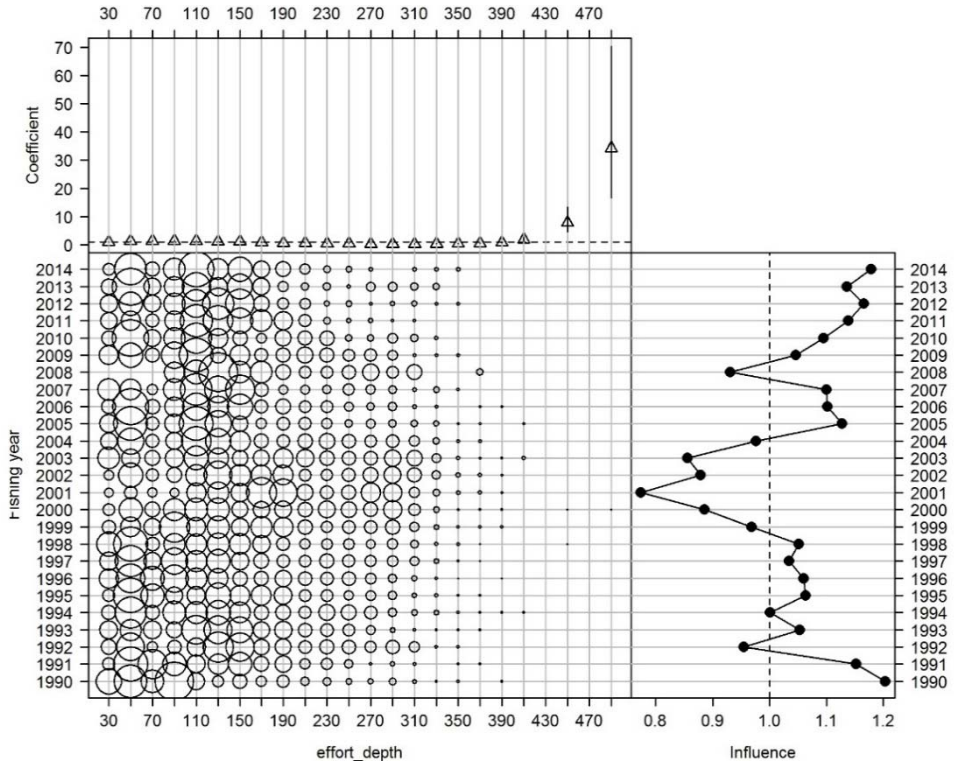


Figure D6c: Effect and influence of effort depth (m) in the ECSI TCEPR tow-by-tow core mixed target BT lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of the effort by variable and fishing year. Bottom right: influence of variable on unstandardised CPUE by fishing year.

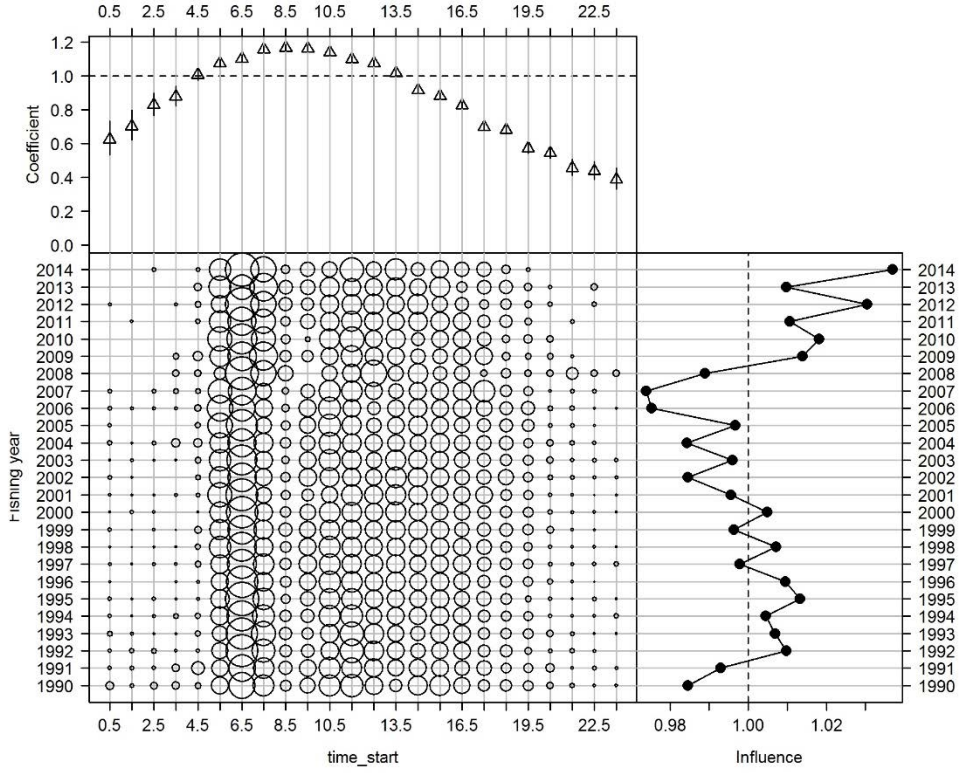


Figure D6d: Effect and influence of tow start time (h) in the ECSI TCEPR tow-by-tow core mixed target BT lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of the effort by variable and fishing year. Bottom right: influence of variable on unstandardised CPUE by fishing year.

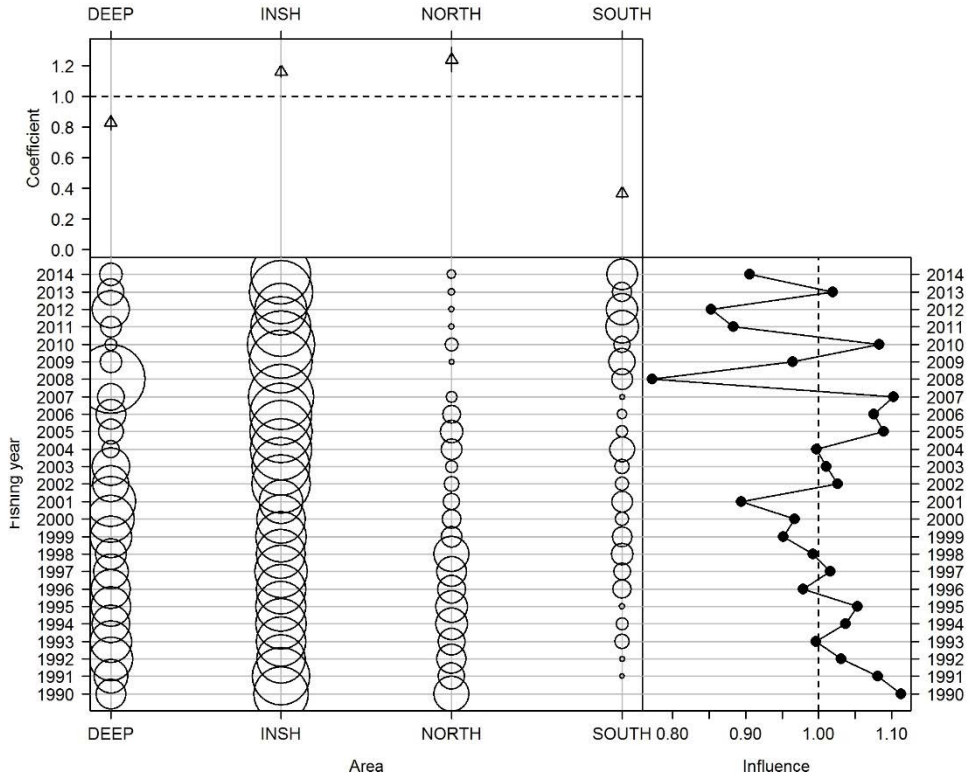


Figure D6e: Effect and influence of area in the ECSI TCEPR tow-by-tow core mixed target BT lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of the effort by variable and fishing year. Bottom right: influence of variable on unstandardised CPUE by fishing year.

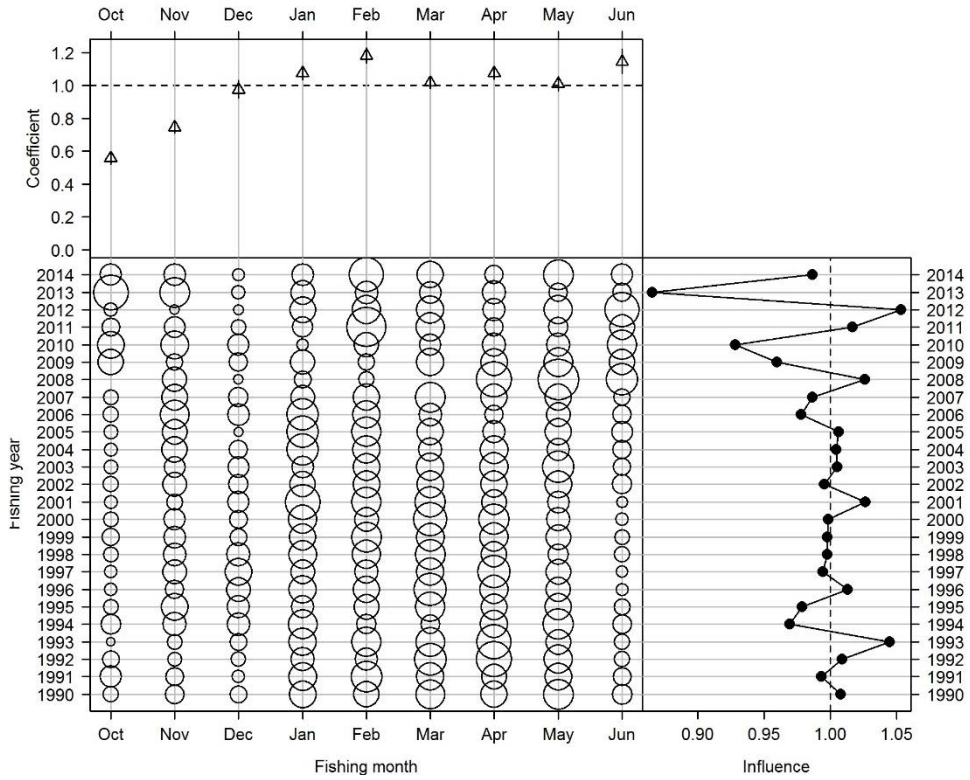


Figure D6f: Effect and influence of month in the ECSI TCEPR tow-by-tow core mixed target BT lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of the effort by variable and fishing year. Bottom right: influence of variable on unstandardised CPUE by fishing year.

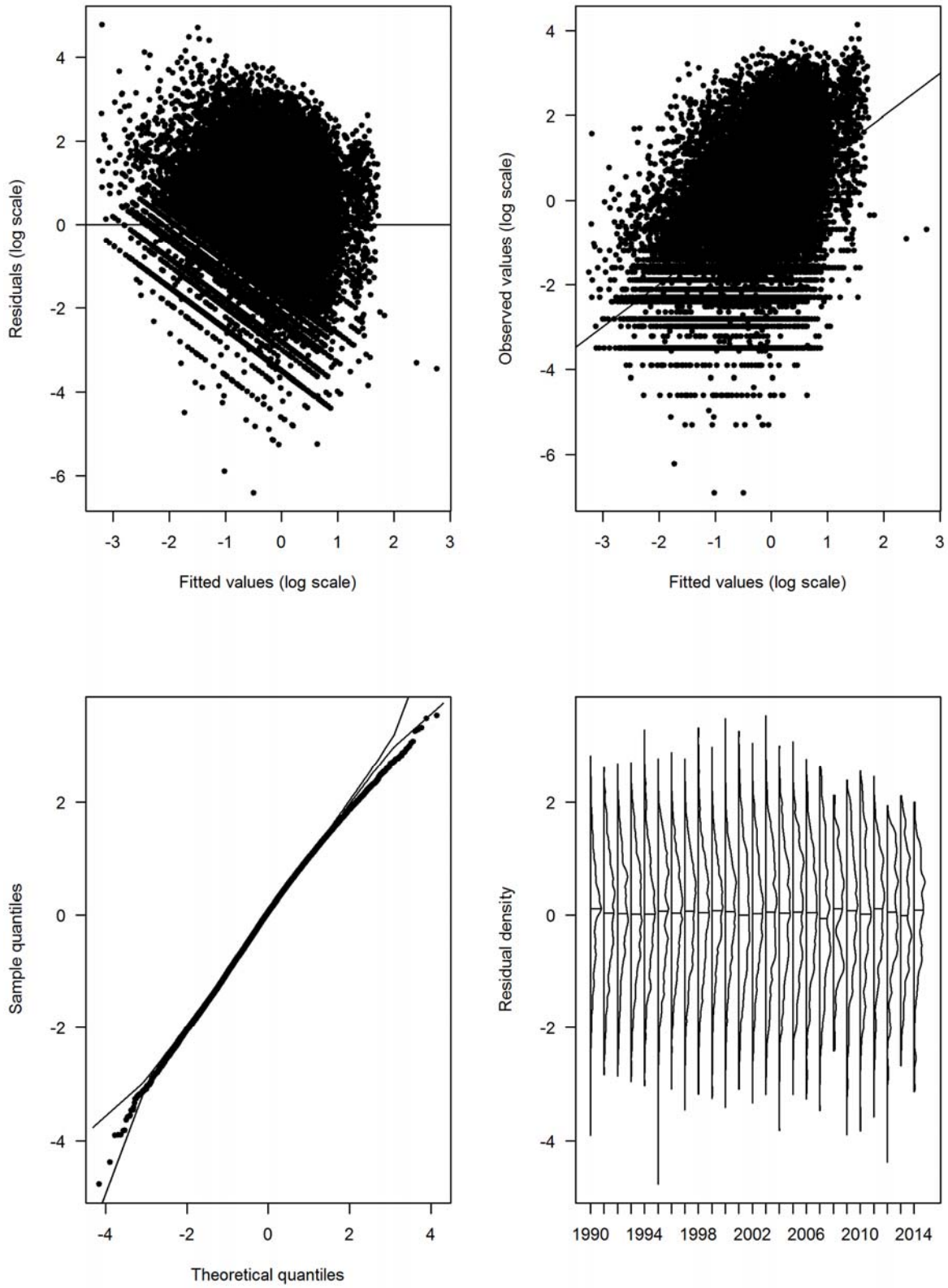
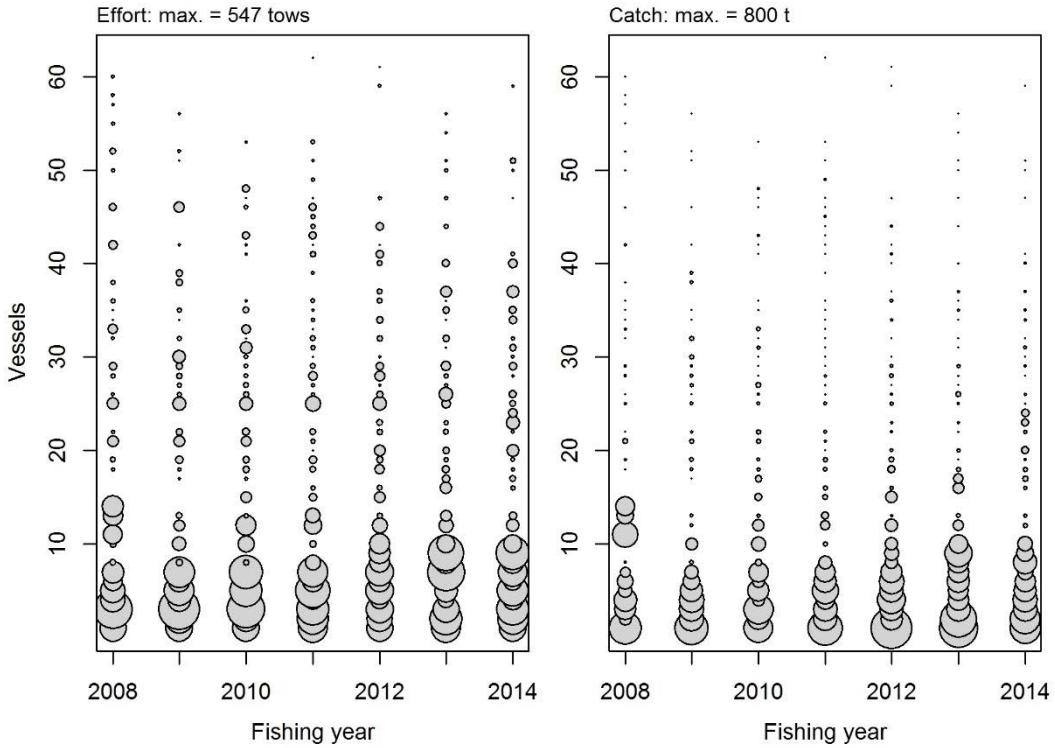


Figure D7: ECSI TCEPR tow-by-tow BT lognormal model (estimated catch for core vessels and mixed target): distribution of the standardised and observed residuals against fitted values (upper), the quantile–quantile plot of the residuals and density plot of the residuals (lower).

(a) All vessels



(b) Core vessels

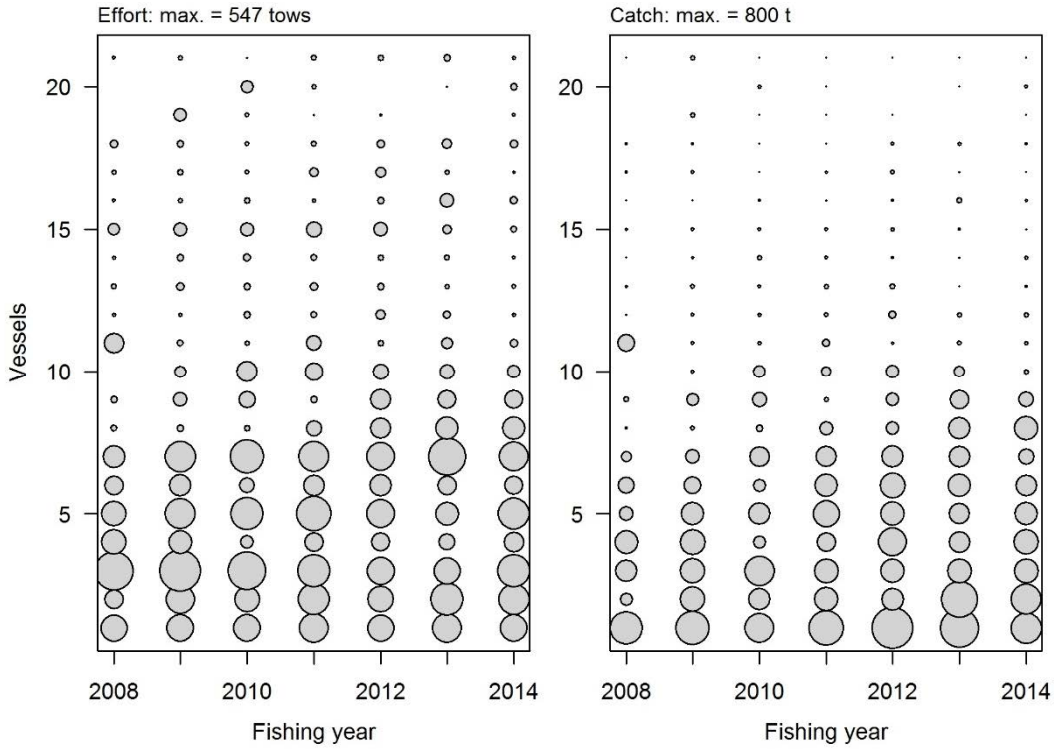


Figure D8: ECSI TCER summary of effort (number of TCER tows) and estimated barracouta catch (t) by fishing year for 1990–2014, for all vessels and core vessels. The symbol area is proportional to either the number of records or the annual catch, and the maximum circle size is shown in the label on the plot.

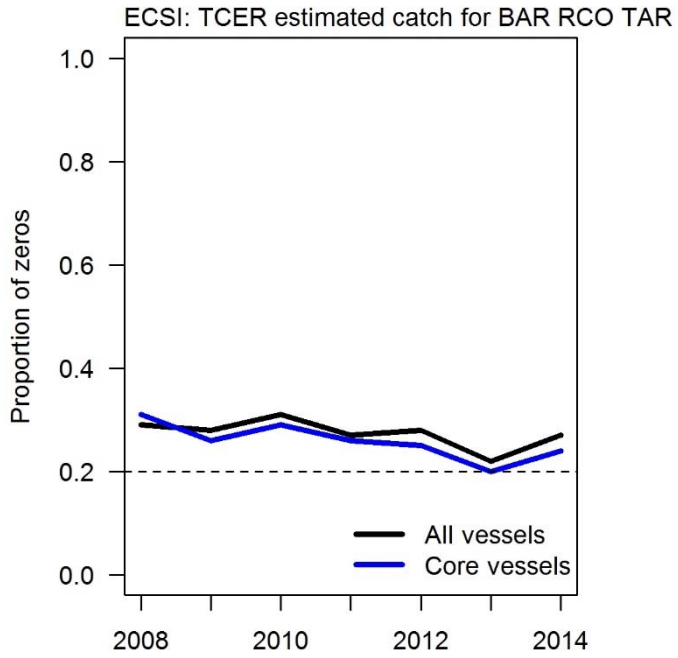


Figure D9: Proportion of zero barracouta catches in the ECSI TCER tow-by-tow bottom trawl data, for all vessels and for core vessels, 1990–2014.

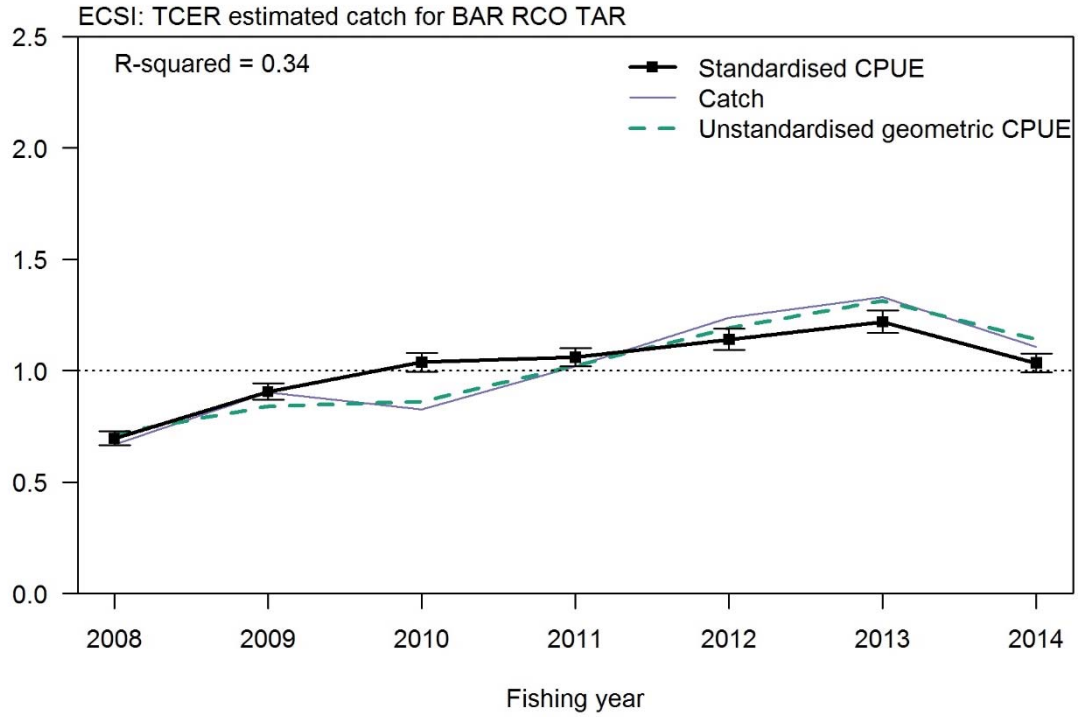


Figure D10a: CPUE lognormal indices for ECSI, based on the TCER bottom trawl mixed target dataset, showing catches (scaled to same mean as indices), and lognormal standardised and unstandardised indices. Bars indicate 95% confidence intervals.

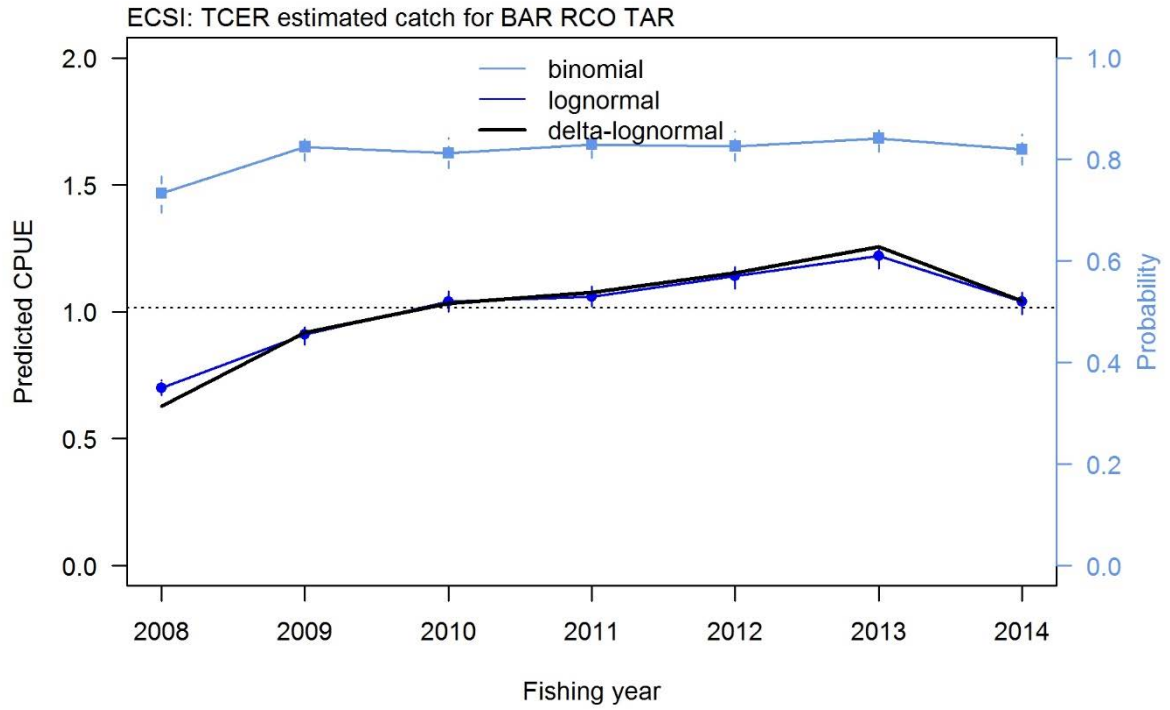


Figure D10b: ECSI TCER CPUE from the lognormal, binomial, and delta–lognormal (combined) core vessel mixed target, bottom trawl estimated catch model, for October–September, 2008–14. Bars indicate 95% confidence intervals.

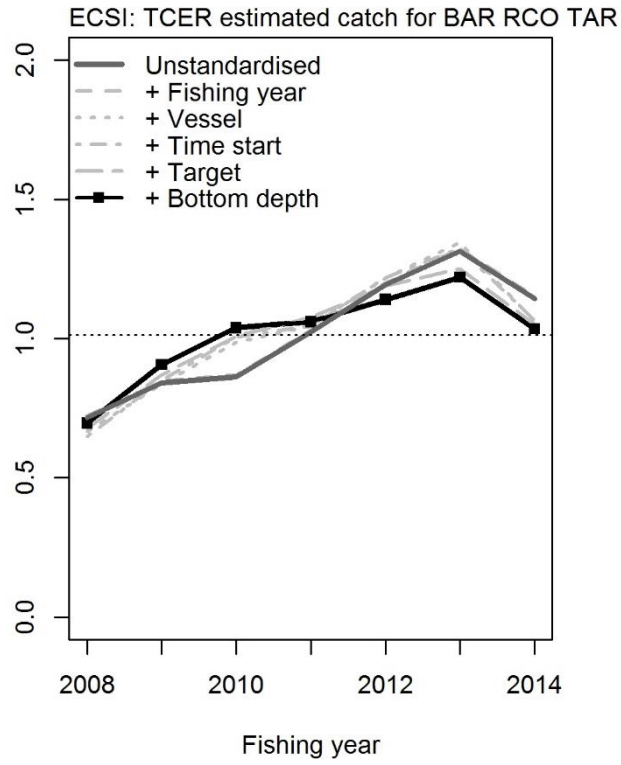


Figure D11: Addition of variables into the lognormal CPUE from the lognormal model for the ECSI TCER trawl fishery using bottom trawls to target barracouta, red cod, and tarakihi in Statistical Areas 018, 020, 022, and 024, during October–September of each fishing year, 2008–14.

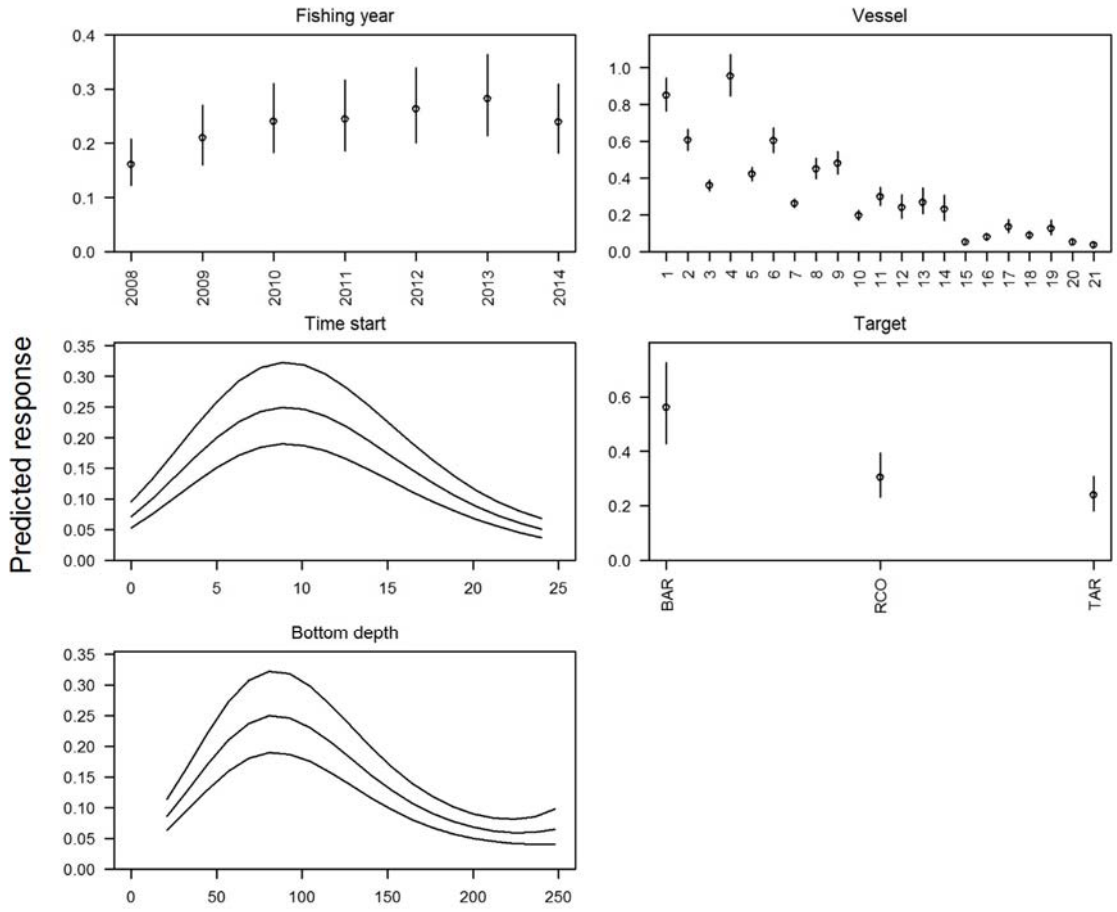


Figure D12: Effects of selected variables in the lognormal model for the ECSI TCER BT estimated catch for core mixed target vessels, 2008–14. Bars indicate 95% confidence intervals.

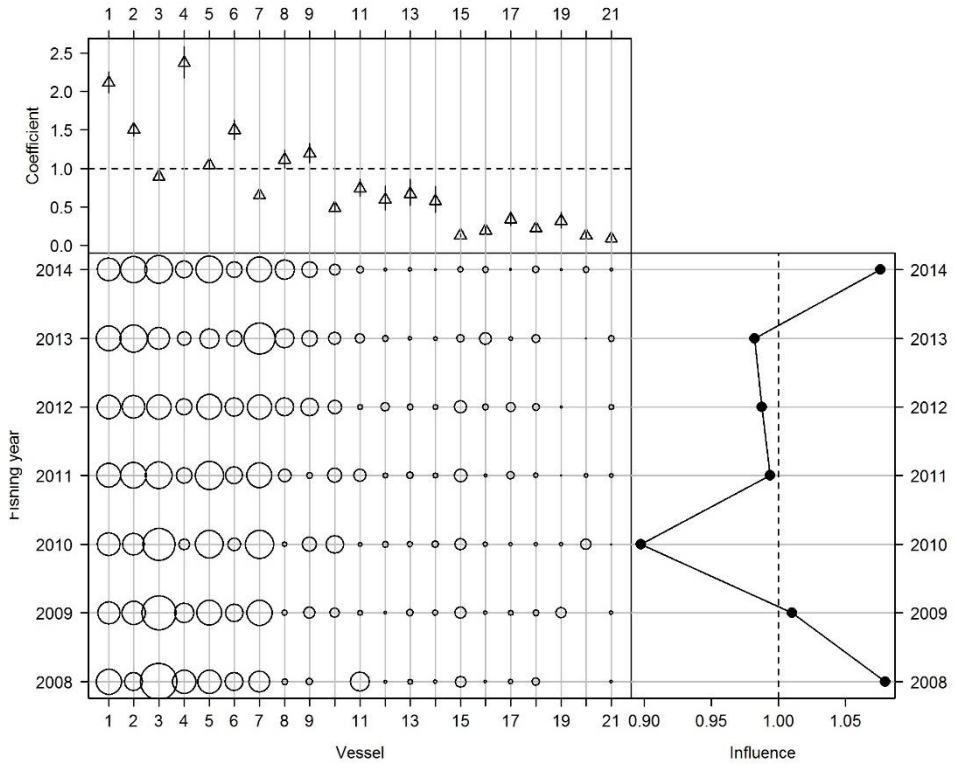


Figure D13a: Effect and influence of vessel in the ECSI TCER tow-by-tow core vessel mixed target BT lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of the effort by variable and fishing year. Bottom right: influence of variable (vessel) on unstandardised CPUE by fishing year.

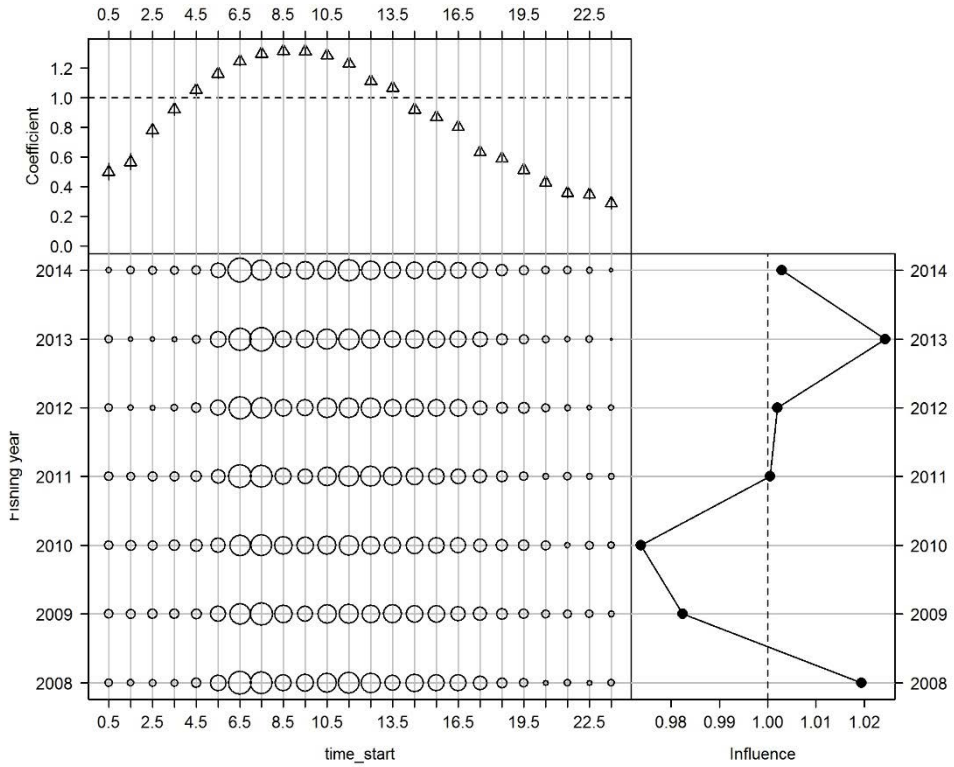


Figure D13b: Effect and influence of start time of tow (time_start) in the ECSI TCER tow-by-tow core vessel mixed target BT lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of the effort by variable and fishing year. Bottom right: influence of variable on unstandardised CPUE by fishing year.

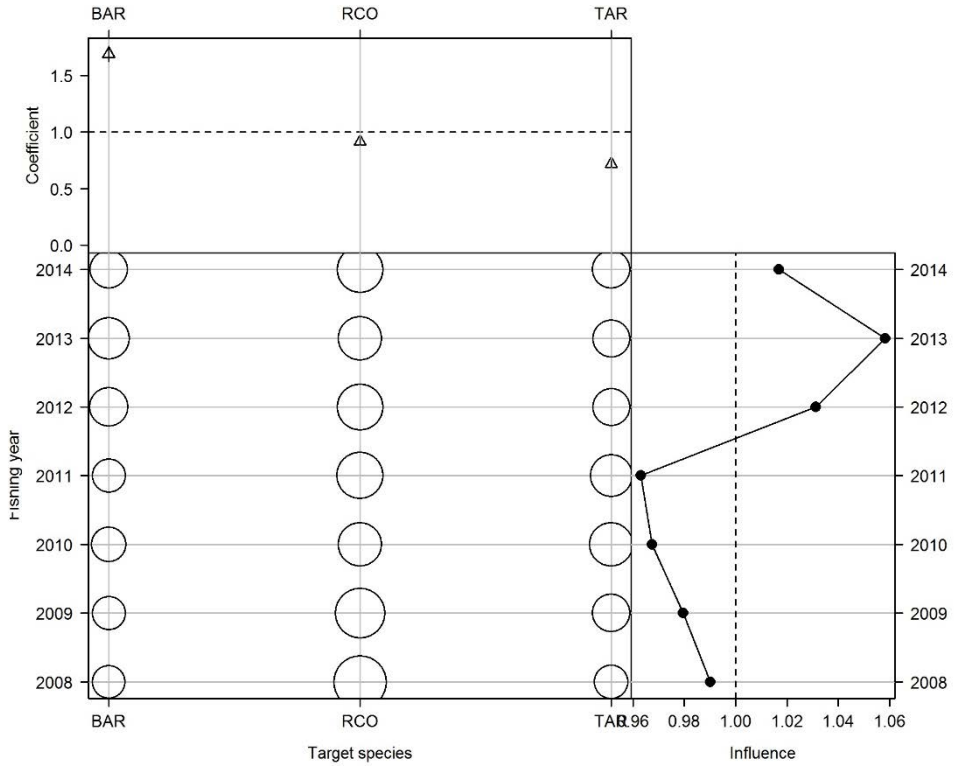


Figure D13c: Effect and influence of target species in the BAR 1 ECSI TCER tow-by-tow core vessel mixed target BT lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of the effort by variable and fishing year. Bottom right: influence of variable on unstandardised CPUE by fishing year.

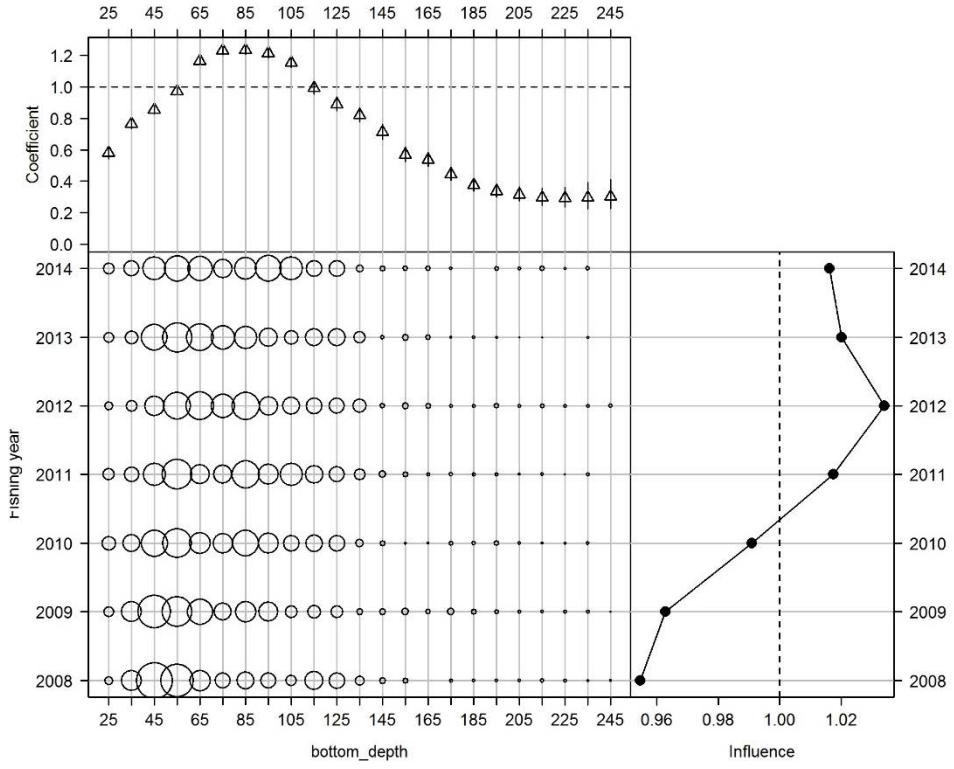


Figure D13d: Effect and influence of bottom depth in the ECSI TCER tow-by-tow core vessel mixed target BT lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of the effort by variable and fishing year. Bottom right: influence of variable on unstandardised CPUE by fishing year.

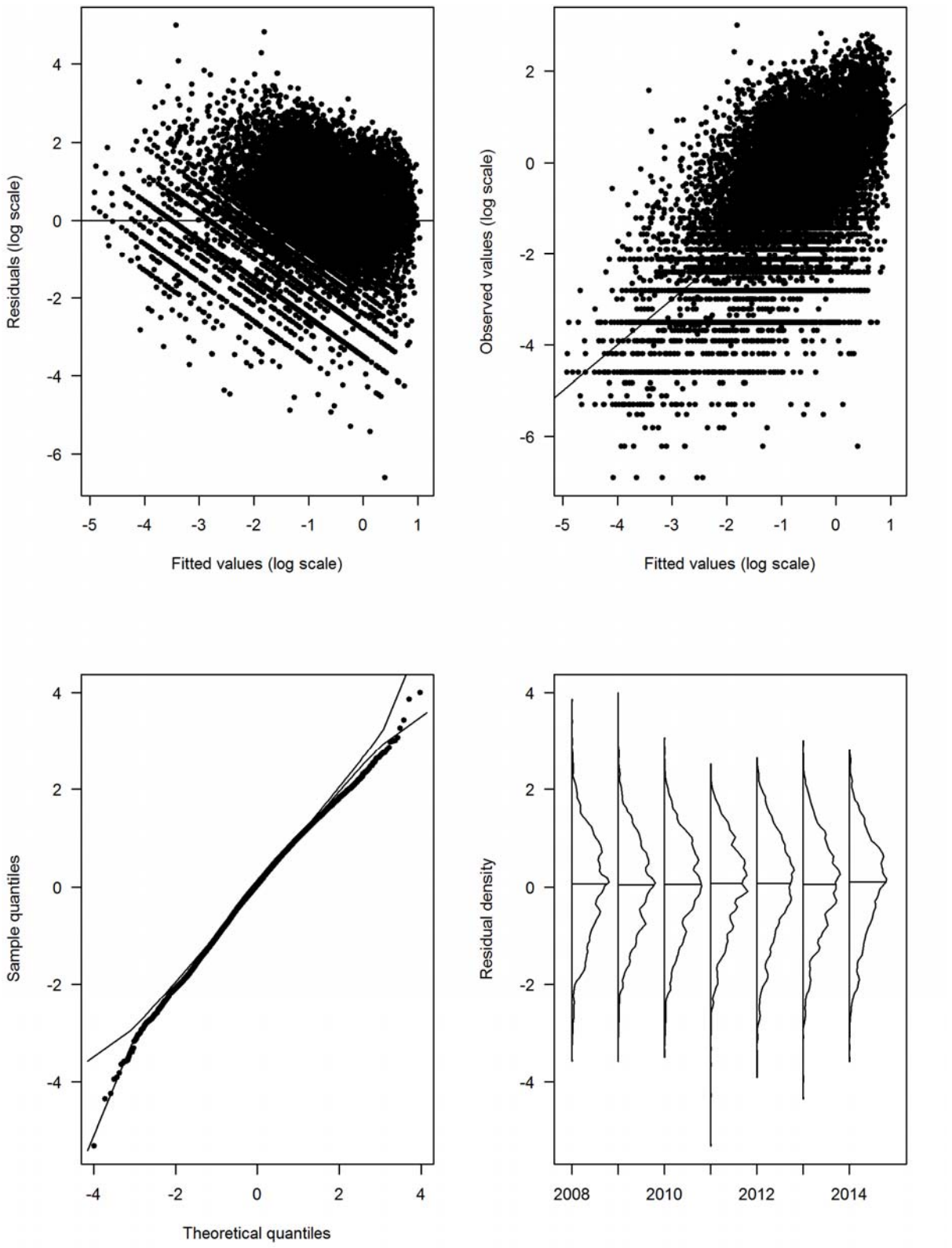
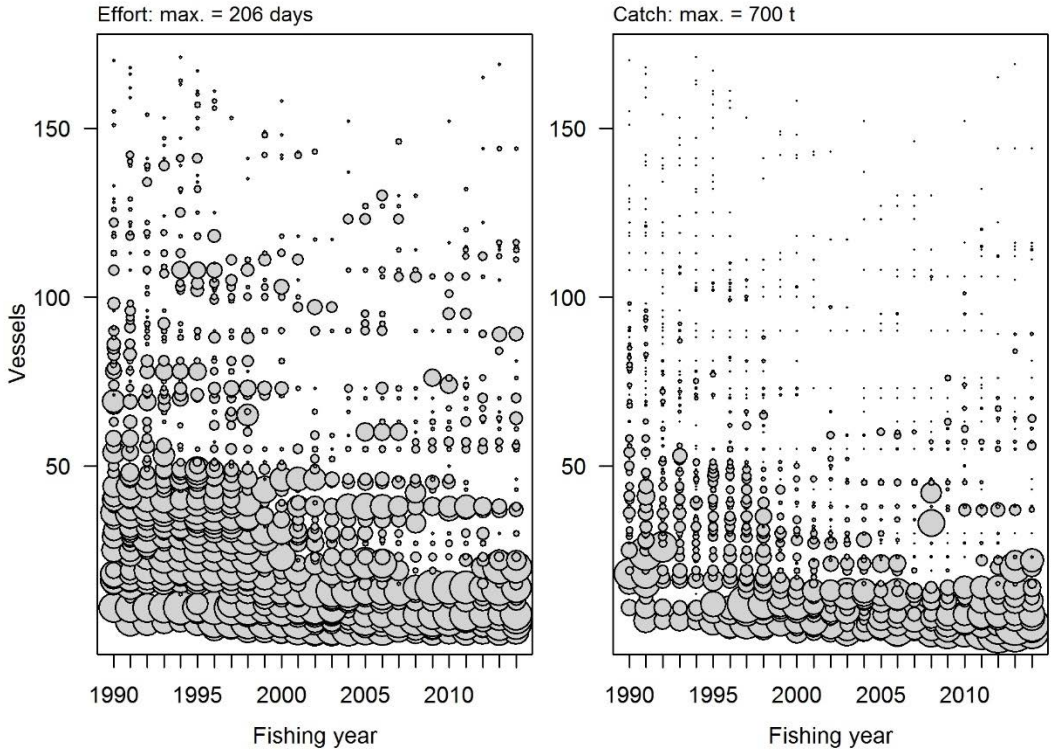


Figure D14: ECSI TCER tow-by-tow BT lognormal model (estimated catch for core vessels and mixed target): distribution of the standardised and observed residuals against fitted values (upper), the quantile–quantile plot of the residuals and density plot of the residuals (lower).

(a) All vessels



(b) Core vessels

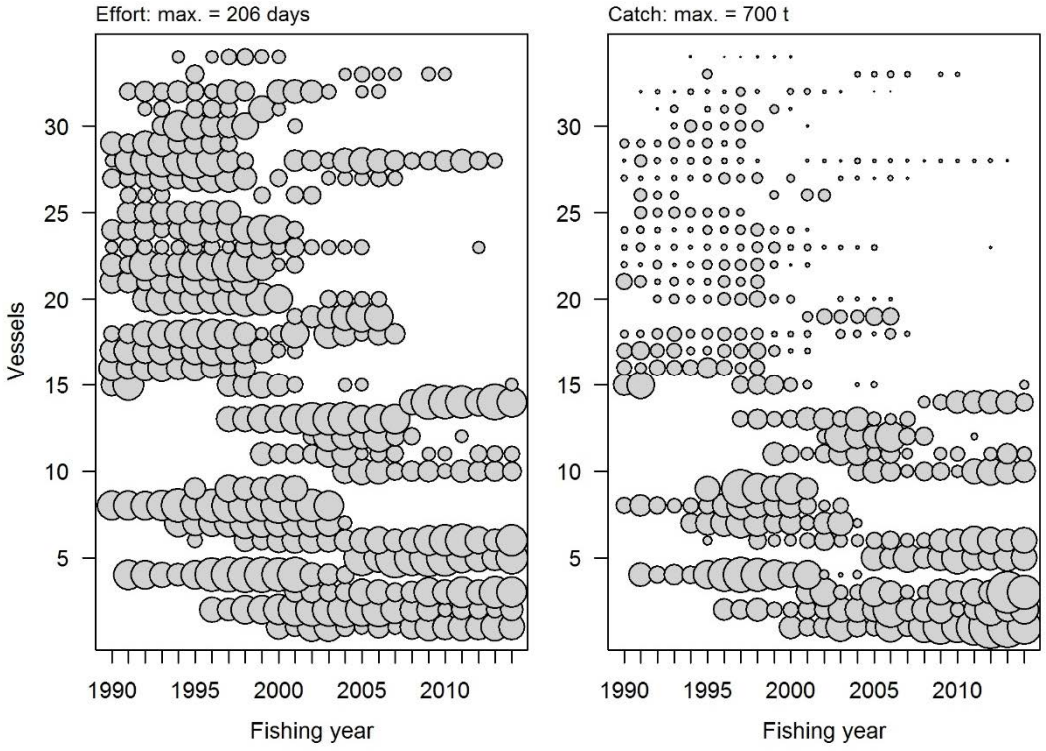


Figure D15: BAR 1 ECSI summary of effort (number of CELR and TCER daily records) and landed barracouta catch (t) by fishing year for 1990–2014, for all vessels and core vessels. The symbol area is proportional to either the number of records or the annual catch, and the maximum circle size is shown in the label on the plot.

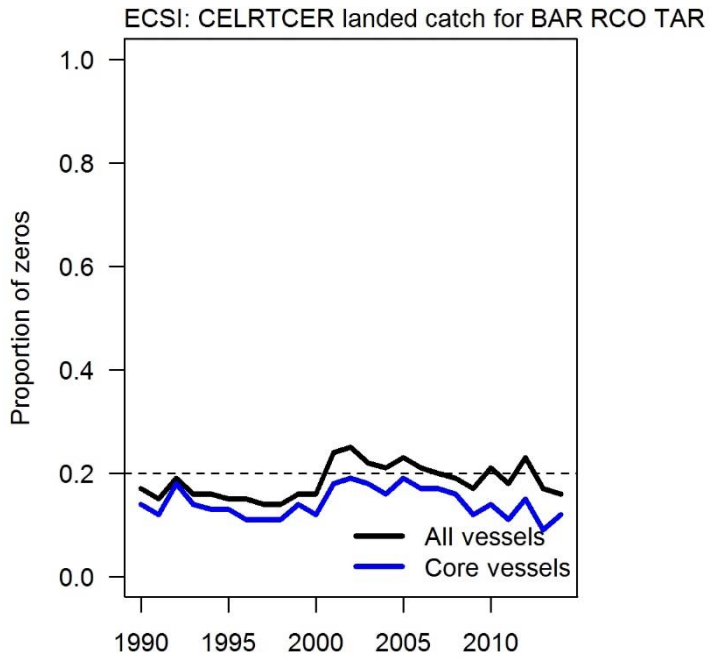


Figure D16: Proportion of zero barracouta catches in the ECSI CELR/TCER daily bottom trawl records, for all vessels and for core vessels, 1990–2014.

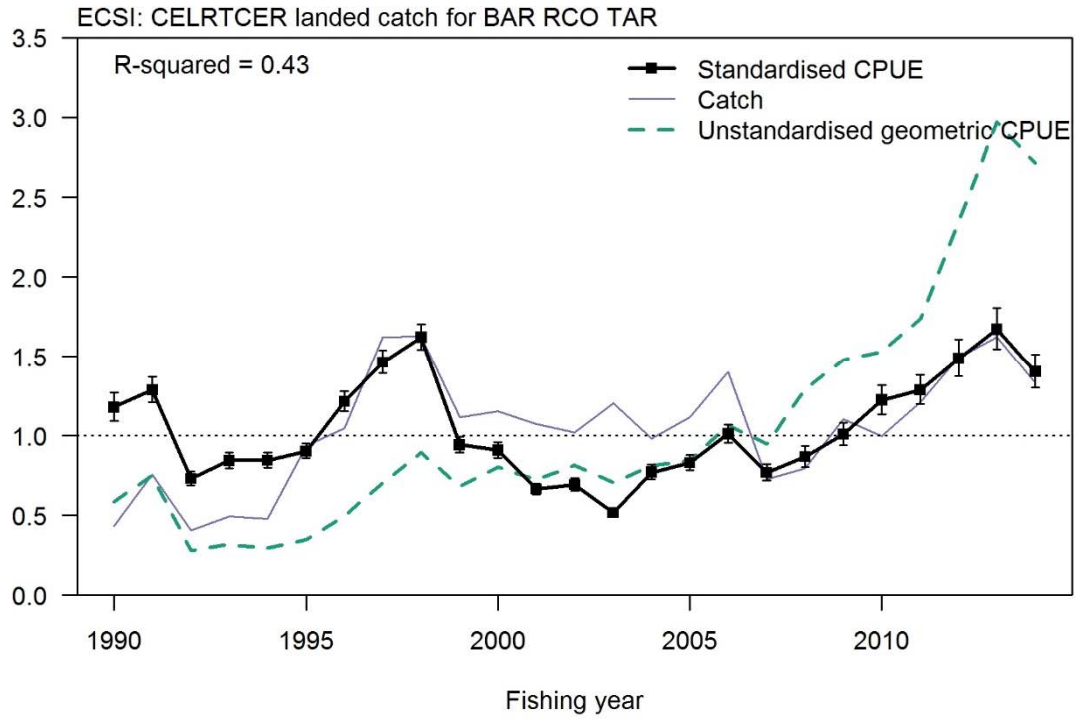


Figure D17a: CPUE lognormal indices for ECSI, based on the CELR/TCER bottom trawl mixed target dataset, showing catches (scaled to same mean as indices), and lognormal standardised and unstandardised indices. Bars indicate 95% confidence intervals.

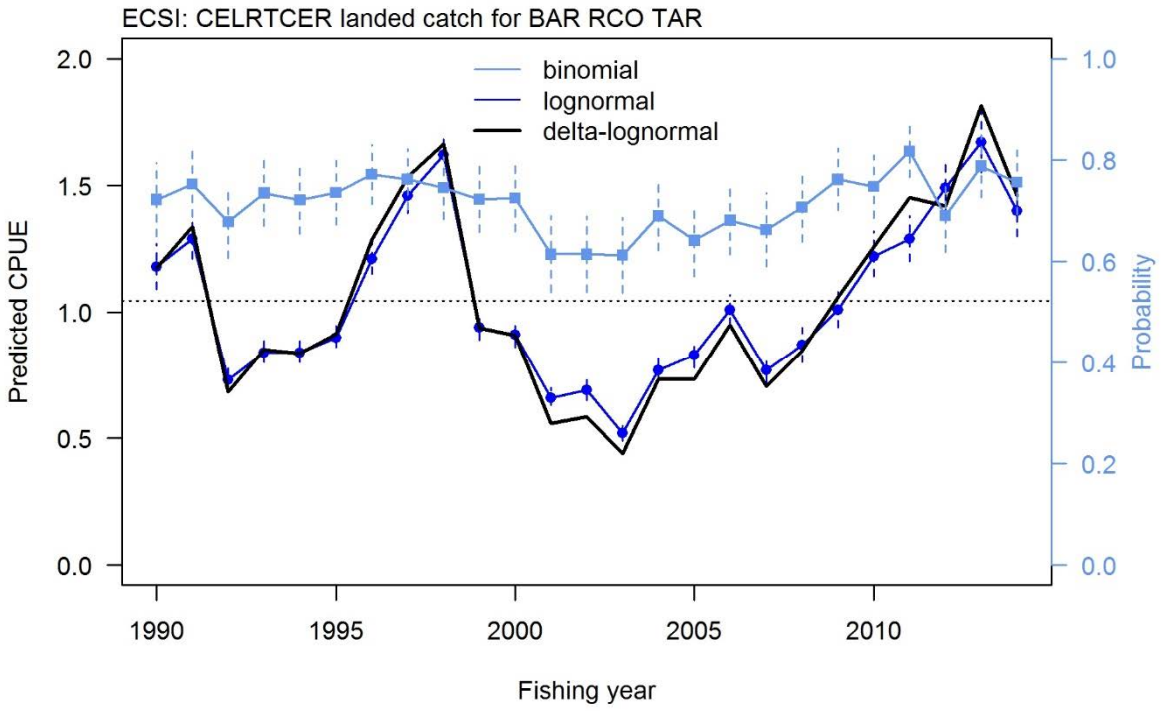


Figure D17b: ECSI CELR/TCER CPUE from the lognormal, binomial, and delta–lognormal (combined) core vessel mixed target, bottom trawl landed catch model, for October–September, 1990–2014. Bars indicate 95% confidence intervals.

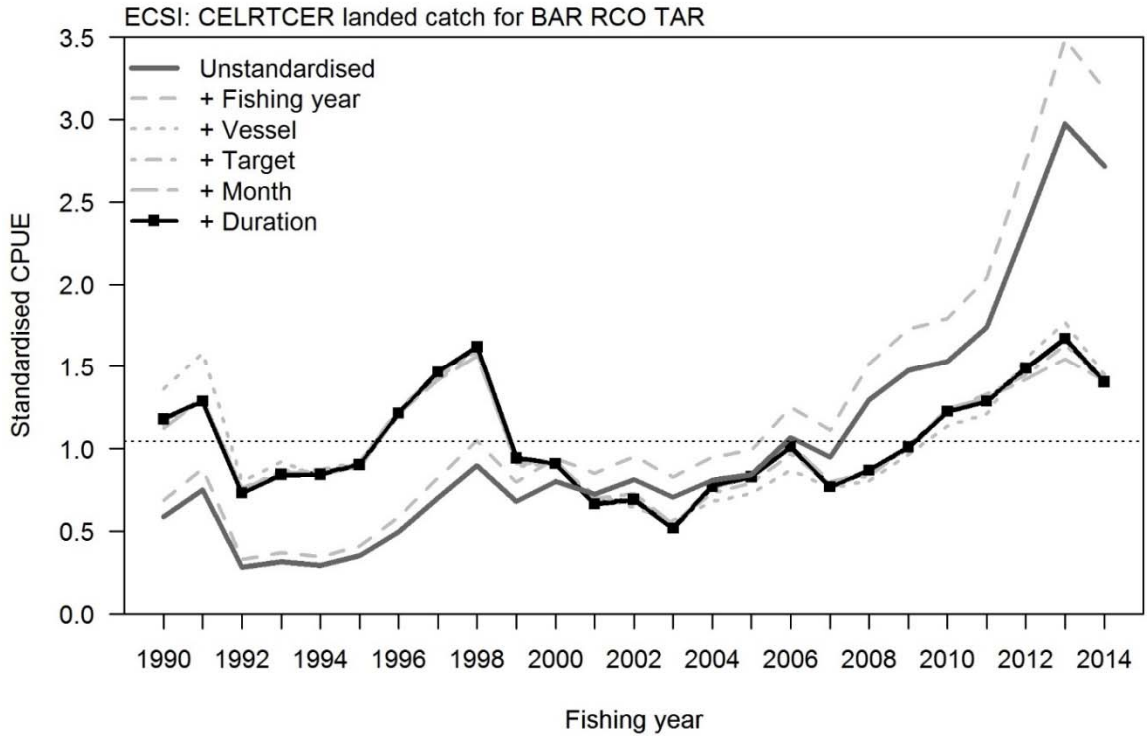


Figure D18: Addition of variables into the lognormal CPUE from the lognormal model for the ECSI CELR/TCER trawl fishery using bottom trawls to target barracouta, red cod, and tarakihi in Statistical Areas 018, 020, 022, and 024, during October–September of each fishing year, 1990–2014.

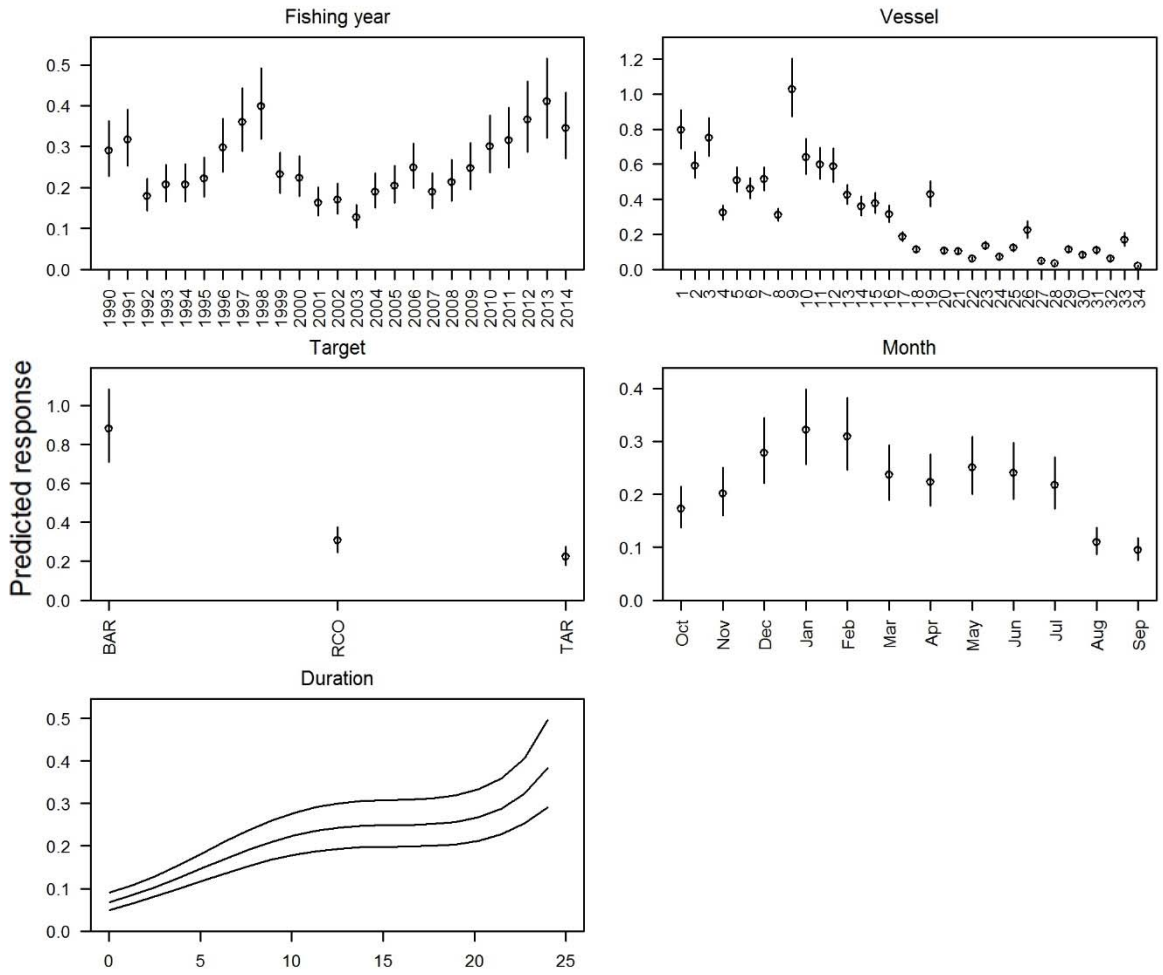


Figure D19: Effects of selected variables in the lognormal model for the ECSI CELR/TCER BT landed catch for core mixed target vessels, 1990–2014. Bars indicate 95% confidence intervals.

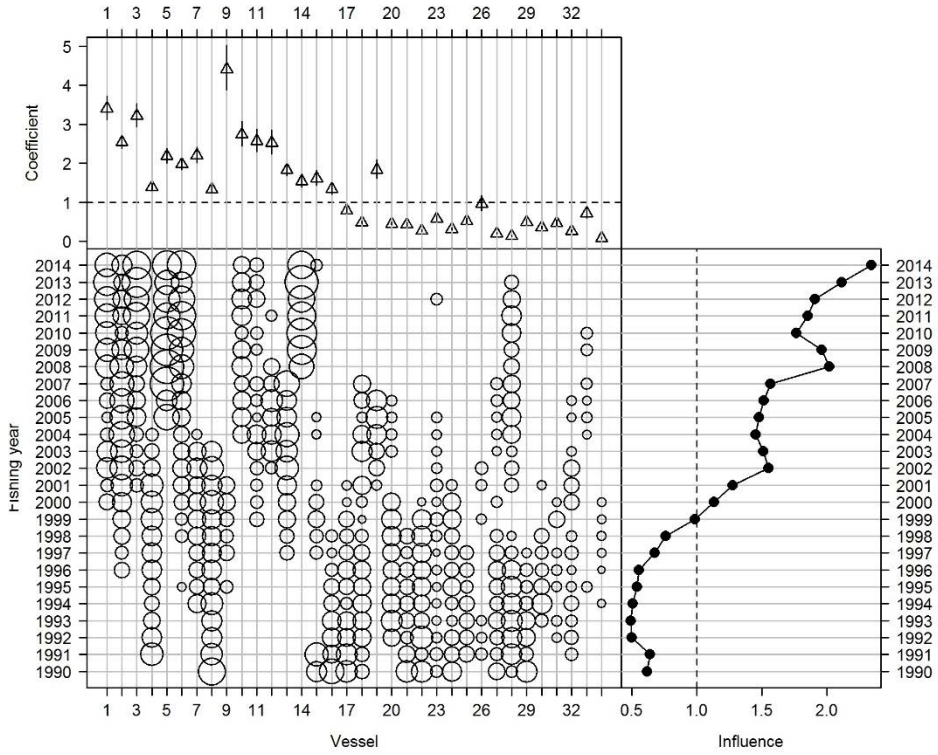


Figure D20a: Effect and influence of vessel in the ECSI CELR/TCER day-by-day core vessel mixed target BT lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of the effort by variable and fishing year. Bottom right: influence of variable (vessel) on unstandardised CPUE by fishing year.

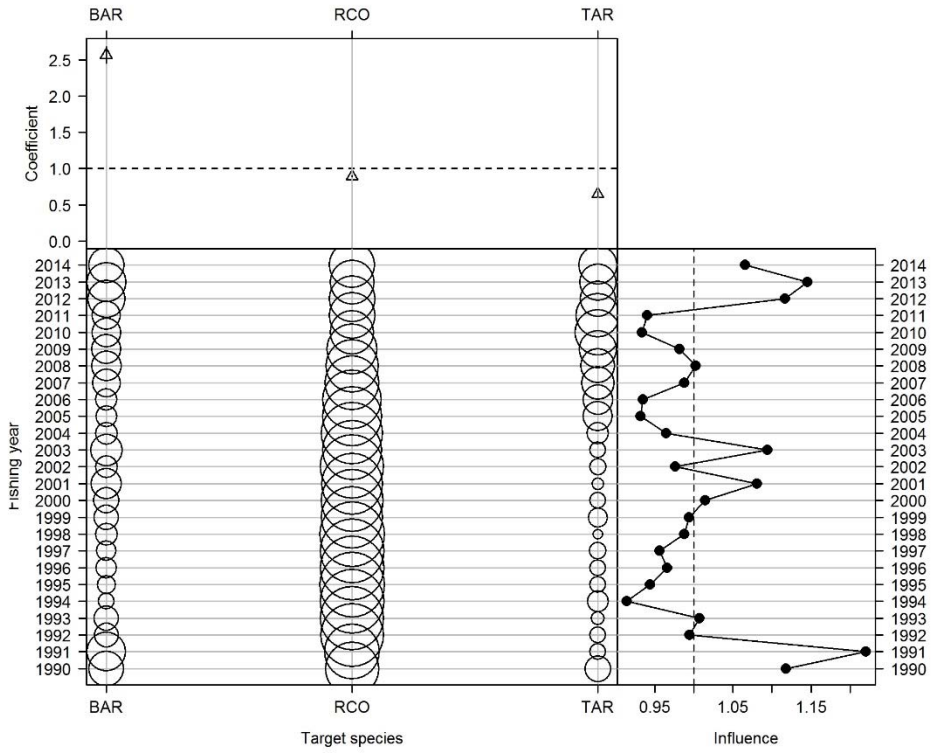


Figure D20b: Effect and influence of target species in the ECSI CELR/TCER day-by-day core vessel mixed target BT lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of the effort by variable and fishing year. Bottom right: influence of variable on unstandardised CPUE by fishing year.

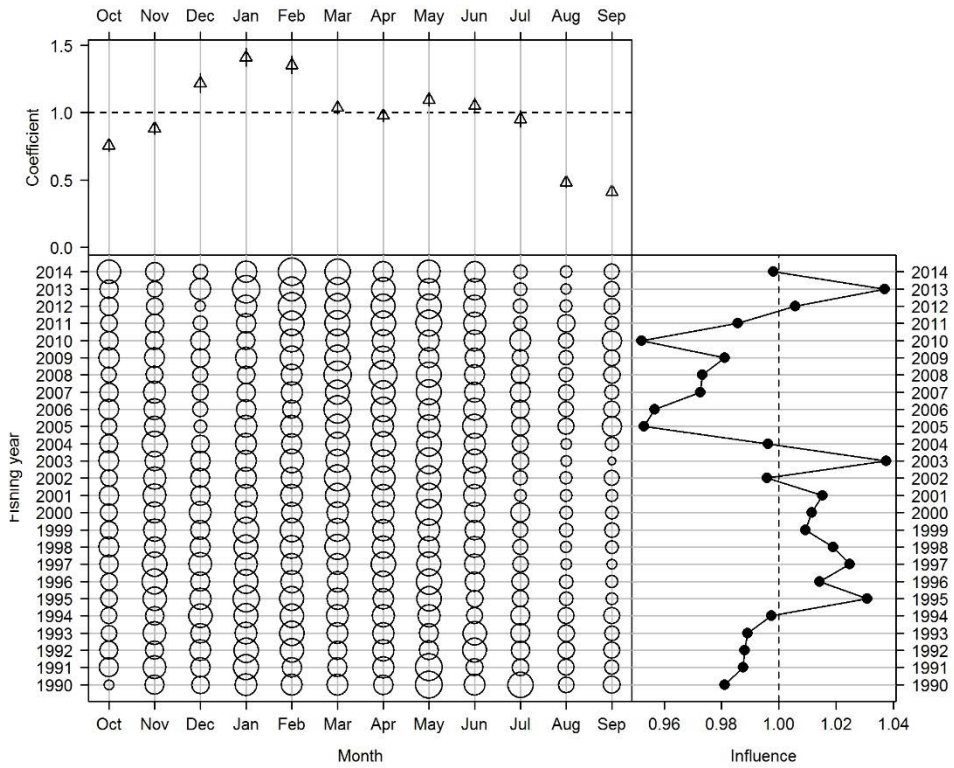


Figure D20c: Effect and influence of month in the BAR 1 ECSI CELR/TCER day-by-day core vessel mixed target BT lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of the effort by variable and fishing year. Bottom right: influence of variable on unstandardised CPUE by fishing year.

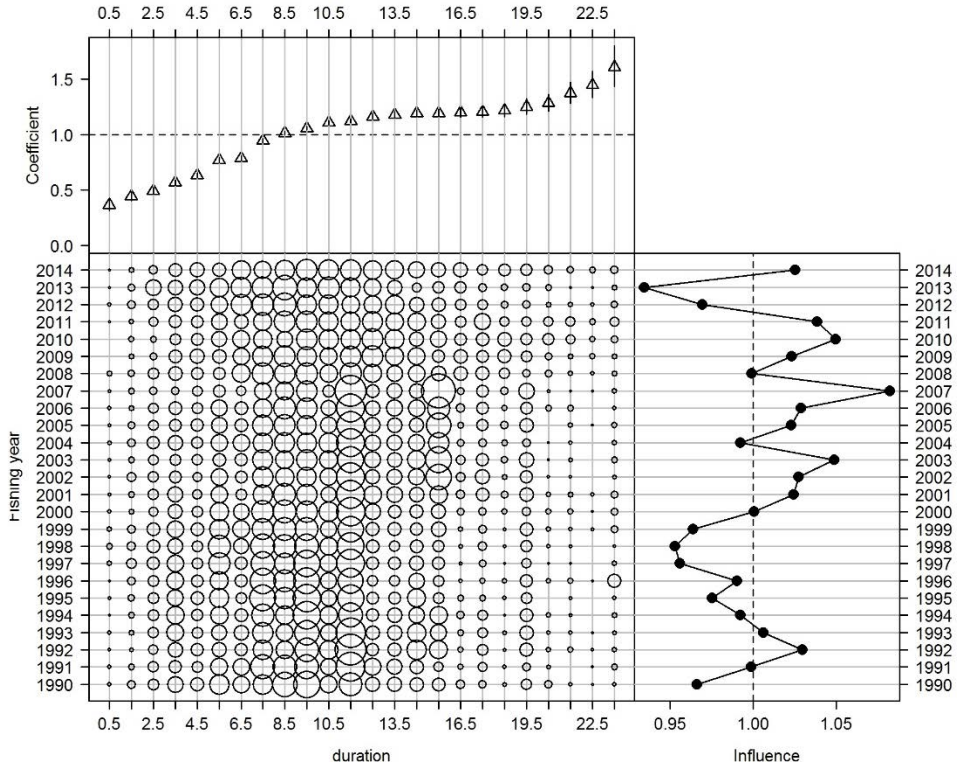


Figure D20d: Effect and influence of fishing duration in the ECSI CELR/TCER day-by-day core vessel mixed target BT lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of the effort by variable and fishing year. Bottom right: influence of variable on unstandardised CPUE by fishing year.

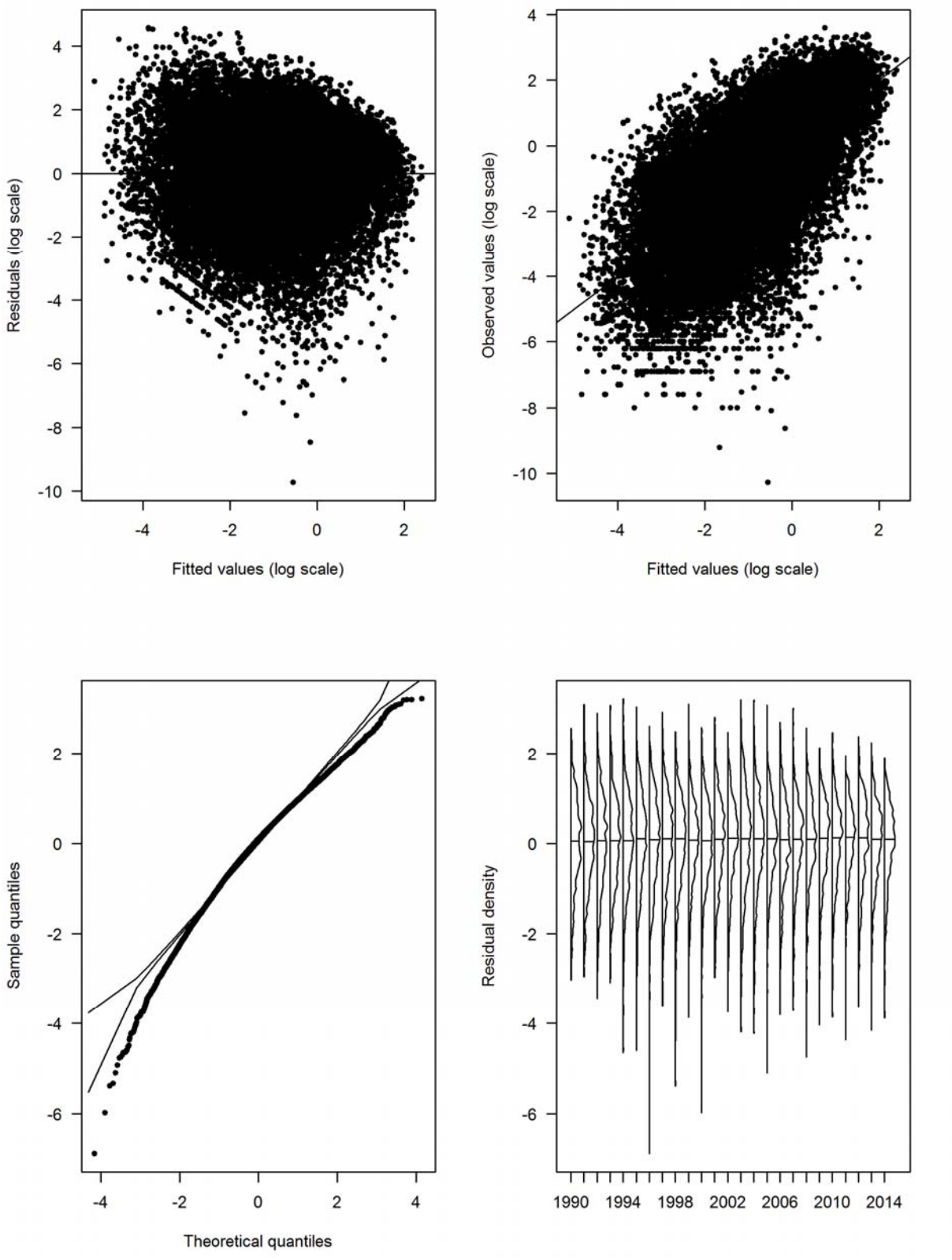
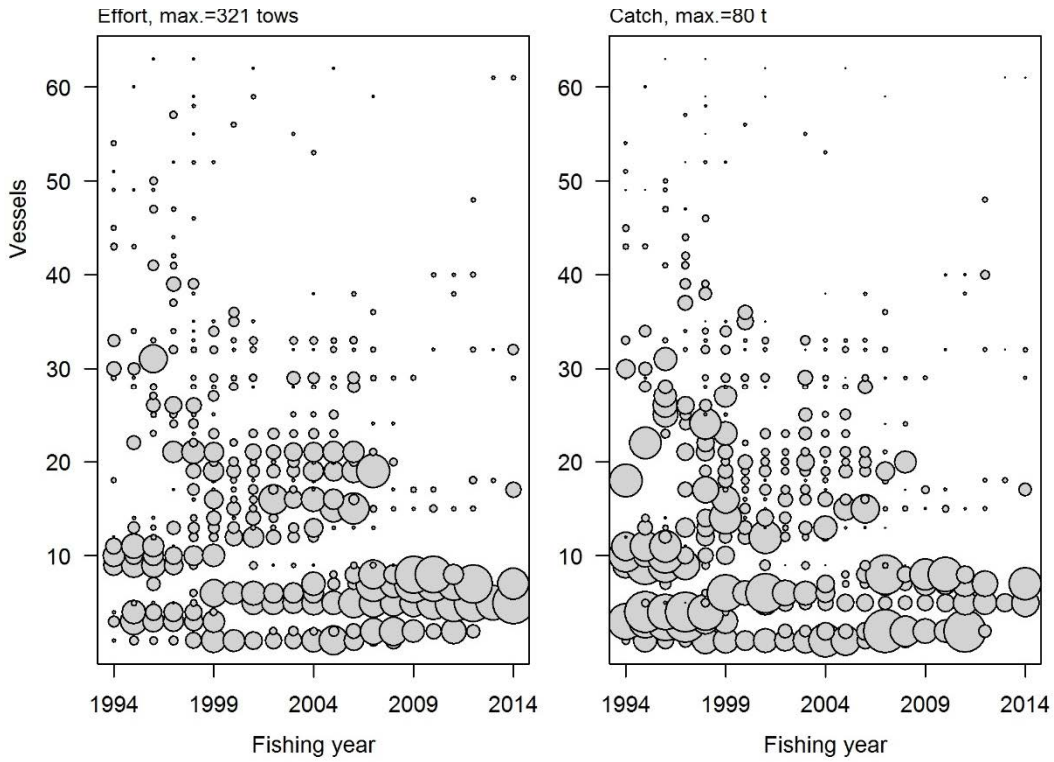


Figure D21: ECSI CELR/TCER day-by-day BT lognormal model (landed catch for core vessels and mixed target): distribution of the standardised and observed residuals against fitted values (upper), the quantile–quantile plot of the residuals and density plot of the residuals (lower).

(a) All vessels



(b) Core vessels

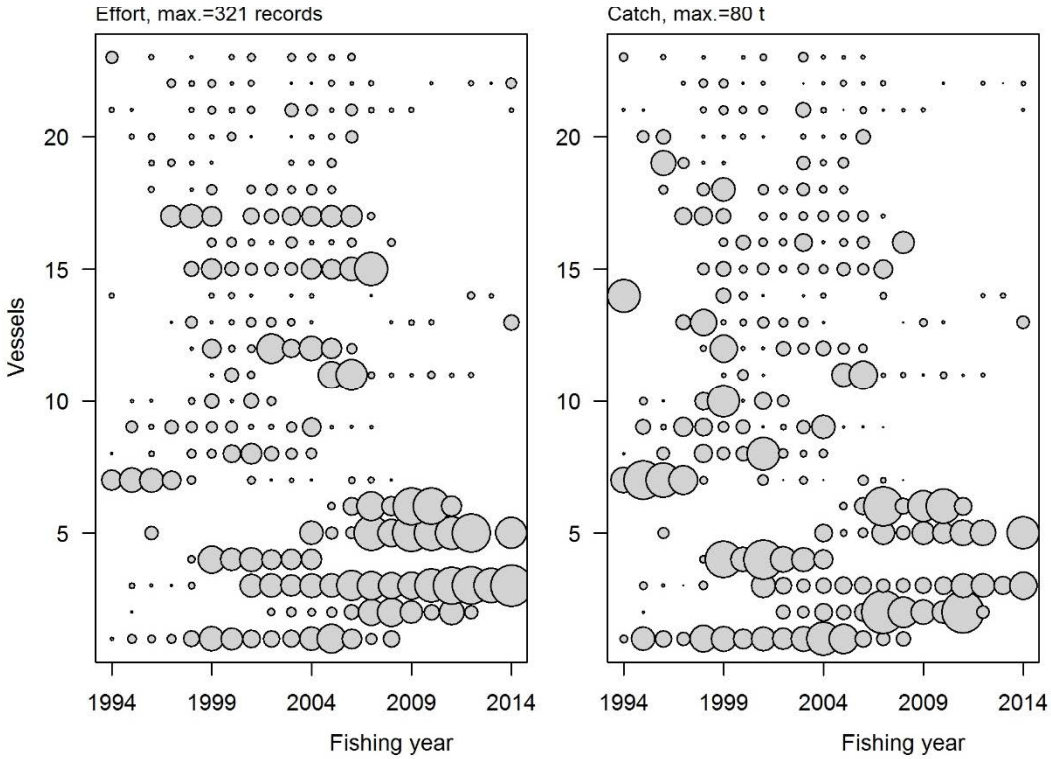


Figure D22: ECNI TCEPR summary of effort (number of bottom trawls) and landed barracouta catch (t) by fishing year for 1994–2014, for all vessels and core vessels. The symbol area is proportional to either the number of records or the annual catch, and the maximum circle size is shown in the label on the plot.

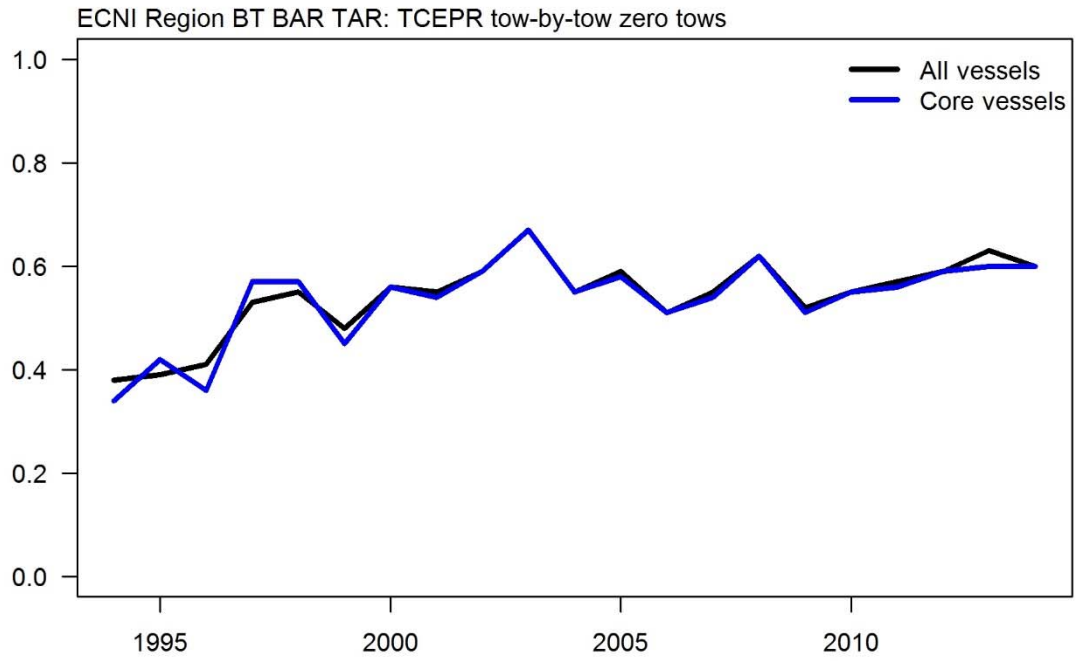


Figure D23: Proportion of zero barracouta catches in the ECNI TCEPR tow-by-tow bottom trawl, mixed target data for all vessels and for core vessels, 1994–2014.

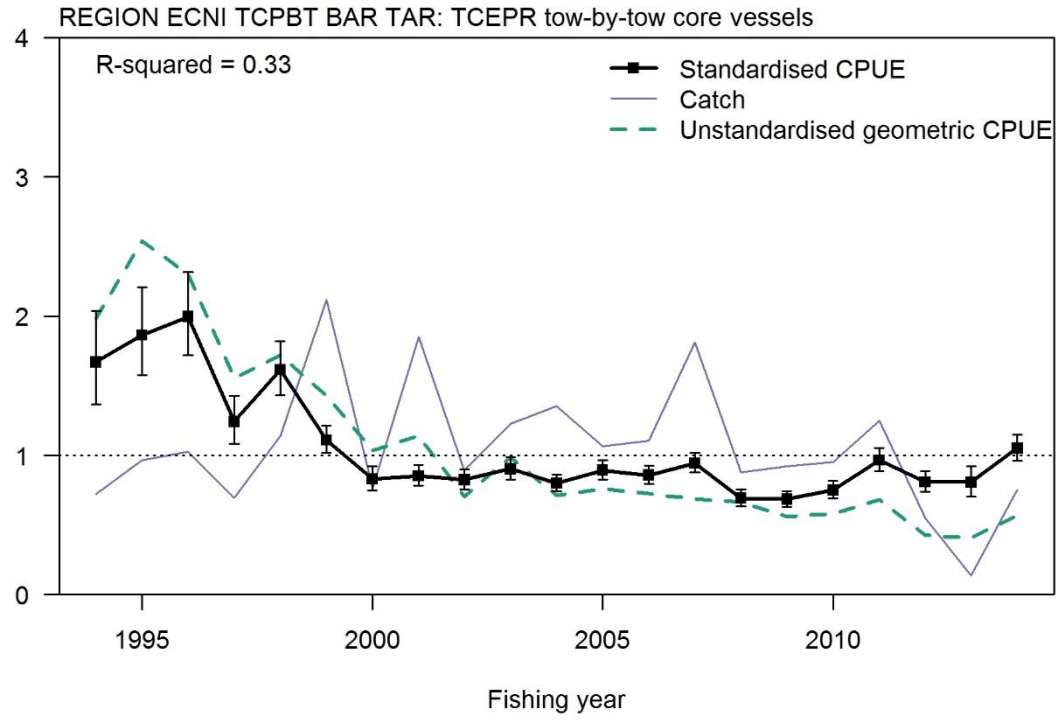


Figure D24a: CPUE lognormal indices for ECNI TCEPR bottom trawl, mixed target data, showing catches (scaled to same mean as indices), and lognormal standardised and unstandardised indices. Bars indicate 95% confidence intervals.

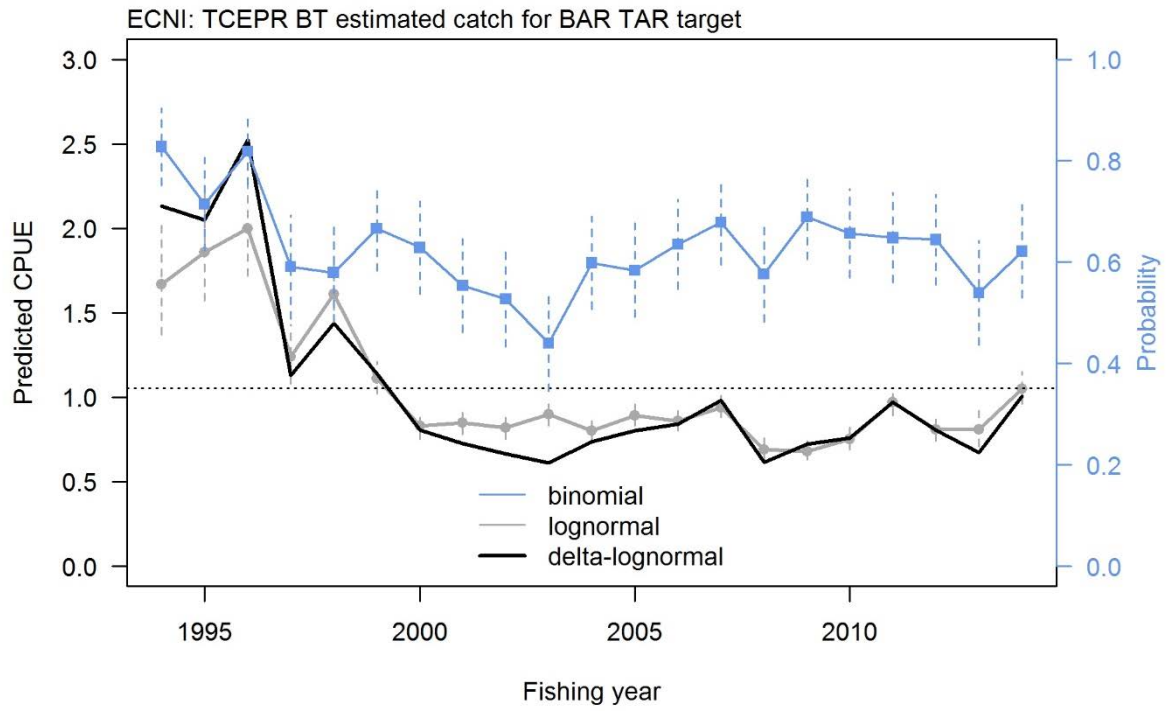


Figure D24b: ECSI TCEPR CPUE from the lognormal, binomial, and delta–lognormal (combined) core vessel mixed target, bottom trawl estimated catch model, for October–June, 1990–2014. Bars indicate 95% confidence intervals.

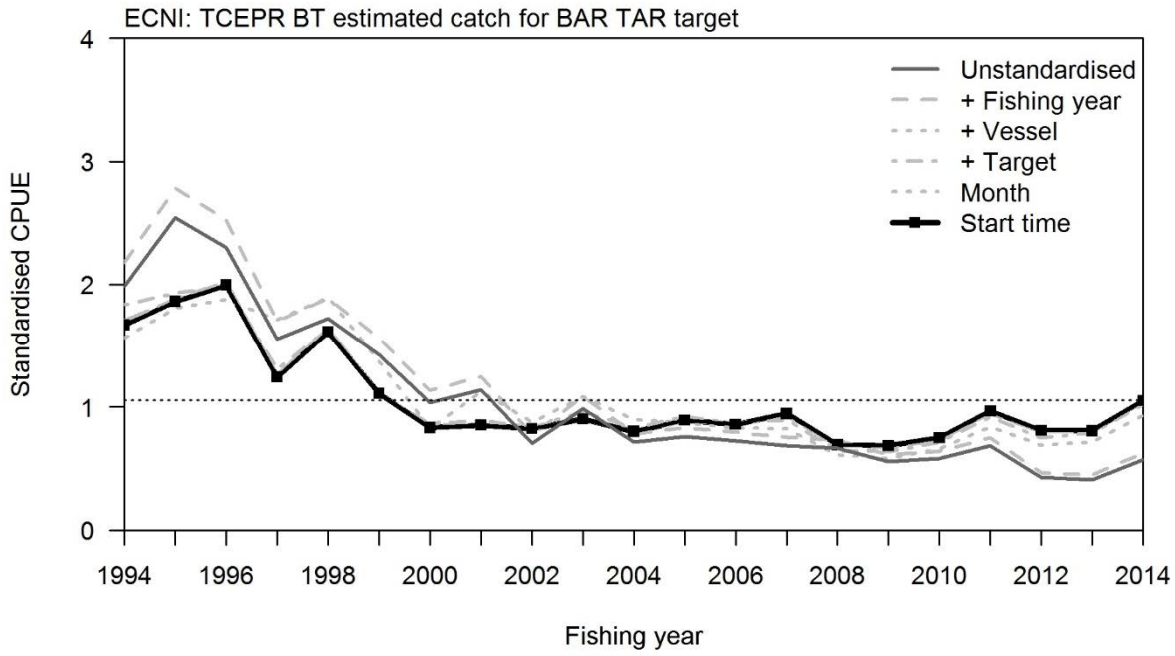


Figure D25: Addition of variables into the lognormal CPUE from the lognormal model for the ECNI TCEPR trawl fishery using bottom trawls to target barracouta and tarakihi in Statistical Areas 009-014, during October–September of each fishing year, 1994–2014.

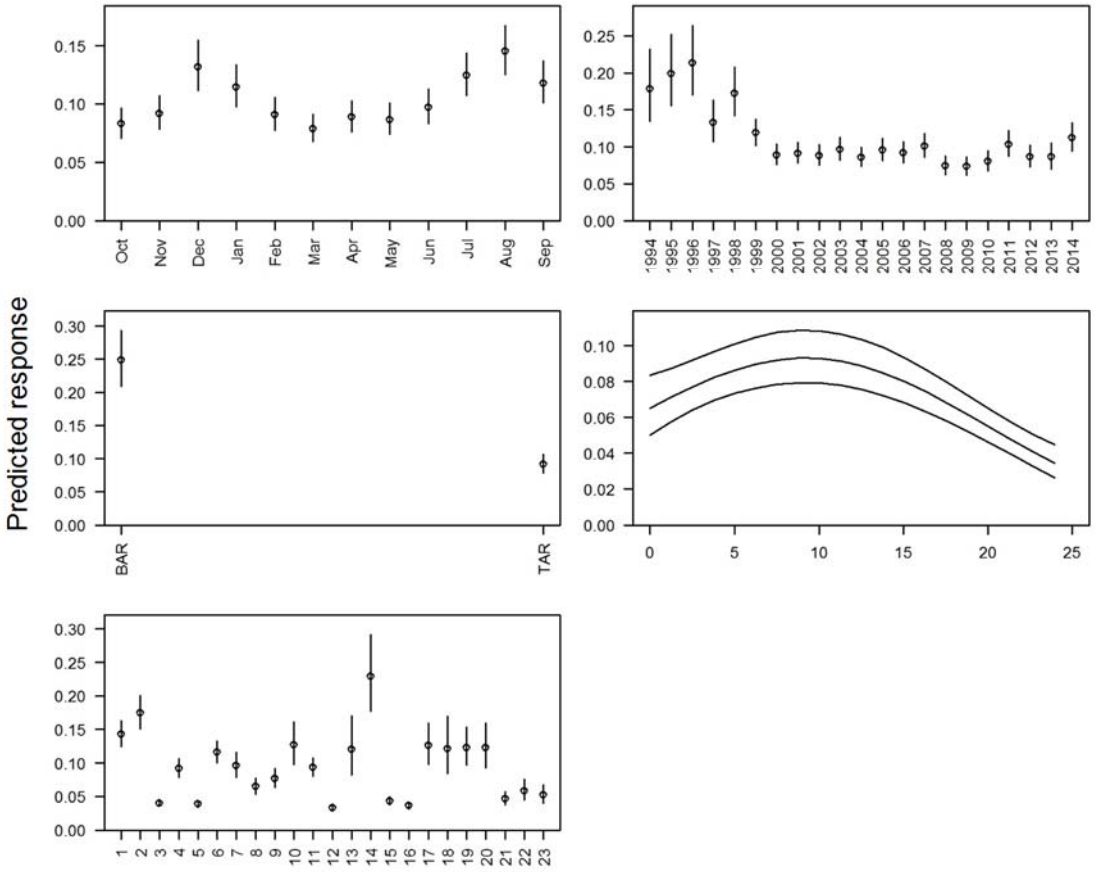


Figure D26: Effects of selected variables in the lognormal model for the ECNI TCEPR BT estimated catch for core mixed target vessels, 1994–2014. Bars indicate 95% confidence intervals. Top: month, fishing year; middle: target species, start time of tow; bottom: core vessel.

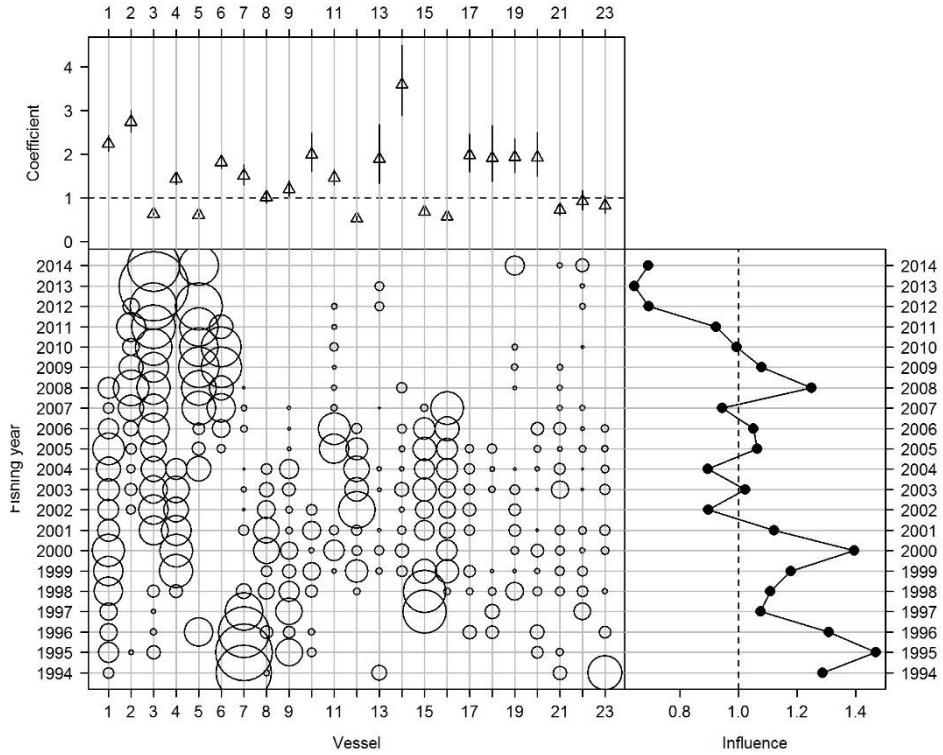


Figure D27a: Effect and influence of vessel in the ECNI TCEPR tow-by-tow core vessel target BAR and TAR BT lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of the effort by variable and fishing year. Bottom right: influence of variable (vessel) on unstandardised CPUE by fishing year.

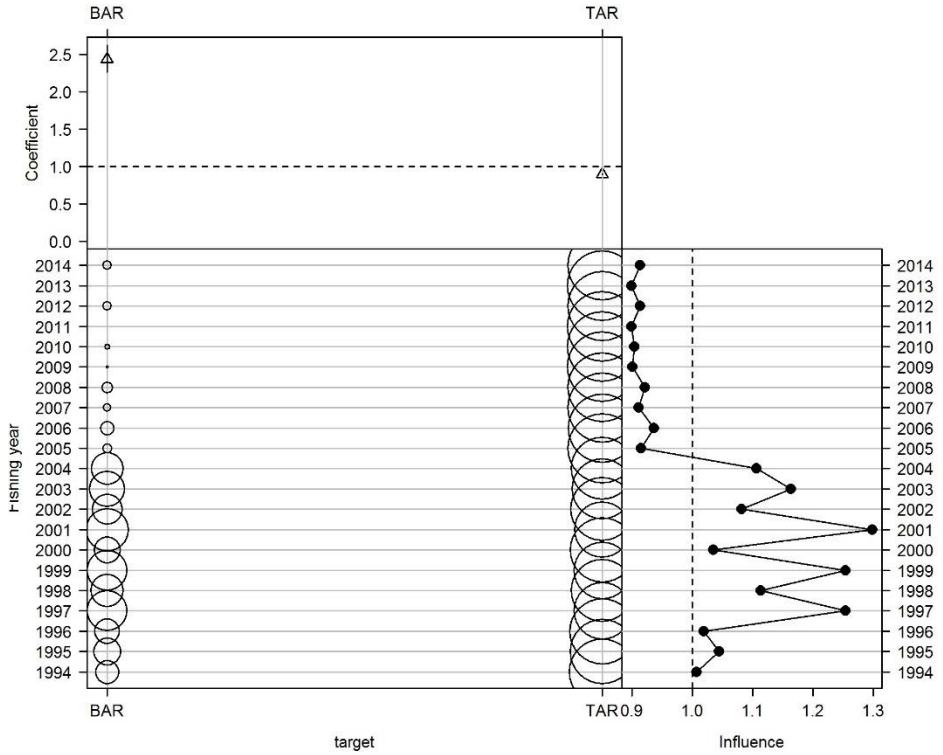


Figure D27b: Effect and influence of target species in the ECNI TCEPR tow-by-tow core vessel target BAR and TAR BT lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of the effort by variable and fishing year. Bottom right: influence of variable on unstandardised CPUE by fishing year.

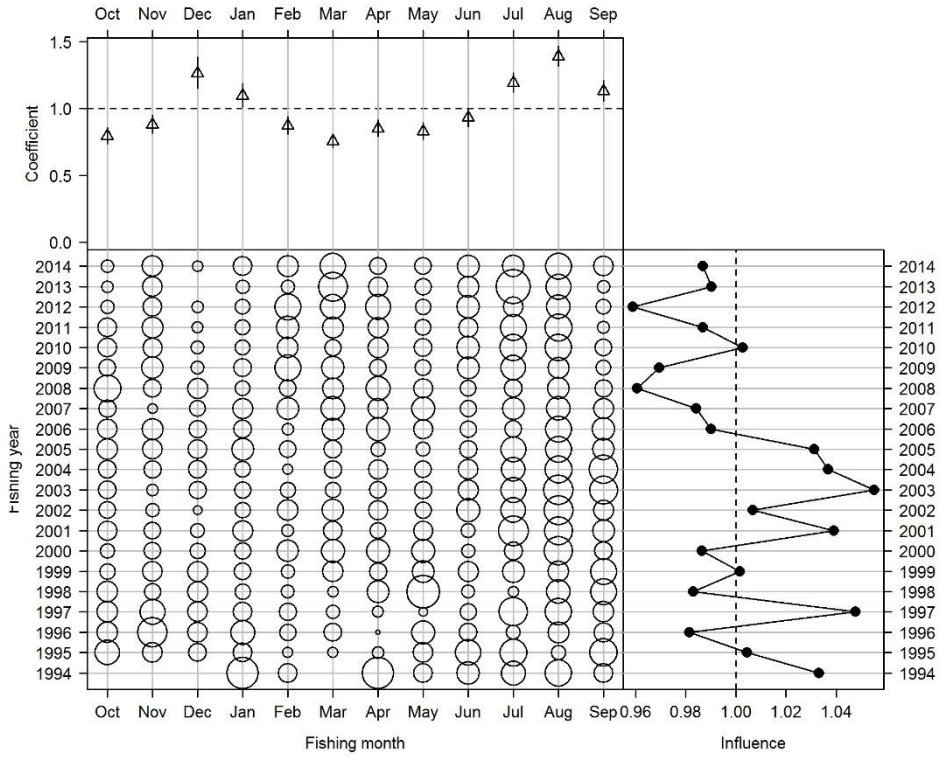


Figure D27c: Effect and influence of fishing month in the ECNI TCEPR tow-by-tow core target BAR and TAR BT lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of the effort by variable and fishing year. Bottom right: influence of variable on unstandardised CPUE by fishing year.

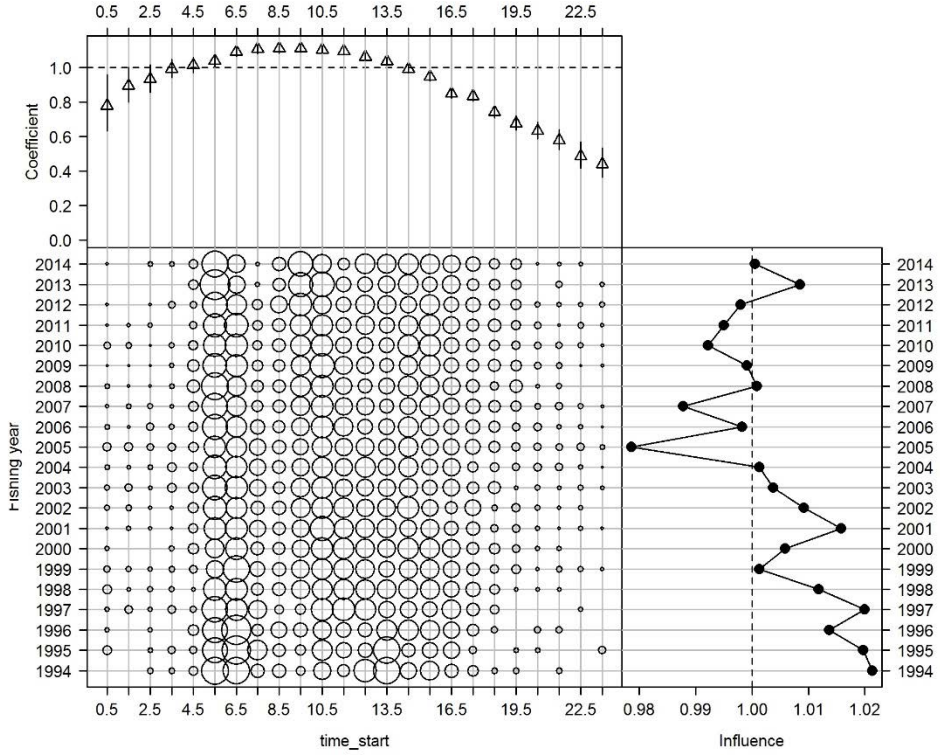


Figure D27d: Effect and influence of tow start time (h) in the ECNI TCEPR tow-by-tow core target BAR and TAR BT lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of the effort by variable and fishing year. Bottom right: influence of variable on unstandardised CPUE by fishing year.

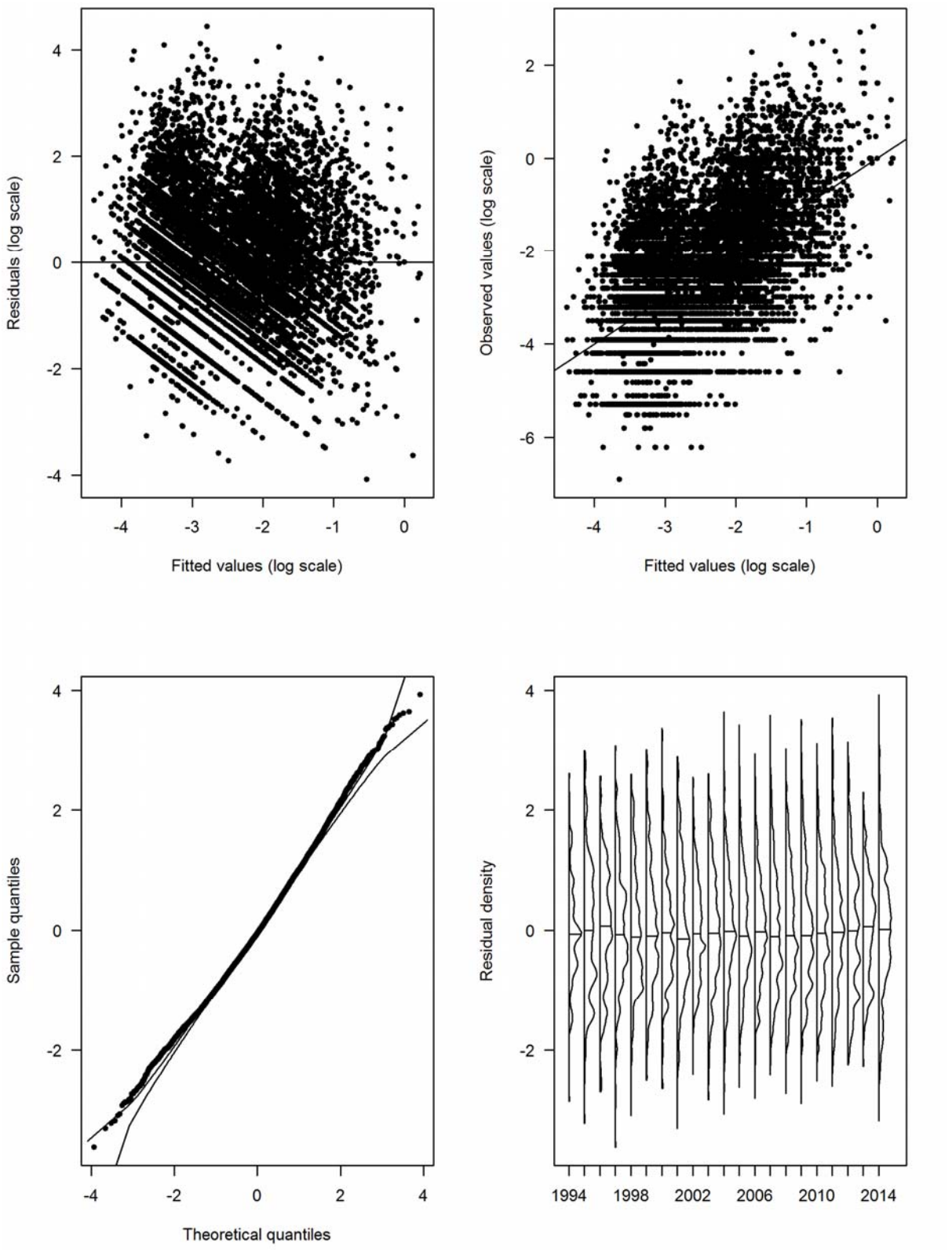
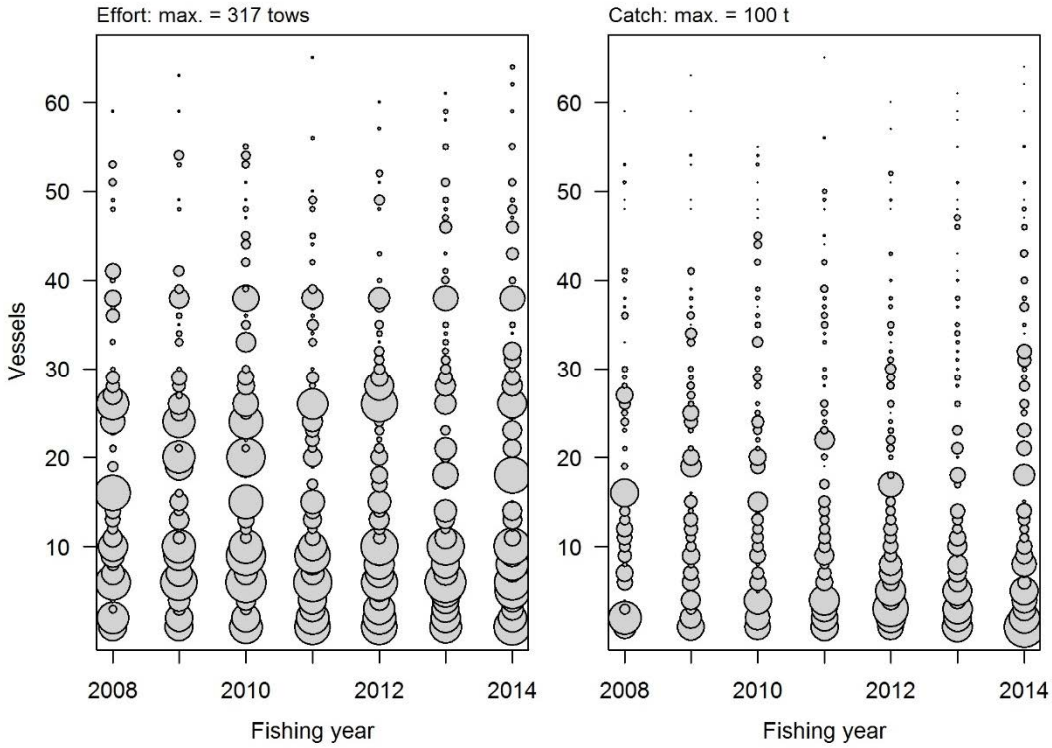


Figure D28: ECNI TCEPR tow-by-tow BT lognormal model (estimated catch for core vessels and BAR and TAR target): distribution of the standardised and observed residuals against fitted values (upper), the quantile–quantile plot of the residuals and density plot of the residuals (lower).

(a) All vessels



(b) Core vessels

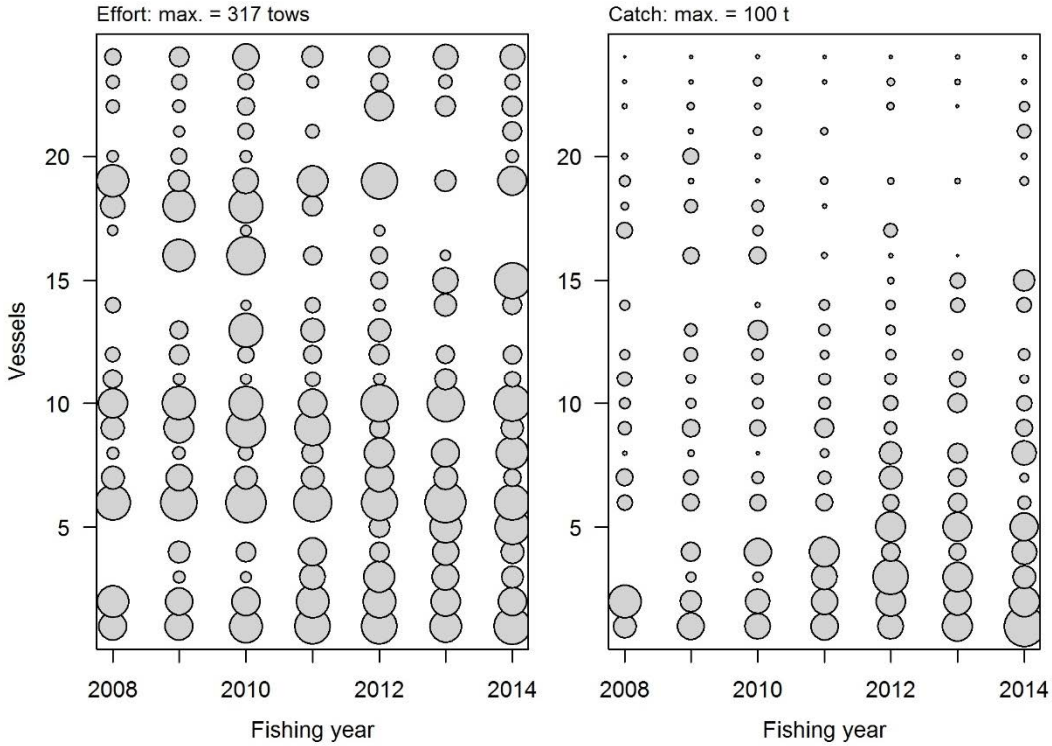


Figure D29: ECNI TCER summary of effort (number of TCER tows) and estimated barracouta catch (t) by fishing year for 2008–2014, for all vessels and core vessels. The symbol area is proportional to either the number of records or the annual catch, and the maximum circle size is shown in the label on the plot.

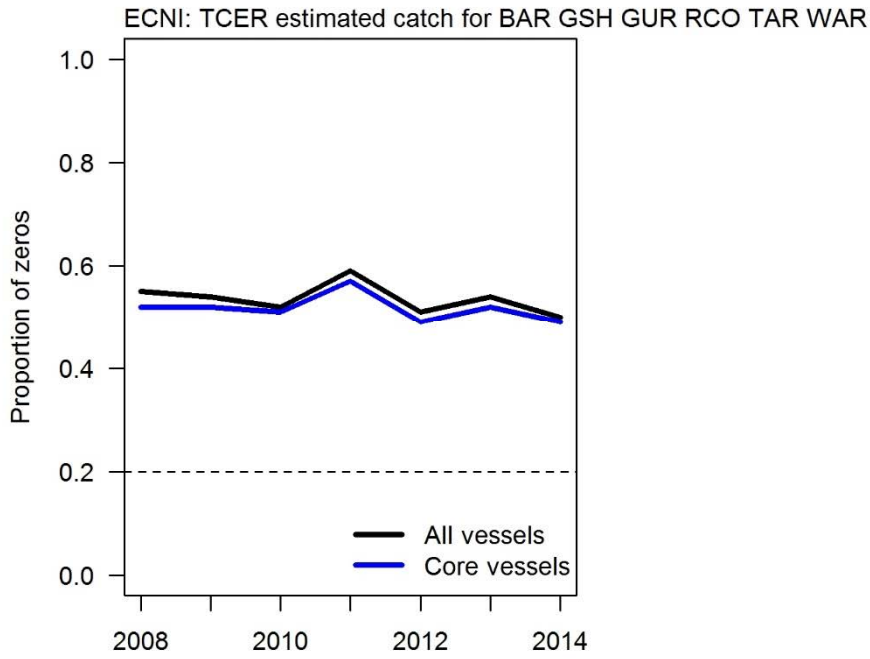


Figure D30: Proportion of zero barracouta catches in the ECNI TCER tow-by-tow bottom trawl data, for all vessels and for core vessels, 2008–14.

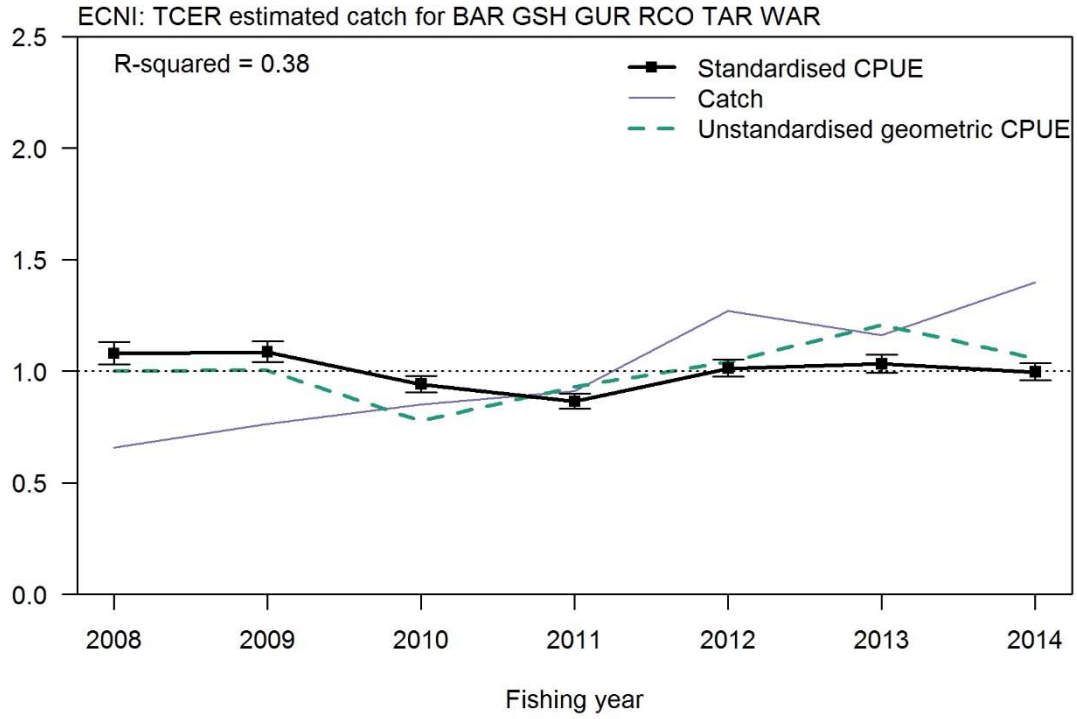


Figure D31a: CPUE lognormal indices for ECNI, based on the TCER bottom trawl mixed target dataset, showing catches (scaled to same mean as indices), and lognormal standardised and unstandardised indices. Bars indicate 95% confidence intervals.

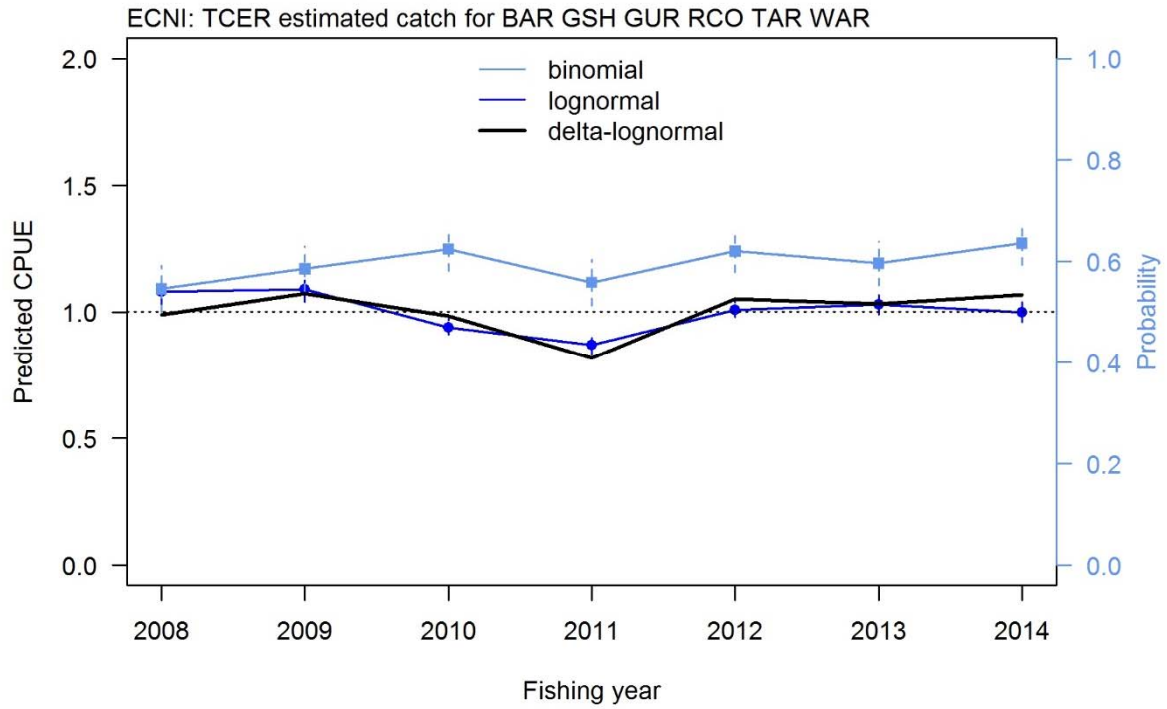


Figure D31b: ECNI TCER CPUE from the lognormal, binomial, and delta–lognormal (combined) core vessel mixed target, bottom trawl estimated catch model, for October–September, 2008–14. Bars indicate 95% confidence intervals.

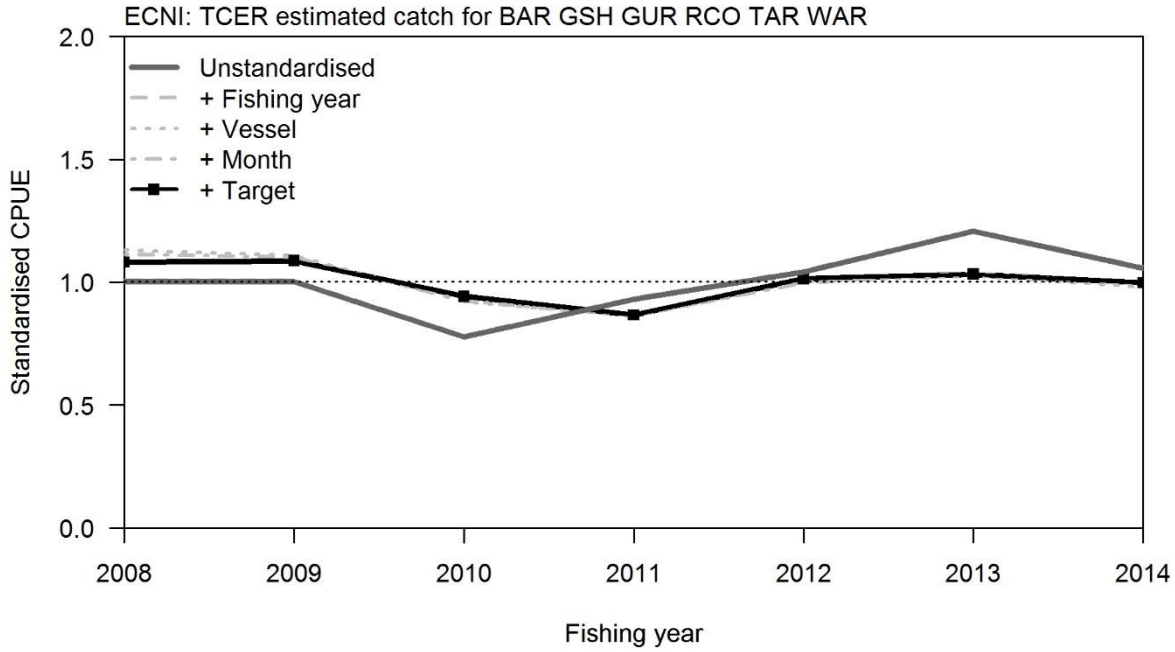


Figure D32: Addition of variables into the lognormal CPUE from the lognormal model for the ECNI TCER trawl fishery using bottom trawls to target barracouta, ghost shark, red gurnard, red cod, tarakihi, and blue warehou in Statistical Areas 012-017, during October–September of each fishing year, 2008–14.

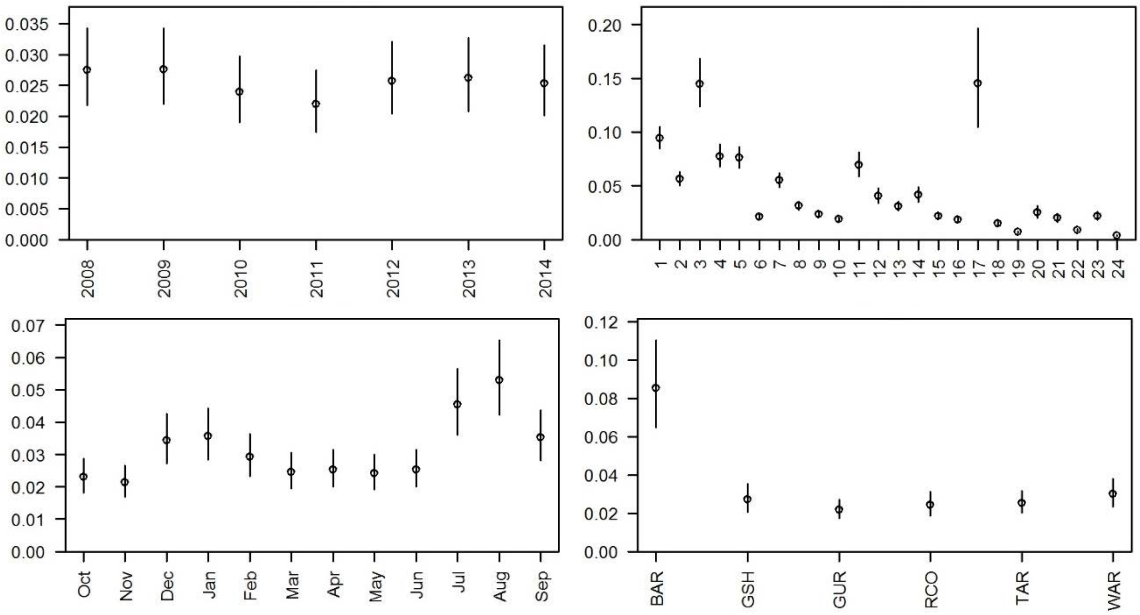


Figure D33: Effects of selected variables in the lognormal model for the ECNI TCER BT estimated catch for core mixed target vessels, 2008–14. Bars indicate 95% confidence intervals on the predicted response. Top: fishing year, core vessel; bottom: month, target species.

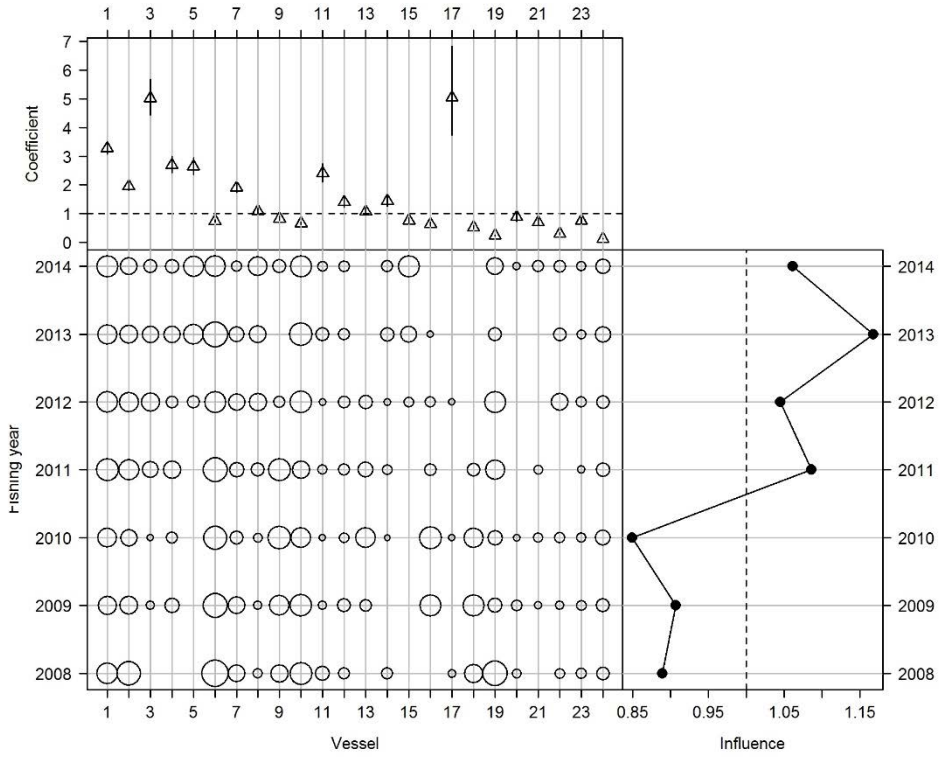


Figure D34a: Effect and influence of vessel in the ECNI TCER tow-by-tow core vessel mixed target BT lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of the effort by variable and fishing year. Bottom right: influence of variable (vessel) on unstandardised CPUE by fishing year.

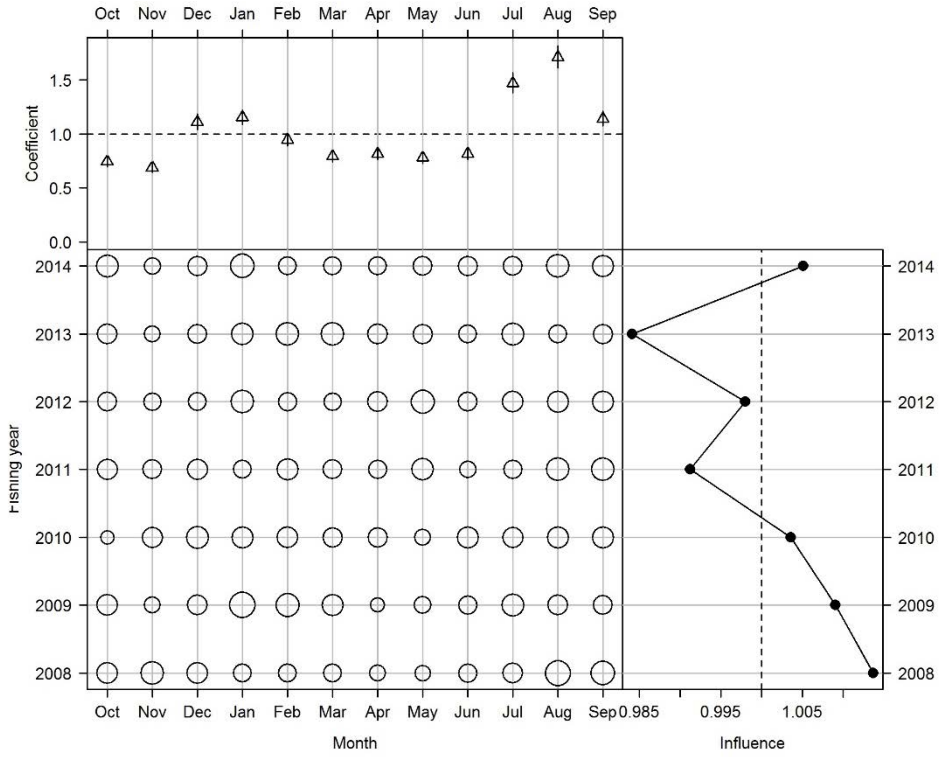


Figure D34b: Effect and influence of month in the ECNI TCER tow-by-tow core vessel mixed target BT lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of the effort by variable and fishing year. Bottom right: influence of variable on unstandardised CPUE by fishing year.

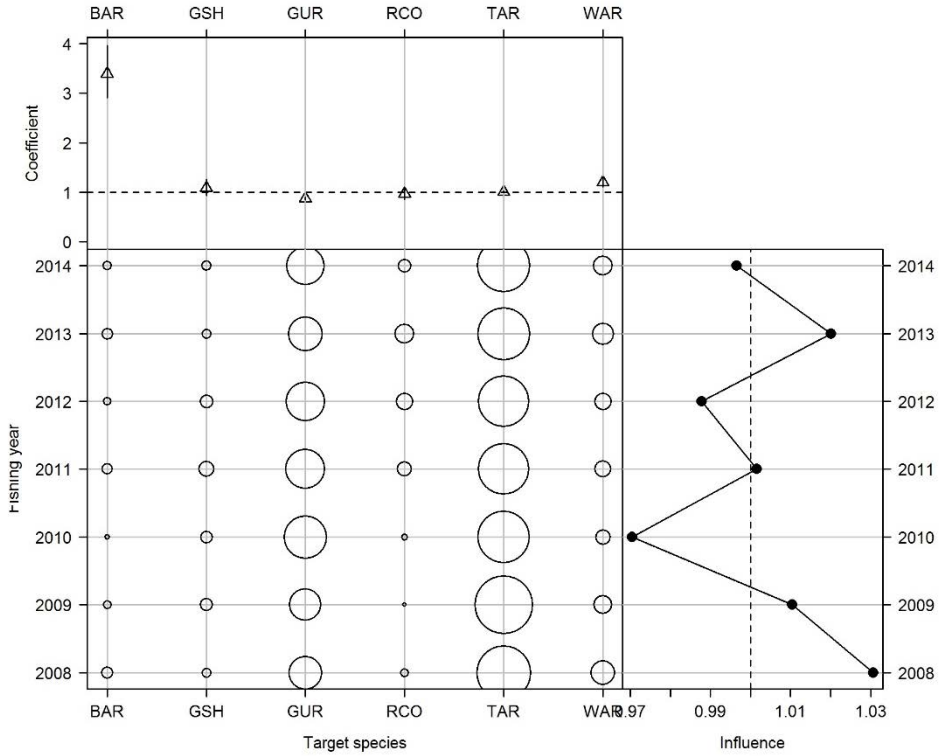


Figure D34c: Effect and influence of target species in the BAR 1 ECNI TCER tow-by-tow core vessel mixed target BT lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of the effort by variable and fishing year. Bottom right: influence of variable on unstandardised CPUE by fishing year.

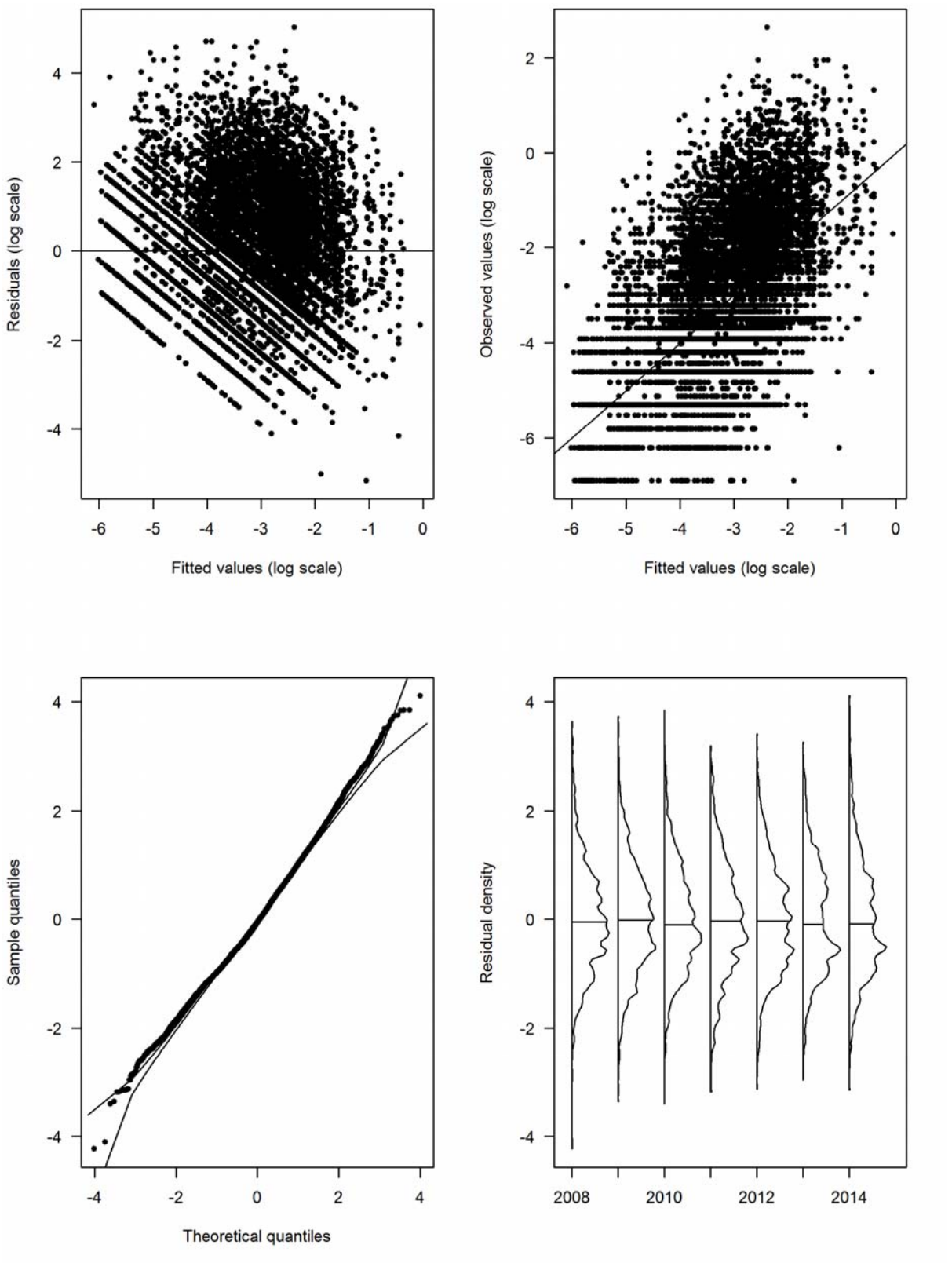
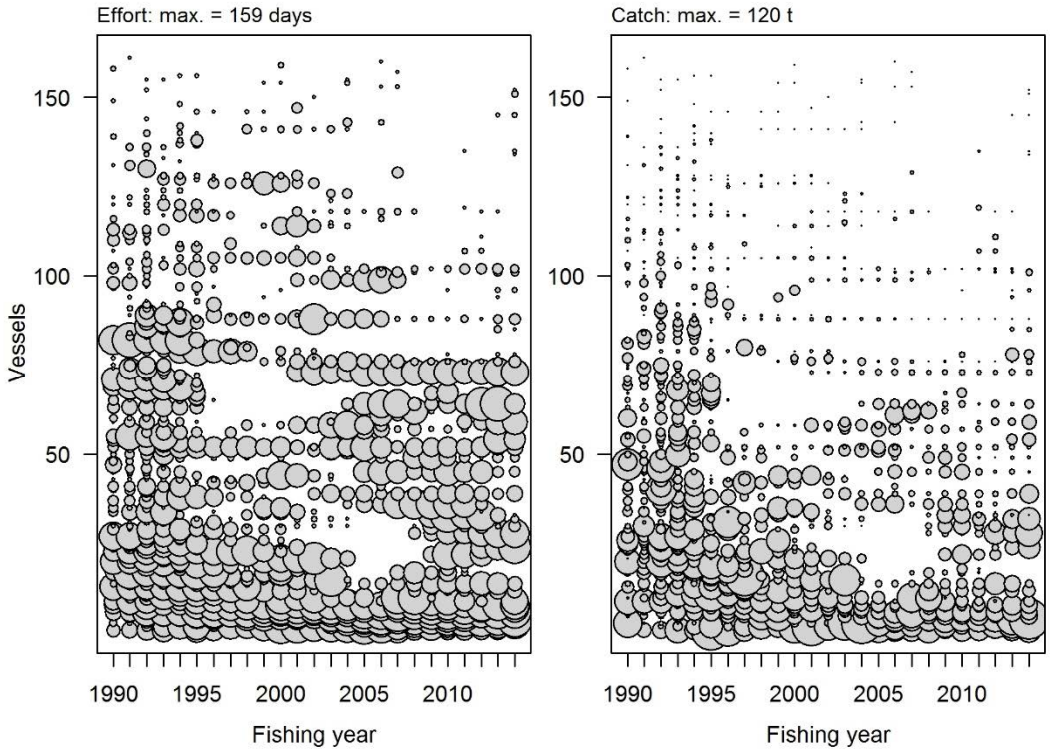


Figure D35: ECNI TCER tow-by-tow BT lognormal model (estimated catch for core vessels and mixed target): distribution of the standardised and observed residuals against fitted values (upper), the quantile–quantile plot of the residuals and density plot of the residuals (lower).

(a) All vessels



(b) Core vessels

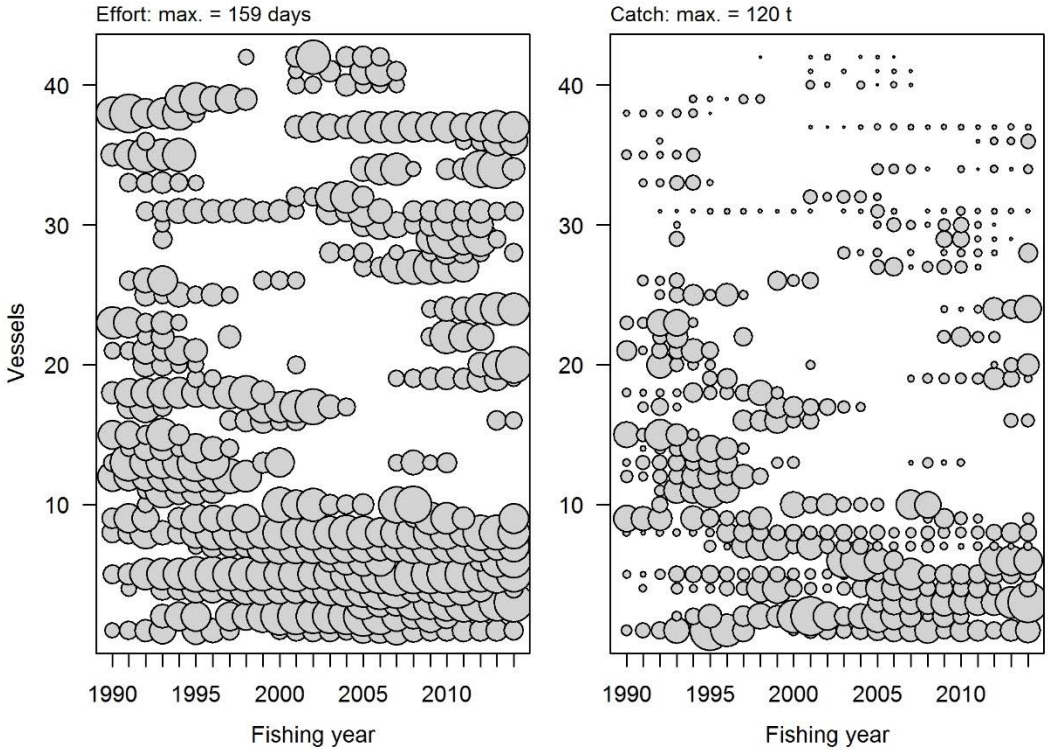


Figure D36: BAR 1 ECNI summary of effort (number of CELR and TCER daily records) and landed barracouta catch (t) by fishing year for 1990–2014, for all vessels and core vessels. The symbol area is proportional to either the number of records or the annual catch, and the maximum circle size is shown in the label on the plot.

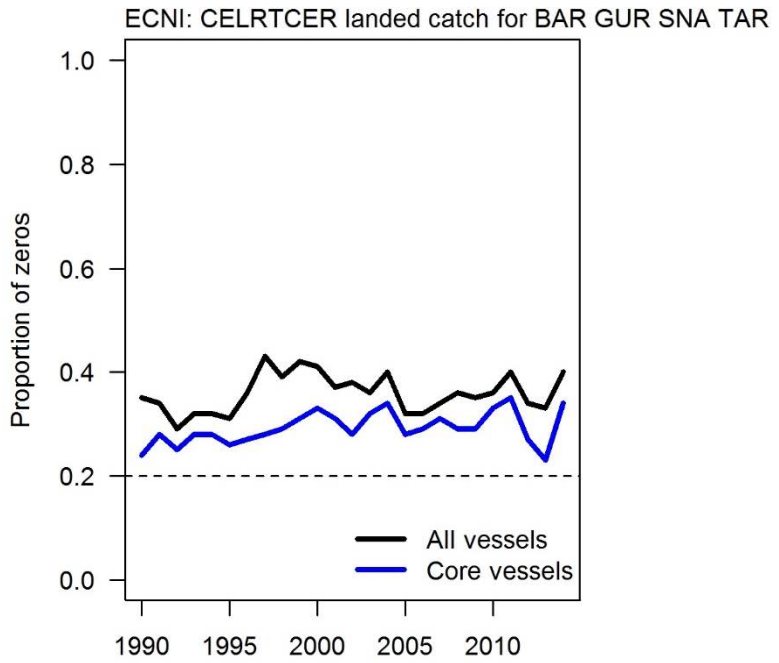


Figure D37: Proportion of zero barracouta catches in the ECNI CELR/TCER daily bottom trawl records, for all vessels and for core vessels, 1990–2014.

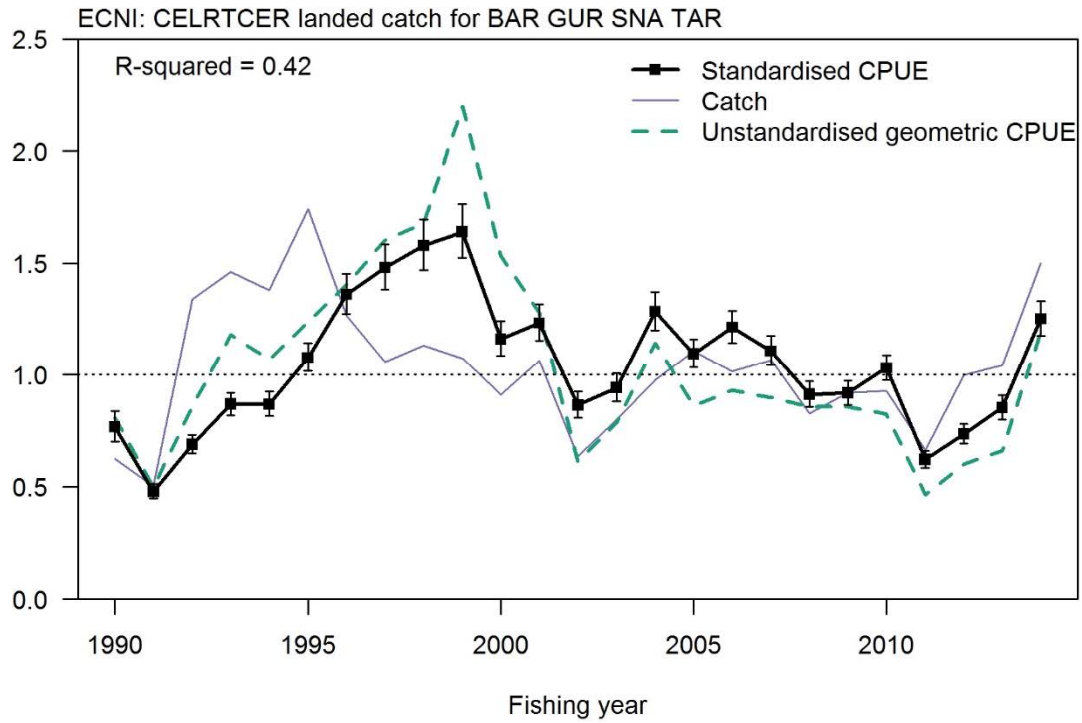


Figure D38a: CPUE lognormal indices for ECNI, based on the CELR/TCER bottom trawl mixed target dataset, showing catches (scaled to same mean as indices), and lognormal standardised and unstandardised indices. Bars indicate 95% confidence intervals.

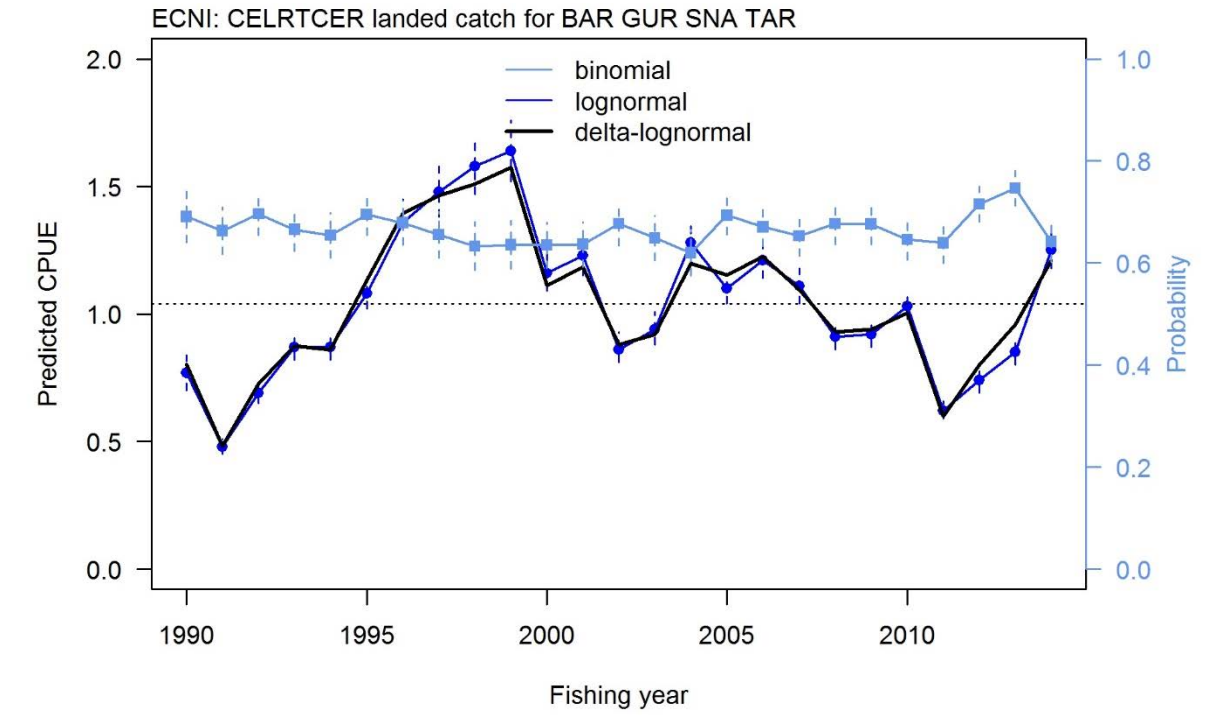


Figure D38b: ECNI CELR/TCER CPUE from the lognormal, binomial, and delta–lognormal (combined) core vessel mixed target, bottom trawl landed catch model, for October–September, 1990–2014. Bars indicate 95% confidence intervals.

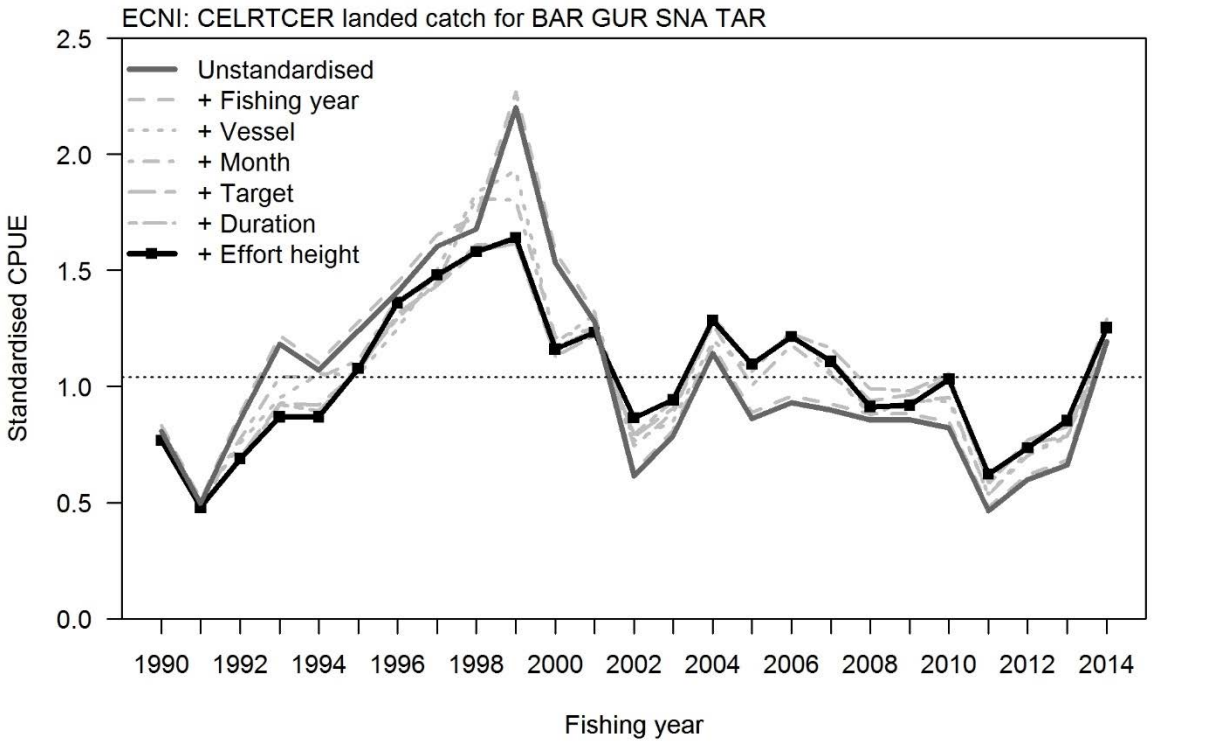


Figure D39: Addition of variables into the lognormal CPUE from the lognormal model for the ECNI CELR/TCER trawl fishery using bottom trawls to target barracouta, red gurnard, snapper, and tarakihi in Statistical Areas 009–017, during October–September of each fishing year, 1990–2014.

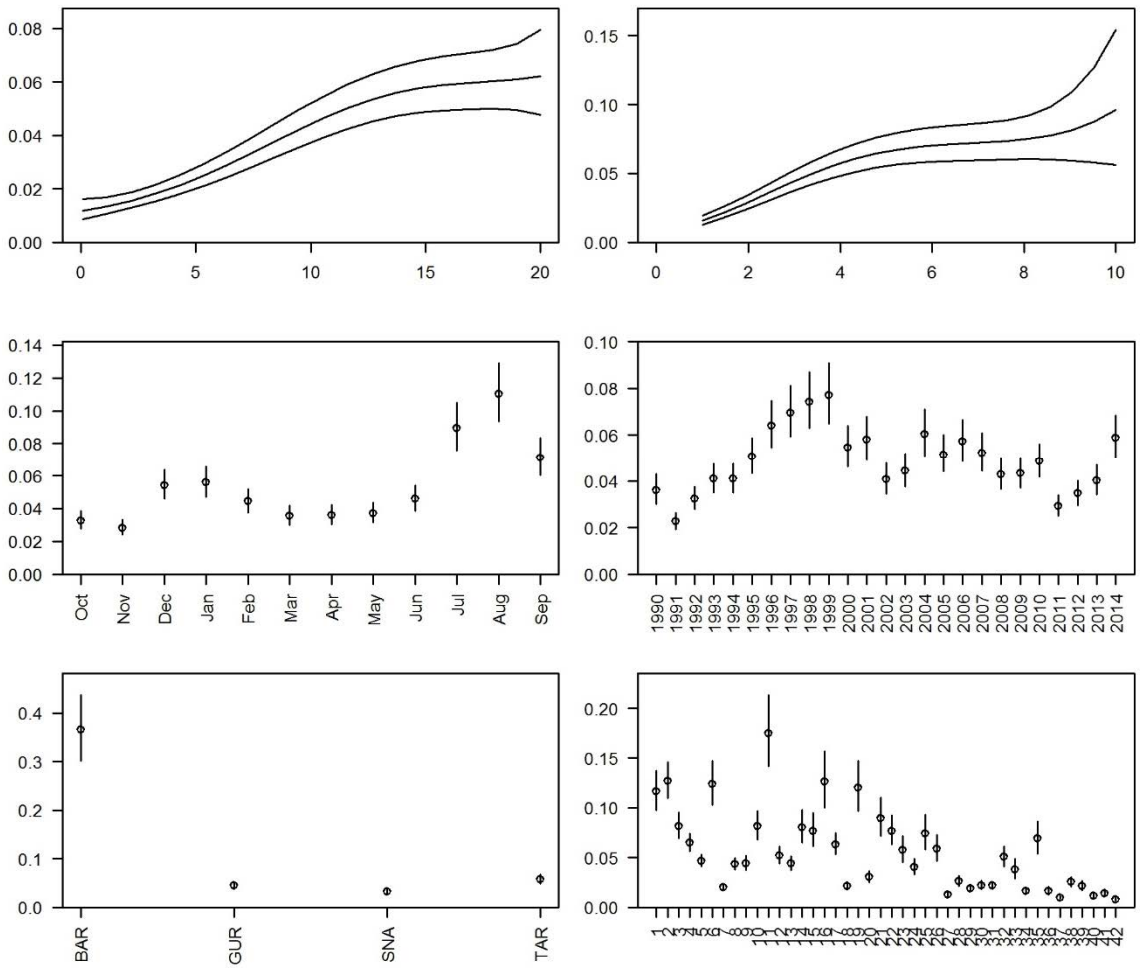


Figure D40: Effects of selected variables in the lognormal model for the ECNI CELR/TCER BT landed catch for core mixed target vessels, 1990–2014. Bars indicate 95% confidence intervals for the predicted response. Top: fishing duration (left), headline height (right); middle: month, fishing year; bottom: target species, core vessel.

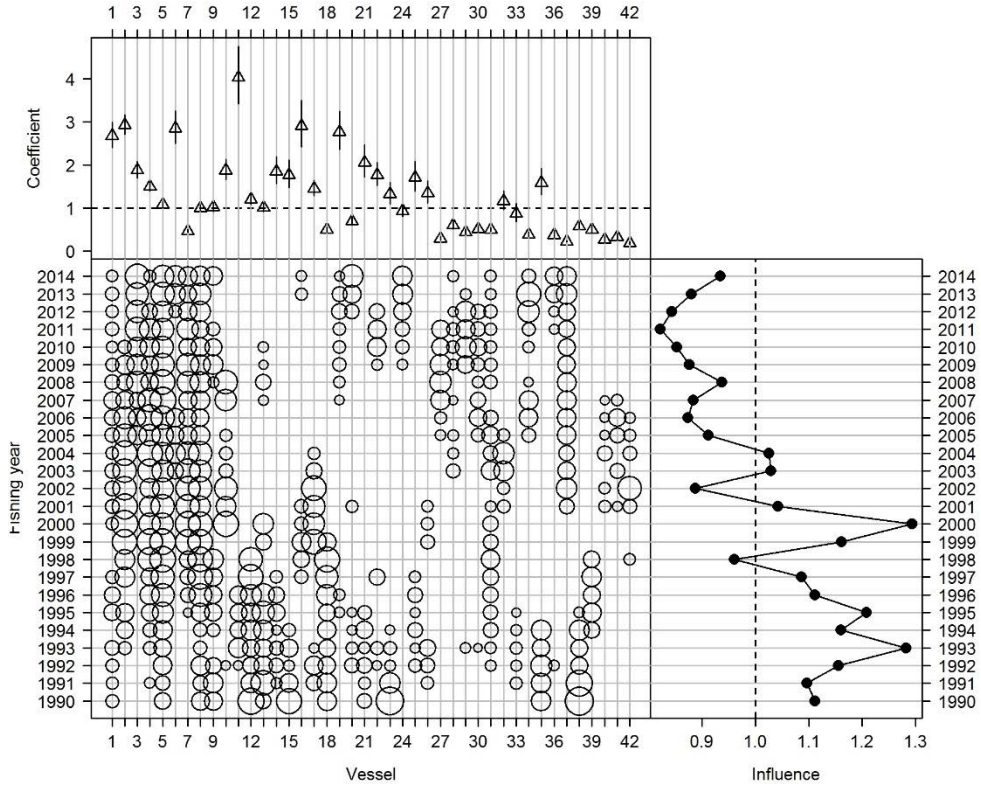


Figure D41a: Effect and influence of vessel in the ECNI CELR/TCER day-by-day core vessel mixed target BT lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of the effort by variable and fishing year. Bottom right: influence of variable (vessel) on unstandardised CPUE by fishing year.

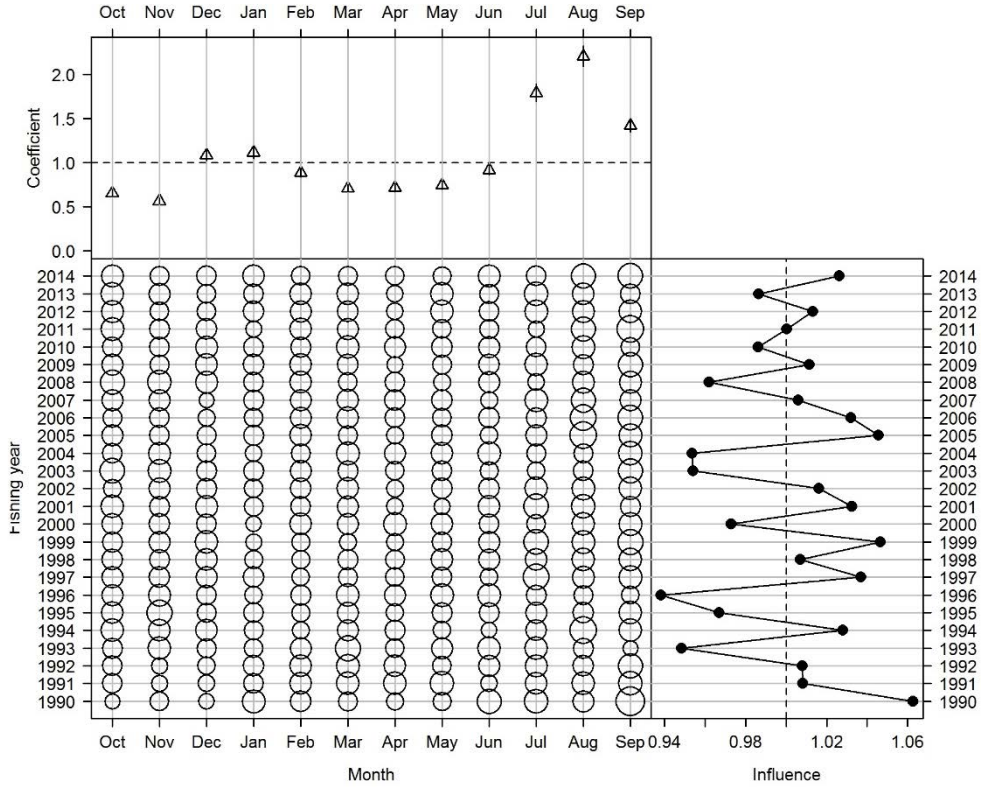


Figure D41b: Effect and influence of month in the ECNI CELR/TCER day-by-day core vessel mixed target BT lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of the effort by variable and fishing year. Bottom right: influence of variable on unstandardised CPUE by fishing year.

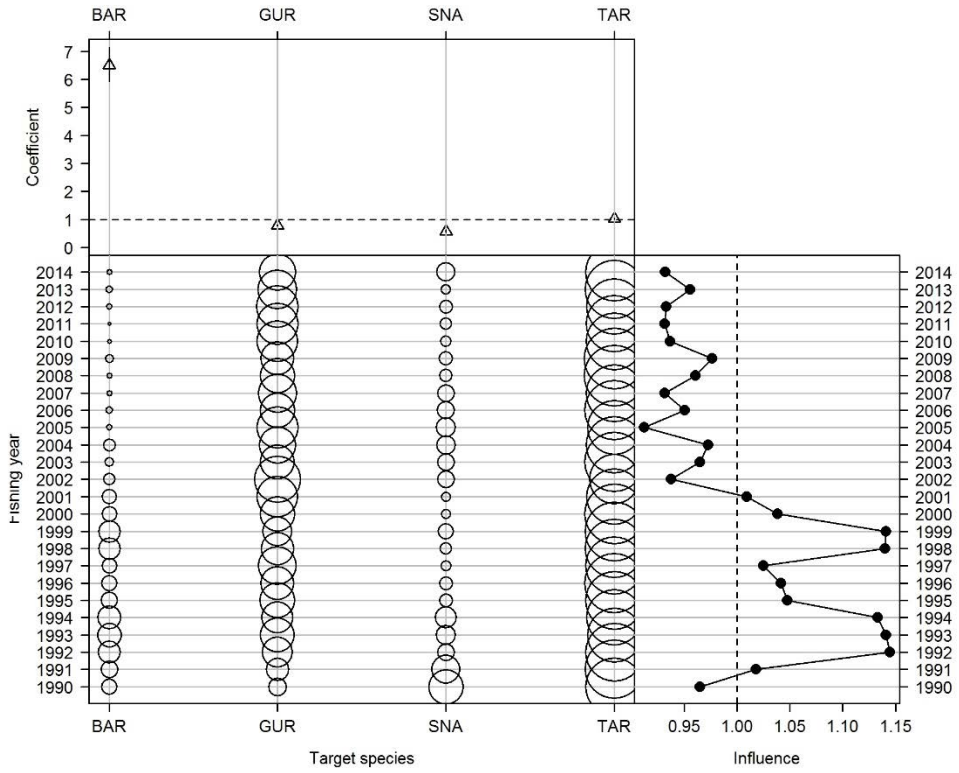


Figure D41c: Effect and influence of target species in the BAR 1 ECNI CELR/TCER day-by-day core vessel mixed target BT lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of the effort by variable and fishing year. Bottom right: influence of variable on unstandardised CPUE by fishing year.

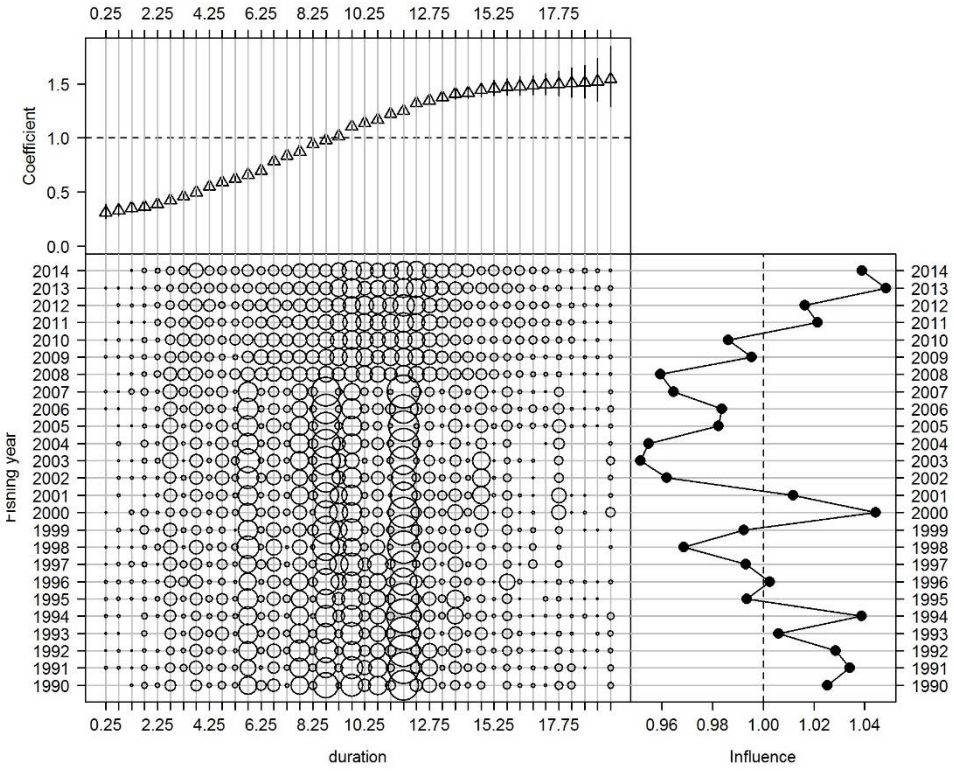


Figure D41d: Effect and influence of fishing duration in the ECNI CELR/TCER day-by-day core vessel mixed target BT lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of the effort by variable and fishing year. Bottom right: influence of variable on unstandardised CPUE by fishing year.

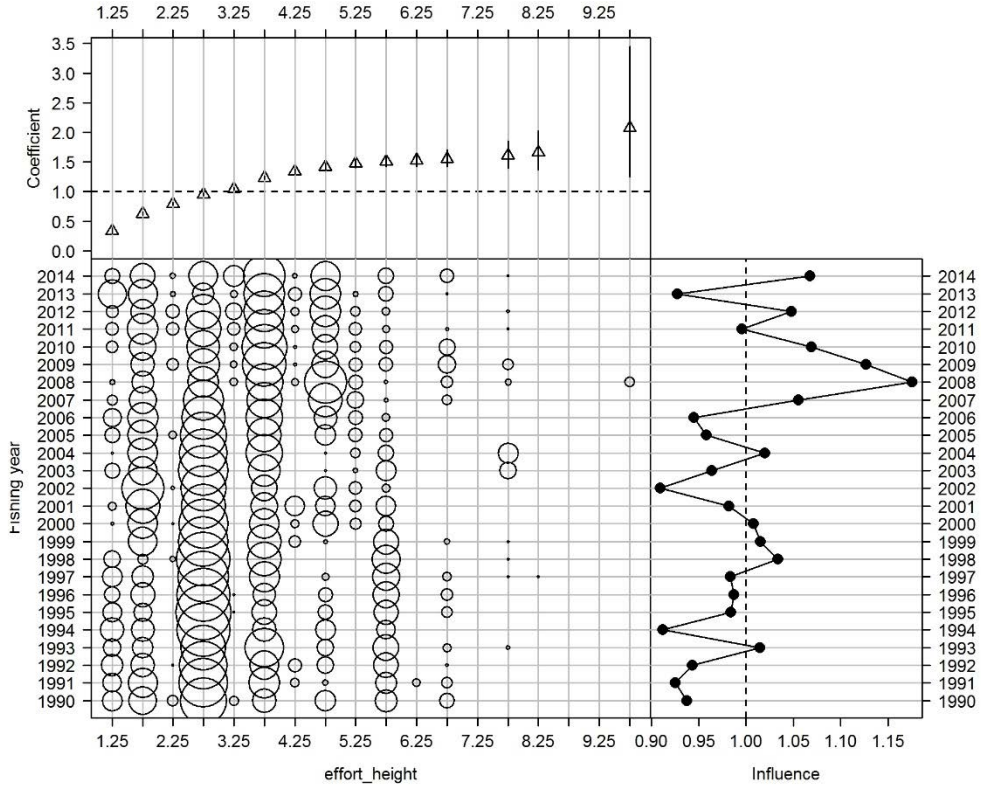


Figure D41e: Effect and influence of headline height (m) in the ECNI CELR/TCER day-by-day core vessel mixed target BT lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of the effort by variable and fishing year. Bottom right: influence of variable on unstandardised CPUE by fishing year.

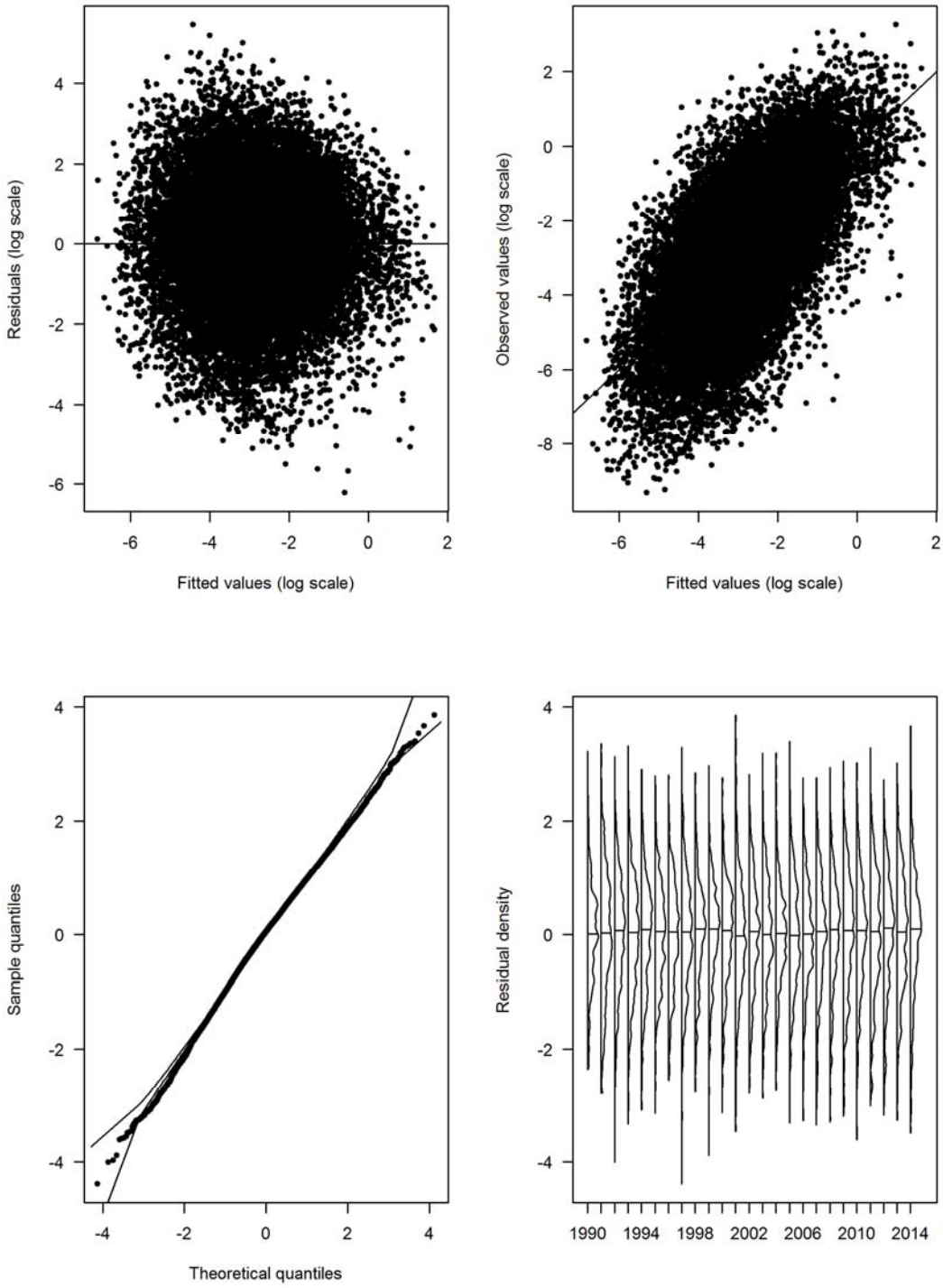


Figure D42: ECNI CELR/TCER day-by-day BT lognormal model (landed catch for core vessels and mixed target): distribution of the standardised and observed residuals against fitted values (upper), the quantile–quantile plot of the residuals and density plot of the residuals (lower).