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Fishery characterisation and standardised CPUE analyses for lookdown dory, *Cyttus traversi* (Hutton, 1872) (Zeidae), 1989–90 to 2011–12

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This report is part of a series of middle depth fishery characterisations for species or stocks that are not regularly assessed, and is an update of the most recent characterisation of lookdown dory fisheries carried out with data from 1990 to 2009 (MacGibbon et al. 2012). This study covers lookdown dory catch in LDO 1 (West coast and East Coast North Island) and LDO 3 (Chatham Rise and Sub-Antarctic). The lookdown dory are mostly taken by vessels considered part of the New Zealand deepwater fleet that operate mainly at depths of 200–1000 m. Trawl survey and observer data are also analysed. The standardised reporting format is followed, with additional information and analyses where appropriate.

Lookdown dory entered the Quota Management System on 1 October 2004, with a Total Allowable Commercial Catch (TACC) of 783 t. The TACC in each Fishstock has remained unchanged since 2004. From 2005 to 2012, the total annual landings were about 48–60% of the overall TACC, but landings from LDO 1 slightly exceeded the LDO 1 TACC in 2006 and 2008. Most estimated catch is recorded on Trawl Catch Effort and Processing Return (TCEPR) forms on which only the top five species are recorded. As lookdown dory is caught in relatively small quantities compared with other species, it is rarely represented in the top five estimated catches and so daily processed catch records were used as catches in the report and for CPUE analyses.

Lookdown dory is mainly caught as bycatch in a variety of target fisheries. The catch from the Chatham Rise fishery is widespread, and is mainly bycatch from the hoki (*Macruronus novaezelandiae*) bottom trawl fishery from October to June. The west coast South Island catch is mainly bycatch of the spawning hoki and hake (*Merluccius australis*) bottom and midwater trawl fisheries from June to September, but with some targeting occurring before the main hoki season by smaller boats. The Sub-Antarctic fishery is mainly from September to June, with lookdown dory primarily caught as bycatch of hoki and ling (*Genypterus blacodes*) bottom trawl fisheries. As lookdown dory is primarily caught as a bycatch species, any seasonal effect is likely to be related to the timing of the target fisheries in which it is caught.

Random trawl surveys of the Chatham Rise and Sub-Antarctic areas by R.V. *Tangaroa* in summer have been conducted since 1991 to survey hoki, hake, and ling and provided relative biomass indices of lookdown dory, with most annual coefficients of variation (CV) less than 10% and 25% respectively. The Chatham Rise series shows a slight overall increase in biomass to 2002, with a subsequent decline to 2011, whereas the Sub-Antarctic survey series declined to 2001–2002, but then increased through until 2009, before declining to its lowest level in 2011. In both survey time series female biomass is much greater than male biomass. Length frequency plots from the Chatham Rise trawl survey time series indicate that it may be possible to track the youngest year classes, although age validation would need to be done in order to know the actual ages of these cohorts. The west coast South Island (WCSI) trawl survey shows no trend. Collection of length and gonad staging data on the *Kaharoa* WCSI inshore trawl survey in autumn, especially in 300–400 m depth strata could improve knowledge on spawning.

Standardised CPUE analyses were developed using TCEPR daily processed catch data from bottom trawl fisheries for Chatham Rise hoki, WCSI hoki and hake, and Sub-Antarctic hoki and ling fisheries. Observer tow-by-tow data were used for CPUE analyses of LDO in the Chatham Rise hoki bottom trawl fishery and the WCSI hoki and hake bottom and midwater trawl fisheries. The Chatham Rise CPUE and trawl survey indices are similar in most years, however, the Sub-Antarctic CPUE and survey indices are not. The WCSI CPUE and trawl survey indices both show no strong trends.

Observer sampling of commercial catches of lookdown dory was driven by the location and timing of the main target fisheries being observed. Sampling by the observer programme is currently sporadic and insufficient and would need to be better optimised to be able to be used to monitor lookdown dory fisheries. No catch-at-age series has been developed and ageing using otoliths has not been validated.

1. INTRODUCTION

Lookdown dory is one of the many species caught in middle depth and inshore fisheries within New Zealand's EEZ for which the catch is not regularly assessed. This project is designed to ensure that data available for monitoring important middle depth species are routinely summarised and assessed under a three to four year rotating schedule as described in the 10 year Research Programme for Deepwater Fisheries (Ministry of Fisheries 2010).

Lookdown dory is generally caught by bottom trawling in depths of 200 to 800 m mainly as bycatch in the hoki fishery, but also in a variety of other target fisheries such as barracouta, hake, ling, scampi, squid and jack mackerel (Ministry for Primary Industries 2013a). A small amount of target fishing for lookdown dory is reported from FMA 7. Most of the catch has come from FMA 3 (east coast South Island), FMA 4 (Chatham Rise), and FMA 7 (west coast South Island).

Middle depth research trawl surveys designed principally to estimate hoki, hake, and ling abundance (but also coincidentally other species) have been carried out on a regular basis on the Chatham Rise and Sub-Antarctic annually by *Tangaroa* since 1991 (with no Sub-Antarctic surveys from 1995 to 1999, or in 2010), and provide reasonable biomass estimates for two of the four main fishing areas identified in this study. A winter WCSI trawl and acoustic survey also contributes a WCSI biomass estimate for lookdown dory. Lookdown dory biomass is usually in the top 10 species for the Chatham Rise series (Ministry for Primary Industries 2013a). The survey samples their depth distribution well and coefficients of variation (CV) are low (usually less than 10%). Lookdown dory are less abundant in the Sub-Antarctic and biomass estimates have higher CVs than on the Chatham Rise.

This report is an update of the most recent characterisation of lookdown dory fisheries that was carried out with data from 1989–90 to 2008–09 (MacGibbon et al. 2012). That analysis indicated four major fisheries for which the following recommendations were made: the east coast South Island and Chatham Rise fishery should be monitored by the Chatham Rise trawl survey; the Sub-Antarctic fishery should be monitored by the Sub-Antarctic trawl survey; and the west coast South Island could potentially be monitored by the WCSI acoustics and trawl combined survey (which was planned to start in 2011). There is no information for the ECNI. These recommendations were accepted by the Middle Depth Species Working Group.

The previous study also found that there were gaps in the data, such as spawning season timings and biological characteristics of the catch in the commercial fishery (MacGibbon et al. 2012). It was thought that improved estimated catches by the commercial fleet (from tow by tow data) could lead to more meaningful CPUE indices being developed, particularly for the Chatham Rise where most lookdown dory is caught. Improved coverage of all fishing areas by the observer programme was suggested, which would involve collection of all key aspects of biology including length, weight, sex, gonad development and possibly the collection of otoliths.

This report summarises the analyses carried out for the Ministry for Primary Industries (MPI) under project DEE201007LDO to characterise the New Zealand lookdown dory fisheries by analysis of commercial catch and effort data up to 2011–12 through the following objectives:

- To carry out standardised CPUE analyses for the major fisheries (Fishstocks) where appropriate;
- to review the indices from CPUE analyses, all relevant research trawl surveys and Observer logbooks to determine any trends in biomass, size frequency distributions or catch rates;
- To review stock structure using data accessed above and any other relevant biological or fishery information;

- To assess the availability and utility of developing a series of age-frequency distributions from trawl survey and Observer collected data; and
- To make recommendations on future data requirements (including recommendations for annual levels of Observer sampling) and methods for monitoring the stocks.

The report contains sections of text and tables that can be transferred to the MPI Plenary report as appropriate. Some topics present in plenary reports were not reported on in this report but the headings are listed in the appropriate place in grey. Tables and figures are provided in four Appendices: A, Survey data; B, Observer data; C. Fishery Characterisation; and D, Catch-per-unit-effort analyses.

2. FISHERY SUMMARY

2.1 Commercial fisheries

Lookdown dory occurs throughout New Zealand waters, Australia (where it is called king dory) and around South Africa over the continental shelf at depths of between 200 and 800 m. In New Zealand it is most often caught on the Chatham Rise. Lookdown dory is generally caught by bottom trawling in depths of 200 to 800 m mainly as bycatch in the hoki fishery, but also in a variety of other target fisheries such as barracouta, hake, ling, scampi, squid and jack mackerel (Ministry for Primary Industries 2013a). A small amount of target fishing is reported on the west coast South Island (WCSI). Most of the catch has come from FMA 3 (east coast South Island), FMA 4 (Chatham Rise), and FMA 7 (WCSI).

Lookdown dory was introduced into the Quota Management System (QMS) on 1 October 2004 with a TACC of 783 tonnes (Table 1). It is currently managed as three fishstocks (Figure 1). LDO 1 comprises FMAs 1–2, and 7–9 while LDO 3 comprises FMAs 3–6 (Figure 1). The Kermadec region (LDO 10) has an administrative TACC of 1 t but no catch of lookdown dory has been reported from this area.

Commercial catch-effort and landings reporting forms available since the 1989–90 fishing year (1 October to 30 September) provide the data used in this report (Tables 2 and 3). Catch Effort Landing Returns (CELRs) collected daily catch-effort and landings data from trawl vessels under 28 m and vessels operating in various other fisheries (such as those using longline methods and setnets) up to 1 October 2007. The Trawl Catch Effort Returns (TCERs) introduced on 1 October 2007 for small (6–28 m) trawl vessels, and Trawl Catch Effort Processing Returns (TCEPRs) introduced in 1989 for vessels over 28 m long, collect tow-by-tow catch-effort data and have associated landings data reported on Catch Landing Returns (CLRs). The CELR form was replaced by specific fishery catch-effort-landing method forms for some fisherin methods in 2008.

Landings data are available from the 1989–90 fishing year after the introduction of the Catch Landing Return (CLR) and Catch Effort Landing Return (CELR) forms (Tables 2 and 3). In most years CLR forms correspond well with records of annual landings from Licensed Fish Receiver Returns (Ministry for Primary Industries 2013a). Landings increased from 128 t in 1989–90 to a high of 892 t in 2002–03, and have since decreased. Estimated tow-by-tow catch in the early 1990s accounted for around 60–70% of the landed catch, but has declined in recent years to less than 30%. Lookdown dory will often not be included within the top five species in a trawl haul, but the reason for the declining percentage of landings recorded as catch is unknown (Ministry for Primary Industries 2013a).

The TACC in LDO 3 has never been caught. This probably reflects the reduction in the trawl effort targeting hoki on the Chatham Rise where the greatest proportion of lookdown dory has been taken as bycatch. No catch has been reported from LDO 10. While three administrative stocks exist, for the purpose of this report, LDO 10 is ignored, and LDO 1 and LDO 3 have been divided into four main fisheries (Figure 2). These regions are East Coast North Island ("ECNI", FMAs 1 & 2), East Coast South

Island and Chatham Rise ("CHAT", most of FMA 3 and all of FMA 4), Sub-Antarctic ("SUBA", the lower part of FMA 3 just south of Dunedin and FMAs 5 & 6), and West Coast (FMAs 7–9).

Figure 3 shows landings and TACC values for LDO 1 and LDO 3. Since entering the QMS, catches in LDO 1 have exceeded the TACC slightly in the 2006 and 2008 fishing years (Table 2). Catches in LDO 3 have never come close to reaching the TACC of 614 t.

Table 1: Recreational and customary non–commercial allowances, TACCs and TACs, by Fishstock, for lookdown dory (Source: Ministry for Primary Industries Lookdown Dory Plenary May 2013).

Fishstock	Recreational Allowance	Customary non–commercial Allowance	TACC	TAC
LDO 1	0	0	168	168
LDO 3	0	0	614	614
LDO 10	0	0	1	1
Total	0	0	783	783

Table 2: Reported historic landings (rounded to nearest tonne) of lookdown dory by FMA and fishing year 1989–90 to 2003–04.

Year	FMA 1	FMA 2	FMA 3	FMA 4	FMA 5	FMA 6	FMA 7	FMA 8	FMA 9	FMA 10	Total
1989–90	2	1	40	20	12	2	51	-	-	-	128
1990–91	3	4	46	59	10	11	33	< 1	-	-	166
1991–92	1	2	96	75	17	3	55	-	-	-	249
1992–93	1	4	63	112	10	2	83	-	-	-	275
1993–94	< 1	2	62	50	4	3	67	-	< 1	-	188
1994–95	1	6	73	108	7	3	85	-	< 1	-	283
1995–96	2	4	99	78	11	3	62	-	< 1	-	259
1996–97	7	10	108	110	11	7	100	< 1	< 1	-	353
1997–98	5	8	159	272	11	25	82	-	< 1	-	562
1998–99	3	3	161	295	21	17	124	< 1	10	-	634
1999–00	3	5	161	295	21	17	124	< 1	10	-	636
2000–01	2	6	203	318	24	25	111	< 1	4	-	693
2001–02	10	10	181	331	26	28	170	3	2	-	761
2002–03	8	8	261	365	48	32	167	1	2	-	892
2003–04	13	8	135	210	22	24	113	3	1	-	529
Total	61	81	1 848	2 698	255	202	1 427	7	29	0	6 608

Table 3: Reported domestic landings (t) of lookdown dory by Fishstock and TACC from 2004–05 to 2011–12 (Source: Ministry for Primary Industries Lookdown Dory Plenary May 2013).

Fishstock	LDO 1		LDO 3		LDO 10			
FMA	1,2,7,8&9		3,4,5&6		10			Total
	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC
2004–05	110	168	272	614	0	1	382	783
2005–06	180	168	290	614	0	1	470	783
2006–07	147	168	284	614	0	1	431	783
2007–08	174	168	256	614	0	1	430	783
2008–09	144	168	315	614	0	1	459	783
2009–10	161	168	274	614	0	1	435	783
2010–11	165	168	216	614	0	1	480	783
2011–12	153	168	229	614	0	1	382	783

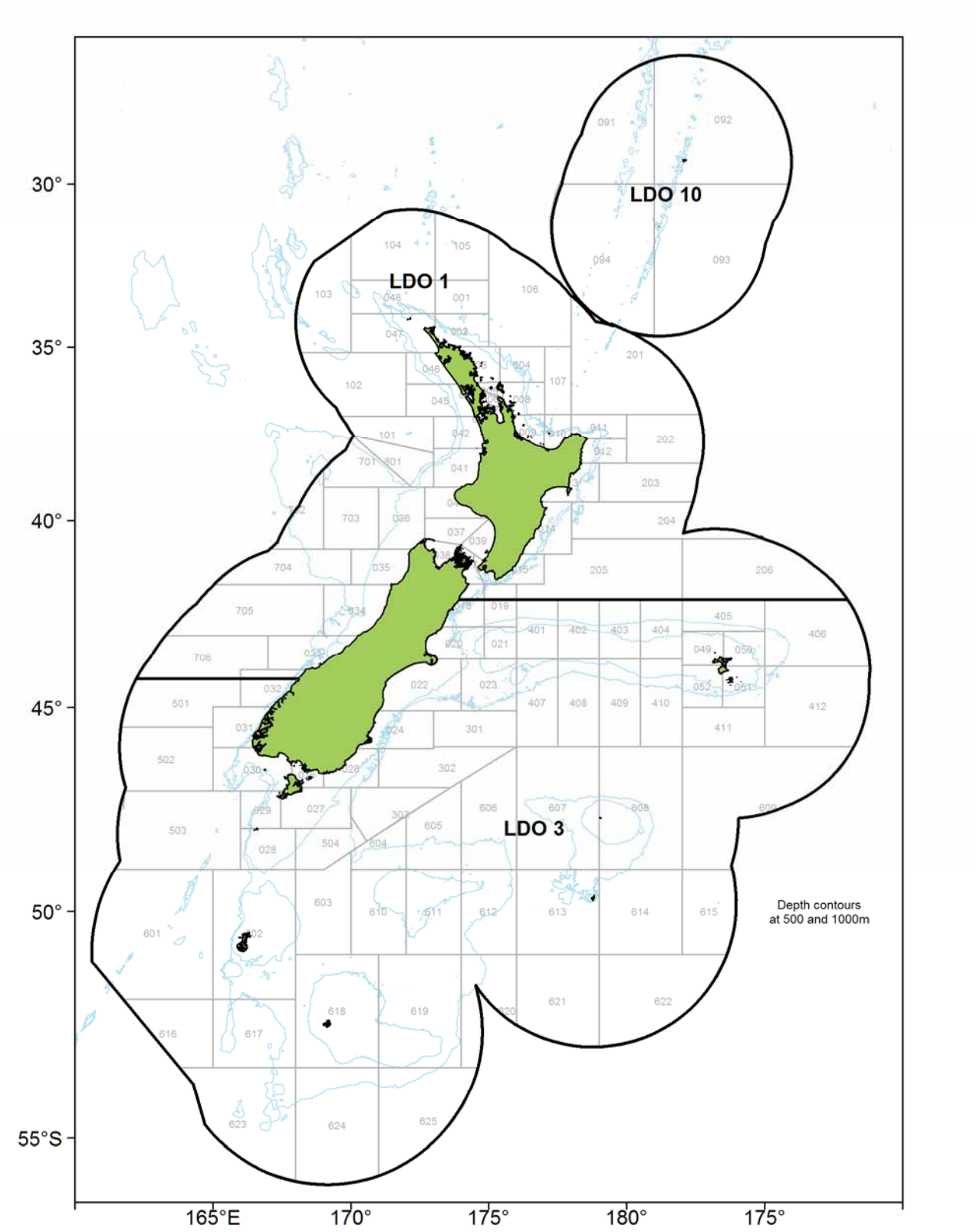

Figure 1: Map showing the administrative fishstock boundaries for LDO 1 and LDO 3, including statistical areas, and the 500 m and 1000 m depth contours.

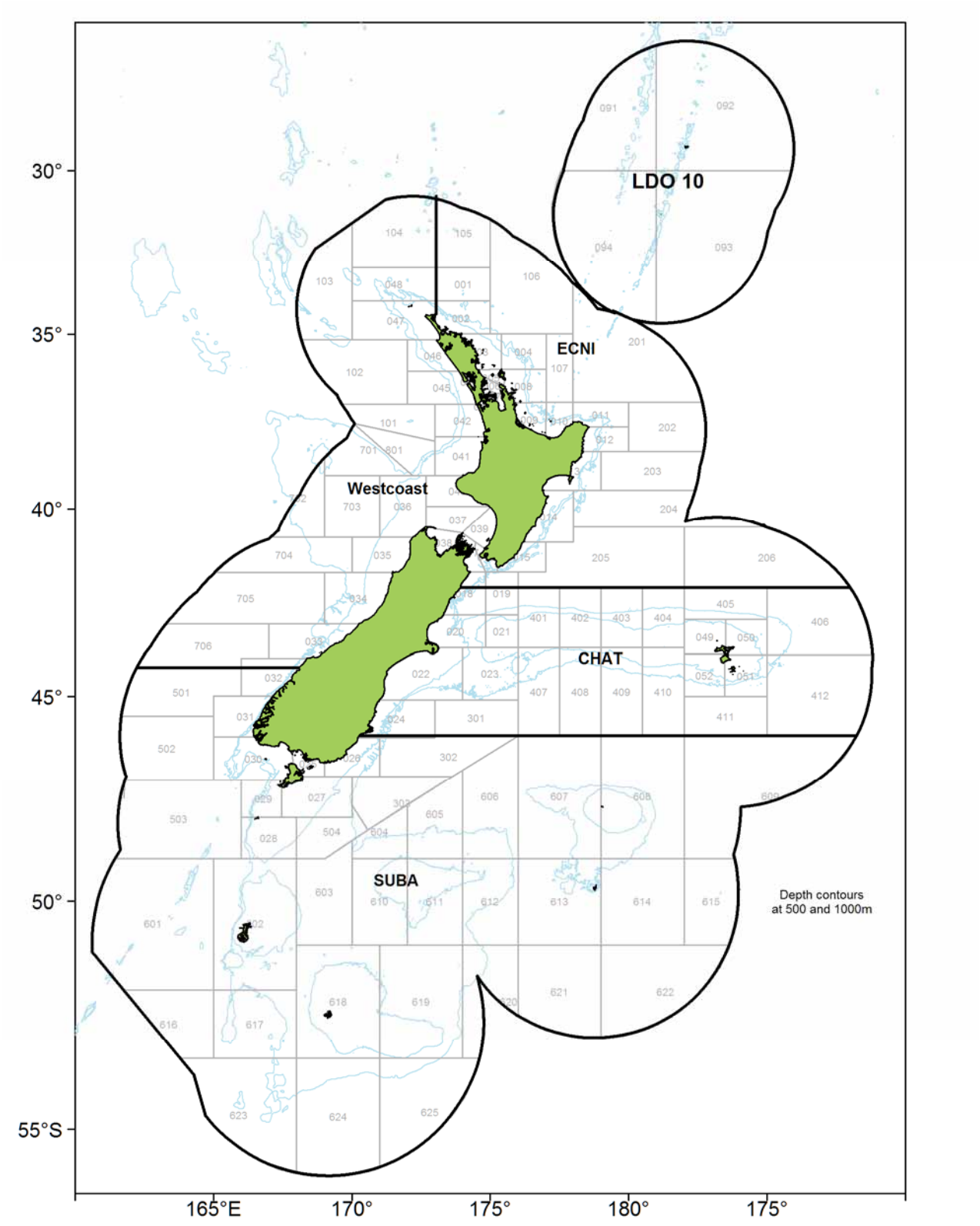

Figure 2: Map showing the areas used in this analysis, including statistical areas, and the 500 m and 1000 m depth contours. ECNI, east coast North Island; CHAT, east coast South Island and the Chatham Rise; Westcoast, west coast New Zealand; SUBA, Sub-Antarctic.

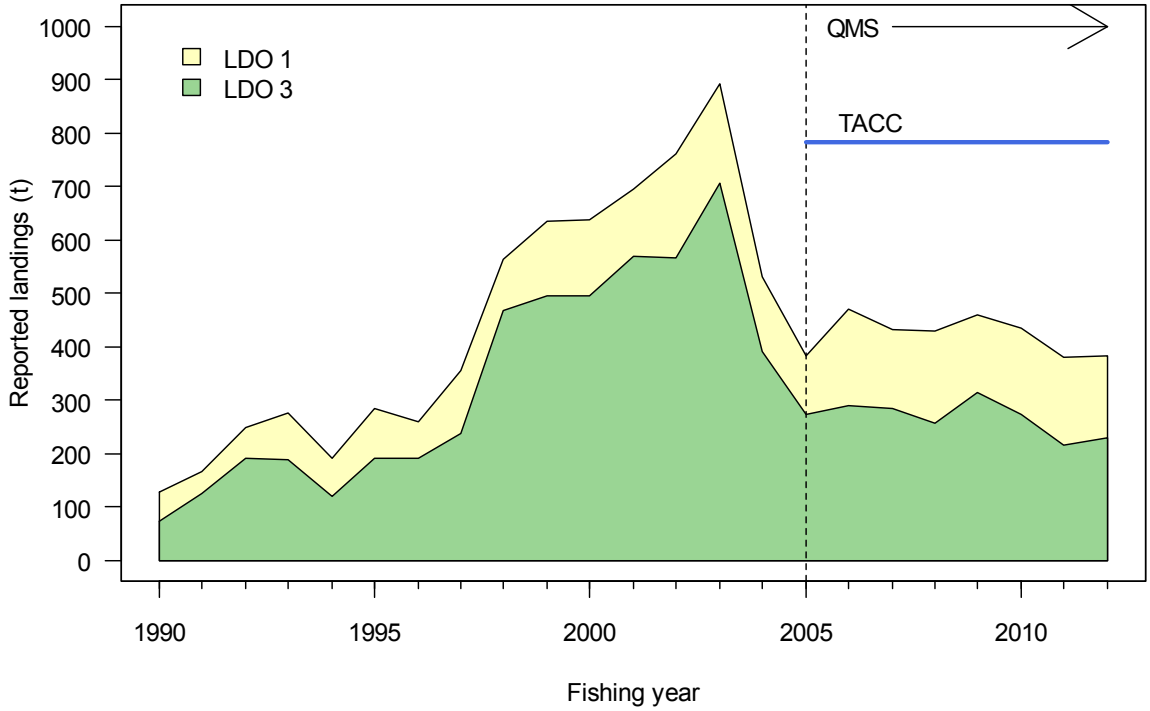

Figure 3: Total reported landings by QMA (shaded regions) from fishing years 1990 to 2012, and the total TACC.

2.2 Recreational fisheries

There is no available information on the recreational harvest of lookdown dory but given the offshore nature of the fishery, recreational catch is likely to be negligible if not non-existent.

2.3 Maori customary fisheries

There is no available information on the recreational harvest of lookdown dory but given the offshore and deep nature of the fishery customary catch is likely to be negligible if not non-existent.

2.4 Illegal and misreported catch

There is no quantitative information available on the illegal or misreported catch of lookdown dory.

2.5 Other sources of mortality

There is no quantitative information available on other sources of mortality of lookdown dory. Given the relatively low value of lookdown dory it is possible that much of the catch was discarded prior to its introduction into the QMS.

2.6 Regulations affecting the fishery

Current and historical limits on catch for lookdown dory are described in Section 2.1. Minimum codend mesh-size regulations that currently apply to the trawl fisheries specify 60 mm for Sub-Antarctic (FMA 6) fisheries and FMA 5 south of 48°S; and 100 mm elsewhere. From 1 October 1977, the codend mesh-size change took effect at the boundary between the Snares and Auckland Islands fisheries (the old EEZ area F/E boundary), which was at 48° 30'S. The management area boundary was changed on 1 October 1983 to 49°S (now the FMA5/6 boundary) but the codend mesh size change takes effect at latitude 48°S to allow for targeting of squid around the Snares Islands (Hurst 1988).

Protection of bycatch species in multi-species fisheries (particularly relevant in trawl fisheries such as lookdown dory) is mainly through the QMS, with quotas currently set for 628 fishstocks. Catch of protected species such as seabirds and furseals is monitored through the Observer programme and all trawl vessels have been required to deploy seabird mitigation devices to minimise interactions with trawl warps since April 2006 (Ministry of Fisheries 2009).

3. BIOLOGY

3.1 Distribution

Lookdown dory belongs to the family Zeidae. This family includes 13 species in seven genera distributed among the Atlantic and Pacific Oceans and the Mediterranean Sea (Ministry for Primary Industries 2013a). Lookdown dory are restricted to the Southern Hemisphere, and in the Southeast Atlantic they are known from Walvis Ridge and from off Cape Town to Algoa Bay in South Africa, extending as far north as about 20° S (Ministry for Primary Industries 2013b). They are also known from the south coast of Australia, including Tasmania, where they are more commonly known as king dory (May & Maxwell 1986).

In New Zealand lookdown dory are widely distributed throughout the EEZ from the Three Kings Islands (about 34° S) to the southern edge of the Campbell Plateau (about 54° S), including the Challenger Plateau, Chatham Rise, and Bounty Plateau. Adults are most common between 400 to 600 m, but have a wide depth range, from 50 to 1200 m (Anderson et al. 1998), and are most abundant across the Chatham Rise. In research trawl surveys, nearly all tows on the Chatham Rise contain lookdown dory, which are most abundant at depths of 350 to 650 m. They are also caught on Sub-Antarctic trawl surveys but the distribution is much patchier and they are less abundant there than on the Chatham Rise (O'Driscoll & Bagley 2001). Juveniles up to a total length of about 12 cm are found in surface waters (May & Maxwell 1986), at which stage a metamorphosis occurs associated with the transition from a pelagic to a demersal habitat (James 1976). Surveys show much higher abundance of immature fish on the Chatham Rise compared to the Sub-Antarctic (O'Driscoll et al. 2003). Immature fish less than 33 cm have a similar geographical and depth distribution to adults (Hurst et al. 2000, O'Driscoll et al. 2003).

Lookdown dory is one of the less abundant members of a loosely associated group of about 23 common species, which together form the upper slope assemblage of New Zealand's continental shelf (Francis et al. 2002). The main species in this group are hoki, javelinfish, ling, pale ghostshark, sea perch, hake, and longnose spookfish (chimaerid). It was identified as a key species characterising the demersal fish community between 350 and 550 m on the Chatham Rise (Bull et al. 2001).

The length distributions of lookdown dory caught during trawl surveys (see Section 5 and Appendix A) and observed commercial fishing (Section 6 and Appendix B) show that larger fish were generally taken in the Sub-Antarctic with smaller lookdown dory generally taken on the Chatham Rise and WCSI.

Biomass trends and length frequencies for research survey series that cover appropriate depth ranges for lookdown dory are summarised in Appendix A and Section 5. These are the summer Chatham Rise surveys, summer, autumn and spring Sub-Antarctic surveys and WCSI surveys on R.V. *Tangaroa*. The main conclusions from these data are that most surveys are characterised generally by small catches with occasional larger catches; biomass on the Chatham Rise is consistently greater than on the Sub-Antarctic; Chatham Rise biomass is fairly evenly distributed across the Rise; and female biomass is generally dominant.

3.2 Spawning

There is little known about aggregations or migrations associated with spawning lookdown dory. Clark & King (1989) observed ripe fish around the North Island, more often in autumn and winter, but also in summer. Spent females were more common in winter and particularly spring but have been observed in all seasons. Livingston et al. (2002) reported early signs of ripening to spawn in January Chatham Rise trawl surveys. A *WJ Scott* WCSI survey series in 1983 found mature lookdown dory in February, mature to ripe fish in March, and running ripe females in April (Neil Bagley NIWA, pers. comm.).

Observer collected gonad information summarised in this study (Appendix Figure B7b) shows that most spawning takes place in autumn and winter and is not a discrete event but occurs over much of the year. In the Chatham Rise, most females are resting/immature or maturing throughout the year (consistent with the trawl survey records). Ripe females are more common in summer months on the Chatham Rise, running ripe females have been found in late summer to winter, and spent females are more common in winter. Observer data collected from Westcoast comes mainly from the hoki spawning season on the WCSI in June to September and shows that most females are resting, immature or spent in winter, but all stages including ripe and running ripe females are present. There is minimal data for Chatham Rise and Sub-Antarctic, but there is evidence of some spawning activity in the Bay of Plenty and around the Bounty Islands (Figure B7a and b). Immature fish less than 13 cm long have been recorded, mostly in about 250–650 m depth, on the Chatham Rise, the WCSI, in the Bay of Plenty, along the south-east coast of the North Island, at Puysegur, on the Pukaki Rise and around the Sub-Antarctic Islands (Auckland, Campbell, and Bounty Islands) (O'Driscoll et al. 2003). These observations suggest the possibility of substocks within the LDO 1 & 3 Fishstock areas, although it is possible that fish spawned in different locations mix, or that individual biological stocks have multiple spawning areas. Clearly, more data are needed to enable a fuller understanding of lookdown dory spawning biology.

3.3 Stocks and spatial distribution

There has been no previous work on stock structure, recruitment, age or any other biological characteristics that could help identify biological stock boundaries. The previous study (MacGibbon et al. 2012) found some differences in size and abundance between the Chatham Rise and Sub-Antarctic which suggests the possibility of separate stocks. This is described in more detail in Section 5.1.

3.4 Ageing

Ageing of lookdown dory has not been validated. Preliminary work in Australia suggests that this species may live to over 30 years (Stewart & Smith 1992).Tracey et al. (2007) attempted to use lead-radium dating to validate zone counts of otoliths but were unsuccessful as levels of lead-210 were too low to give any meaningful results. Tracey et al. postulated that zone counts would quite likely be validated if whole otoliths were used for lead-radium dating rather than just the core material as was used in their study. Based on unvalidated zone counts, they observed maximum ages of 38 and 25 years for males and females respectively for New Zealand lookdown dory from the Chatham Rise. Maximum age is estimated to be about 40 years (Tracey et al. 2007), and the radiometric results did eliminate the possibility of a very high maximum age (i.e., older than 50 yr.). They estimated the

mean length at first maturity to be 18.3 cm and 5.2 years for males and 21.6 cm and 6.3 years for females, based on macroscopic maturity estimates. This is a smaller size at maturity than the 33 cm reported by Clark & King (1989).

There are about 2000 unread lookdown dory otoliths from various observer trips, otoliths from *Shinkai Maru* surveys in 1977 and 1983, from the *James Cook* survey JCO7703, and from the *Tangaroa* Sub-Antarctic trips TAN0219, TAN0317, TAN0414, and the Chatham Rise summer TAN0201 survey. There are not many otoliths from each source or year, however.

3.5 Growth curves

Von Bertalanffy parameters for lookdown dory from the Chatham Rise were estimated by Tracey et al. (2007) and are presented in Table 4. A lack of aged juvenile fish resulted in the t_0 parameter being poorly defined. Females also attain larger maximum size than males. Initial growth of the species is rapid. Smith & Stewart (1994) estimated growth curves for lookdown dory from Australia. There is no strong dissimilarity between the New Zealand and Australian estimates.

Table 4: Summary of von Bertalanffy growth parameters for Chatham Rise lookdown dory. L_∞, cm total length.

Sex	*N*	L_∞	SE	95% CI	*K*	SE	95% CI	t_0	SE	95% CI
All	382	50.7	2.5	(45.7, 55.7)	0.058	0.007	(0.044, 0.073)	-3.5	0.7	(-4.8, -2.2)
Males	191	38.8	1.7	(35.5, 42.1)	0.074	0.011	(0.053, 0.095)	-4.3	0.9	(-6.0, -2.6)
Females	191	69.9	5.7	(58.8, 81.1)	0.039	0.006	(0.027, 0.051)	-3.9	0.7	(-5.3, -2.5)

3.6 Natural mortality (*M*)

Natural mortality (*M*) is not known for lookdown dory. Tracey et al. (2007) estimated *total* mortality (*Z)* to be in the range of 0.12–0.17 using the Chapman-Robson (Chapman and Robson, 1960), A_{max}, and catch curve regression methods to give estimates but noted that their estimates of *Z* included unknown components of fishing mortality (*F*). Their estimate also assumed that the first reader of otoliths in the study read them correctly, and that zone counts are a valid method for estimating age in lookdown dory. Based on the method of Hoenig (1983), they concluded that an acceptable point estimate of *M* is 0.12 y^{-1}, with a likely range from 0.10 to 0.15.

3.7 Length-weight relationship

Length weight parameters for Chatham Rise lookdown dory were estimated by Tracey et al. (2007) and are given in Table 5.

Table 5: Length-weight parameters for lookdown dory. Weight (g) = aL^b, where L is total length (cm).

	a	*b*
Males	0.025	2.96
Females	0.022	2.98

3.8 Feeding and trophic status

The main prey of lookdown dory are natant decapod crustaceans, followed by euphausiid, mysid, galatheid, and nephropsid crustaceans, and fish (Clark & King 1989, Forman & Dunn 2010). Lookdown dory forage close to the seabed as stomachs examined from three different coastal areas of

the North Island found natant decapods were their main prey (Clark & King 1989). Lookdown dory are also benthopelagic omnivores, as most stomachs examined from eastern Tasmania contained macrourid and mesopelagic fishes (Blaber & Bulman 1987). Forman & Dunn (2010) sampled lookdown dory from three consecutive middle depth Chatham Rise trawl surveys on *Tangaroa* from January 2005–2007. They investigated the relationship between variability in diet and a variety of biological and environmental predictors and found depth and fish length to be the best predictors of diet variability. Diet was characterised by macrourid fish, natant decapods and galatheid decapods. The only commercially important species found in lookdown dory stomachs was the red cod, *Pseudophycis bachus*. Diet changes with depth were most apparent for crustacean prey. Diet changes in ontogeny suggested four categories of feeding: pelagic (fish smaller than 13.9 cm total length), benthopelagic invertebrate-feeding juveniles (13.9–25.8 cm total length), maturing males and females (26–39.5 cm total length, benthopelagic omnivores), and an exclusively female group (mature females greater than 40 cm total length, benthopelagic piscivores/omnivores).

A total of 30 different fish and elasmobranch species' stomachs were sampled on the Chatham Rise surveys on which lookdown dory stomachs were sampled (Forman & Dunn 2010). None contained lookdown dory, suggesting that they are not common prey for other species on the Chatham Rise. Forman & Dunn (2010) concluded that biomass fluctuations in other commercially important species are unlikely to affect lookdown dory through predation, but there is competition for important prey items such as natant decapods and macrourid fishes between lookdown dory and other commercially important species such as hake, hoki, and ling.

Stevens et al. (2011) reviewed and summarised diet information for New Zealand fish species available from research trawl database records from 1960–2000. Around the North Island, 82% of lookdown dory stomachs contained crustaceans which were mainly natant decapods. Teleosts were present in 20% of stomachs, the most commonly identified were myctophids and silver roughy, *Hoplostethus mediterraneus* (both 2%), and teleosts also increased in importance as prey species in larger fish (36 cm or above). The small number of samples from other areas is not adequate to assess relative importance of prey groups. In total, at least five main crustacean groups, and seven fish species were identified. At the time of this review, there were no other feeding records known for this species in New Zealand. However, a study of *Cyttus traversi* off Tasmania also found that crustaceans, in particular natant decapods, and fish, in particular myctophids, were important (Blaber & Bulman 1987).

4. CURRENT AND ASSOCIATED RESEARCH PROGRAMMES

Ministry for Primary Industries

Lookdown dory is one of 18 species included on a list to be characterised once every three years under the MPI 'Deepwater 10–year Plan'. There are no specific research programmes for lookdown dory. Research trawl surveys on *Tangaroa* on the Chatham Rise and Sub-Antarctic in summer are the only ongoing time series in which lookdown dory catches and length frequencies are regularly recorded (see Section 5). Note that there were only four autumn Sub-Antarctic trawl surveys, and one spring Sub-Antarctic survey. Numbers of lookdown dory measured per survey ranged from 810–2675 on the Chatham Rise time series and from 63–256 on the summer Sub-Antarctic time series. Biomass estimates on the Chatham Rise time series range from 3257–8821 t, and 327–1095 t on the summer Sub-Antarctic time series. Precision is good on the Chatham Rise with CVs usually under 10%. CVs are higher for the Sub-Antarctic but acceptable (11–35%). Surveys on *Tangaroa* off the WCSI during winter are new; numbers of lookdown dory measured ranged from 502–1613, and biomass ranged from 155–228 t.

5. FISHERY INDEPENDENT OBSERVATIONS

5.1 Research survey biomass indices and length frequencies

Biomass indices, length and age frequencies

Bottom trawl surveys in waters within the depth range of lookdown dory are summarised in this section. The surveys are part of standardised time series with potential use to monitor lookdown dory abundance. The relevant trawl survey outputs are summarised in Table 6 and Appendix A. Note that years referred to in the research survey section are calendar years. The following trawl survey series were analysed using NIWA's research trawl survey analysis program "SurvCalc" (Francis & Fu 2012): *Tangaroa* surveys on the Chatham Rise (core strata of 200–800 m), in Sub-Antarctic waters summer, autumn, and spring (core strata of 300–800 m), a short series in Southland waters (30–600 m), and a WCSI winter series (core strata of 300–650 m, all strata 200–800 m). *Kaharoa* surveys in inshore shallower waters during winter and summer off the east and west coast of the South Island were not used as they did not cover the entire depth range appropriate for this species.

There have been no surveys designed specifically to estimate lookdown dory abundance. The Chatham Rise (1992–2013) and Sub-Antarctic (1991–1993, 2010–2009, 2011–2012) *Tangaroa* random bottom trawl survey time series, were primarily aimed at surveying hoki, hake, and ling (O'Driscoll et al. 2011). The core strata of all these cover the appropriate depth and provide relatively precise biomass indices (Chatham Rise CVs usually less than 10%, Sub-Antarctic summer survey CVs usually less than 25%) (Figure A1, Table 6). The Sub-Antarctic *Tangaroa* autumn (1992–93, 1996, 1998) and spring (1992) surveys, and the WCSI *Tangaroa* winter surveys (2000, 2012–2013) also cover the range well. The Southland *Tangaroa* series (1993–1996) also cover the depth range, although most lookdown dory are caught in depths more than 300 m and station density is more limited in strata less than 300 m depth (Figure A1).

The distribution of lookdown dory length data extracted from the *trawl* database for surveys between 1979 and 2013 represent a mix of years, areas, vessels, and gear. The largest fish were generally found in the Sub-Antarctic with smaller lookdown dory generally found on the Chatham Rise and WCSI (Figure A2).

Length frequencies were determined using SurvCalc which involves scaling by percentage sampled and area trawled to estimate the population in the survey area available to the trawl. The length–weight coefficients used to determine the frequencies are from the reports of each trawl survey listed in Table 6.

5.1.1 *Tangaroa* trawl survey time series

Chatham Rise summer trawl survey series

The Chatham Rise January *Tangaroa* trawl survey analysis presented here covers surveys from 1992 – 2013 in the core strata depths of 200–800 m (Table 6). Lookdown dory were recorded from 89–100% of all core strata tows in each year (Table A1), with tows with lookdown dory catches located across the whole survey area (see Figure A1). Lookdown dory catches were generally small (median catches per survey ranged from 8–25 kg), with maximum catches generally under 400 kg; the largest catch of 410 kg was caught in 2012. The Chatham Rise trawl core survey area and depth range is appropriate for lookdown dory, with the biomass often in the top ten species, and hence lookdown dory are considered to be well estimated by the core survey (O'Driscoll et al. 2011).

The biomass indices for the Chatham Rise January survey appear to be well estimated with CVs ranging 5–13%, other than in 2011 at 21% which had the lowest biomass of the time series (Table 6, Figure A3). Note that in the 2011 survey the relative biomass for the 30 key species was 20% lower

than in 2010, and this survey had the highest average doorspread in the series (Stevens et al 2012). Biomass for LDO shows no clear trend since the start of the time series, although there is a slight overall increase in biomass to 2002, with a subsequent decline to 2011, and increasing variability in biomass in the 2000s (Table 6, Figure A3).

The female biomass was generally about double that of the males, and the female biomass trend was aligned closely with the overall biomass trend (Figure A3). Biomass estimates east of 180° were generally higher than for west of 180° (Figure A3), although the 2011 biomass estimate was lower, and the biomass east of 180° appears to contribute more to the overall biomass trend. The biomass from the 400–600 m depth strata follows the overall trend in all years, and the biomass from the 600–800 m strata is low (Figure A3).

The median number of lookdown dory measured from Chatham Rise *Tangaroa* surveys was 1536 over the time series. Fish length was generally between 10 and 55 cm with females covering this length range, and most males smaller than 40 cm (Figure A4). Length frequency plots show that females are usually more numerous than males with a mean ratio for the time series of 1.11 females to every male (range 0.78–1.51).

Lookdown dory showed multiple modes in the length frequency data suggesting that recruitment is variable (Figure A4), and this may be useful to track changes in year-class strength (O'Driscoll et al. 2011. A fairly strong newly recruited year class (around 10–15 cm, more apparent in the faster-growing females) can be seen from the first survey in 1992, and it progresses through until at least the sixth survey in 1997. Another newly recruited year class apparent in the 1998 survey can be tracked for around four years until the 2002 survey. There appear to be fewer fish smaller than 20 cm from 2008 to 2012, and distributions appear more unimodal (Figure A4). Generally, when a strongly recruiting year class is present, the male length frequencies are often bimodal and females show two or three modes.

There was a period of higher recruitment from 1999 to 2004. Mean length has decreased and then increased since the start of the time series for both males and females. The mean length ranged from 31–33 cm for females and 28–31 cm for males from 1992–1999, and then decreased to 26 and 22 cm, respectively, by 2004. It has since then increased back to a similar level to that of the early 1990s. Gonad stage data showed that most fish were immature, resting, or maturing (see Figure A16).

Ageing has not been validated for lookdown dory. An attempt was made by Tracey et al. (2007) using otoliths collected on two Chatham Rise trawl surveys, but was unsuccessful (Section 3.5). No otoliths have been collected on other surveys. Therefore, no catch-at-age history has been developed for lookdown dory from trawl surveys.

Sub-Antarctic summer, spring, and autumn trawl survey series

The Sub-Antarctic *Tangaroa* trawl survey analyses presented here cover summer surveys (1991–1993, 2010–2009, 2011–2012), autumn surveys (1992–1993, 1996, 1998) and a spring (1992) survey in the core strata depths of 300–800 m (Table 6). The Sub-Antarctic core survey area and depth range is appropriate for lookdown dory as this species is rarely found deeper than 800 m (Bagley et al. 2013a). Lookdown dory were caught on 36–59% of the summer core strata survey stations, 32–42% of the autumn survey stations, and 42% of the spring survey stations (Table A2). Most catches were small (median catches between 0 and 1 kg) and maximum catches ranged from 8–41 kg in the spring and summer surveys, with higher maximum catches (22–142 kg) for the autumn surveys. Maximum catches were generally lower than from the Chatham Rise surveys.

Biomass indices for the summer Sub-Antarctic surveys declined from 2000 to be relatively low in 2002, with a subsequent increase until 2009. In 2011 and 2012 estimated biomass was at its lowest level (Figure A5, Table 6). Female biomass was higher than that of the males, except in 2002, and the female biomass trend was more variable and reflected the overall biomass trend (Figure A5). The

biomass from the 300–600 m depth strata follows the overall trend in all years, and the biomass from the 600–800m strata is low (Figure A5).

Biomass for the autumn Sub-Antarctic surveys showed an increase between 1992 and 1993, with a subsequent decrease in 1996 and 1998 (Table 6, Figure A6). Where there are comparable years with the summer series (1992 and 1993), the autumn 1992 shows similar biomass but 1993 has much higher biomass, although it also has a much higher CV (Table 6, Figure A7). This may be due to the 1993 survey occurring later in autumn than the other surveys. The Sub-Antarctic spring 1992 survey had a similar biomass to the Sub-Antarctic summer 1992 survey and autumn 1992 survey (Table 6, Figures A7 and A8). Biomass for the previous Sub-Antarctic *Amaltal Explorer* surveys in 1989 and 1990 were within the range of the Sub-Antarctic *Tangaroa* surveys, despite differences in the two vessels.

The CVs for the summer Sub-Antarctic series of surveys are generally slightly higher (range 11–35%) than for the Chatham Rise and lower than the autumn Sub-Antarctic series (17–46%).

Fewer fish than in Chatham Rise surveys were measured from the Sub-Antarctic summer surveys, with 65–292 per survey (Figure A9). Length frequencies from the summer Sub-Antarctic series (Figure A9) do not show clear modes and hence no tracking of cohorts is possible. Overall, scaled population numbers are much lower for both sexes than on the Chatham Rise but females again are more numerous than males with a mean ratio for the time series of 1.7 females for every male (range 0.6–3.9). Females grow to a larger size than males but both sexes appear to grow to a larger size in the Sub-Antarctic than on the Chatham Rise. This difference in maximum size between areas may be indicative of separate biological stocks. Alternatively, lookdown dory may be less exploited in the Sub-Antarctic and are able to grow to a larger size due to lower fishing pressure.

For the Sub-Antarctic summer surveys mean length for both males and females decreased from the 1991–93 levels (32–34 cm for males and 37–40 cm for females) to a low of 28 cm for males in 2000 and 33 cm for females in 2002. Mean length subsequently increased, although it has decreased again in the last two surveys.

Length frequencies for three of the four autumn Sub-Antarctic surveys (Figure A10) also show that females are more numerous with a mean ratio for the time series of 1.8 females for every male (range 0.7–3.3). Females grow to a larger size than males. There were relatively fewer large lookdown dory over 30 cm in 1996 and 1998, and hence the mean length was lower in these surveys. There were more females in the 1992 spring survey with a ratio of 1.9, and mean lengths of 42 cm for females and 34 cm for males. Length frequencies from the spring Sub-Antarctic survey show larger fish (Figure A11).

Gonad stage data in Sub-Antarctic summer surveys indicate that most fish are resting to ripe, and female fish in autumn 1998 were mainly immature, ripe or spent (Table A2).

Southland late summer *Tangaroa* trawl survey series

The *Tangaroa* trawl surveys carried out in waters around the Stewart–Snares shelf and off Puysegur (known as the "Southland" series) during February–March of years 1993–96 were conducted in depths of 30–600 m. This survey series was optimised for 10 species, which did not include lookdown dory (Hurst & Bagley 1994). The core survey area is appropriate for lookdown dory but sampling intensity may not be adequate in the 400–600 m depth range (Figure A1). Catches of lookdown dory were recorded from between 8 and 13% of stations per survey (Table A1). Catch rates were low with maximum catches ranging from 7–38 kg. The Southland biomass estimates are much lower than estimates from other *Tangaroa* surveys (Table 6, Figure A12), with most catches taken in waters deeper than 300 m. Biomass estimates increased over the four surveys, but are not well estimated, with CVs ranging from 26–38%.

The length frequency distributions shown in Figure A13 are not informative. Males show a flat distribution between 15 and 48 cm, except in 1995 where there was a distinct mode between 30–42 cm, and the female distribution is relatively flat, with lengths between about 10 and 52 cm. The numbers of fish measured per survey ranged from 22 to 94. The female to male ratio was about 2.2 for the first year and then dropped to 0.7–1.1 in the other surveys.

WCSI winter *Tangaroa* trawl survey series
Trawl surveys were carried out on the WCSI during July–August in 2000 and 2012–2013. The 2000 survey was part of a series of acoustic surveys of WCSI hoki spawning areas. The 2012 and 2013 surveys were carried out as part of a WCSI combined trawl and acoustic survey series of the WCSI hoki spawning areas (O'Driscoll et al. in press). The trawl survey design was changed in 2012 by adding strata in the north to cover the depth range of other key species (O'Driscoll et al. 2014). To enable comparisons of the 2000 survey with the 2012 and 2013 surveys, biomass and scaled length frequencies from the daytime random trawl component of the 2000 survey were run using the revised 2012 stratum areas (O'Driscoll et al. in press for depths 300–650m.

The WCSI survey series was optimised for various middle depth species north of Hokitika Canyon, which included lookdown dory, and the total survey area and depth range is appropriate for lookdown dory (Figure A1). Core strata (depths of 300–650 m) are used for direct comparisons with the 2000 survey. A 200–800 m depth range would be more appropriate for lookdown dory, however.

Catches of lookdown dory were recorded at 74–78% of all stations per survey (Table A1). Median catches per survey were about 7 kg with maximum catches ranging from 44–66 kg. The WCSI biomass estimates are much lower than estimates from the Chatham Rise and Sub-Antarctic *Tangaroa* surveys, although slightly higher than the Southland surveys (Table 6, Figure A14). Total biomass estimates for core strata were similar in the 2000 and 2012 surveys, but higher in the 2013 survey, and are reasonably well estimated, with CVs ranging from 11–14%, suggesting that the core strata are suitable for monitoring lookdown dory. Biomass estimates for all strata showed an increase from 2012 to 2013, with CVs of 11 and 12% (Table 6).

Length frequencies for the WCSI surveys (Figure A15) show that there are similar numbers of females and males with a mean ratio for the core strata time series of 1 female for every male (range 0.99–1.1). Females grow to a larger size than males. Length frequencies exhibited little variation in the relative size of the modes from survey to survey, and hence no tracking of cohorts is possible (Figure A15). This may become possible with a longer times series. There was also a large increase in small lookdown dory in the 10–20 cm range in 2013 which may be able to be tracked with future surveys. Mean length for both males and females increased in the 2012 survey and then decreased in the 2013 survey due to the catches of small fish.

Females on the WCSI are mostly resting, immature or spent in winter, with over 50% of females spent (gonad stage 5).

5.1.2 Female maturity

The female maturity data were summarised here using the observer five stage reproductive scale: immature and resting, maturing, ripe, running ripe, and spent. The relative proportions of the reproductive stage data are shown in Figure A16 by area, the monthly distribution is shown in Figure A17, and the numbers of fish sampled are given in Table A2. Ripening and spent fish were found in the Chatham Rise and Sub-Antarctic in summer, although there were a lot of immature/resting or spent fish. On the WCSI a few running ripe fish were found in winter, although the majority were immature/resting or spent. Most spawning probably takes place in autumn and winter, although ripe lookdown dory are found over much of the year, with running ripe males found on the WCSI in July and August (Figure A17) indicating that spawning is not a discrete event.

Table 6: Doorspread biomass indices (t) and coefficients of variation (CV) for lookdown dory from *Tangaroa* (TAN), *Shinkai Maru* (SHI), and *Amaltal Explorer* (AEX) trawl surveys (with assumptions: areal availability, vertical availability and vulnerability = 1). The SHI8304 survey covers the area east of 176°E only. Note: SHI8301 and SHI8304 are wingspread biomass estimates.

Trip code	Date	Reference	Biomass (t)	% CV
Chatham Rise*				
SHI8301	Mar 1983	Fenaughty & Uozumi (1989)	41 900	9
SHI8304	Nov–Dec 1983	Hatanaka et al. (1989b)	31 200	6
SHI8602	Jun–Jul 1988	Livingston et al. (1991)	8 611	9
AEX8903	Nov–Dec 1989	Livingston & Schofield (1995)	4 323	6
TAN9106	Dec 1991–Feb 1992	Horn (1994a)	4 797	5.6
TAN9212	Dec 1992–Feb 1993	Horn (1994b)	6 439	5.2
TAN9401	Jan 1994	Schofield & Horn (1994)	7 664	7.2
TAN9501	Jan–Feb 1995	Schofield & Livingston (1995)	5 270	6.5
TAN9601	Dec 1995–Jan 1996	Schofield & Livingston (1996)	7 540	8
TAN9701	Jan 1997	Schofield & Livingston (1997)	6 568	7.6
TAN9801	Jan 1998	Bagley & Hurst (1998)	7 019	6
TAN9901	Jan 1999	Bagley & Livingston (2000)	7 417	8.2
TAN0001	Dec 1999–Jan 2000	Stevens et al. (2001)	7 655	7
TAN0101	Dec 2000–Jan 2001	Stevens & Livingston (2002)	7 713	6.5
TAN0201	Dec 2001–Jan 2002	Stevens & Livingston (2003)	8 821	11.1
TAN0301	Dec 2002–Jan 2003	Livingston et al. (2004)	5 853	7
TAN0401	Dec 2003–Jan 2004	Livingston & Stevens (2005)	6 304	8
TAN0501	Dec 2004–Jan 2005	Stevens & O'Driscoll (2006)	6 351	9.3
TAN0601	Dec 2005–Jan 2006	Stevens & O'Driscoll (2007)	7 818	8.5
TAN0701	Dec 2006–Jan 2007	Stevens et al. (2008)	5 714	7.7
TAN0801	Dec 2007–Jan 2008	Stevens et al. (2009a)	5 230	9.3
TAN0901	Dec 2008–Jan 2009	Stevens et al. (2009b)	7 789	8.7
TAN1001	Jan 2010	Stevens et al. (2011)	4 896	9.7
TAN1101	Jan 2011	Stevens et al. (2012)	3 257	21.4
TAN1201	Jan 2012	Stevens et al. (2013)	5 913	13.2
TAN1301	Jan 2013	Stevens et al. (2014)	7 141	11

Table 6: continued. Doorspread biomass indices (t) and coefficients of variation (CV) for lookdown dory from *Tangaroa* (TAN), *Shinkai Maru* (SHI), and *Amaltal Explorer* (AEX) trawl surveys (with assumptions: areal availability, vertical availability and vulnerability = 1). Note: SHI8301 is wingspread biomass estimate.

Trip code	Date	Reference	Biomass (t)	% CV
Sub-Antarctic (early surveys)				
SHI8301	Mar–Apr1983	Uozumi et al. (1987)	40 147	9
SHI8303	Oct–Nov 1983	Hatanaka et al. (1989a)	7 200	13
AEX8902	Oct–Nov 1989	Livingston & Schofield (1993)	762	18
AEX9001	Jul –Aug 1990	Hurst & Schofield (1995)	1 104	16
AEX9002	Nov–Dec 1990	Hurst & Schofield (1995)	793	15
Sub-Antarctic (summer) ǂ				
TAN9105	Nov–Dec 1991	Chatterton & Hanchet (1994)	1 095	12.8
TAN9211	Nov–Dec 1992	Ingerson et al. (1995)	1 048	11.1
TAN9310	Nov–Dec 1993	Ingerson & Hanchet (1995)	821	13.2
TAN0012	Nov–Dec 2000	O'Driscoll et al. (2001)	877	15.2
TAN0118	Nov–Dec 2001	O'Driscoll & Bagley (2003a)	566	19.7
TAN0219	Nov–Dec 2002	O'Driscoll & Bagley (2003b)	446	22.1
TAN0317	Nov–Dec 2003	O'Driscoll & Bagley (2004)	636	23.7
TAN0414	Nov–Dec 2004	O'Driscoll & Bagley (2006a)	614	27.9
TAN0515	Nov–Dec 2005	O'Driscoll & Bagley (2006b)	703	19.1
TAN0617	Nov–Dec 2006	O'Driscoll & Bagley (2008)	509	35.3
TAN0714	Nov–Dec 2007	Bagley et al. (2009)	725	20
TAN0813	Nov–Dec 2008	O'Driscoll & Bagley (2009)	811	24.7
TAN0911	Nov–Dec 2009	Bagley & O'Driscoll (2012)	820	25.1
TAN1117	Nov–Dec 2011	Bagley et al. 2013b	327	34.9
TAN1215	Nov–Dec 2012	Bagley et al. 2014	436	29.1
Sub-Antarctic (autumn)				
TAN9204	Apr–May 1992	Schofield & Livingston (1994a)	995	46.1
TAN9304	May–Jun 1993	Schofield & Livingston (1994b)	1 950	44.2
TAN9605	Mar–Apr 1996	Colman (1996)	1 058	17.8
TAN9805	Apr–May 1998	Bagley & MacMillan (1999)	519	33.2
Sub-Antarctic (spring)				
TAN9209	Sep–Oct 1992	Schofield & Livingston (1994c)	1 001	17.3
Southland (late summer)				
TAN9301	Feb–Mar 1993	Hurst & Bagley (1994)	15	28.4
TAN9402	Feb–Mar 1994	Bagley & Hurst (1995)	42	26.8
TAN9502	Feb–Mar 1995	Bagley & Hurst (1996a)	64	32.3
TAN9604	Feb–Mar 1996	Bagley & Hurst (1996b)	76	38.4
WCSI core				
TAN0007	Jul–Aug 2000	O'Driscoll et al. (2004)	169	14.4
TAN1210	Jul–Aug 2012	O'Driscoll et al. (2014)	155	11.9
TAN1310	Aug 2013	O'Driscoll et al. (in press)	198	11.7
WCSI all				
TAN1210	Jul–Aug 2012	O'Driscoll et al. (2014)	181	10.8
TAN1310	Aug 2013	O'Driscoll et al. (in press)	228	12.1

* A summary of the Chatham Rise *Tangaroa* trawl survey time series is given by O'Driscoll et al. (2011.
ǂ A summary of the summer *Tangaroa* Sub-Antarctic trawl survey series is given by Bagley et al. (2013a).

6. FISHERY DEPENDENT OBSERVATIONS

6.1 Observer data

Length and age sampling

All tables and figures relating to observer data collected from lookdown dory fisheries are provided in Appendix B (Tables B1–B8, Figures B1–B8. The main fishery areas used in this section are those given in Figure 2. These data have been collected since 2001–02, though the number of fishing events sampled is low (370) during this period (Tables B1–B4). Most observer sampling was from the Chatham Rise and WCSI fisheries. On average, about 43% of the Chatham Rise lookdown dory processed catch was observed (annual range 9–146%), compared with 68% for Sub-Antarctic (range 3–1330%), 50% for WCSI (10–236%), and 36% (0–208%) for ECNI. In some years observed catches have been greater than processed catches.

The representativeness of observer sampling of lookdown dory was evaluated by plotting the proportion of landed catch for each year by area and by month as circles, and overlaying this with the proportion of the observed catch for those same circles as crosses (Figures B1–B2). If the proportions are the same, the plots align; if over- or under-sampling has occurred, the crosses are either larger or smaller than the circles. Observed catches by area are representatative of catches from the Chatham Rise and the WCSI, so CPUE series were produced for these areas (Figure B1, see Section 8, Appendix D). Although catches are low in the Sub-Antarctic a CPUE series was also produced for this area. Length frequency samples from Chatham Rise and WCSI appear to be representative of the catch (Figure B1). The Sub-Antarctic was under-sampled in most years, and Chatham Rise and WCSI were reasonably well sampled, although variable (Figure B1 and B2). This observer effort generally represents the timing of the main fisheries for middle depth and deepwater fisheries. This is particularly evident off WCSI where much of the data collection occurred during the hoki spawning season that operates between June and September. Sampling has occurred in most months for the Chatham Rise area, but has been variable from year to year.

A total of 768 pairs of otoliths have been taken from lookdown dory by the observer programme. These have not been aged. Ageing of lookdown dory by zone counts (from Chatham Rise trawl survey fish) has not been validated (see Section 3.5) so it is not possible to develop a catch-at-age history for lookdown dory from observer data.

The numbers of fish measured by observers when lookdown dory was caught varied, with between 1 and 100 lookdown dory sampled from 1.1% of tows with lookdown dory catches, and 62% of sampled tows having a sample size of between 1 and 20 lookdown dory. The length distributions of observed lookdown dory over all years combined show little size discrimination by geographical region (Figure B3).

Over 4100 fish were measured and sexed (Table B5), and 73% of these were caught from the Chatham Rise throughout the year, but this was variable by month and year (Table B6). More females than males were caught in this area, with the percentage of females over 50% in all years. The WCSI observer coverage accounted for 23% of the measured lookdown dory. These were sampled mainly from June–September, and again generally more females were caught than males (Table B6). Lookdown dory from the Sub-Antarctic and ECNI fishery areas each made up about 2% of the total sampled numbers, and annual and monthly numbers were very variable, with overall more females than males measured (Table B4, B5 and B6).

Very few individual lookdown dory weight data were collected by observers (12 in 2011, and 27 in 2012).

Length and age frequencies

Scaled length frequencies were determined using the 'catch.at.age' software (Bull & Dunn 2002) which scales the length frequency 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 frequencies. Numbers of lookdown dory were estimated from catch weights using an overall length–weight relationship for the 2012 trawl survey on the Chatham Rise (a = 0.024006, b = 2.968296, Stevens et al. 2013) for the Chatham Rise; from the WCSI 2012 survey (a = 0.028792, b = 2.927209), and 2011 summer survey for Sub-Antarctic (a = 0.033832, b = 2.896497, Bagley et al. 2013b). Length data from tows with more than three lookdown dory measured were used to create the length frequencies by area.

Length frequencies are presented for the Chatham Rise, WCSI, and Sub-Antarctic in Figures B4, B5 and B6, respectively. The ranges of lookdown dory lengths were similar in all the above areas, although there are hardly any fish less than 20 cm seen in observer data. These areas had a varying number of tows sampled per year (each with three or more lookdown dory): 3–41 tows for CHAT, 1–21 for WCSI, and only 1 or 2 tows for Sub-Antarctic.

The observer length frequencies for males from the Chatham Rise are similar to those from the Chatham Rise trawl surveys, but the female distributions are more variable, and few fish less than 20 cm are seen (see Figures A4 and B4). Sample sizes are small and the plots are not informative with respect to tracking of cohorts through time. As in the *Tangaroa* surveys of the same area, male fish appear to be less numerous and smaller than female fish.

Sample sizes on the WCSI are also small and there is no clear picture of cohorts moving through the fishery (Figure B5). As in other regions females are usually more numerous and grow to a larger size than males, and there are few fish less than 20 cm. As in the *Tangaroa* surveys of the same area, male fish appear to be less numerous and smaller than female fish, but there appears to be fewer small female fish than on the surveys.

Sample sizes on the Sub-Antarctic area are small and therefore not informative. The size range appears bigger for the females than the males (Figure B6).

Female maturity

Observer collected data on female lookdown dory maturity using a 5-stage gonad scale (immature/resting, maturing, ripe, running ripe, spent) are summarised in Tables B7–B8 and Figures B7–B8. Data are available throughout the year for the Chatham Rise, with both immature/resting and maturing fish being present throughout the year. Ripe fish are present mainly from November to May, running ripe fish are present in February, May and August, and spent fish are present from February–August, and November–December, but peak in June. This suggests an extended spawning season from at least February to August.

West coast data are available from June to November as most are collected during the hoki spawning season. The proportion of immature/resting stage fish is lower, and the proportion of spent fish is higher, than for the same period for the Chatham Rise. Maturing, ripe and running ripe fish are present in all months indicating that spawning there occurs at least from June to November. There is very little data for the ECNI and the Sub-Antarctic but on the Chatham Rise, spawning females have been found in March, and spent females found in November, and in the Sub-Antarctic spent females have been found in August.

The location of spawning activity (ripe and running ripe fish) includes WCSI, the north, west, and south of Chatham Rise, to the north east of the Auckland Islands, and in the Bay of Plenty (Figure B7 and B8).

6.2 Catch and effort data sources

Catch-effort, daily processed, and landed data were requested from the MPI catch-effort database "warehou" as extract 8961 (Table C1). The data consist of all fishing and landing events associated with a set of fishing trips that reported a positive catch or landing of lookdown dory in LDO fish stock areas (see Figure 1) between 1 October 1989 and 30 September 2012. Data are analysed by fishing year (1 October to 30 September), referred to as, for example, 1990 for the 1989–1990 fishing year. The fields from the database tables requested are listed in Table C1.

TCEPR and TCER forms record tow-by-tow data with the estimated catch (by weight) of the top five species (TCEPRs) or the top eight species (TCERs) in each individual tow. CELR forms record estimated daily catches for the top five species, which are further stratified by statistical area, method of capture, and target species. Greenweight data associated with landing events are reported on the bottom part of the CELR forms, or on CLR forms for fishing reported on TCEPRs and TCERs. Information on total harvest levels are provided via the Quota Management Report/Monthly Harvest Return (QMR/MHR) system, but only at the resolution of Quota Management Area.

Concerns have been expressed (e.g., Phillips 2001) that bycatch species, such as lookdown dory, may not be well reported at the fishing event level on TCEPRs (or, since 2007, TCERs) as lookdown dory is a minor bycatch species that does not often make up one of the top five species in a haul. 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 was caught and can be split among days.

In some instances the fish processed on a given day will not necessarily have been caught on that day. For example, target species are likely to be given processing priority resulting in bycatch species such as lookdown dory not being processed until the following day, or bycatch species may not be caught in sufficient numbers to warrant processing them until there is enough to make up whatever units a vessel produces (e.g., box of fillets, head and gut block). There is no apparent way around this and so for the purposes of this study daily processed records are treated as having being caught on the day of processing.

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) as implemented by Manning et al. (2004), with refinements by Blackwell et al. (2005) and Manning (2007), and further modifications for this study to make use of daily processed catch data in place of estimated catch data. 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 and TCEPR reporting systems (frequent non-reporting of species that make up only a minor component of the catch). The procedure was developed for monitoring bycatch species in the Adaptive Management Programme. The major steps are as follows.

Step 1: The fishing effort, processed catch, 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 will be excluded.

Step 2: The fishing effort data are collapsed to one record per unique end date and vessel key. For each record, the fields are populated as follows:

FIELD	METHOD
Form type	All TCP where daily processed data exists.
Trip ID	Most common.
Midday longitude and latitude	Most common.
Start stats area code	If all fishing events for a vessel occur in the same statistical area use that statistical area, otherwise use most common.
Target species	Dominant species (if there is a species targeted for more than 50% of the trawls in a day, use this species, else leave as 'Mixed').
Primary method	Dominant method (if one method is used for more than 50% of tows in a day use that method, otherwise use 'Mixed).
Fishing duration	Sum
Effort depth	Mean
Effort speed	Mean
Effort height	Mean
Effort width	Mean
Bottom depth	Mean
Effort num (one per vessel-day for TCP)	Sum
Fishing distance	Sum
LDO catch	The daily processed catch for LDO, matched by end date/vessel key in the fishing effort data with processed date/vessel key in the processed catch data. Where a trip lands both LDO 1 and LDO 3, the proportion landed for each is calculated and the LDO catch is multiplied accordingly to get LDO 1 catch and LDO 3 catch.

Step 3: The greenweight landings for each fish stock for each trip are then allocated to the effort data. The greenweight landings are mapped to the effort strata using the relationship between the statistical area for each effort stratum and the statistical areas contained within each fish stock and trip ID.

Step 4: The greenweight landings are then allocated to the effort strata using the total processed catch in each effort stratum (date/vessel key) as a proportion of the total processed catch for the trip. If processed catches are not recorded for the trip, but a landing was recorded for the trip, then 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.

Step 5: 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 the merged trip level data. But 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.

7 DESCRIPTIVE ANALYSIS OF CATCH

7.1 Summary of catches

All tables and figures relating to characterisation of lookdown dory fisheries are contained in Appendix C (Tables C1–13, Figures C1–55). Table C1 provides a summary of the data requested from MPI for this characterisation, and Table C13 contains a list of species codes used. Unless otherwise stated "estimated catch" refers to greenweight catches estimated from daily processed catch.

The reported QMR/MHR landings, ungroomed catch-effort landings, and TACCs for LDO 1 and 3 from 1990–2012 are shown in Figure C1. MHR landings and TACCs were also presented earlier in Tables 1 to 3. For both Fishstocks, the ungroomed catch-effort landings are fairly close to the reported MHR landings, particularly in LDO 3 (Figure C1). LDO 1 ungroomed landings exceeded the TACC slightly in the 2005–06 and 2007–08 fishing years when the species entered the QMS (Table 3, Figure C1). The TACC in LDO 3 has never been caught. This probably reflects the reduction in the size of the trawl fishery on the Chatham Rise where the greatest proportion of lookdown dory has been taken as bycatch (Ministry for Primary Industries 2013a). No catch has been reported from LDO 10. There may be a slight inflation of estimated catch in the 1980s and early 1990s as records of lookdown dory from depths shallower than 150 m are likely to be mis-identifications of silver dory (Bagley pers. comm.), as lookdown dory are rarely recorded from these depths in research trawl tows (O'Driscoll et al. 2012) .

The landings data provide a verified greenweight 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, as well as interim landing events, where catch is transferred or retained, and may therefore appear subsequently as a final landing event (SeaFIC 2007). The procedure of Starr (2007) separates final and interim landings based on the landing destination code, and only landings with destination codes that indicate a final landing are retained (see table 2 in Starr (2007)).

Table C2 summarises the number of landing events for the major destination codes in the dataset. The majority of landing events on CELR forms were recorded as "L" (Landed). The proportion of landing events recorded with "T" (transferred to another vessel) and "R" (retained on board) destination codes (both defined as interim landing events by Starr (2007)) for both stocks is relatively high for CLR forms from the 1990s to around the early 2000s. From then on there are few "T" events, "R" events decrease (as a proportion of the total) and the majority of landing events are "L" (landed to NZ). It is unclear how the catches from "T" trips are recorded, as the transferred catches could have been landed by foreign vessels to ports outside New Zealand. Other interim landing events (retained as bait, in holding receptacles, or on board) were also dropped (after Starr 2007, Parker & Fu 2011).

The weight, number of records, and description of each potential landed state is given in Table C3. Details of the data corrections by imputation and removal of invalid records during the grooming process are given in Table C4. The grooming process excluded a small number of trips with invalid codes in fishing method, target species, statistical area, and trip date which could not be fixed using the median imputation method. The catch and landings removed from the dataset in this process were generally insignificant over the time series. The retained landings, interim landings, and total landings dropped during data grooming are shown in Figure C2.

For LDO 1, the reported MHR landings do not match the retained landings well for a number of fishing years, particularly from 1990 to 1997. By keeping "T" (transhipments) in the retained landings in this analysis, this effect is less pronounced than in the previous analysis of MacGibbon et al. (2012) where transhipment records were dropped. Total daily processed catch and retained landings from LDO 1 represent 78% and 74% respectively of total reported QMR/MHR landings for the study period (Table C4), with better agreement in MHR catches from 1998 (Figure C2). For LDO 3, retained landings and processed catch are much closer to MHR landings, they represent 98% and 87% respectively of total reported QMR/MHR landings for the study period (Figure C2, Table C4).

The main processed state for retained landings of lookdown dory in the two fish stocks was "DRE" (includes "dressed", "headed and gutted", and "trunked") with smaller amounts landed green or made into fishmeal (Figure C3). "Other" processed states are common in the early 1990s but as reporting improved over time "other" processed states became less commonplace. The "DRE" and "MEA" code use is likely to reflect the presence of larger vessels operating more offshore. For some QMS species conversion factors have changed over time since entering the QMS. This means that for those species different amounts of greenweight catch are associated with the same amount of processed catch for particular product forms. In such cases, the greenweights can be standardised using the most recent conversion factor for each processed 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. However, other than a minor adjustment of 5.56 to 5.6 for fishmeal, lookdown dory conversion factors have been static and adjustments have not been necessary in this study.

The retained landings adjusted for the changes in conversion factors were allocated to the effort strata based on the statistical areas within each fish stock. For this study, the "centroid method" was used in which the midpoint of each statistical area is used to allocate it to the larger fish stock area, for example, Statistical Areas 018 and 019 were allocated to LDO 3. This resulted in a closer relationship between QMR/MHR landings, merged landings, and processed catch for both stocks. Details of the retained landings in unmerged and merged datasets and processed catches in the groomed and merged datasets are given in Table C5. 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 for LDO 3, indicating a consistent match between the recorded position or statistical area on the catch forms (CELR, TCEPR, TCER, LCER, LTCER, and NCELR) and the stocks reported on the CELR/CLR/NCLER forms on a trip basis, although the recovery rate for LDO 1 was more variable.

Processed catch, QMR, retained, and merged landings are plotted in Figure C5 and summarised in Table C5. In LDO 1 the retained landings are slightly lower than the QMR/MHR landings, and processed catch matches the merged landings closely although they are consistently lower than the QMR/MHR landings. In LDO 3 retained and merged landings and the processed catch follow each other very closely throughout the time period.

The reporting rate, defined to be the ratio of the greenweight calculated from annual processed catch to the retained landings in the groomed and merged dataset, is shown in Figure C6. The TCEPR/CLR reporting rate is quite variable in LDO 1 until about 2000 and is fairly steady afterwards, though it drops off in the last few years. The reporting rate is usually less than one, and, apart from the first four years, is over 50%, and could be due to misreporting of landing weights or perhaps incorrect reporting of processed states and/or catches as often lookdown dory catches are small. Since 2007 there is 60–70% agreement between processed weight and retained landings. In LDO 3, there is some variability seen in the first five years but from 1995 on there is very good agreement between processed weight and retained landings, with ratios being very close to one every year. This consistency indicates a reasonable match between the statistical areas calculated from the positions on the TCEPR and the stocks reported on the CLR on a trip basis. Although estimated catches may not be recorded when they are small (because vessels only report the top five species caught on TCEPRs and the top eight species on TCERs), the processed catches captured 74% of the harvest reported via the MHR/QMR system for LDO 1, and 98% for LDO 3 (see Table C5).

The percentage of TCEPR forms recording a zero catch in the tow-by-tow section, but a positive value for lookdown dory on the processing section of the form ranged from about 28–58% in LDO 1 and 9–34% in LDO 3 (Table C6). On CELR/TCER recorded trips, the percentage is generally higher with 31–79% and 53–100% of trips recording no estimated catch on CELR/TCER forms for LDO 1 and LDO 3 respectively. Figure C7 also shows that on a trip by trip basis for each fishing year, there appears to be a reasonably close match, where there are larger catches, between processed catch and reported landings at trip level, in most years, though some trips that recorded no processed catch reported a small amount of landings, especially in LDO 1 (Figure C7).

The estimated, processed catches and retained landings by form type for each fish stock are shown in Figure C8. For both stocks, most of the catch is reported landed on the CLR form, with a small amount of LDO 1 reported landed on the CELR form. This disappears after 2008 as TCER data is landed to the CLR form. The TCEPR catch in Figure C8 shows the same catches represented as both processed and estimated catch. TCEPRs contribute the greatest to the total estimated annual catch, with the contribution from the processed part of the form greater than that from the estimated part of the form as the processed catch estimates are capturing more of the actual catch, and lookdown dory sometimes does not make

the top five species on the estimated part of the form. There is a minor contribution from CELRs in LDO 1 throughout the time series and from TCER forms in later years.

7.2 Fishery Summary

Lookdown dory is caught as bycatch in a variety of target fisheries around mainland New Zealand. This study identified four main regions in which lookdown dory is caught: east coast South Island & Chatham Rise (CHAT), Sub-Antarctic (SUBA), West coast (almost exclusively WCSI), and east coast North Island (ECNI).

The spatial distribution of the total commercial catch is shown in Figure C9. The highest catches, particularly since the mid-1990s have come from the CHAT region (Table C7, Figure C10). Within this region the most important Statistical Areas are 020 and 023 for the more inshore areas, with catches being fairly even across most of the Chatham Rise (Figures C9, C10). Other areas with higher catches include WCSI Statistical Areas 034 and 035 where much of the effort in the hoki winter spawning fishery is concentrated, with reported catches being steady since the mid-1990s, and SUBA Statistical Areas 602 (Auckland Islands), 028 (Snares Shelf), and 030 (Puysegur Bank). Higher catches from the ECNI have consistently been from Statistical Area 014 (southern Hawke Bay) followed by 015 (Wairarapa Coast), with small sporadic catches from area 008 (Figure C9).

Total estimated catch for each region from the groomed and merged dataset are shown in Table C7 and Figure C10. All areas had little reporting of lookdown dory catches in the early 1990s, but since the mid-1990s the CHAT region has been dominant with annual catches regularly in excess of 200 t, compared to SUBA and WCSI which produced 8–81 t and 18–162 t, respectively. The ECNI catch is minor, ranging from just 1–8 t and totalling 128 t for the entire period.

Across all areas bottom trawling is the dominant fishing method that catches lookdown dory (Figure C10). In all areas a small amount is also taken by midwater trawling, and midwater trawling on the bottom. On some days vessels report an even number of bottom and midwater tows. The method for these days is reported as ‘mixed’ but this accounts for only a very small proportion of the catch. A variety of other fishing methods are reported to catch lookdown dory but they are not reported on TCEPR forms (which include daily processed catch information), and catch is negligible.

Lookdown dory was caught as bycatch in a variety of target fisheries around mainland New Zealand throughout the year, predominantly by bottom trawling (Figure C10). The dominant fishery where lookdown dory has been taken as bycatch is the hoki fishery (Figure C10), with hake target catch increasing in importance since the mid-2000s. Barracouta, jack mackerel, ling, scampi, squid, silver warehou and white warehou all feature as target species, though their relative importance is minor compared to hoki and inconsistent through time. ’Mixed’ target species is used when a vessel does not state the same target species more than 50% of the time for a given day. ‘Mixed’ target species will most likely include all of the species just mentioned. There is a small amount of target fishing from FMA 7, but the amount is negligible and this study found that vessels reporting processed catches of lookdown dory never reported it as a target species, although there is a proportion reported on TCER forms (see Figure C23d).

Across all fisheries there is no distinct season in which most lookdown dory catches are taken (Figure C10) except for on the West coast where nearly all of the catch is taken between June and October, and most taken in June and August. This coincides with the hoki and hake fisheries that operate on the WCSI.

Most lookdown dory catch was from New Zealand vessels, with a large proportion of the remainder from Korean and Japanese vessels (Figure C11, Table C8). All vessel sizes caught lookdown dory, but the majority of vessels are 5–70 m metres in length and are over 2000 kilowatts in power, and 1700 gross tonnes. A minor amount of lookdown dory is taken by much smaller inshore vessels.

In this characterisation section, finer scale areas (Figure 2 are used to review the hypothesised stock structure as a prelude to developing CPUE analyses that might be useful for monitoring the major fisheries. The fisheries that are the focus of this study of lookdown dory catches are: CHAT (the east coast South Island and Chatham Rise), the WCSI part of West coast, SUBA (Sub-Antarctic), and the ECNI (Figure 2).

7.2.1 East Coast South Island and Chatham Rise (CHAT)

The CHAT region contributes by far the greatest proportion of the country's lookdown dory catch for the study period (Table C7, Figure C10). Lookdown dory catches from this area were mainly reported on TCEPR forms with more of the data captured by the TCEPR processed form (Figure C12a).

Lookdown dory were mainly caught by trawlers that fished predominantly with bottom trawls and targeted a variety of species, with highest catches of lookdown dory as bycatch in hoki trawls (Figures C12b and C12c). Annual processed lookdown dory catches from this area were relatively small during 1990–97, then increased over time (Table C9a) with catches at 352–603 t during 1998–2004. Since becoming a QMS species at the beginning of the 2005 fishing year, catches have decreased and varied between 192–281 t. No clearly distinct season is apparent for the region, although it appears that catches may decrease slightly in July and August when the hoki fleet (which takes the majority of the lookdown dory catch) moves away from the Chatham Rise to target hoki spawning fisheries (Table C9a, Figures C12b and C12c).

On the east coast South Island, Statistical Areas 020 and 023 produce relatively high catches and account for 29% of the total CHAT processed catch. The spread of catch across the statistical areas on the Chatham Rise was more even, although Statistical Areas 402 and 408 produced a high proportion of processed catch in some years (Table C9b, Figures C12b and C12c). Overall, almost 96% of the lookdown dory processed catch in CHAT was taken by bottom trawling, with the remainder from midwater trawls (Table C9c, Figure C12b and C12c). Since 2006, all of the catch has been taken by bottom trawlers (Table 9c).

Hoki was the key target species on CHAT and accounted for 86% of the total lookdown dory catch. The catches in hoki trawls were from across CHAT and highest in Statistical Areas 020, 023, 401–402, 407–410 and in depths of 400–600 m (Figures C13, C14 and C15). Although catches in hoki trawls occurred throughout the year, catches in July–September were minimal. Other main target species included barracouta, hake, jack mackerel, ling, scampi, sea perch, squid, and silver warehou (Table C9d, Figures C12b and C12c).

The largest catches in hake fisheries were in Statistical Areas 403 and 404, generally from October–December and in depths of 400–600 m (Figures C13–C15). Small catches from silver warehou tows were mainly reported in Statistical Areas 020–023 in most months and from 200–600 m. Ling target catches were taken mainly on the east coast South Island and western Chatham Rise from July–January and from 300–500 m depths (Figures C13–C15). The largest catches in scampi fisheries were in areas 021 and 401 throughout the year in depths of 300–500 m; sea perch had largest catches in areas 401 and 402 from October–January in depths of 300–500 m; squid had largest catches in 020–022 throughout the year in depths of 100–500m, and red cod had largest catches in areas 020–022 and 401 in September–December in depths of 200–400 m (Figures C13–C15).

For the main trawl target, hoki, the proportion of zero vessel-days in the merged data has been less that 40%, and has been less than 20% since 1998 (Figure C16). The proportions of zero vessel-days for target hake and ling trawls has generally been less than 50% since 1999, and for other species generally higher and more variable (Figure C16).

Unstandardised catch rates (kg per tow) of lookdown dory are presented in Figure C17. For most target species, the lookdown dory catch rate was variable with little trend. For the main target fishery of hoki,

the catch rates decreased and then increased in the early 2000s, and subsequently decreased in the following years. Throughout the time series, hoki target catch rates ranged from about 30 to 60 kg per tow. In other main target fisheries where the effort is much less than for hoki, annual catch rates ranged up to almost 500 kg per tow, with rising catch rates evident from 2005 onwards from silver warehou, ling, and squid targeting. Target hake catch rates showed no trend and ranged from 30–50 kg per tow. Catch rates in scampi tows have decreased in recent years and catch rates for sea perch and red cod were variable.

Fishing duration for bottom tows targeting hoki with reported lookdown dory catch was generally in the range 12–20 hours per vessel day with an increasing trend over the time series, but with a dip around 2008 (Figure C18). Daily bottom tow duration for hake rose from the early 1990s to peak at about 20 hours a day in 2009, but has decreased markedly since then. Daily bottom tow durations for targets silver warehou, ling and squid showed shorter durations to hoki but the overall trend was flat. Sea perch and scampi showed variation but with overall increases, and red cod exhibited a decrease in recent years.

Median effort depth for bottom trawls with lookdown dory catch has been constant from the late 1990s for hoki, at about 500–600 m (Figure C19). Effort depth for hake is similar to hoki but with a slightly narrower range. Generally other targets caught lookdown dory in shallower waters: under 500 m for silver warehou and ling; at about 400 m for scampi; 200–300 m for squid; and under 400 m, but variable, for sea perch and red cod.

The distributions for data describing bottom trawl gear width (wingspread), gear height, distance towed, and vessel speed, tonnage, and length by target (when lookdown dory catches were reported) are shown in Figure C20. Effort widths were generally about 30–45 m, apart from the twin-net scampi trawls at 50–60 m. Scampi headline heights were the lowest, at about 1 m. Generally, the tows targeted at middle depth species had headline heights of under 4 m, apart from red cod which was about 4.5–5 m. Effort speed was similar for most middle depth target species, at between 3.5 and 4.5 kt, though scampi tows had a speed of about 2.5 kn. Most daily fishing distances were between 40 and 110 km per day, though hoki, hake and sea perch targeting often resulted in distances as great as 120 km per day. Vessels that caught lookdown dory on hoki target tows were generally about twice the tonnage of vessels catching other targets. Smaller vessels targeted scampi and red cod, and larger vessels (most 56–65 m long) targeted other species. The full range of vessel size shown in Figure C20 reflects the spread of smaller inshore vessels fishing at Mernoo Bank and inshore waters of the Chatham Islands and the larger vessels fishing a range of depths across the Chatham Rise.

The distribution of lookdown dory catch by vessels reporting on TCEPR forms has not changed since 1990, although in some years they are more widespread (Figure C21). Highest catches for this time period are from the Mernoo Gap area, along the northern and southern end of the Chatham Rise, and just east of Mernoo Bank.

Lookdown dory was caught in most target tows for target hoki, hake, ling and silver warehou (Figure C22). Other species showed some tows with no lookdown dory caught, especially orange roughy in deeper waters.

7.2.2 West coast

The West coast region contributed 2109 t of processed lookdown dory, second only to CHAT, and amounting to 23% of the country's lookdown dory processed catch for 1990–2012 (Table C7, Figure C10). Lookdown dory catches from this area were mainly reported on TCEPR forms with more of the data captured by the TCEPR processed form, although overall 29% of the estimated catch is reported on CELR or TCER forms. Since the TCER form has come into existence a third of the estimated catch has been recorded on the TCER form, and 16–32% of TCER estimated and TCEPR processed catch is reported on the TCER form (Table C10a, Figure C23a).

Lookdown dory are caught predominantly by bottom trawling for a variety of target species, with highest catches as bycatch in hoki, hake, lookdown dory, and ling trawls (Figures C23b and C23c). Annual lookdown dory catches from this area were relatively small during 1990–1998 at 19–94 t, but increased from 1999 to levels ranging from 97–182 t (Table C10a). There was a drop in catches in 2005 to 97 t (the year lookdown dory came into the QMS system), but catches subsequently varied from 123 to 170 t. A distinct season is apparent for the region, with nearly all of the catch being taken from June to October, mainly in July–August on the west coast South Island (WCSI) (Table C10b, Figures C23b, C23c, and C23d). This period coincides with the hoki and hake spawning fisheries on the WCSI.

On the WCSI, Statistical Areas 033–036 have the highest catches and account for 98% of the total West coast catch (processed or merged estimated) (Table C10c, Figures C23b and C23c). TCEPR data were mainly from Statistical Areas 034 and 035, and CELR and TCER data from Statistical Areas 033 and 034 (Figures C23b and C23c), and this distribution has remained fairly constant despite cuts in the hoki quota starting in the 2001–02 fishing year. Overall, almost 77% of the lookdown dory processed catch on the WCSI was taken by bottom trawling, with the remainder from midwater trawls (Table C10d, Figures C23b and C23c), and the bottom trawl component of the catch has increased to over 90% since 2005 (Table C10d). Almost all lookdown dory target catch was reported on the TCER and CELR forms (Figure 23d).

Lookdown dory reported on CELR and TCER forms are mainly from WCSI Statistical Areas 033 and 034 by bottom trawling from February–June, targeting lookdown dory, hoki and ling, in depths of 100–700 m (Figure C23d). On the CELR form, 0–41 t of annual catch have been recorded, and 19–39 t recorded on the TCER form each year since 2008 when this form was introduced (Figure C23d).

Hoki was the key target species on the WCSI and accounted for 64% and 67% of the total processed and estimated lookdown dory catch, respectively (Table C10e). Processed catches in hoki trawls were from Statistical Areas 034 and 035 from June–September, and in depths of 300–900 m by both midwater and bottom tows (Figures C24–C26). The other main target species producing processed lookdown dory catches was hake, with very small quantities for barracouta, and silver warehou target fishing (Table C10e, Figures C24– C26).

Lookdown dory caught from the hake target fishery had largest catches in Statistical Areas 034 and 035 from June–September, and in depths of 500–800 m by both midwater and bottom tows (Figures C24–C26.

When bottom trawling for target hoki or hake, the proportion of vessel-days with zero catch in the merged data has generally been less that 40%, except for hoki target in 1990–1992 and target hake in 1997 (Figure C27a). The proportions of zero vessel-days for other bottom trawl target species has been high and variable (Figure C27a). Midwater trawling proportions of zero vessel-days for the main target species has also been high and variable, with hoki between 50–80% and hake between 10–100% (Figure C27b).

Unstandardised catch rates (kg per tow) of lookdown dory for bottom and midwater trawling are presented in Figure C28. For the main target fishery of hoki, there was an expansion of effort in both bottom and midwater tows from 1999–2004, and bottom trawl catch rates have been fairly stable since 1996 at 50–70 kg per tow. However, catch rates in the midwater fishery have shown a steady decline. The catch of lookdown dory per tow in the hake fishery has been fairly variable, but increasing or decreasing over time for the bottom and midwater trawl fisheries, respectively.

Daily fishing duration for bottom tows with reported lookdown dory catch from target hoki is fairly constant through the study period at around 10–18 hours per day for bottom tows, although with a decreasing trend since about 2006 (Figure C29a). Daily bottom tow duration for hake has varied between 10 and 20 hours a day, although has primarily been near the upper end of this range in the last few years. Daily bottom tow durations for other targets generally showed lower durations to hoki with more variation within a year.

Daily fishing duration for midwater tows in the hoki target fishery is shorter than that of bottom tows, at around 10–17 hours until 2006, but has gradually declined since then to 5–14 hours (Figure C29b). Daily tow duration for hake in midwater tows is similar to that of hoki at 10–18 hours a day but is slightly more variable through time, and also shows a decline since 2007. Data is variable for jack mackerel target fishing before 1997, but since then daily tow duration is relatively constant at 5–12 hours. Daily midwater tow durations for other targets are more variable with little trend and data are often patchy.

Median effort depth for bottom trawls with lookdown dory catch for hoki target fishing is very constant at depths of between 400–600 m and ranges of around 200–800 m in most fishing years (Figure C30a). Effort depth for hake is slightly deeper than hoki at around 500–700 m, and usually ranging from about 400–800 m. Generally other targets caught lookdown dory in shallower waters than hoki or hake (i.e. less than 500 m). Lookdown dory target catches were mainly taken from 200–700 m (Figure 23d).

For midwater tows, mean effort depth is similar to bottom tows for both hoki and hake (Figure C30b), although hoki shows a gradual decrease over time. Jack mackerel and barracouta midwater tows are usually shallower, with most being around 150–250 m deep. Data for other target species catching lookdown dory is variable and patchy.

The distributions for data describing bottom trawl gear width (wingspread), gear height, distance towed, and vessel speed, tonnage, and length by target (when lookdown dory catches were reported) are shown in Figure C31. Effort widths for bottom trawls for most main target species trawls were generally about 35–45 m, except for ling and tarakihi with effort widths ranging 20–30 and 18–22 m, respectively (Figure C31a). Generally, the bottom tows had headline heights under 5 m, apart from jack mackerel and ling which were about 4–7 m, and 3–5.5 m respectively. Effort speed was similar for most middle depth target species, at between 3.5 and 4.5 knots, although ling and tarakihi target tows ranged 3–3.5 knots. Most daily fishing distances were between 50 and 120 km per day, though hake and squid targets often amounted to 130–140 km per day, and hake and barracouta targeting distances were often as low as 30 km a day.

Vessels that caught lookdown dory on hoki, hake, silver warehou, barracouta, and jack mackerel target tows tended to be the larger vessels (Figure C31a). Smaller vessels targeted ling and tarakihi. Target species for the West coast region are much the same as for the SUBA and CHAT regions, and other effort variables and vessel characteristics are similar, most likely because the same vessels that fish in those areas also fish on the WCSI during the hoki spawning season.

Hake and hoki effort widths for midwater trawls have a wider upper limit (greater than 150 m) than for bottom trawls as expected but effort speed is similar at around 4–4.5 knots for most tows (Figure C31b). Vessel tonnage and length are similar (mainly greater than 60 m) as most of the vessels using midwater gear are the same vessels that also use bottom trawl gear.

The distribution of lookdown dory catch by vessels reporting on TCEPR forms has not changed since 1990, with the lookdown dory catch from the West Coast almost entirely from the WCSI, where fishing is located on the hoki and hake spawning grounds (Statistical Areas 034 and 035) mainly along the 500 m contour (Figure C32a). In some years catches are more widespread, being further north on the WCSI (Statistical Area 036) and between Cook Strait and Cape Egmont (Statistical Areas 037, 039, 040, and 801), especially between 2002 and 2005 (Figure C32a), although these more northern data may be errors in species identification. The distribution of lookdown dory catch by vessels reporting on TCER forms was almost entirely in Statistical Areas 033 and 034 also along the 500 m contour (Figure C32b).

Vessels targeting hoki, hake, silver warehou, squid, and ling off the west coast generally caught lookdown dory (Figure C33). Fisheries targeting barracouta and jack mackerel showed some areas with lookdown dory catch. Other target species fisheries overlapped patchily with lookdown dory (Figure C33).

7.2.3 Sub-Antarctic (SUBA)

The Sub-Antarctic region contributed only 7% of the total lookdown dory catch since 1990, much less than the CHAT and WCSI regions (Table C7 and C11, Figure C34a). Lookdown dory catches from SUBA were mainly reported on TCEPR forms, with more of the data captured by the TCEPR processed form (Figure C34a).

Lookdown dory are mainly caught by bottom trawls targeting a variety of species, with highest catches as bycatch in hoki trawls (Figures C34b and C34c). Overall annual processed lookdown dory catches from this area were relatively small at 8–81 t (Table C11a). During the 1990s catches ranged from 8–37 t, and from 2000–2004 they increased to 40–81 t. Since becoming a QMS species at the beginning of the 2005 fishing year, catches have decreased and varied between 17–31 t annually. No clearly distinct season is apparent for the region, although it appears that catches may decrease slightly in August when vessels targeting hoki move to hoki spawning grounds (Table C11a, Figures C34b and C34c).

Most lookdown dory is caught in Statistical Areas 602 (Auckland Islands), 028 (Snares Shelf) and 030 (Puysegur Bank), and account for 64% of the total SUBA processed catch, although a number of areas contribute to the overall catch (Table C11b, Figures C34b, C34c). Overall, almost 92% of the lookdown dory processed catch in SUBA was taken by bottom trawling, with the remainder from midwater trawls (Table C11c, Figures C34b, C34c).

Hoki was a main target species in SUBA and accounted for 48% of the total lookdown dory catch. Hoki target accounted for as much as 90% of the lookdown dory catch in some years, but its contribution has declined somewhat, particularly since 2002 (Table C11d). This is likely to be due to the reductions in hoki quota from this time. The catches in hoki trawls were mainly on the Snares Shelf (areas 026–028), at Puysegur (030), and around the Auckland Islands (602), in depths of 300–800 m (Figures C35–C37). Although catches in hoki trawls occurred throughout the year, catches in July and August were minimal.

Lookdown dory bycatch is much less in other target fisheries, with the main contributors being hake, ling, scampi, squid, silver warehou, white warehou, and southern blue whiting (Table C11d, Figures C34b and C34c). Ling target catches were taken mainly in Statistical Areas 026–028, 030, 602 and 610 from September–January, and in 300–700 m depths (Figures C35–C37). There has been an increasing amount of lookdown dory caught by ling target in recent years (Table C11d). There has also been an increasing amount of lookdown dory being taken in white warehou fisheries in recent years (Table C11d), in Statistical Areas 028 and 030 throughout the year, and in depths of 400–600 m. Catches from silver warehou tows were mainly reported in Statistical Areas 026–028, 030, and 504 in most months except August and September, and in depths of 200–600 m. Squid fisheries had largest catches in 026–028, 030, 504 and 602, from December to July, in depths of 100–500 m; scampi had largest catches in the Auckland Islands (602) from October to May in depths of 400–600 m; hake fisheries had larger lookdown dory catches in Statistical Areas 028 and 602, generally from October–March and in depths of 400–700 m; and southern blue whiting had larger catches in in 608, 610, 618 and 619 in August–October in depths of 300–600 m (Figures C35–C37).

For the main trawl target, hoki, the proportion of vessel-days with zero catches of lookdown dory in the merged data has decreased from nearly 90% in the early 1990s to 50–60% in recent years (Figure C38). The proportions of zero catch days for target ling trawls has generally been less than 50% since 2000, for white warehou and hake at about 30% and 20% respectively in the last few years, and for other species is high and variable (Figure 38).

Unstandardised catch rates (kg per tow) of lookdown dory are presented in Figure C39 and for most target species, the lookdown dory catch rate varied markedly. For the main target fishery of hoki, the trend is variable through to 1998, stable in the years of expansion of effort in the early 2000s (to about 1300–2000 tows a year), and then decreased slightly since about 2005 when the hoki fishery TACC was lower (and effort was about 500 tows per year). Mean catch rate has ranged from about 15–20 kg per tow since 1998. Catch rates for most other trawl targets, for which there was much less effort, show the effect

of occasional large catch rates of lookdown dory on occasion. Annual catch rates ranged from 0–20 kg per tow, although there were some higher catch rates for target ling, silver warehou and southern blue whiting fisheries in some years. Catch rates in the white warehou fishery showed an increase to 2006, with a subsequent decrease, and squid fishery catch rates were low and showed no trend.

Fishing duration for bottom tows with reported lookdown dory catch in the hoki fishery remained constant throughout the time period, at around 10–18 h for most vessel-days (Figure C40). Daily bottom tow duration for ling rose during the early 1990s and is now usually between 10 and 18 hours a day, although it has decreased slightly in the last few years. Daily bottom tow durations for target fisheries white warehou (5–15 hours) and squid (8–16 hours) showed lower durations to hoki but the overall trend was flat with more variation within a year. The range in duration for scampi tows was wider in the 1990s (10–20 hours) but narrower and generally longer (15–20 hours) in later years. Other less important target fisheries have more variable daily tow durations.

Median effort depth for bottom tows in the Sub-Antarctic is similar to many of the same target species in the Chatham Rise region, with most tows being in 400–600 m for most species and ranging from 200–800 m (Figure C41). There were some clear distinctions in depth ranges of TCEPR bottom tows that caught lookdown dory: targets included squid in waters at about 200 m; silver warehou in 200-400 m; white warehou and scampi in 400–500 m; ling in 400–700 m; and hoki mainly in 500–700 m.

The distributions for data describing bottom trawl gear width (wingspread), gear height, distance towed, and vessel speed, tonnage, and length by target (when lookdown dory catches were reported) are shown in Figure C42. Effort widths were generally about 30–45 m, except for white warehou and hake trawls with effort widths 10–30 m, and twin-net scampi trawls at 50–60 m. Scampi headline heights were the lowest, at about 1 m. Generally, the tows targeted at middle depth species had headline heights of under 4 m, apart from white warehou and hake which was up to 7 m. Effort speed was similar for most middle depth target species, at between 3.5 and 4.5 knots, except for scampi tows at about 2.5 knots. Most daily fishing distances were between 40 and 110 km per day, except for white warehou and hake tows which were at 20–40 km per day. Vessels range from around 100–4500 tonnes with the majority being between 500 and 2500 tonnes. Vessels that caught lookdown dory on hoki and southern blue whiting target tows had higher vessel tonnage compared with other target fisheries. Vessel length for most species is around 50 to 70 m, with scampi vessels being noticeably smaller at between 20–40 m.

The distribution of lookdown dory catch reported on TCEPR forms was similar each year, with most of the catch taken around the Auckland Islands, Snares Shelf, and Puysegur Bank (Figure C43). In some years reasonable catches are taken from the Pukaki Rise, the south western Bounty Plateau, and around the Campbell Rise. Catches appear to increase over time but this is most likely owing to better reporting of catches rather than an actual change in catch.

Vessels targeting hoki, hake, ling, white warehou, and silver warehou in the Sub-Antarctic generally caught lookdown dory (Figure C44). Tows in shallower waters targeting squid, red cod, barracouta and common warehou often caught no lookdown dory, as did tows in deeper waters targeting hake.

7.2.4 East Coast North Island (ECNI)

Of the four main areas identified in this study, ECNI contributes by far the least amount of the country's lookdown dory catch, ranging from 1–14 t each year and just 128 t of processed catch for the study period (Table C12a, Figure C45). Lookdown dory catches from this area were reported on a mixture of TCEPR, and TCER forms with very little lookdown dory catch recorded on the CELR form (Figure C45a). TCEPR processed and estimated data show more catch for estimated data from 1997–2002, and more processed data from 2003, however, catches reported on both parts of the form are low. TCER catch is about 35–74% of the TCEPR estimated catch from 2008 to 2012 (Table 12a).

Lookdown dory are mainly caught by bottom trawls targeting a variety of species, with highest catches as bycatch in hoki, scampi, and ling trawls (Figures C45b and C45c). No clearly distinct season is apparent for ECNI (Table 12b, Figures C45b and C45c).

Higher catches were in Statistical Areas 014 and 015 (southern Hawke Bay and Wairarapa Coast) in all years, along with Statistical Areas 008–010 (Coromandel Peninsula to Bay of Plenty) from 1997 (Table C12c, Figures C45b and C45c). Catches in other areas are low and patchy. Overall, almost 97% of the lookdown dory processed catch from ECNI was taken by bottom trawling, with the remainder by midwater trawls (Table C12d, Figure C45).

The small annual catches (2–4 t) of lookdown dory reported on TCER forms are mainly from Statistical Areas 008–011 and 014, by bottom trawling targeting hoki and ling throughout the year, and in depths of 300–500 m (Figure C45d).

Scampi was the most common target species producing lookdown dory catch on ECNI, mainly in Statistical Areas 008–009 and 014 throughout the year in depths of 300–500 m; it accounted for 56% of the total lookdown dory processed catch (Figures C46–C48). Hoki and ling target trawls contributed 19% and 5% of the lookdown dory processed catch from 1990–2012, respectively. Hoki target lookdown dory catch was mainly in Statistical Areas 008–009 and 015–016 from October–April in depths of 300–700 m, and target ling catches occurred mainly in Statistical Areas 014 and 015 in 2007–2011 in August and September in depths of 300–500 m (Figures C46–C48). There is no targeted fishing for lookdown dory in the ECNI region.

For the main trawl target, scampi, the proportion of vessel-days with zero lookdown dory catch in the merged data has been more that 40%, for target hoki and ling trawls it has generally been less than 50% since 1993, and for other species it has been high and variable (Figure C49).

Unstandardised catch rates (kg per tow) of lookdown dory are presented in Figure C50. For most target species, the lookdown dory catch rate was variable with little trend. For the main target fishery, scampi, catch rates of lookdown dory are fairly constant through time at around 5–20 kg per tow. Catch rates are more variable in the hoki target fishery ranging from 1–24 kg per tow. Data are variable and patchy in other target fisheries.

Daily fishing duration for bottom tows with reported lookdown dory catch in the scampi fishery increased from 1990–1997, and then was fairly consistent, usually around 12–20 hours per day (Figure C51). Hoki target daily tow duration appears to be variable and ranged 5–14 hours per day. Tow duration data is patchy for other target species where lookdown dory catch was reported.

Median effort depth for bottom trawls with lookdown dory catch were consistent for scampi targeting with most tows being between 350 m and 420 m, and in the hoki target fishery at depths of between 200–500 m. (Figure C52). Data for other target species is very patchy.

The distributions for data describing bottom trawl gear width (wingspread), gear height, distance towed, and vessel speed, tonnage, and length by target (when lookdown dory catches were reported) are shown in Figure C53. Effort widths were generally about 20–45 m, apart from the twin-net scampi trawls at 50–60 m. Scampi headline heights were the lowest, at about 1 m. Generally, the tows targeted at middle depth species had headline heights of under 4 m, apart from hoki which was about 3–15 m. Effort speeds were slightly slower than those seen in most fisheries in other areas, generally ranging 3–3.5 knots, although scampi tows are about 2.5 knots. Most fishing distances were between 40 and 100 km per day, though alfonsino and orange roughy had much shorter distances of 10–25 km per day. Vessels that caught lookdown dory in ECNI were generally small with most being less than both 750 GRT and 40 m in length.

The distribution of lookdown dory catch by vessels reporting on TCEPR forms has not changed consistently over time, although in some years they are more widespread (Figure C54). The catch is

mainly taken from Statistical Areas 014 and 015 on the lower east coast with small amounts from Cook Strait and east of Coromandel Peninsula.

Vessels targeting scampi or hoki generally caught lookdown dory, although there was more likely to be no lookdown dory catch in the north (Figure C55). For most other target fisheries there was a scatter of target tows up the ECNI, but lookdown dory was only sometimes caught (Figure C55).

7.2.5 Summary

A summary of the characterisations by fishery areas is given in Table 7. Lookdown dory is rarely if ever targeted or recorded in the top five species on TCEPR forms. This necessitated the use of daily processed data for characterisations.

The CHAT region contributes the greatest proportion of the country's lookdown dory. Lookdown dory catches from this area were mainly reported on TCEPR forms with more of the data captured by the TCEPR processed form. Lookdown dory are mainly caught by bottom trawlers targeting a variety of species, with highest catches as bycatch in hoki trawls (86%). Other main targets included hake, ling, scampi and silver warehou. Annual processed lookdown dory catches from this area were relatively small during 1990–97, then increased over time with catches at 352–603 t during 1998–2004. Since becoming a QMS species at the beginning of the 2004–05 fishing year, catches have decreased to between 192–281 t annually. No clearly distinct season is apparent for the region, although it appears that catches may decrease slightly in July and August when the hoki fleet moves away to target hoki spawning fisheries. The overall distribution of lookdown dory catch has been relatively constant over the study period. Highest catches are from the Mernoo Gap area, along the northern and southern end (edges) of the Chatham Rise, and just east of Mernoo Bank.

The WCSI region of the West Coast contributed the second largest proportion of the country's lookdown dory processed catch. Catches were mainly reported on TCEPR forms with more of the data captured by the TCEPR processed form, although 29% of the estimated catch is reported on CELR or TCER forms, with about 33–58% of the estimated catch recorded on the TCER form since 2008. About 77% of the lookdown dory processed catch was taken by bottom trawling, with the remainder from midwater trawls; the bottom trawl component has increased to over 90% since 2005. Lookdown dory are caught in a variety of target fisheries, with highest processed catches of lookdown dory as bycatch in tows for hoki and hake. Lookdown dory bycatch in the hake fishery has increased since 2006 and has overtaken hoki in its importance. Annual lookdown dory catches from this area were relatively small during 1990–1998 at 19–94 t, but they increased from 1999 to be 97–182 t. The smallest catch in this period (97 t) occurred in 2005, the year lookdown dory came into the QMS system. The west coast lookdown dory catch is almost entirely from the WCSI, where fishing is located on the hoki and hake spawning grounds (Statistical Areas 034 and 035) mainly along the 500 m contour, and occasionally further north. The distribution of lookdown dory catch on TCER forms is almost entirely in Statistical Areas 033 and 034 from February–June, also along the 500 m contour. A small amount of lookdown dory target fishing is recorded, and this makes up over 40% of the estimated catch in the two most recent years (Table C10e).

The Sub-Antarctic region contributes 7% of the total lookdown dory catch. Catches were mainly reported on TCEPR forms with more of the data captured by the TCEPR processed form. Lookdown dory are mainly caught by bottom trawlers targeting a variety of species, with highest catches as bycatch in hoki trawls. Other target fisheries included hake, ling, squid, silver warehou, and white warehou. Annual lookdown dory catches were small at 8–81 t. During the 1990s catches ranged from 8–37 t, and increased to 40–81 t from 2000–2004, but since becoming a QMS species at the beginning of the 2004-05 fishing year, catches have decreased to between 17–31 t. Catches appear to increase over time, but this is most likely owing to better reporting of catches rather than an actual change in catches. No clearly distinct season is apparent for the region, although catches may decrease slightly in August when vessels move to hoki spawning grounds. Most lookdown dory is caught around the Auckland Islands, Snares Shelf, and Puysegur Bank. In some years reasonable catches are taken on the Pukaki Rise, the south western Bounty Plateau, and around the Campbell Rise.

The ECNI contributes the least amount of the country's lookdown dory catch, with 128 t of processed catch for the study period. Lookdown dory catches from this area were reported on TCEPR and TCER forms. TCER catch (mainly from target hoki and ling tows) is about 35–74% of the TCEPR estimated catch from 2008 onwards. Lookdown dory is mainly caught by bottom trawlers targeting a variety of species, with highest catches of lookdown dory as bycatch in scampi and hoki trawls. No clearly distinct season is apparent for ECNI. The catch is mainly taken from Statistical Areas 014 and 015 (southern Hawkes Bay and Wairarapa Coast), with smaller amounts from Cook Strait and east of Coromandel peninsula.

Fishing effort variables, target species and vessel characteristics are similar between the CHAT, SUBA, and WCSI regions. It is likely that many of the vessels that catch lookdown dory are active in all three areas at different times of the year.

On the basis of this characterisation the CHAT, WCSI and SUBA are the regions where catches have been large enough and stable enough over time to carry out a standardised CPUE analysis. This is discussed in the following section.

Table 7: Summary of features of the main lookdown dory fisheries. BT, bottom trawl. Area definitions are given in Figure 2; species codes in Table C13.

Area	ECNI	CHAT	SUBA	West coast
FMA	1 & 2	Upper 3, all of 4	Lower 3, all of 5 & 6	7, 8, & 9
General characteristics				
Key fishery areas	South Hawkes Bay/ Wairarapa Coast Coromandel/Bay of Plenty	East Coast South Island/Chatham Rise	Auckland Islands/ Snares Shelf	West coast South Island
Key Statistical Areas	014, 015	020, 022, 023	028, 030, 602	033–036
Secondary Statistical Areas	008, 009	052, 401–402 407–411	026, 027, 610	
Season	Year round	Year round, decline Jul–Aug	Year round, decline Aug	Jun–Sep (TCEPR) Feb–Jun (TCER)
Gear type	BT	BT	BT	BT
Target species				
Key target species	SCI	HOK	HOK	HOK, HAK
Secondary target species	HOK, LIN	HAK, LIN, SWA, SCI	LIN, SWA, SQU	JMA, LDO
Target LDO as a % of total catch	0 %	0 %	0 %	29% estimated catch since 2008 14% of TCER and processed TCEPR since 2008

8. CPUE ANALYSES

The focus of this analysis is on the three fishery areas CHAT, WCSI, and SUBA, where deepwater vessels operate using bottom trawl. All tables and figures relating to CPUE analyses for lookdown dory are contained in Appendix D (Tables D1–D6, Figures D1–D46). For standardised CPUE analyses of trawl catches, the use of tow-by-tow data allows for the trend in catch rates to be modelled using smaller spatial and temporal scales, and also enables additional factors influencing CPUE to be included (such as tow distance or bottom depth). As not all look lookdown dory catch is recorded on the top five species estimated tow-by-tow part of the TCEPR form, this study used daily processed catch for the main fishery areas (Figure D1). This means that some variables normally available for CPUE analyses cannot be used at the tow-by-tow resolution, but require summing over the day or taking a daily mean, as described in Section 6.2. Observer tow-by-tow catch was analysed for the Chatham Rise and WCSI areas, as there were consistent sets of data from these two areas (Figure D1).

Annual unstandardised (raw) CPUE indices were calculated as the mean of the catch per tow (in kilograms) for observed tow-by-tow data, or catch per vessel-day for daily processed 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 2013) 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. Interaction terms were ignored because most data were from bottom tows. The WCSI observer tow-by-tow dataset comprised both midwater and bottom trawling, but an analysis using bottom tow data only produced similar indices. A stopping rule of 1% change in residual deviance was used because 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, and represents a possible index of abundance. *Year* was standardised to the first year. Year indices were standardised to the mean and were presented in canonical form (Francis 1999).

Categorical and continuous variables offered to the model 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, *statistical area* and *latitude* or *longitude* were not allowed to enter the same model at the same time because they were correlated. For the observer estimated catch run, all variables were included. For the processed catch runs, *date*, *time start*, and *time mid* were not included because they were redundant. Date was included in the processed catch runs as *year* and *month* or *day of year*. Twin trawl vessels for the years 1996–2007 were defined as in Hurst (2009), data from 2008 was identified as a possible twin trawl tow using vessels identified in Hurst (2009), and from 2009–2012 were identified from the catch effort primary method code (Table D2).

For daily processed data, vessel was incorporated into the CPUE standardisation to allow for differences in fishing power between vessels. Vessels not involved in the fishery for at least three consecutive years should be excluded because they provided little information for the standardisations, which could result in model over-fitting (Francis 2001). Thus, CPUE analyses were undertaken for "core" vessels that were determined for each area analysis using gear- and area-specific criteria based on approximately 80% of positive lookdown dory catch, the number of years of vessel participation, and the number of vessel-days or tows per vessel-year (Table D3, Figure D2). For observer data, there was not enough data to select 'core' vessels in a similar manner, so vessels that had participated in the fishery for at least two years, and had 35 tows overall were chosen (Table D3, Figure D2).

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

Model fits to the lognormal component of the combined model were investigated using standard residual diagnostics. For each model, a plot of residuals against fitted values and a plot of residuals against quantiles of the standard normal distribution were produced to check for departures from the regression assumptions of homoscedasticity and normality of errors in log-space (i.e., log-normal errors). For the binomial component, model fits were investigated visually using randomised quantile residuals (Dunn & Smyth 1996). Randomised quantile residuals are based on the idea of inverting the

estimated distribution function for each observation to obtain exactly standard normal residuals. For discrete distributions, such as the binomial, some randomisation was introduced to produce continuous normal residuals.

The data constraints applied to each of the four lognormal, binomial, and delta-lognormal models presented here are given in Table D3 The following models were run:

a. CHAT TCEPR daily processed hoki bottom trawl fishery during 1998–2012;
b. CHAT Observer tow-by-tow hoki bottom trawl fishery during 1998–2012;
c. WCSI TCEPR daily processed hoki or hake bottom trawl fishery during 1994–2012;
d. WCSI Observer tow-by-tow hoki or hake bottom trawl fishery during 1990–2012;
e. SUBA TCEPR daily processed hoki or ling bottom trawl fishery during 1997–2012.

For each of the models listed above, the number of vessels, amount of effort, proportion of zeros, and amount of lookdown dory catch, and the unstandardised CPUE are listed in Table D4, for all vessels and for core or final vessels, where appropriate. The variables retained in each model are given in Table D5 and the CPUE indices by fishing year are given for each model in Table D6.

Unstandardised CPUE was also derived for each year from the available data sets. The annual indices were calculated as the mean of the individual daily catch (kg) for daily processed data or catch per tow (kg) for observer trawl data.

8.1 Chatham Rise (CHAT)

TCEPR daily processed hoki BT model

The Chatham Rise lookdown trawl fishery is mainly bycatch in bottom trawling for the hoki target fishery (Figure C12). The timing of the catch has varied between years, but is generally throughout the year, with low catches in July and August during the hoki spawning season (Figure C12). Most of the lookdown dory catch was reported on the TCEPR processed form (Figure D1), hence this is an appropriate dataset to analyse.

A Chatham Rise bottom trawl for hoki target fishery model used data from fishing years 1998 to 2012. The data constraints used for the daily processed model are given in Table D3. A total of 60 unique vessels (range 16–45 vessels each year) targeting hoki using bottom tows processed 4096.9 t of lookdown dory since 1998, from 24 430 vessel days (Table D4). The percentage of vessel-days with zero catch ranged from 6 to 19%. Core vessels for the daily processed index were defined as those participating in the fishery for four or more years, and reporting 50 or more vessel-days per vessel-year (Table D3, Figures D2 and D3). Sixteen core vessels (range 7–14 per year) processed 3597.9 t of lookdown dory, representing 87% of the total catch during 1998–2012. Processed lookdown dory catches for core vessels ranged from 106.5 to 436.3 t annually (Table D4) and the largest catch by vessel for a year was 100 t (Figure D2).

Six variables were selected into the lognormal model, resulting in a total R^2 of 30.8%, with *statistical area* explaining 16.2% of the residual deviance (Table D5). The other variables selected were *vessel*, *month*, *depth of bottom*, and *duration*. In contrast for the binomial model, 14.9% of the residual deviance was explained by five retained variables, with *depth of bottom* excluded.

Indices from the models are presented in Table D6 and Figures D4–D8. Overall the lognormal standardised catch indices are fairly flat, although they showed an increasing trend from 1999 to 2002, after which they showed a slight overall decrease to 2012. Confidence intervals are small, probably due to the small yet consistent nature of lookdown dory catches. This catch index matches the unstandardised index reasonably well. The low binomial probability results in some differences between the lognormal and the delta-lognormal indices, especially in 1998, 2002–2003, and 2011. There is little effect in the addition of retained variables in the lognormal model (Figure D6). Indices of catch per tow and catch per kilometre were similar to catch per hour indices (Figure D7).

Standardised biomass indices from the Chatham Rise trawl survey series and CPUE lognormal indices appear to follow each other reasonably well in most years (Figure D8).

The effects of the selected variables on the expected catch rates of lookdown dory in the lognormal daily processed catch models are shown in the CDI plots in Figure D9. Generally, the changes in the influence of the main variables was small. For statistical area – the variable with the most explanatory power – changes are largely related to fishing area, with relatively high catch rates in statistical areas 052, 403 and 407–410. Predicted CPUE by statistical area generally followed the overall lognormal CPUE trend for most statistical areas, although there were some exceptions in individual years (Figure D10). For vessel, changes are related to the movement of vessels out of the fishery, and the positive influence for 1998–2001 is influenced by one vessel (vessel 5) in the fishery in these years. Higher coefficients were estimated when the effort was in November–February, and bottom depths were between 400 and 550 m.

The effects of variables selected into the binomial model and the model diagnostics are shown in Figure D11, and show the trend in expected zero catches are small, probably due to the small yet consistent nature of lookdown dory catches.

The diagnostics were poor and the quantile–quantile plot for the lognormal model indicated a large deviation from the normal distribution of the residuals at both the lower and upper ends i.e., very small and very large catch rates were not well modelled (Figure D12). This suggests that the lognormal models can be improved, and there may be violations of model assumptions (i.e., the assumption of normally distributed constant variance residual errors). The diagnostics for the binomial model indicated a reasonable pattern in the residuals and the quantile-quantile plot appeared adequate (Figure D12).

Observer tow-by-tow hoki BT model

Data collected by observers from the Chatham Rise target hoki trawl fishery were also analysed to produce a CPUE series, using the combined model from fishing years 1998 to 2012. Data constraints used for the tow-by-tow estimated model are given in Table D3. The total data set included 46 observed vessels, while the final data set had 25 vessels that had been observed for at least two years and had at least 35 observed tows overall (Table D3 and D4, Figure D13). Only four of the final vessels had been observed in two years, with 12 having been observed in 5 or more years. There were 10 126 tows in the final data set, and 2282 (23%) reported no lookdown dory catch (range 10–33%) (Table D4).

Six variables were selected into the lognormal model, resulting in a total R^2 of 35%, with *vessel* explaining 22% of the residual deviance (Table D5). The other variables selected included *statistical area*, *mid time of tow*, *duration* and *month*. The binomial model explained 16% of the residual deviance with seven retained variables, with the inclusion of *depth of bottom*.

Indices from the models are presented in Table D6 and Figures D14–D18. The lognormal standardised catch index shows an increasing trend to 2002 and then a gradual decline, and it matches the unstandardised index reasonably well (Figure D14). The binomial series has no trend, although indices are higher in 2001, 2008, and 2009, and the delta-lognormal indices are generally similar to the lognormal model, although they are affected by years when the binomial indices are higher (Figure D15). The addition of retained variables in the lognormal model have an effect of smoothing out indices (Figure D16). Standardised lognormal TCEPR daily processed indices, observer indices and biomass indices from the Chatham Rise trawl survey series appear to follow each other reasonably well in most years, and all indicate a decline from 2002 to 2011 (Figure D17). This is also the case if all observer data is used from 1990 (Figure D18). [Note: observer data for all years was not used in the final observer model as pre-1998 data exhibited trends in influence plots for most variables. For consistency, 1998–2012 was chosen.]

The effects of the selected variables on the expected catch rates of lookdown dory in the lognormal daily processed catch models are shown in the CDI plots in Figure D19. Generally, the changes in the influence of the main variables was small. For vessel, higher catch rates are related to change in vessels, and the positive influence in 2001, 2003, and 2010 affected by effort from a few vessels in these years. For statistical area, the changes are related to fishing area, with higher catch rates in Statistical Areas 052 and 407–410 as for the TCEPR processed analysis (see Figure D19). Higher coefficients were estimated when more effort occurred during the middle of the day; when the effort was in December, January, and July; and when there were longer tows in 2010. The effects of variables selected into the binomial model and the model diagnostics show expected zero catches are more likely for particularly short or long tows, night tows, and particularly shallow or deep tows, and in Statistical Areas 018–022 (Figure D20).

The model assumptions were well satisfied, with very balanced residuals and no significant deviations from normality (Figure D21).

8.2 WCSI

TCEPR daily processed hoki or hake BT model

The WCSI lookdown dory trawl fishery is mainly bycatch in the hoki target fishery although the lookdown dory caught in hake target tows has been increasing since 2005 (Figure C25). The timing of the catch has varied slightly between years, but most catch has been taken from May to October, often with a peak from June to September during the hoki spawning season (Figure C25). As most of the lookdown dory catch was reported on the TCEPR processed form, data from this form type is an appropriate dataset to analyse (Figure D1).

A WCSI bottom trawl for hoki or hake target fisheries model used data from years 1994 to 2012 (June–September). The data constraints used for the daily processed model are given in Table D3. From 1994, 71 vessels (range 16–35 vessels each year) targeting hoki or hake using bottom tows processed 1176.2 t of lookdown dory, from 9590 tows vessel days (Table D4). The percentage of vessel-days with zero catch ranged from 7 to 38%. Core vessels for the daily processed index were defined as those participating in the fishery for six or more years, and all vessel-days for these vessels were used (Table D3, Figures D2 and D22). Twenty-eight core vessels (range 8–25 per year) processed 1053.6 t of lookdown dory, representing 89% of the total catch during 1994–2012. Processed lookdown dory catches for core vessels ranged from 16.8 to 88.8 t annually (Table D4) with the largest catch by a vessel for a year at 20 t (Figure D22).

Five variables were selected into the lognormal model, resulting in a total R^2 of 29.8%, with *day of year* explaining 16.7% of the residual deviance (Table D5). The other variables selected were *vessel*, *depth of bottom*, and *distance*. The binomial model explained 19.1% of the residual deviance with five retained variables, with *duration* instead of *distance*.

Indices from the models are presented in Table D6 and Figures D23–D26. The lognormal standardised catch index is generally flat, although spiky from 1994 to 1998, after which it showed an overall slight increase to 2012, and matches the unstandardised index reasonably well (Figure D23). Confidence intervals are largest in the first four years. The low binomial probability results in some differences between the lognormal and the delta-lognormal indices, especially in 1998, 2005, and 2008–2010 (Figure D24). There is little effect in the addition of retained variables in the lognormal model (Figure D25). Indices of catch per tow matched catch per hour indices, but there appeared to be some effect from the tow length with catch per kilometre differing from the other indices, especially during 2007–2010 (Figure D26).

The effects of the selected variables on the expected catch rates of lookdown dory in the lognormal daily processed catch models are shown in the CDI plots in Figure D27. Generally, the change in the influence of the main variables was small. *Day of year* was the variable with the most explanatory

power, and change is related to the time of year fished, with higher catch rates earlier in the time period (June). For *vessel*, the changes are related to the changes in vessel, and the positive influence for 1995–1998, and 2006–2012 represents effort by vessels with higher coefficients, and hence shows that fleet dynamics and behaviour have changed. Higher coefficients were estimated when there was effort at bottom depths of 500–700 m and at longer fishing distances. These variables had a small positive effect when the years of greater effort corresponded with the higher catch coefficients.

The effects of variables selected into the binomial model are shown in Figure D28, and show that the trend in expected zero catches is small, probably due to the small nature of lookdown dory catches, although they are more likely in particularly shallow or deep tows, later in the time period (August–September), and with short fishing durations.

The diagnostics were poor and the quantile–quantile plot for the lognormal model indicated a large deviation from the normal distribution of the residuals at both the lower and upper ends i.e., very small and very large catch rates were not well modelled (Figure D29). This suggests that the lognormal models can be improved, and there may be violations of model assumptions (i.e., the assumption of normally distributed constant variance residual errors). The diagnostics for the binomial model indicated a reasonable pattern in the residuals and the quantile-quantile plot appeared adequate (Figure D29).

TCER tow-by-tow lookdown dory, hoki or ling model

TCER data is available from 2008–2012, and there were 973 records for target lookdown dory, hoki, and ling fisheries. However, about 60% of these were zero tows, hence a CPUE analysis was not attempted. There may be mis-information in recording of target species as there were no lookdown dory target zero tows, most hoki target tows were non-zero, and most ling target tows were zero tows. It may be appropriate to investigate this when more years' data are available. An analysis of CELR and TCER data rolled up to vessel-date-statistical area-target would result in very little data per year, and hence is not feasible.

Observer tow-by-tow hoki or hake BT and MW model

Data collected by observers from the target trawl fishery for hoki or hake off WCSI were also analysed to produce a CPUE series, using the combined model. A WCSI bottom and midwater trawl for hoki or hake target fisheries model used data from years 1990–2012 (June–September). The data constraints used for the tow–by–tow estimated model are given in Table D3. The total data set included 106 vessels, and the final data set included 58 vessels that had been observed for at least two years and had at least 35 observed tows overall (Table D3 and D4, Figure D30). Although 17 of these final vessels had been observed in only two years, 28 had been observed in 5 or more years (with the maximum being 12 years). There were 17 929 tows in the final data set, of which almost 11 199 (62%) reported no lookdown dory catch (range 33–77%) (Table D4). About 39% of the midwater tows were reportedly fished on the bottom. Data from the three method categories were included in the model, and *method* was offered as an explanatory variable.

Seven variables were selected into the lognormal model, resulting in a total R^2 of 43%, with *vessel* explaining 30% of the residual deviance (Table D5). The other variables selected were *headline height*, *day of year*, *depth of net*, *duration* and *mid time of tow*. The binomial model explained 28% of the residual deviance with five retained variables, without *duration* and *mid time of tow*.

Indices from the models are presented in Table D6 and Figures D31–D34. The lognormal standardised catch index is fairly flat, although fluctuating, and matches the unstandardised index reasonably well (Figure D31). The binomial series has a decreasing trend from 1990 to about 2000, and then is flattish, and the delta-lognormal indices are similar to the lognormal model (Figure D32). The addition of retained variables in the lognormal model have an effect of flattening out indices (Figure D33). Lognormal standardised indices for bottom tows only showed a similar spiky flat trend to the indices with both bottom and midwater tows for 2000–2012 (Figure D34).

Standardised lognormal TCEPR daily processed indices and observer indices exhibit similar overall trends (Figure D34). The observer CPUE suggests that the earlier years in the TCEPR processed indices where indices are spiky may be noise. The two years of comparable data from the WCSI trawl survey series (2000 and 2012) also correlate well with the CPUE series (Figure D34).

The effects of the selected variables on the expected catch rates of lookdown dory in the lognormal daily processed catch models are shown in the CDI plots in Figure D35. Generally, the changes in the influence of the main variables was small. For *vessel* – the variable with the most explanatory power – the changes are related to the changes in vessels in the fishery, and suggest that fleet dynamics and behaviour have changed. Years with higher influence are those where there is more effort earlier in the time period (June), low headline heights (bottom tows), net depths between 500 and 650 m, longer durations, and mid time of tow close to midday. These variables had a small positive effect when the years of greater effort corresponded with the higher catch coefficients.

The effects of variables selected into the binomial model and the model diagnostics (Figure D36) show expected zero catches are more likely in particularly shallow or deep depths, with higher headline heights (midwater tows), and later in the time period (August–September).

The model assumptions were well satisfied, with very balanced residuals and no significant deviations from normality (Figure D37).

8.3 Sub-Antarctic (SUBA)

TCEPR daily processed hoki or ling BT model

The Sub-Antarctic lookdown trawl fishery is mainly bycatch in the bottom trawling for hoki or ling target fisheries (Figure C36). The timing of the catch has varied between years, but is generally all year around, with lower catches in July and August during the hoki spawning season (Figure C36). As most of the lookdown dory catch was reported on the TCEPR processed form, this is an appropriate dataset to analyse (Figure D1).

The Sub-Antarctic bottom trawl for hoki or ling target fisheries model used data for fishing years 1997 to 2012. The data constraints used for the daily processed model are given in Table D3. For this model, a total of 56 vessels (annual range 18–34 vessels) targeting hoki or ling using bottom tows processed 319.7 t of lookdown dory since 1997, from 13 611 vessel days (Table D4). The percentage of vessel-days with zero catches ranged from 43 to 78%. Core vessels for the daily processed index were defined as those participating in the fishery for four or more years, and included all vessel-days for these vessels (Table D3, Figures D2 and D38). Thirty core vessels (range 15–27 per year) accounted for 91% of the total catch during 1997–2012, and processed 292.8 t of lookdown dory. Processed lookdown dory catches for core vessels ranged from 8 to 36 t annually (Table D4) with the largest catch by a vessel for a year of 7 t (Figure D38).

Five variables were selected into the lognormal model, explained a R^2 of 18%, with *vessel* explaining 12.3% of the residual deviance (Table D5). The other variables selected were *longitude*, *month*, and *depth of bottom*. In the binomial model, 13.8% of the residual deviance was explained by four retained variables, with *month* excluded.

Indices from the models are presented in Table D6 and Figures D39–D43. The standardised year effects show a slight overall decline over the time series, with narrow confidence intervals (Figure D39). This catch index matches the unstandardised index reasonably well. The binomial series has a slight decreasing trend, and the delta-lognormal indices are similar to the lognormal model (Figure D40). There is little effect in the addition of retained variables in the lognormal model, except that the indices are lowered in the first two years (Figure D41). Indices of catch per tow matched catch per hour indices, but there appeared to be some effect of tow length with catch per kilometre having a

much flatter overall trend (Figure D42). Standardised biomass indices from the Sub-Antarctic trawl survey series poorly match the CPUE (Figure D43).

The effects of the selected variables on the expected catch rates of lookdown dory in the lognormal daily processed catch models are shown in the CDI plots in Figure D44. Generally, the changes in the influence of the main variables were small. For *vessel*, the changes are largely related to the movement of vessels out of the fishery, and the positive influence for 1997–1999 reflect effort by vessels with higher coefficients, and hence suggest that fleet dynamics and behaviour have changed. Higher coefficients were estimated when the effort was further east or west. These variables had a small positive effect when the years of greater effort corresponded with the higher catch coefficients.

Variables selected into the binomial model show expected zero catches are more likely in particularly shallow or deep tows, and between longitudes 168–170° E, or for vessels that catch less lookdown dory overall (Figure D45).

The diagnostics were poor and the quantile–quantile plot for the lognormal model indicated a large deviation from the normal distribution of the residuals at both the lower and upper ends i.e., very small and very large catch rates were not well modelled (Figure D46). This suggests that the lognormal models can be improved, and there may be violations of model assumptions (i.e., the assumption of normally distributed constant variance residual errors). The diagnostics for the binomial model indicated a reasonable pattern in the residuals and the quantile-quantile plot appeared adequate (Figure D46).

8.4 CPUE summary

The lookdown catches from fisheries in all three areas are a consequence of bycatch. The Chatham Rise fishery is widespread but concentrated on the western Rise, mainly from September to June. The WCSI fishery is of short duration (June–September), with lookdown dory mainly caught as bycatch of hoki or hake, but with some targeting occurring generally before the main hoki season by smaller boats. The Sub-Antarctic fishery is concentrated on the Snares shelf, around the Auckland Islands, and the Puysegur Bank, with lookdown dory caught mainly from September to June as bycatch from a range of species, but mainly hoki or ling.

The overall R^2 values for each region and CPUE lognormal model varied for core models (18–43%) and was higher for observer models in each area. Some explanatory variables were consistent for all models, i.e., vessel, time of year and depth was important with either month or day of year, and depth of bottom or depth of net entering every model. Fishing duration or distance was important on the Chatham Rise and WCSI, and position (statistical area or longitude) was important on the Chatham Rise and in the Sub-Antarctic. The residual deviance explained by the binomial models was generally lower (ranging from 13–29%), but again was higher for the observer model in each area, with the main predictors being similar to the lognormal models. A large proportion of the underlying variability was not explained. Although this is not unusual for CPUE analyses (e.g., Vignaux 1994, Punt et al. 2000), it may be a reflection of a lack of explanatory information available to the models.

Vessel was important in these areas and the indices reflect the fleet movements of the hoki fishery in particular, on an annual basis as well as a longer period as a response to changes in the TACC – in particular to the lowered hoki TACC during the early 2000s. There may be changes in fleet dynamics as influence plots show a changing trend throughout the middle of the series for the WCSI processed analysis, and in early years for the Sub-Antarctic daily processed and WCSI Observer analysis. A decrease in the last few years in the CPUE from the hoki bottom trawl fishery on the Chatham Rise and Sub-Antarctic may be related to the increased proportions of effort by vessels with lower catch rates. Reporting of target species may have changed. There has been relatively less lookdown dory caught recently by target hoki on the WCSI and Sub-Antarctic. Increased catches of lookdown dory by hake targeting on the WCSI since 2006, and by hake, ling, and white warehou targeting in the Sub-Antarctic may be related to reporting changes depending on TACC constraints by various target

species. Given the changes in fleet structure and behaviour in recent years it is possible that the last few years of the lookdown dory CPUE series may not be representative of abundance.

The Chatham Rise trawl survey time series appears to track the CPUE series reasonably well, with an overall flat trend, although with a slight increasing trend from 1999 to 2002, followed by a slight decrease to 2012. This fishery showed reasonably consistent catch rates throughout the time series. Bottom depth was important in the Chatham Rise hoki fishery and most lookdown dory catches were from tows in 400–600 m, although catches in the trawl survey were from throughout the 200–800 m depth range. Month was also important and the higher proportion of hoki targeting effort in January, when the trawl surveys occur, appeared to have a positive influence in some years. Either the daily processed or observer lognormal model could potentially be used to complement the Chatham Rise trawl survey time series, which is also believed to track relative abundance of lookdown dory well.

For the WCSI, there are no extended fishery independent indices (three comparable survey indices available from 2000, 2012 and 2013). There were no strong trends in the daily processed CPUE indices, and credence may be given to these as they are very similar to the WCSI observed data series. However, it is known that fishing (particularly target fishing) and reporting practices for hoki or hake off WCSI have varied over time, and this could have biased the data, producing CPUE series that do not track lookdown dory abundance. Data before 2000 in the daily processed analysis are more likely to be influenced by changes in fishing behaviour and reporting. The volume of observer data from the WCSI hoki and hake target trawl fishery is large, but many of the vessels (17 out of 58) contributed to the series in only two years. The resulting series is spiky, but showed no trend, and most explanatory variables selected into the observer model are the same as those selected into the TCEPR model. The observer data series should be relatively free of biases, and it showed no trend in lookdown dory biomass.

Sub-Antarctic CPUE indices do not correlate well with the Sub-Antarctic research survey biomass index, which is believed to track lookdown dory abundance relatively well. However, the indices for the Sub-Antarctic between 2001 and 2007 showed no trend for both trawl surveys and CPUE. Vessel, depth of bottom, and area fished (longitude) were important in this area and most likely relate to the effect of the main target trawl fisheries here.

The diagnostic plots for the CPUE analyses show that the lognormal model was unable to capture the extremes in catch rates observed and tended to underestimate the lower and higher catch rates. Clumping of residuals is also apparent, probably due to the different catch rates for each target species and area. This suggests that the lognormal models can be improved, and there may be violations of model assumptions (i.e., the assumption of normally distributed constant variance residual errors). Observer diagnostic plots showed an improvement on daily processed analysis diagnostics. Other models may need investigating. Diagnostics for the binomial models were good; however, there is little published documentation on the success of using randomised quantile residuals as diagnostics for discrete response variable models, so the interpretation of diagnostics should be treated with caution. The delta-lognormal model has a large effect on the Chatham Rise and WCSI daily processed indices, some effect on the Chatham Rise observer indices, but very little effect on the WCSI observer or Sub-Antarctic daily processed indices.

9. PRINCIPLES FOR STOCK ASSESSMENT

9.1 Annual model cycle
9.2 Landings (catch history)
9.3 Exploitation rates

10. ENVIRONMENTAL AND ECOSYSTEM CONSIDERATIONS

10.1 Benthic impact (sea-bed disturbance)
10.2 Incidental catch (fish and invertebrates)

12. SUMMARY AND RECOMMENDATIONS

12.1 Biology

Stock structure of lookdown dory is poorly understood. Distribution of spawning areas and juveniles confirms the existence of at least WCSI and Chatham Rise stocks, and suggests that the Chatham Rise and the Sub-Antarctic might support separate stocks. The difference in maximum size distributions from trawl surveys of Chatham Rise and Sub-Antarctic, particularly for males, also suggests that there may be stock differences between the two areas; that fishing pressure is heavier on the Chatham Rise, preventing fish from growing as large as they do in the Sub-Antarctic; or that there may be different growth rates between areas.

Research trawl surveys of middle depth species on the Chatham Rise and Sub-Antarctic areas since 1991, and the WCSI trawl survey in 2012 and 2013, appear to be appropriate to monitor relative abundance for lookdown dory for these areas, covering most of their depth range and providing relatively precise estimates (mostly with CVs less than 10%, 25%, and 14% respectively). To date, biomass trends for Chatham Rise show a slight increasing trend in biomass to 2002, with a subsequent slight decline. Biomass from the Sub-Antarctic declined to 2002, but has since increased to 2009, although between 2009 and 2011 the biomass decreased to its lowest level, and increased slightly in 2012. Both the Chatham Rise and Sub-Antarctic recorded their lowest biomass indices in 2011. The WCSI biomass estimates are much lower than estimates from the Chatham Rise and Sub-Antarctic surveys, but the WCSI trawl survey does not cover the entire distribution of lookdown dory in that area. The WCSI has been the only area where spawning lookdown dory have been identified in autumn, so collection of length and gonad staging data on the *Kaharoa* WCSI inshore trawl could improve knowledge of spawning biology.

Otolith sampling and development of catch-at-age for Chatham Rise would increase its usefulness for monitoring and aid in interpretation of trends; numbers of fish sampled from the Sub-Antarctic are too low to do this. Ageing by reading possible annual zones on otoliths has yet to be validated (an initial attempt using radiometric techniques was unsuccessful), but it is thought that lookdown dory can live beyond 30 years and start to mature from around 5–6 years of age. Better optimised observer sampling of the main fisheries is required to adequately monitor catch-at-length (and potentially catch-at-age) and spawning times and areas.

Collection of length and gonad data on the Chatham Rise and Sub-Antarctic by observers during autumn (April–June) could increase knowledge of spawning areas, and potential stock relationships within LDO 3.

Collection of stomachs from Chatham Rise trawl surveys showed that natant decapods, macrourid fish and galatheid decapods are the most important components of the lookdown dory diet, with some variation depending on depth and fish size.

12.2 Status of the stocks

Lookdown dory have been harvested commercially at relatively low levels with the largest landed catch since the 1990 fishing year being 1037 t in 2003. Reliable data before 1990 are not available.

Estimates of lookdown dory biomass are available for LDO 1, but are not extensive (three comparable WCSI survey indices in 2000, 2012 and 2013) and therefore it is not known if the current TACC and recent catches are sustainable or whether they are at levels which will allow the stocks to move towards a size that will support the maximum sustainable yield. Nearly all of the lookdown dory catch from LDO 1 is taken on the WCSI in FMA 7 during the hoki spawning season and increasingly in the hake fishery. It is unavoidable as bycatch in these fisheries and landed catches exceeded the LDO 1 TACC slightly in the 2006 and 2008 fishing years. The WCSI CPUE observer and daily processed analyses of the trawlers targeting hoki and hake on the WCSI complements the trawl survey indices, as overall these indices show no strong trends, and the observer CPUE series should be relatively free of biases. Standardised CPUE analyses were not attempted for the fishing area ECNI that makes up part of LDO 1 as catches are patchy and low.

Estimates of biomass in LDO 3 are available for the two main subareas, from Chatham Rise and Sub-Antarctic trawl surveys since 1991. Relative biomass indices on the Chatham Rise have increased slightly to 2002, with a slight subsequent decline. Estimates from Sub-Antarctic declined to a low in 2002, then increased to 2009, but subsequently decreased to their lowest level in 2011. Biomass indices for both the Chatham Rise and Sub-Antarctic were the lowest in the series in 2011. The CPUE analyses of the trawl fishery targeting hoki on the Chatham Rise using either the daily processed data or observer data may complement the trawl survey indices, as these indices appear to follow each other reasonably well in most years. The Sub-Antarctic CPUE indices may be less reliable, however. Length frequency plots from the Chatham Rise trawl survey time series indicate that it may be possible to track at least the first six year classes, although age validation would need to be done in order to know the actual ages of these cohorts.

Lookdown dory sampling by observers would benefit from optimisation in key fishery areas. Observer data for this study were found to be minimal for the ECNI and Sub-Antarctic regions, and not well representative by month for the Chatham Rise and Sub-Antarctic. More optimised coverage may also allow more accurate recording of catch per tow that might allow for better observer CPUE analyses.

If ageing by zone counts in otoliths could be validated for lookdown dory then otolith sampling would be beneficial to develop series of catch-at-age. Some otoliths have been taken in the past by observers but not in large numbers. Collection of length frequency and gonad stage information is also important to help determine stock structure and reproductive biology, as outlined above.

12.3 Future data needs and research requirements

Summer trawl surveys of the Chatham Rise and Sub-Antarctic, and the recent winter trawl survey on the WCSI, provide reasonable biomass estimates for three of the four main fishing areas identified in this study. More data are required to better describe spawning seasons and biological characteristics of the catch in the commercial fishery. Biological information from observer sampling could be enhanced, with the goal of developing appropriate monitoring tools, as follows:

1. Improved estimated catches by the commercial fleet at the tow-by-tow level. More accurate reporting of lookdown dory catches at the tow-by-tow level would provide temporal and spatial information at finer resolution scales. This could lead to more meaningful CPUE indices being developed.

2. Collection of length and gonad staging data on the *Kaharoa* WCSI inshore autumn trawl survey, especially in 300–400m strata could improve knowledge on spawning.
3. Improved coverage of all fishery areas by the observer programme. This would involve collection of all key aspects of biology including length, weight, sex, gonad development and possibly otolith removal (if an ageing protocol can be established). Improved observer coverage could also potentially allow for further development of observer CPUE. Collection of length and gonad data on the Chatham Rise and Sub-Antarctic by observers during autumn (April–June) could increase knowledge of spawning areas, and potentially answer questions about stock boundaries within LDO 3.
4. Validation of otolith ageing by zone counts. Tracey at al. (2007) suggest that the use of whole otoliths in radiometric testing could provide a validation method. Validation would provide the opportunity to develop catch-at-age and length-at-age series.
5. TCER data from the WCSI needs to be checked in the next analysis of lookdown dory to see if there is enough data to complete a target CPUE analysis.

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APPENDIX A: TRAWL SURVEY SUMMARIES

Table A1: Summary of lookdown catches for each *Tangaroa* survey and percent of stations with lookdown dory catches.

(a) Chatham Rise

	Catch (kg) summary				Core strata stations	
Survey	**Min**	**Median**	**Mean**	**Max**	**Total**	**Percent with LDO**
TAN9106	0	20.75	24.4	157.1	184	92.4
TAN9212	0	23.35	29.5	128.1	194	91.8
TAN9401	0	22.5	33.9	281.1	165	93.9
TAN9501	0	19.2	26.1	145.1	122	98.4
TAN9601	0	21.8	31.8	152.7	89	86.5
TAN9701	0.6	24.8	34	156.3	103	100
TAN9801	0	25.4	33.1	148.1	87	95.4
TAN9901	0	24	35.2	149.6	100	89
TAN0001	0	19.85	33.5	159.1	128	93
TAN0101	0	19.2	32.5	178.2	119	95
TAN0201	0	25.4	43.1	268.6	107	94.4
TAN0301	0	15.6	26.8	127	115	93
TAN0401	0	20.9	30	165.9	110	92.7
TAN0501	0	20	28.8	158.7	106	95.3
TAN0601	0	23.15	32.7	210.2	96	91.7
TAN0701	0	18.9	27.1	120.6	101	95
TAN0801	0	12.3	25.5	250.8	101	92.1
TAN0901	0	20.6	32.5	159.4	108	91.7
TAN1001	0	14.1	21.6	88.6	91	93.4
TAN1101	0	8.25	18.6	386.9	90	85.6
TAN1201	0	16.75	27.6	410.2	100	90
TAN1301	0	20.1	31.5	249.5	94	90.4
All	0	19.6	30	410.2	2510	92.9

(b) Sub-Antarctic summer

	Catch (kg) summary				Core strata stations	
Survey	**Min**	**Median**	**Mean**	**Max**	**Total**	**Percent with LDO**
TAN9105	0	1.1	2.7	26.6	154	53.9
TAN9211	0	0	2.5	23.9	155	48.4
TAN9310	0	0	1.7	15	134	44.8
TAN0012	0	1.05	2.9	41	84	59.5
TAN0118	0	0	1.9	20.3	85	49.4
TAN0219	0	0	1.5	11.7	85	48.2
TAN0317	0	0	1.8	14.6	69	49.3
TAN0414	0	0	1.8	20.3	78	47.4
TAN0515	0	0	1.8	15.9	77	48.1
TAN0617	0	0	1.4	14.1	75	38.7
TAN0714	0	0	2	18.6	80	48.8
TAN0813	0	0.9	2.2	13.5	75	53.3
TAN0911	0	0	2.5	21.6	74	44.6
TAN1117	0	0	1.7	14.2	80	43.8
TAN1215	0	0	1.1	8.1	80	36.2
All	0	0	2	41	1385	47.9

Table A1: ctd. Summary of lookdown catches for each *Tangaroa* survey and percent of stations with lookdown dory catches.

(c) Sub-Antarctic autumn

	Catch (kg) summary				Core strata stations	
Survey	**Min**	**Median**	**Mean**	**Max**	**Total**	**Percent with LDO**
TAN9204	0	0	2.5	80.8	90	36.7
TAN9304	0	0	3.6	142.4	100	42
TAN9605	0	0	2.6	28.8	79	38
TAN9805	0	0	1.5	22.1	58	32.8
All	0	0	2.7	142.4	327	37.9

(d) Sub-Antarctic spring

	Catch (kg) summary				Core strata stations	
Survey	**Min**	**Median**	**Mean**	**Max**	**Total**	**Percent with LDO**
TAN9209	0	0	2.3	24.1	101	41.6
All	0	0	2.3	24.1	101	41.6

(e) Southland

	Catch (kg) summary				Core strata stations	
Survey	**Min**	**Median**	**Mean**	**Max**	**Total**	**Percent with LDO**
TAN9301	0	0	0.2	7.4	113	8.0
TAN9402	0	0	0.6	12.0	129	13.2
TAN9502	0	0	0.7	35.3	150	9.3
TAN9604	0	0	0.8	37.5	124	10.5
All	0	0	0.6	37.5	516	10.3

(f) WCSI core

	Catch (kg) summary				Core strata stations	
Survey	**Min**	**Median**	**Mean**	**Max**	**Total**	**Percent with LDO**
TAN0007	0	9.9	13.2	64.7	47	91.5
TAN1210	0	7.1	10.1	44.6	51	82.4
TAN1308	0	8.1	14.5	66.5	55	83.6
All	0	8.3	12.6	66.5	153	85.6

(f) WCSI all

	Catch (kg) summary				Core strata stations	
Survey	**Min**	**Median**	**Mean**	**Max**	**Total**	**Percent with LDO**
TAN0007	0	9.9	13.2	64.7	47	91.5
TAN1210	0	6.0	9.0	44.6	63	74.6
TAN1308	0	6.8	13.1	66.5	65	78.5
All	0	7.1	11.7	66.5	175	80.6

Table A2: Numbers of female lookdown dory at each reproductive stage, from trawl survey data, by month and area. 1, immature or resting; 2, maturing; 3, ripe; 4 running ripe; 5 spent.

	Month											
Stage	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
ECNI												
1	12	-	1	27	-	-	-	1	3	-	-	5
2	36	-	1	52	-	-	-	-	-	-	-	24
3	-	-	-	4	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	8	24	-	-	-
5	-	-	-	20	-	-	-	-	-	-	-	2
Chatham Rise												
1	577	-	-	-	-	3	4	-	-	-	-	82
2	341	-	-	-	-	-	-	-	-	-	-	56
3	27	-	-	-	-	-	1	-	-	-	-	18
4	-	-	-	-	-	-	-	-	-	-	-	-
5	54	-	-	-	-	5	8	-	-	-	-	9
Southland												
1	-	17	-	11	-	-	-	-	-	-	23	107
2	-	4	-	-	-	-	-	-	-	-	43	217
3	-	-	-	1	-	-	-	-	-	-	2	11
4	-	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	5	-	-	-	-	-	-	20	38
Westcoast												
1	7	-	26	-	-	46	99	764	-	-	-	-
2	46	-	38	-	-	-	1	5	-	-	-	-
3	4	-	-	-	-	-	-	2	-	-	-	-
4	-	-	-	-	-	-	-	1	-	-	-	-
5	16	-	20	-	-	10	66	432	-	-	-	-
Total												
1	596	17	27	38	-	49	103	765	3	-	23	194
2	423	4	39	52	-	-	1	5	-	-	43	297
3	31	-	-	5	-	-	1	2	-	-	2	29
4	-	-	-	-	-	-	-	1	-	-	-	-
5	70	-	20	25	-	14	74	440	24	-	20	49

Table A2: ctd. Numbers of male lookdown dory at each reproductive stage, from trawl survey data, by month and area.

	Month											
Stage	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
ECNI												
1	14	-	-	70	-	-	-	1	31	-	-	16
2	-	-	1	-	-	-	-	-	6	-	-	-
3	-	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-	-
Chatham Rise												
1	396	-	-	-	-	3	3	-	-	-	-	118
2	79	-	-	-	-	-	-	-	-	-	-	41
3	162	-	-	-	-	-	-	-	-	-	-	43
4	-	-	-	-	-	-	-	-	-	-	-	-
5	11	-	-	-	-	-	-	-	-	-	-	-
Southland												
1	-	33	-	-	-	-	-	-	1	-	26	153
2	-	-	-	-	-	-	-	-	-	-	11	36
3	-	-	-	-	-	-	-	-	-	-	17	67
4	-	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	1	9
Westcoast												
1	13	-	-	-	-	4	146	970	-	-	-	-
2	-	-	-	-	-	-	18	15	-	-	-	-
3	-	-	-	-	-	-	1	26	-	-	-	-
4	-	-	-	-	-	-	2	8	-	-	-	-
5	-	-	-	-	-	-	1	89	-	-	-	-
Total												
1	423	33	10	70	-	7	149	971	32	-	26	287
2	79	-	1	-	-	-	18	15	6	-	11	77
3	162	-	-	-	-	-	1	26	-	-	17	110
4	-	-	-	-	-	-	2	8	-	-	-	-
5	11	-	-	-	-	-	1	89	-	-	1	9

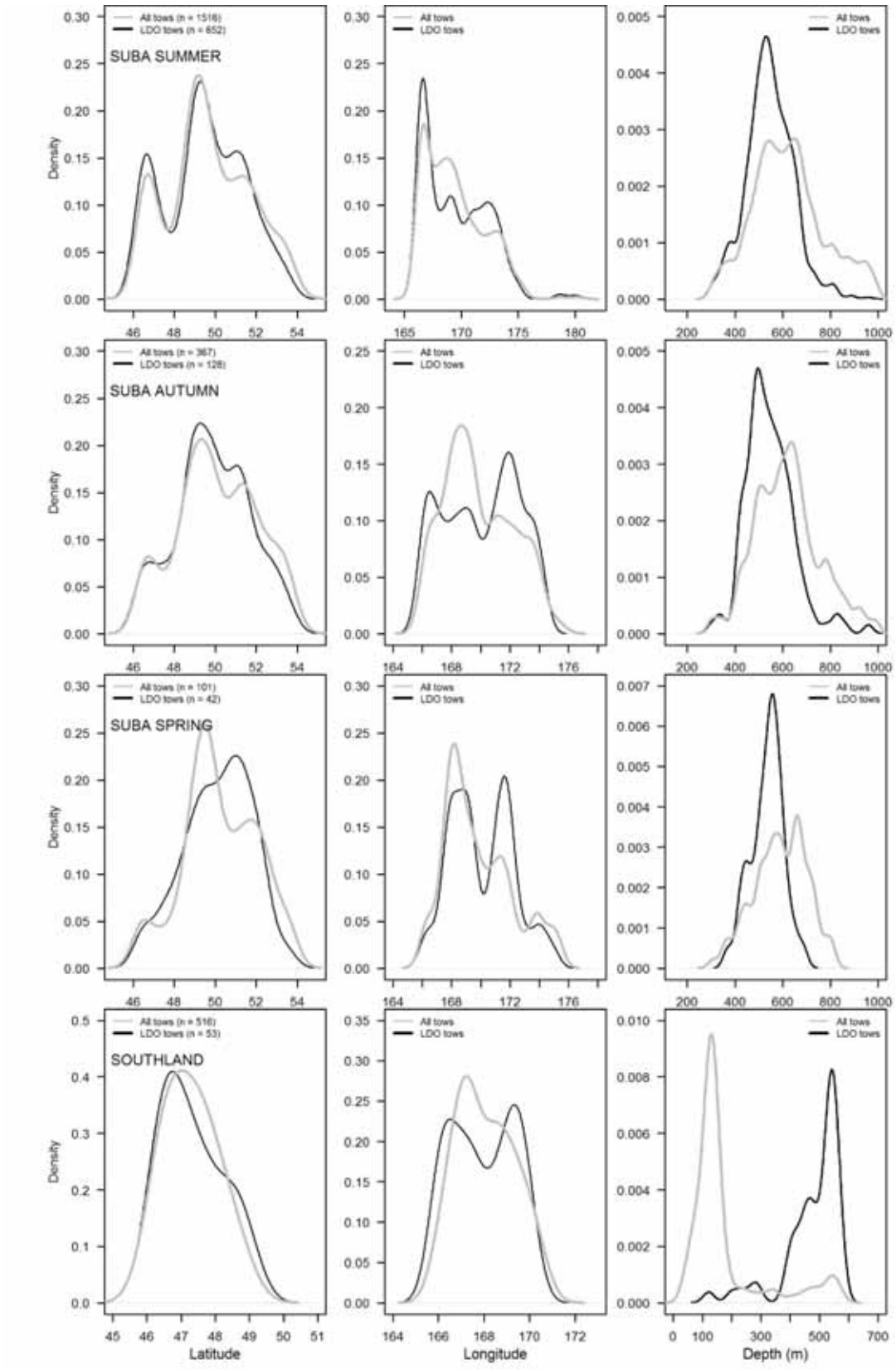


Figure A1: Distribution of *Tangaroa* trawl survey tows with catches of look down dory, for the Sub-Antarctic summer surveys (SUBA), and Southland (SOUTHLAND) late summer surveys, by latitude, longitude, and maximum depth of tow.

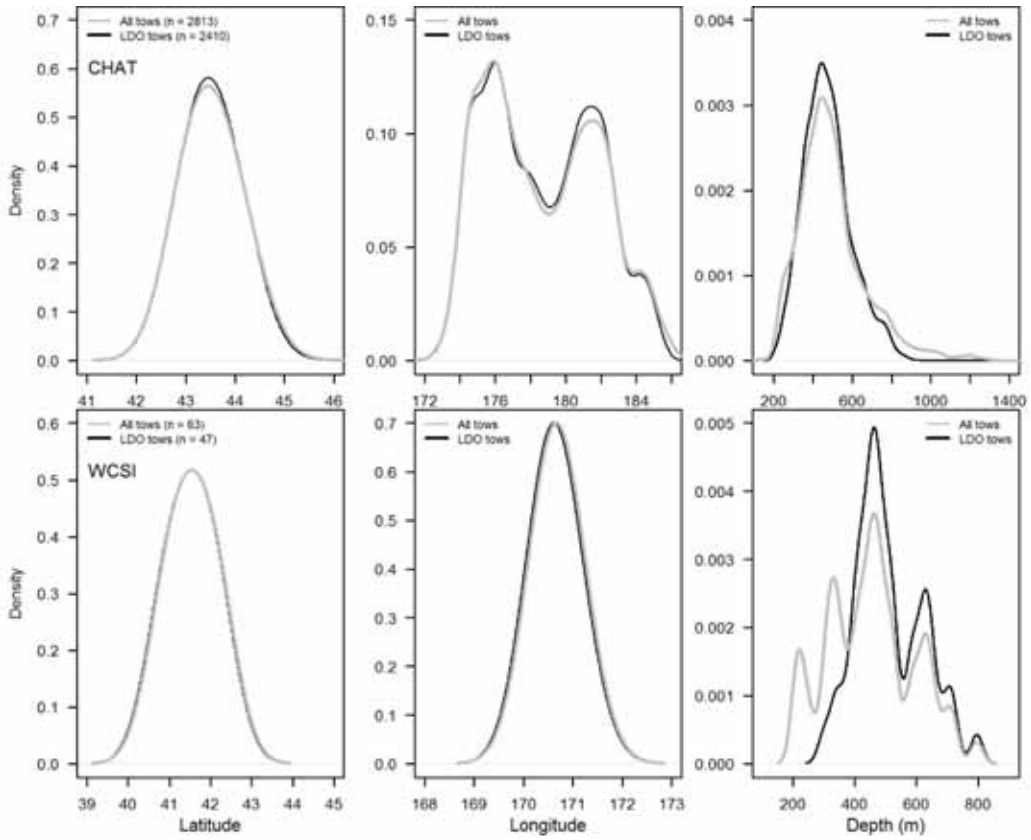


Figure A1 ctd.: Distribution of *Tangaroa* trawl survey tows with catches of look down dory, for the Chatham Rise summer surveys (CHAT), and WCSI (WCSI) surveys, by latitude, longitude, and maximum depth of tow.

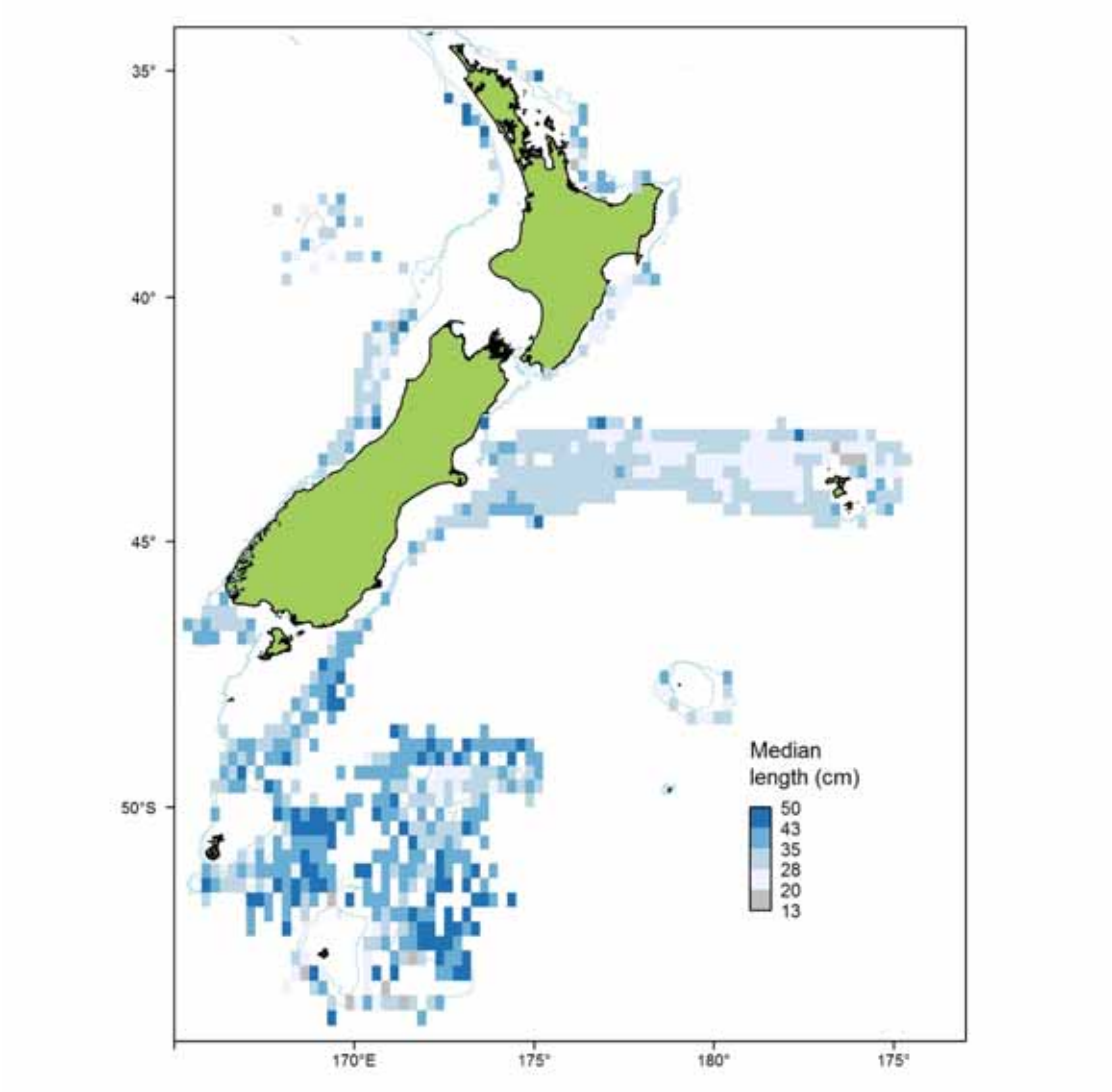


Figure A2: Distribution of lengths (median per 0.2° latitude × longitude cell) from 111 826 lookdown dory caught during trawl surveys completed between 1979 and 2013.

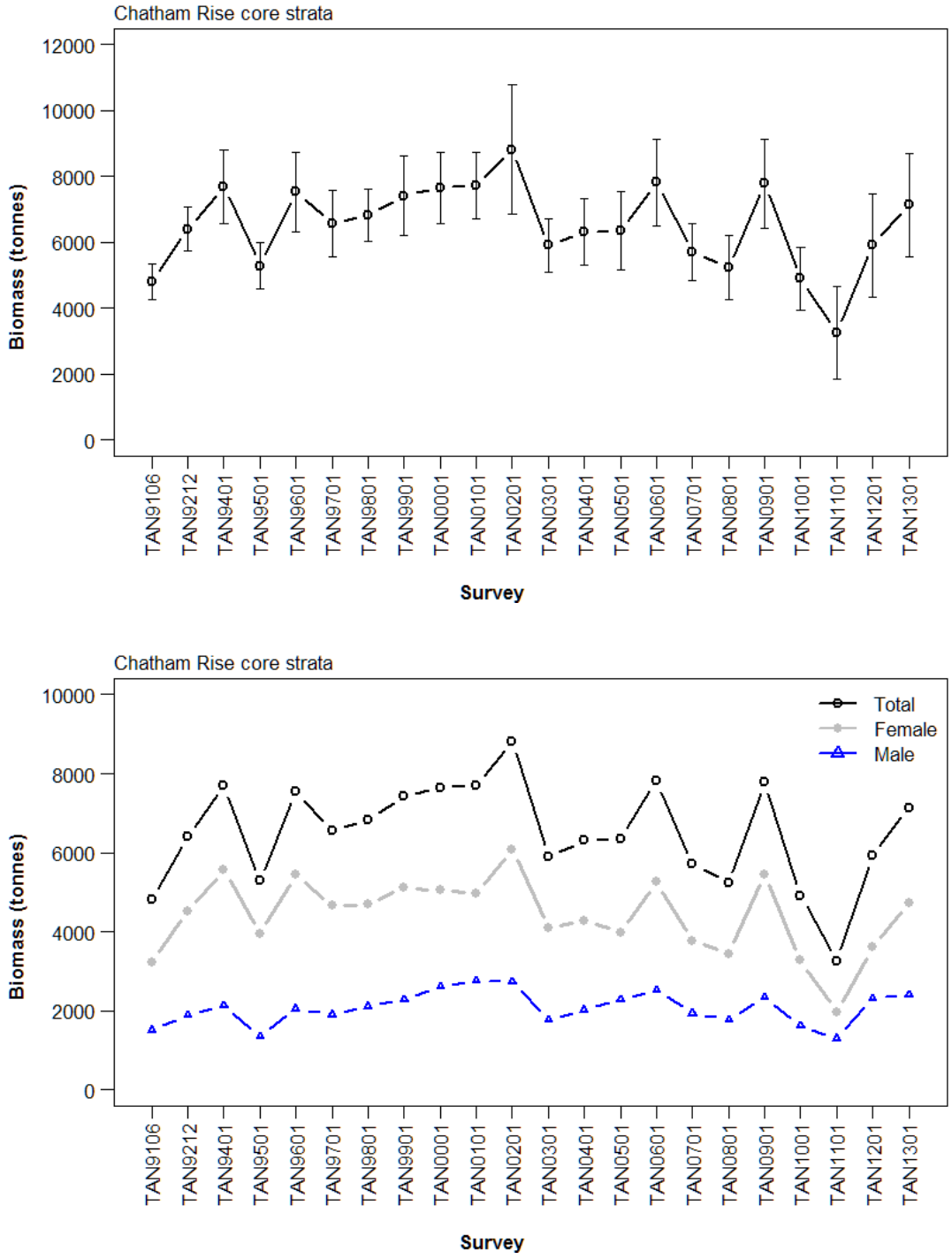


Figure A3. Doorspread biomass estimates, for all lookdown dory (± CV, top panel) and by sex (bottom panel), from the Chatham Rise *Tangaroa* surveys from 1991 to 2013.

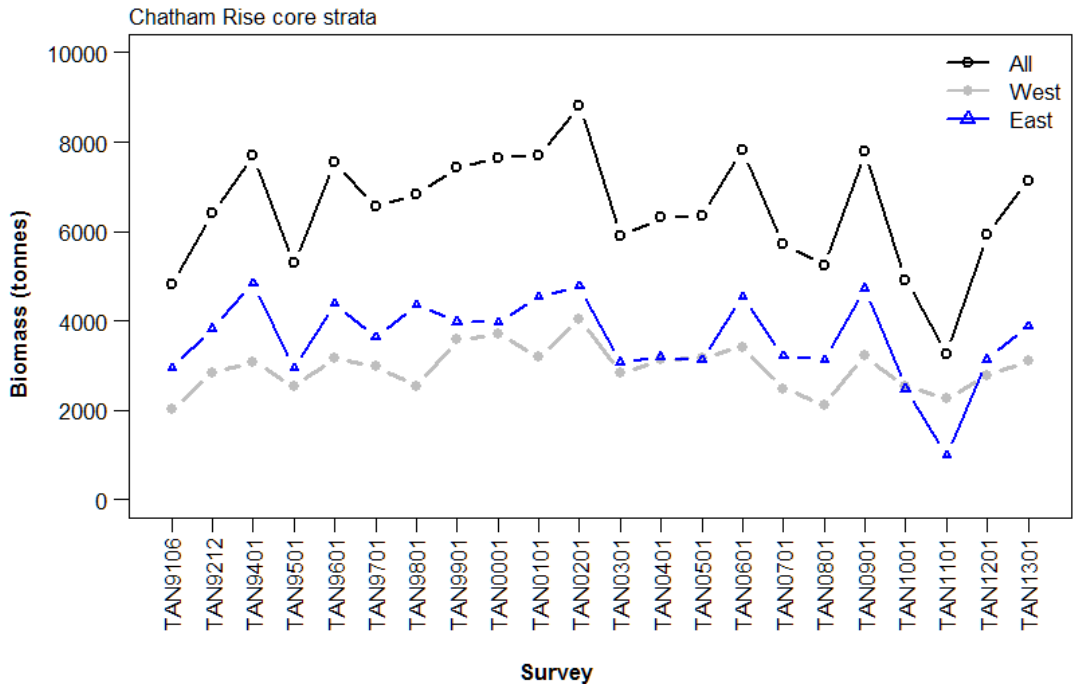


Figure A3 ctd.: Doorspread biomass estimates, for lookdown dory from the summer Chatham Rise *Tangaroa* surveys and for those catches from west or east of 180°, 1991 to 2013.

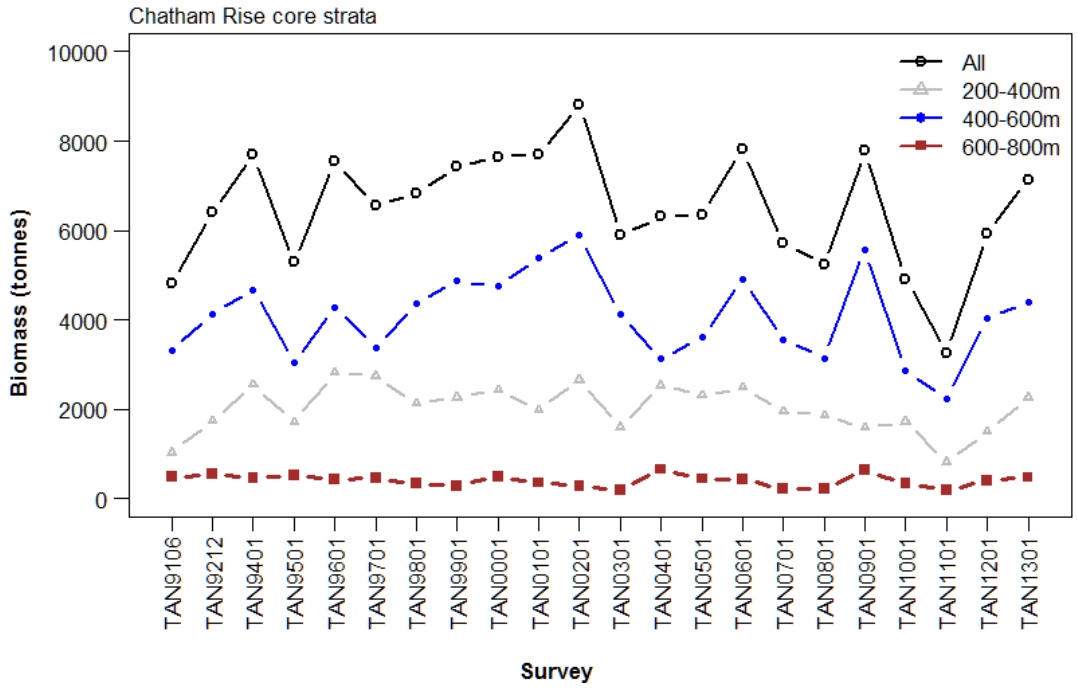


Figure A3 ctd.: Doorspread biomass estimates, for lookdown dory from the summer Chatham Rise *Tangaroa* surveys (200–800m) and for those catches from 200–400 m and 400–600 m, 1991 to 2013.

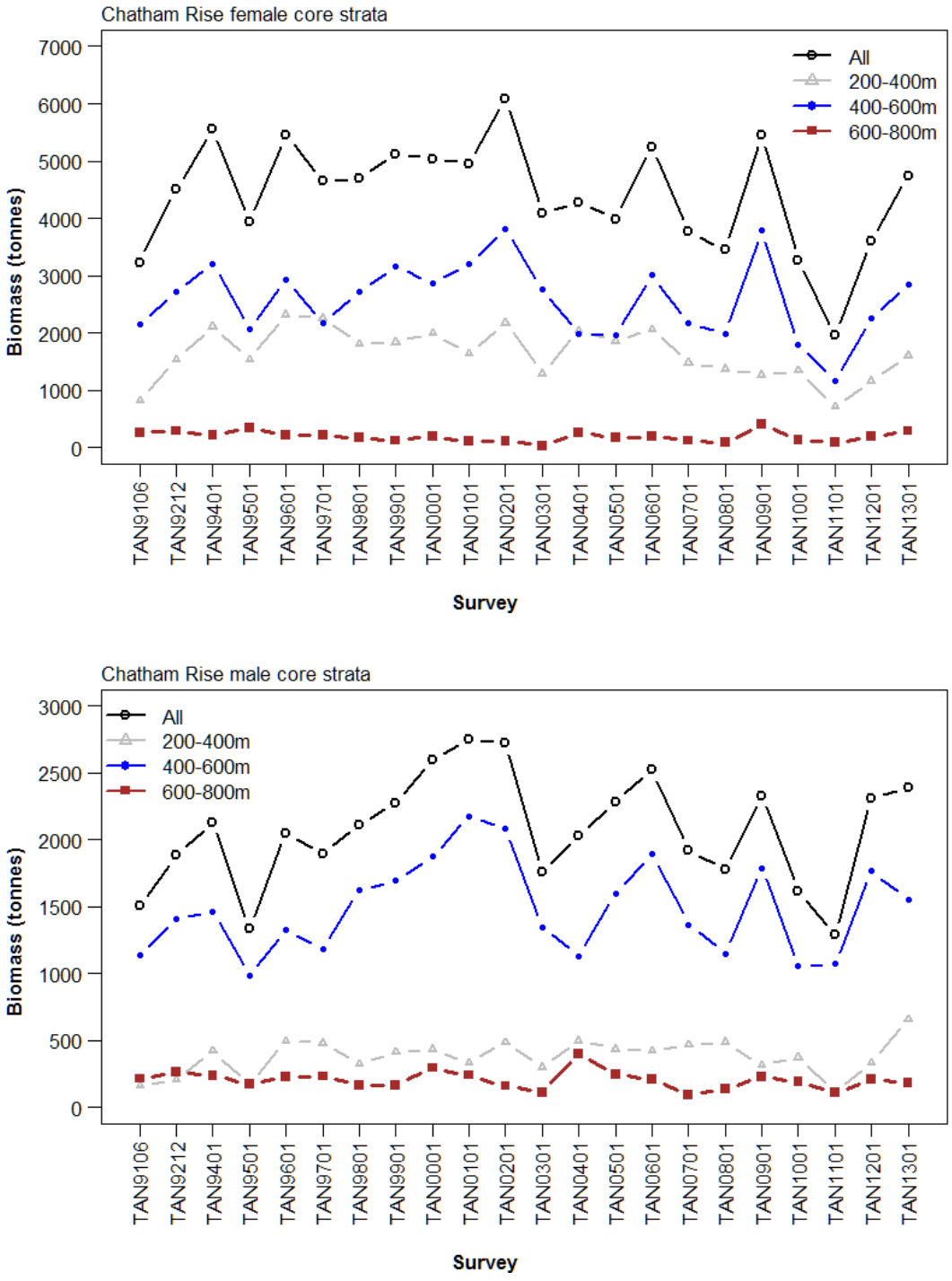
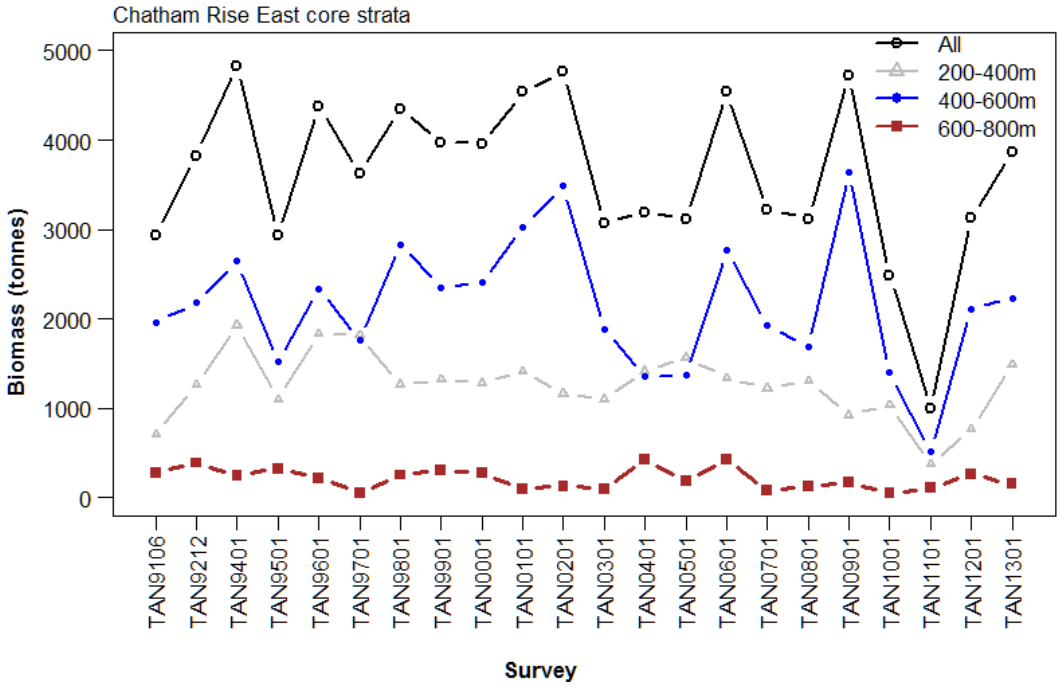


Figure A3 ctd.: Doorspread biomass estimates, for female and male lookdown dory from the summer Chatham Rise *Tangaroa* surveys (200–800m) and for those catches from 200–400 m and 400–600 m, 1991 to 2013.



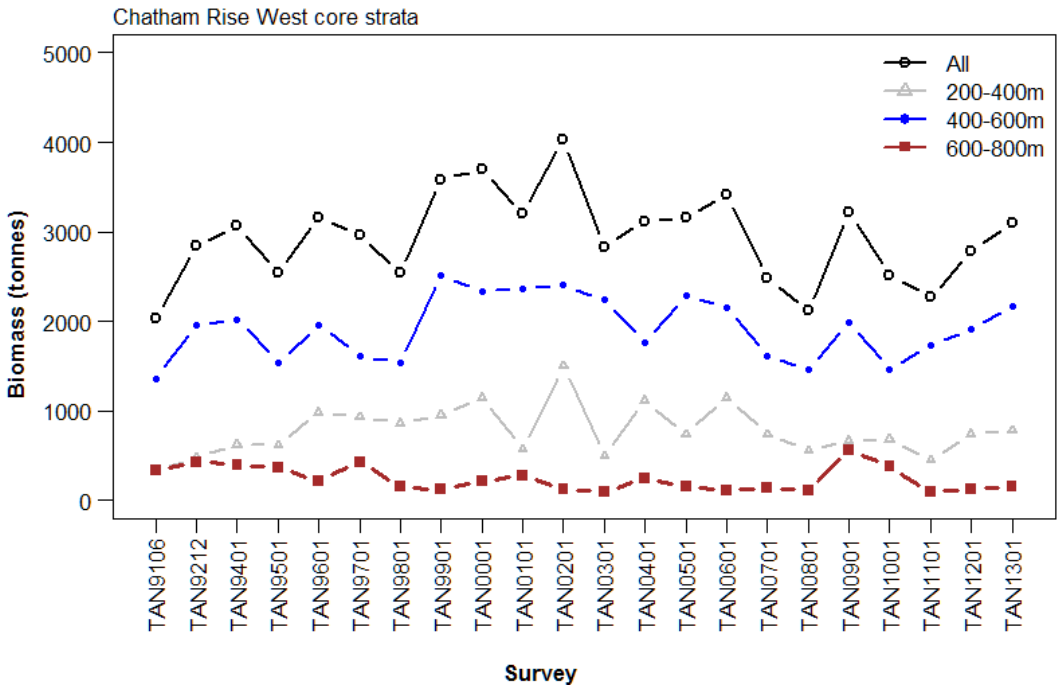


Figure A3 ctd.: Doorspread biomass estimates, for lookdown dory from the summer Chatham Rise *Tangaroa* surveys (200–800m) and for east and west catches from 200–400 m and 400–600 m, 1991 to 2013.

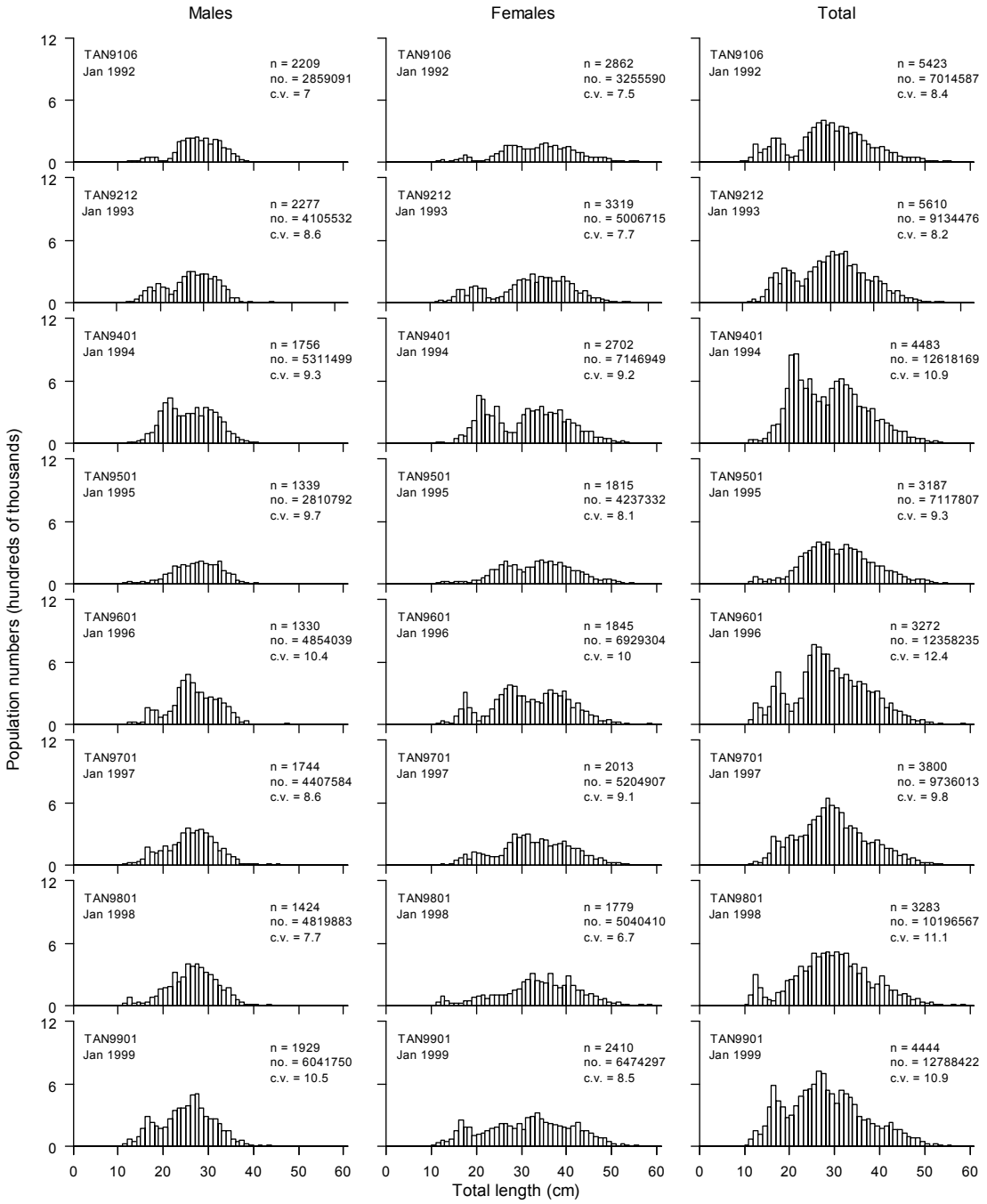


Figure A4: Scaled population length frequencies of lookdown dory from the Chatham Rise January *Tangaroa* (TAN) surveys, 1991 to 1999. [n = number of fish measured, no. = population number, c.v. = coefficient of variation.]

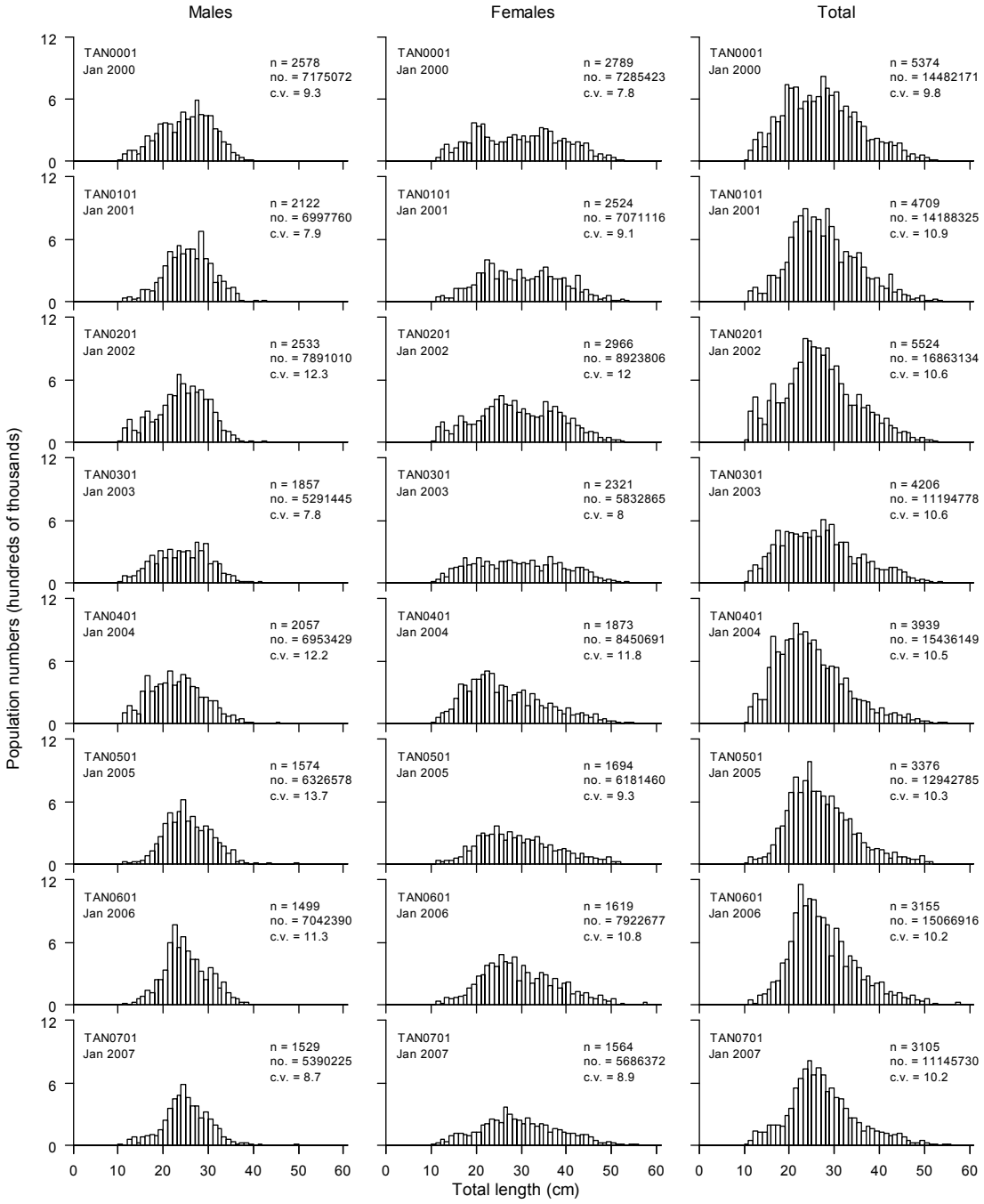


Figure A4 ctd.: Scaled population length frequencies of lookdown dory from the Chatham Rise January *Tangaroa* (TAN) surveys, 2000 to 2007. [n = number of fish measured, no. = population number, c.v. = coefficient of variation.]

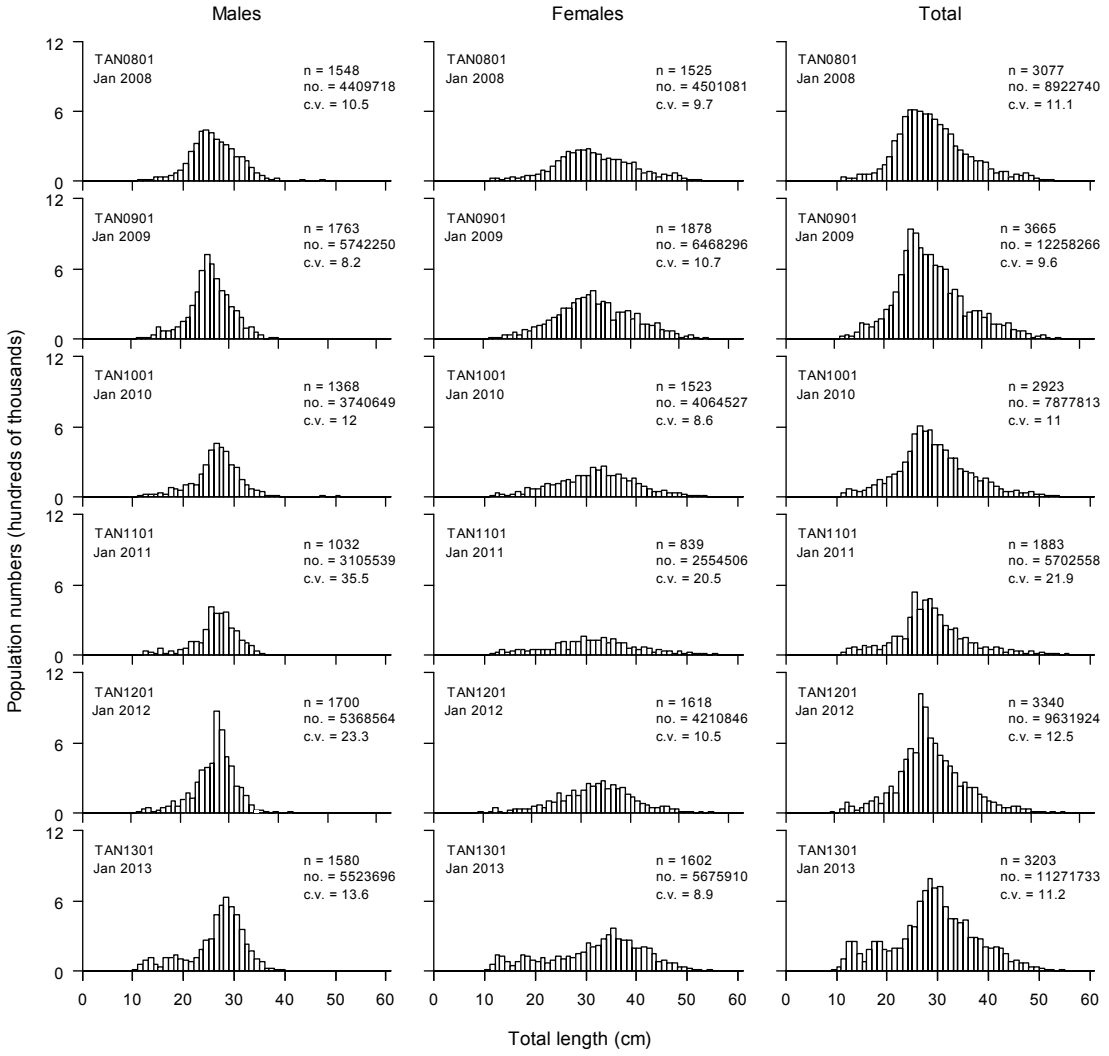


Figure A4 ctd.: Scaled population length frequencies of lookdown dory from the Chatham Rise January *Tangaroa* (TAN) surveys, 2008 to 2013. [n = number of fish measured, no. = population number, c.v. = coefficient of variation.]

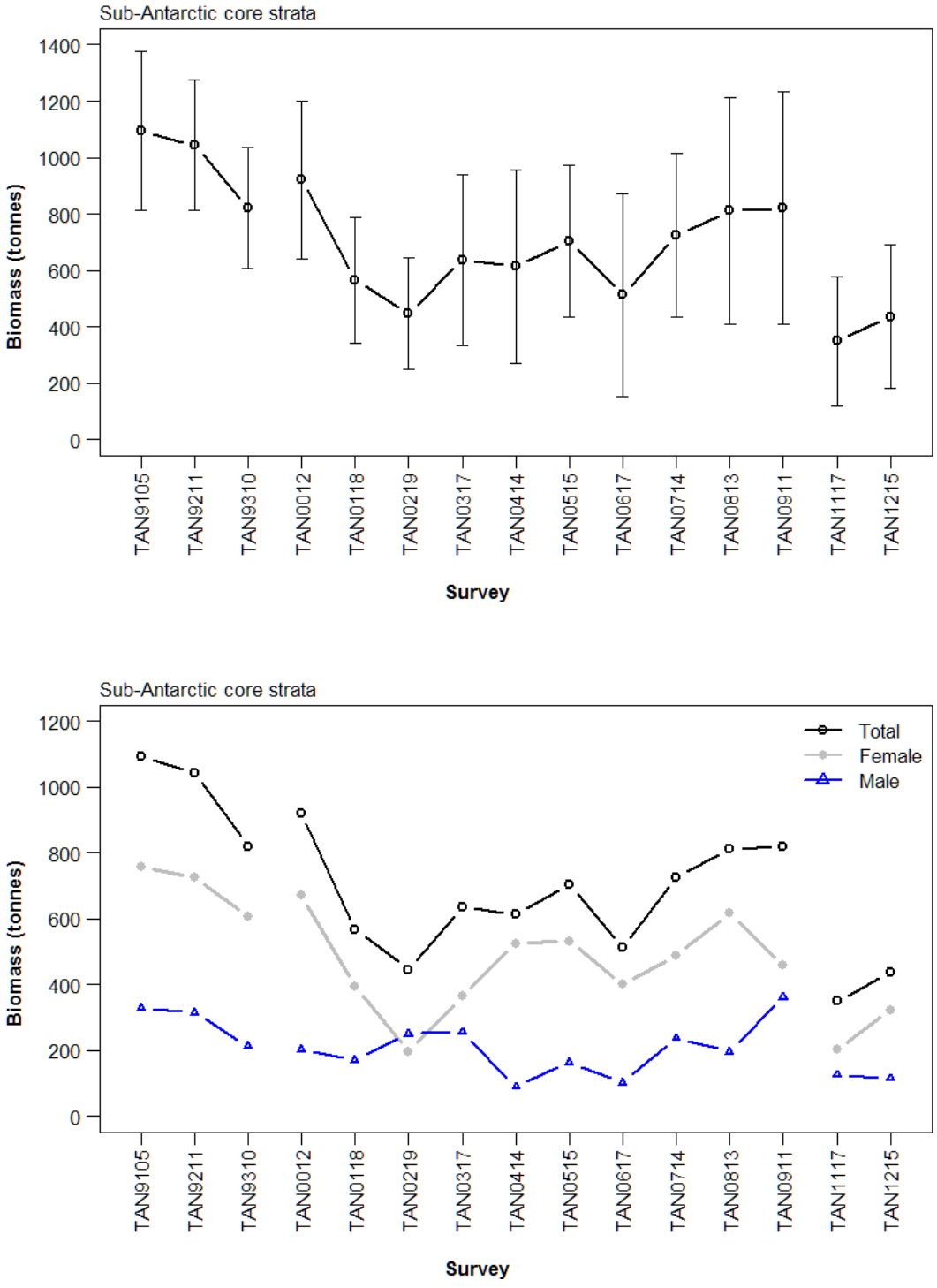


Figure A5: Doorspread biomass estimates, for all lookdown dory (± CV, top panel) and by sex (bottom panel), from summer *Tangaroa* surveys of Sub-Antarctic 1991–1993, 2000–2009, and 2011–2012.

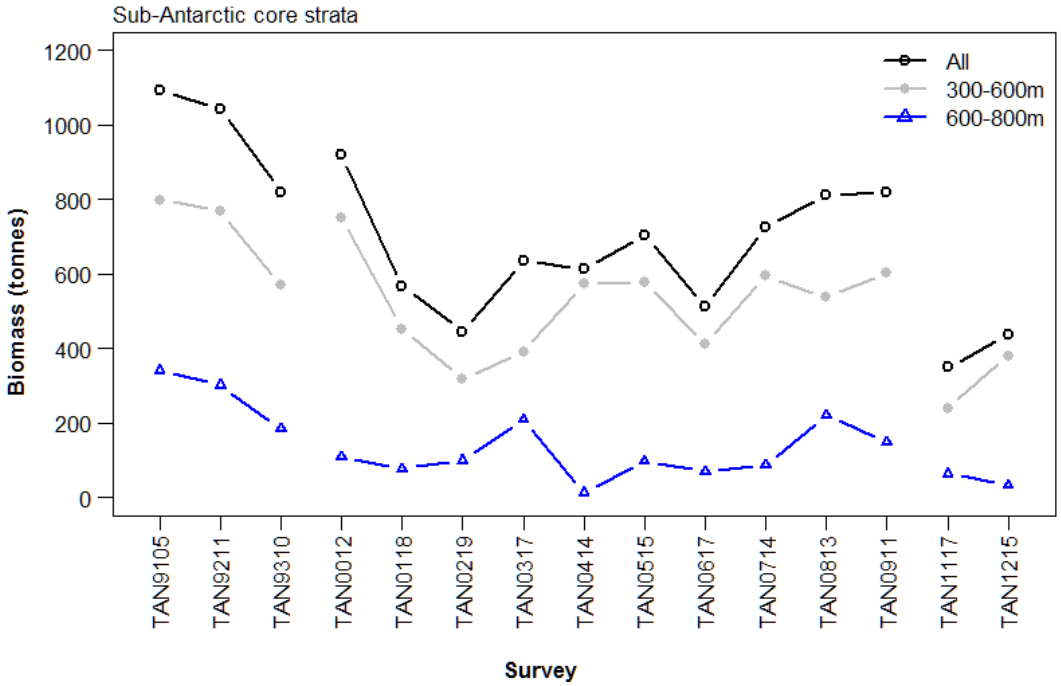


Figure A5 ctd.: Doorspread biomass estimates, for lookdown dory from summer Sub-Antarctic *Tangaroa* surveys (300–800m) and for those catches from 200–600 m and 600–800 m, from 1991–1993, 2000–2009, and 2011–2012.

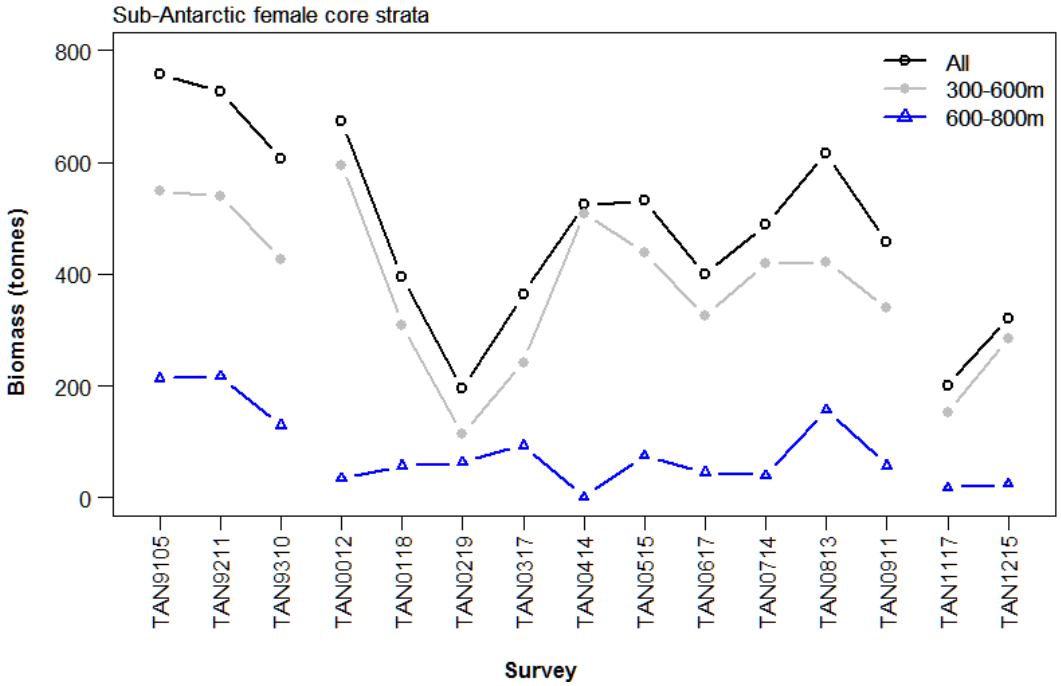


Figure A5 ctd.: Doorspread biomass estimates, for female lookdown dory from summer Sub-Antarctic *Tangaroa* surveys (300–800 m) and for those catches from 200–600 m and 600–800 m, from 1991–1993, 2000–2009, and 2011–2012.

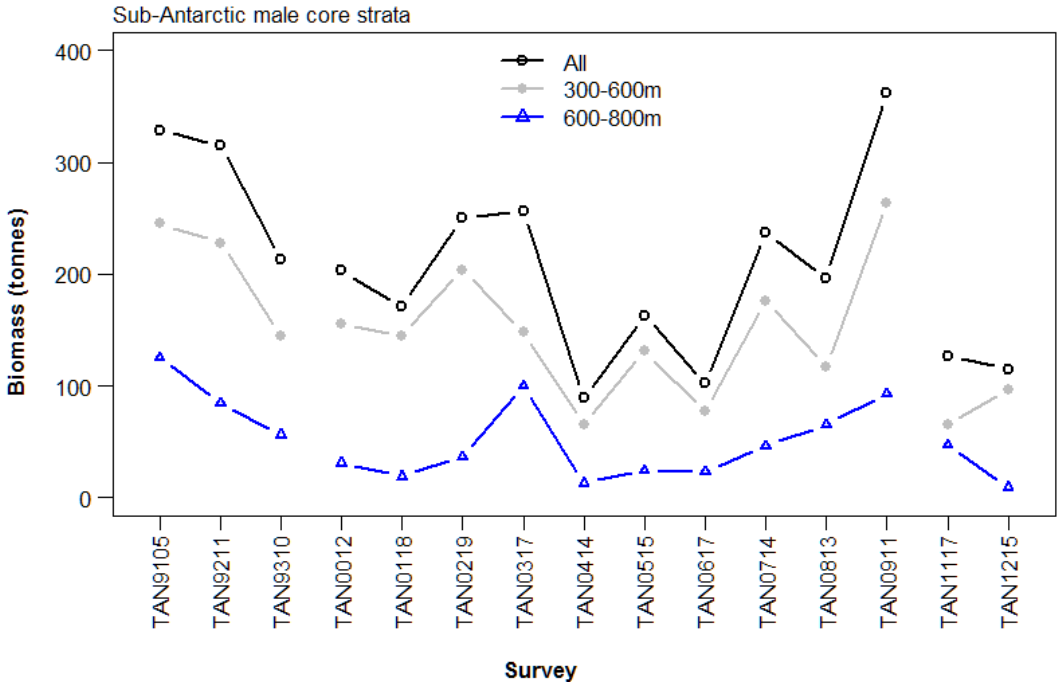


Figure A5 ctd.: Doorspread biomass estimates, for male lookdown dory from summer Sub-Antarctic *Tangaroa* surveys (300–800m) and for those catches from 200–600 m and 600–800 m, from 1991–1993, 2000–2009, and 2011–2012.

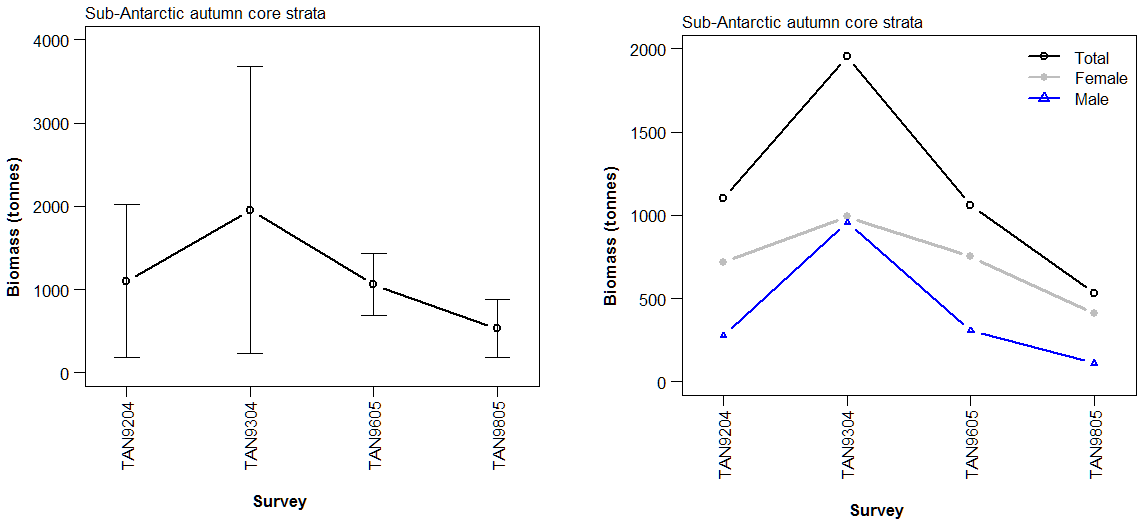


Figure A6: Doorspread biomass estimates, for all lookdown dory (± CV, above) and by sex, from autumn *Tangaroa* surveys of Sub-Antarctic from 1992–1993, 1996, and 1998.

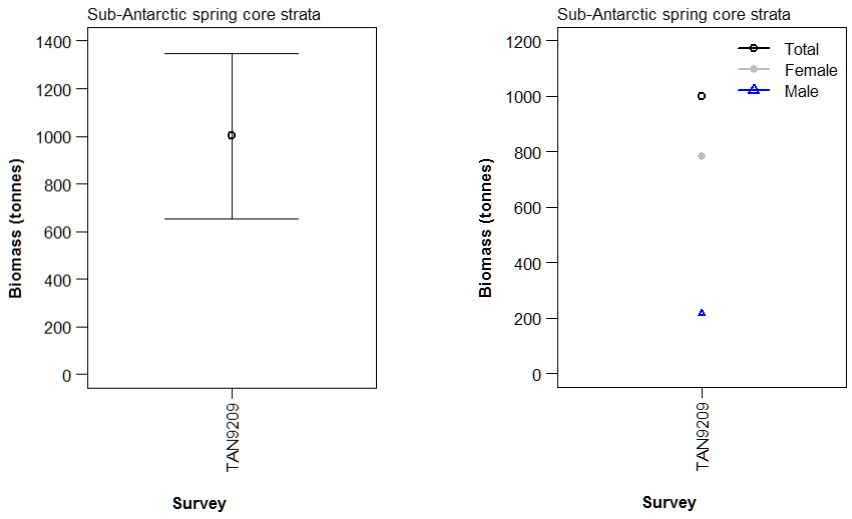


Figure A7: Doorspread biomass estimates, for all lookdown dory (± CV, above) and by sex (below), from the spring Sub-Antarctic Tangaroa survey from 1998.

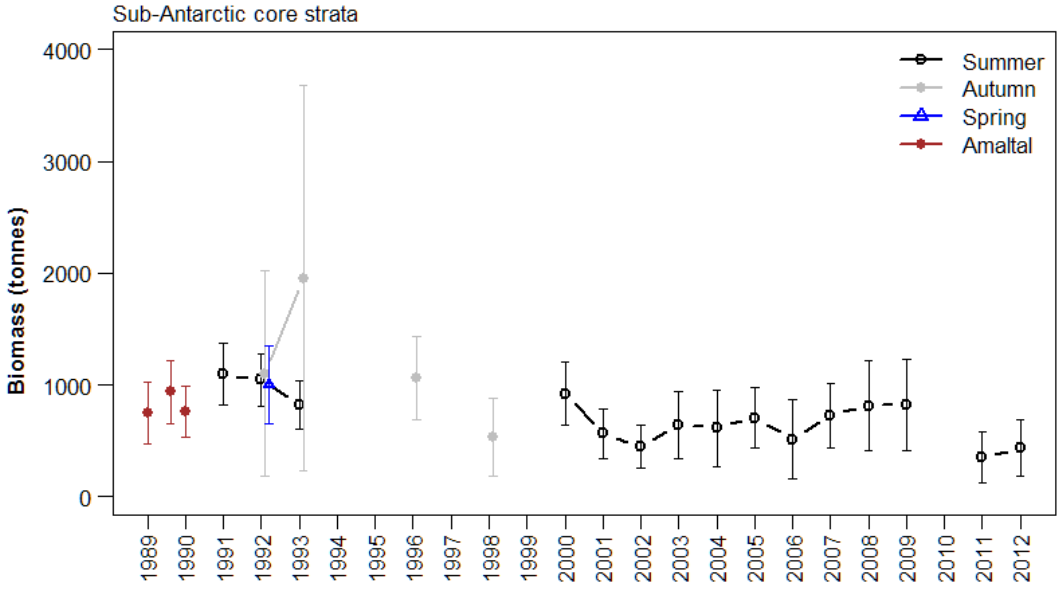


Figure A8: Doorspread biomass estimates of lookdown dory from the *Tangaroa* Sub-Antarctic November–December summer surveys, 2005–2009, and 2011–2012 (Summer); *Tangaroa* Sub-Antarctic autumn surveys from 1992–1993, 1996, and 1998 (Autumn); *Tangaroa* Sub-Antarctic spring survey from 1998 (Spring); and *Amaltal Explorer* Sub-Antarctic surveys in Oct–Nov 1989 and Jul–Aug and Nov–Dec 1990 (Amaltal).

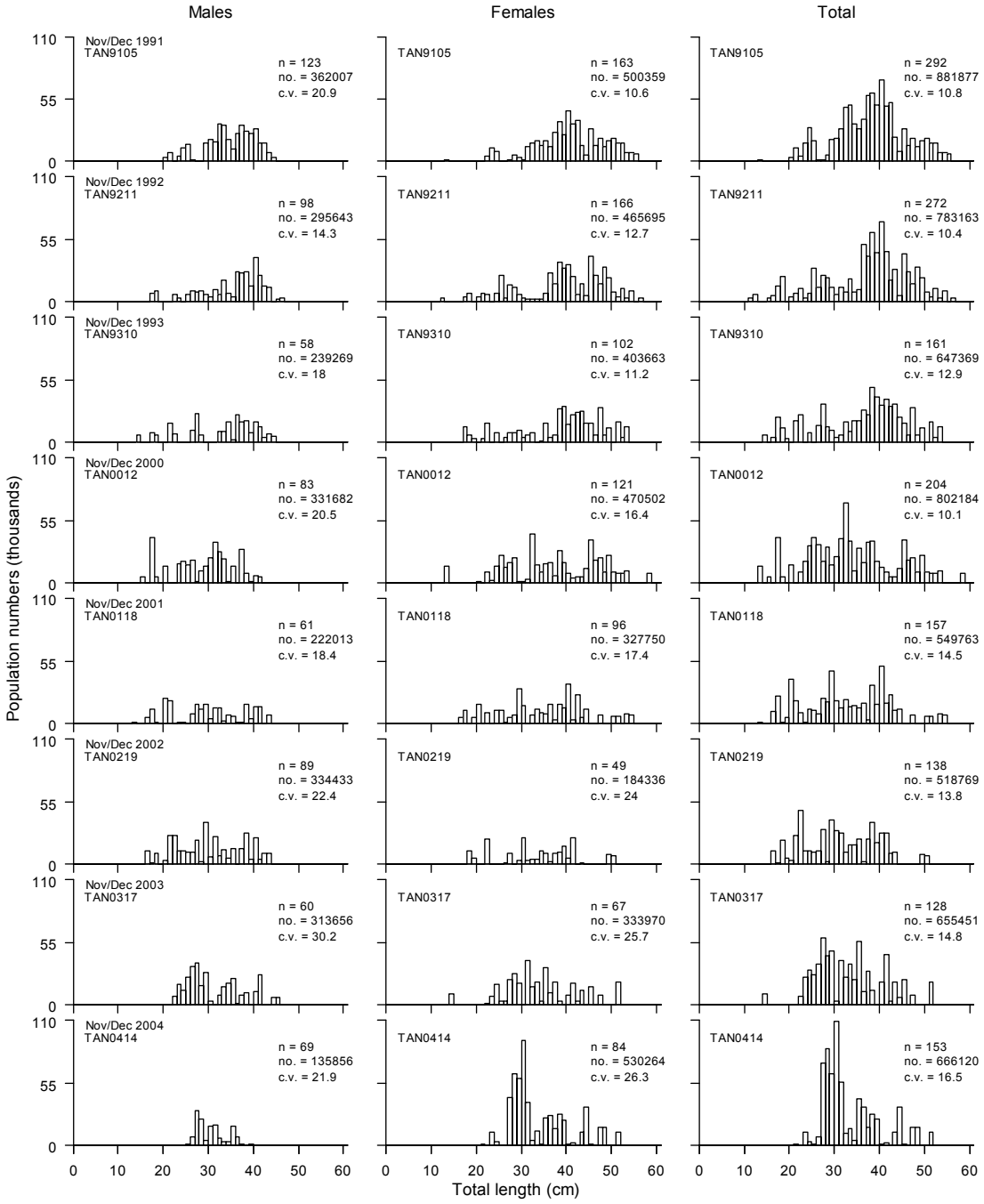


Figure A9: Scaled population length frequencies of lookdown dory from the Sub-Antarctic November–December *Tangaroa* (TAN) surveys, 1991–93 and 2000–04. [n = number of fish measured, no. = population number, c.v. = coefficient of variation.]

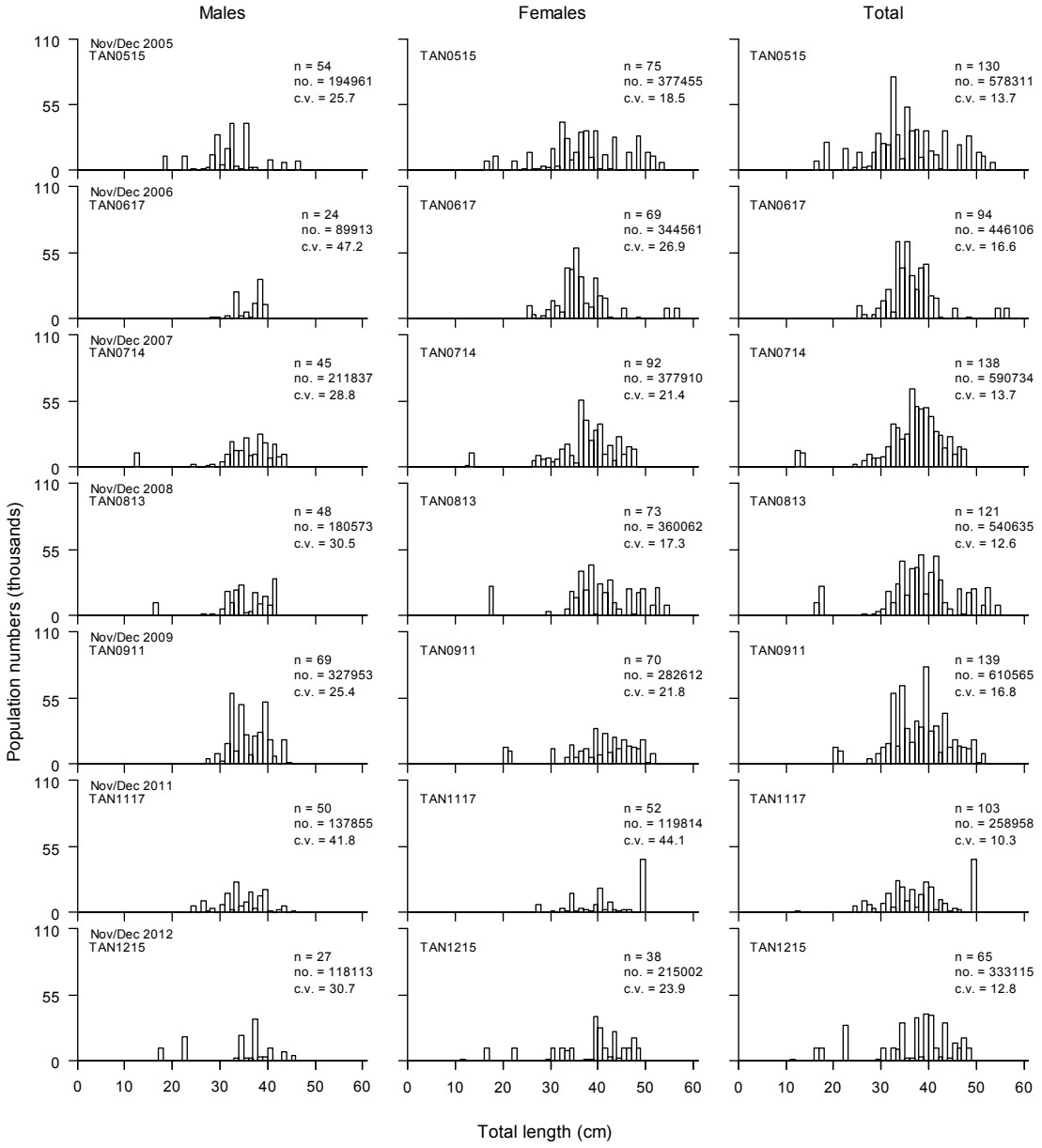


Figure A9 ctd.: Scaled population length frequencies of lookdown dory from the Sub-Antarctic November–December *Tangaroa* (TAN) surveys, 2005–2009, and 2011–2012. [n = number of fish measured, no. = population number, c.v. = coefficient of variation.]

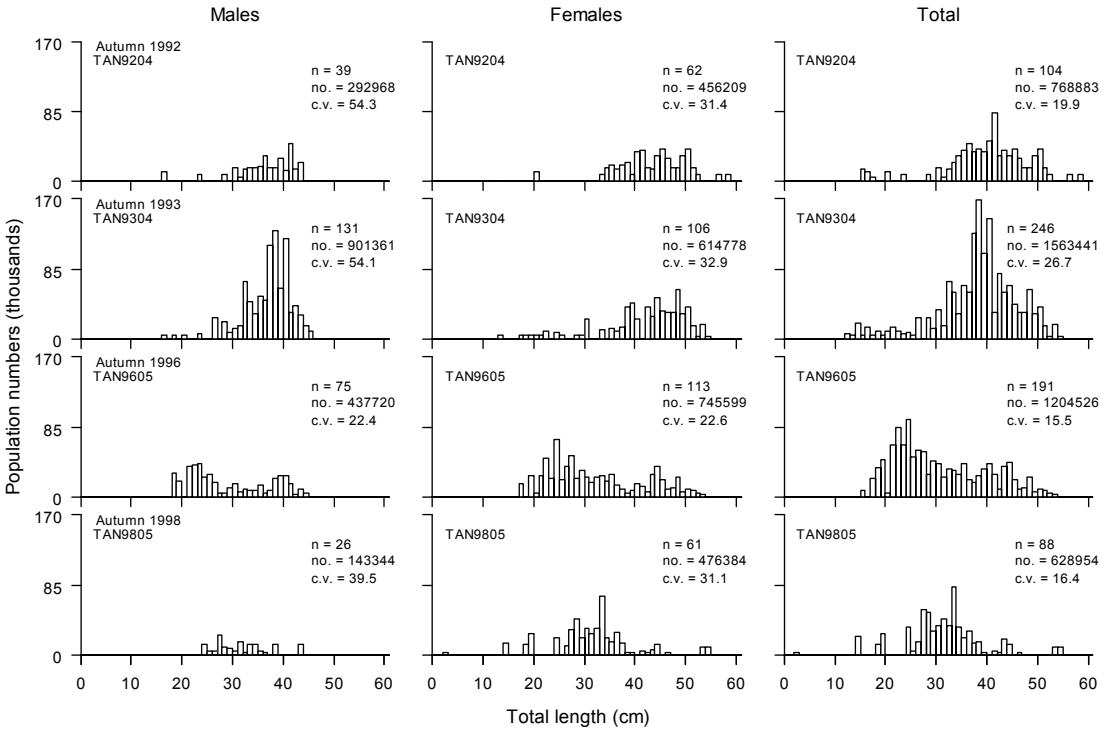


Figure A10: Scaled population length frequencies of lookdown dory from the Sub-Antarctic Autumn *Tangaroa* (TAN) surveys, 1992–1993, 1996, and 1998. [n = number of fish measured, no. = population number, c.v. = coefficient of variation.]

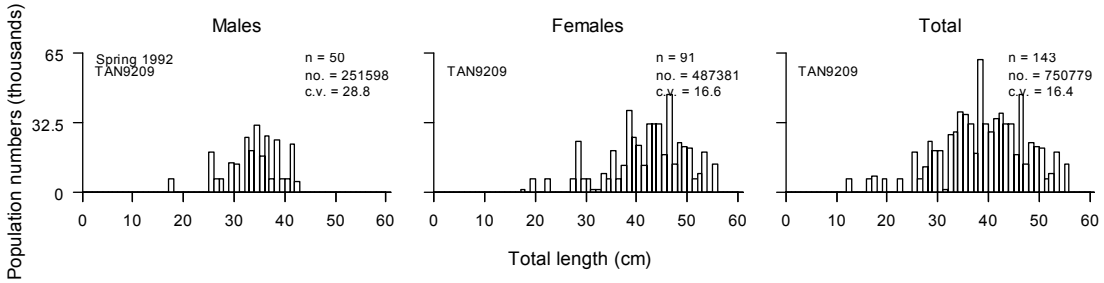


Figure A11: Scaled population length frequencies of lookdown dory from the Sub-Antarctic Spring *Tangaroa* (TAN) survey, 1998. [n = number of fish measured, no. = population number, c.v. = coefficient of variation.]

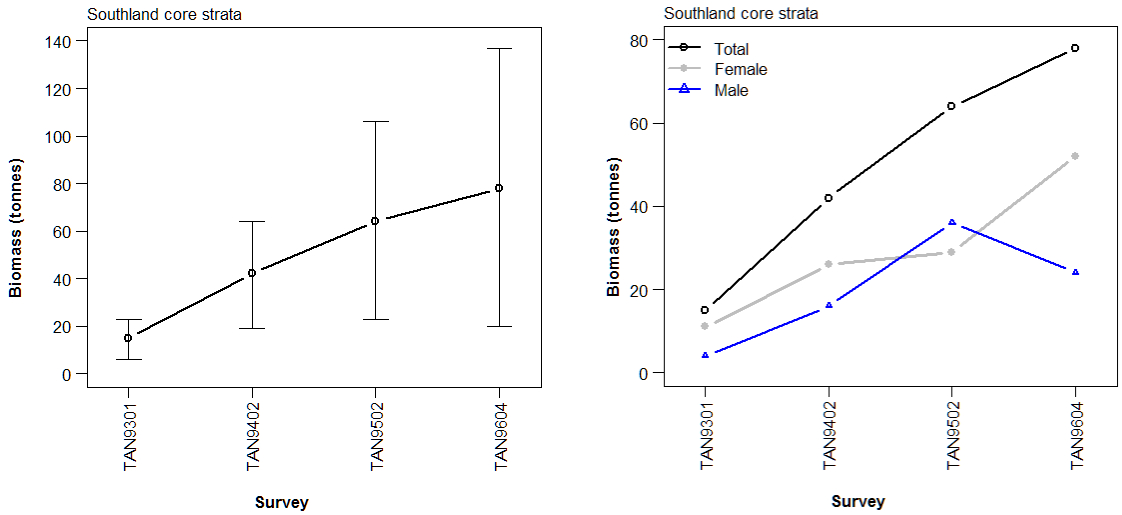


Figure A12: Doorspread biomass estimates, for all lookdown dory (± CV, left panel) and by sex (right panel), from the February–March Southland *Tangaroa* surveys 1993–96.

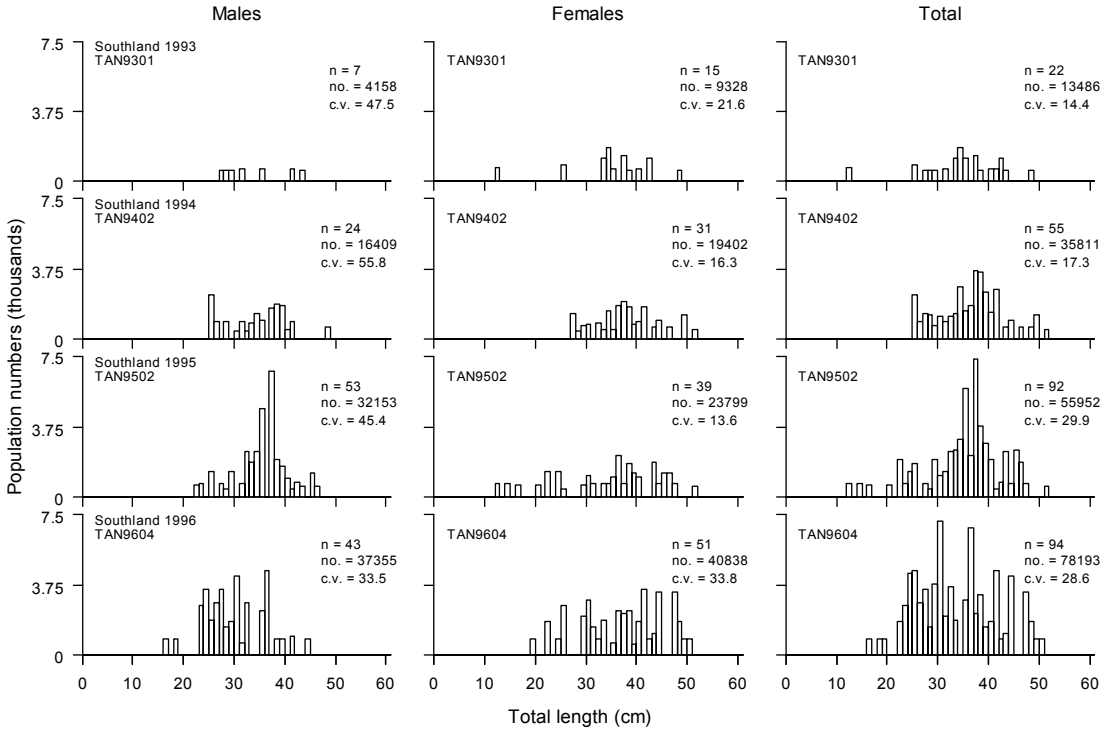


Figure A13: Scaled population length frequencies of lookdown dory from the Southland February–March *Tangaroa* (TAN) surveys, 1993–96. [n = number of fish measured, no. = population number, c.v. = coefficient of variation.]

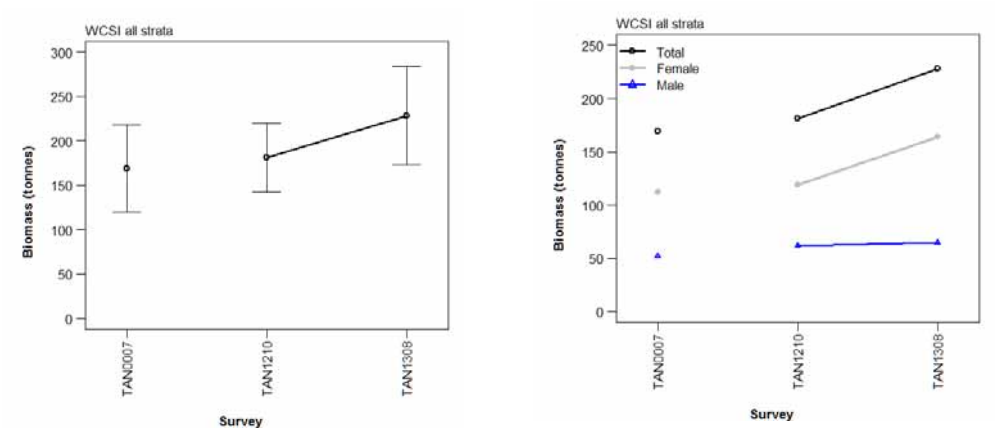


Figure A14: Doorspread biomass estimates, for all lookdown dory (± CV, left panel) and by sex (right panel), from the winter WCSI *Tangaroa* surveys 2000, and 2012–2013. (Note TAN0007 is 300–650 m core strata), and TAN1210 and TAN1308 are all 200–800 m strata).

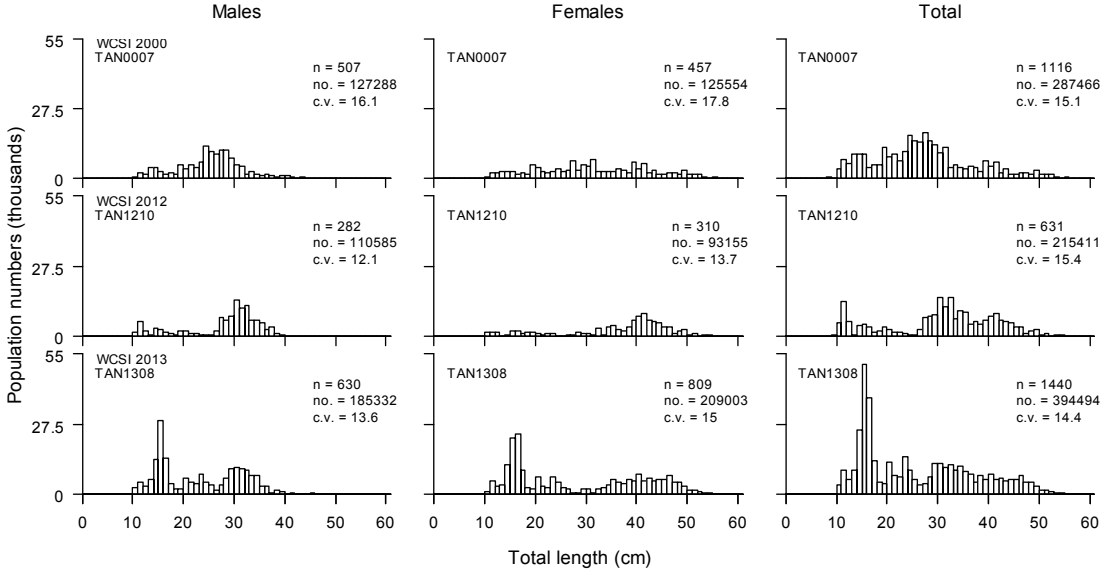


Figure A15: Scaled population length frequencies of lookdown dory from the winter WCSI *Tangaroa* (TAN) surveys, 2000, and 2012–2013. [n = number of fish measured, no. = population number, c.v. = coefficient of variation.] (Note TAN0007 is 300–650 m core strata), and TAN1210 and TAN1308 are 200–800 m strata).

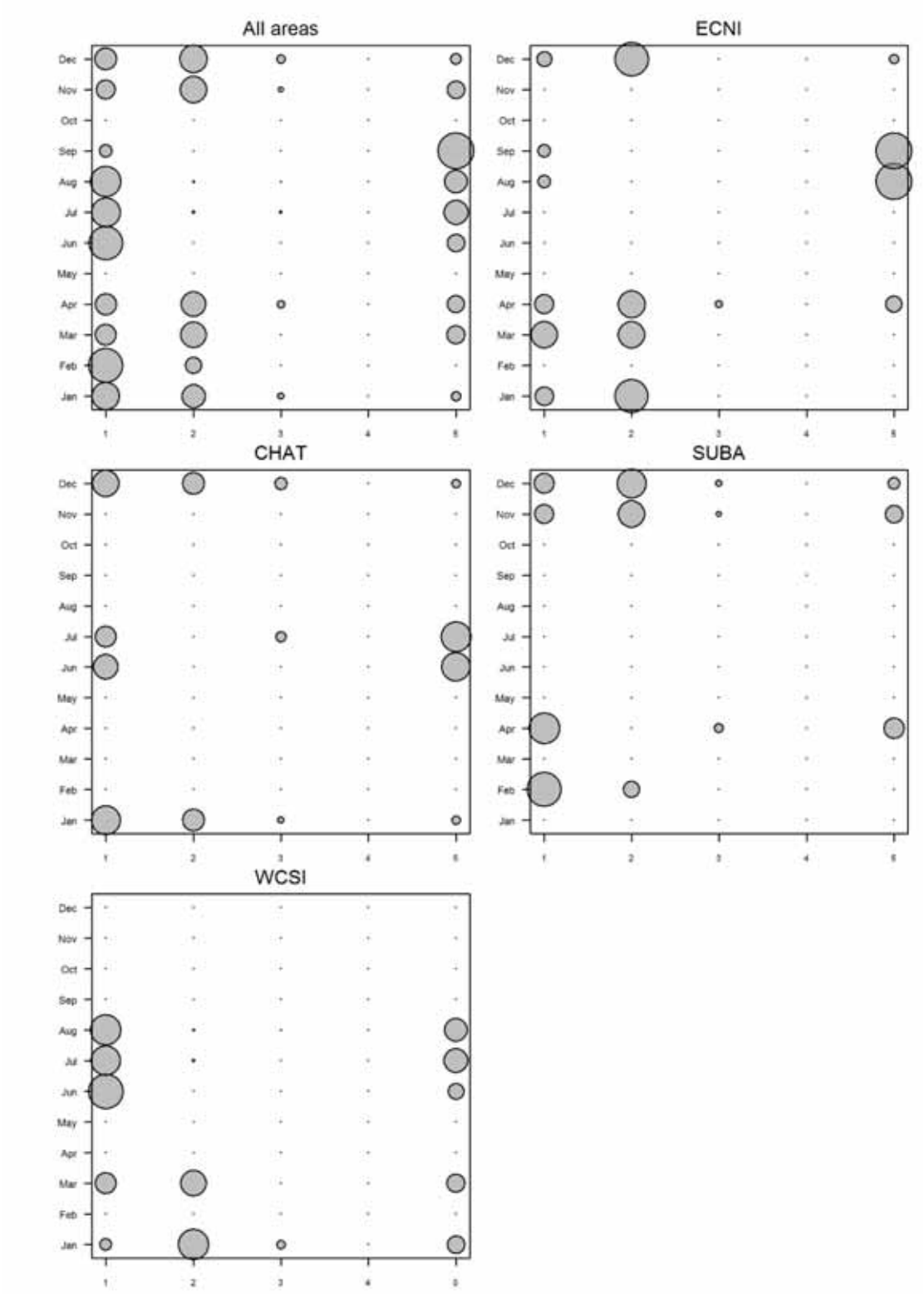


Figure A16: Relative proportions of female lookdown dory reproductive stage data from trawl surveys, by month for each area.

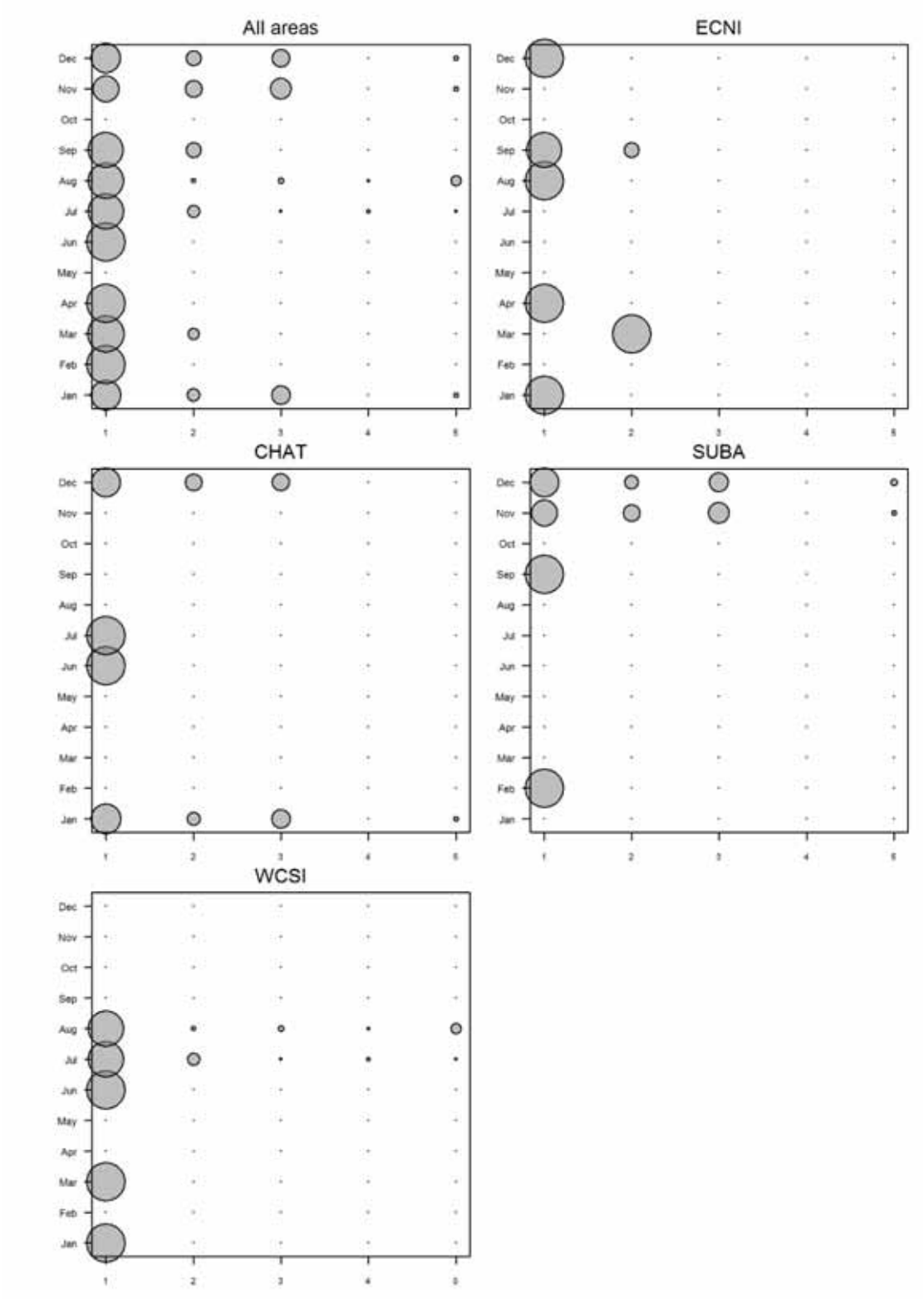


Figure A16: ctd. Relative proportions of male lookdown dory reproductive stage data from trawl surveys, by month for each area.

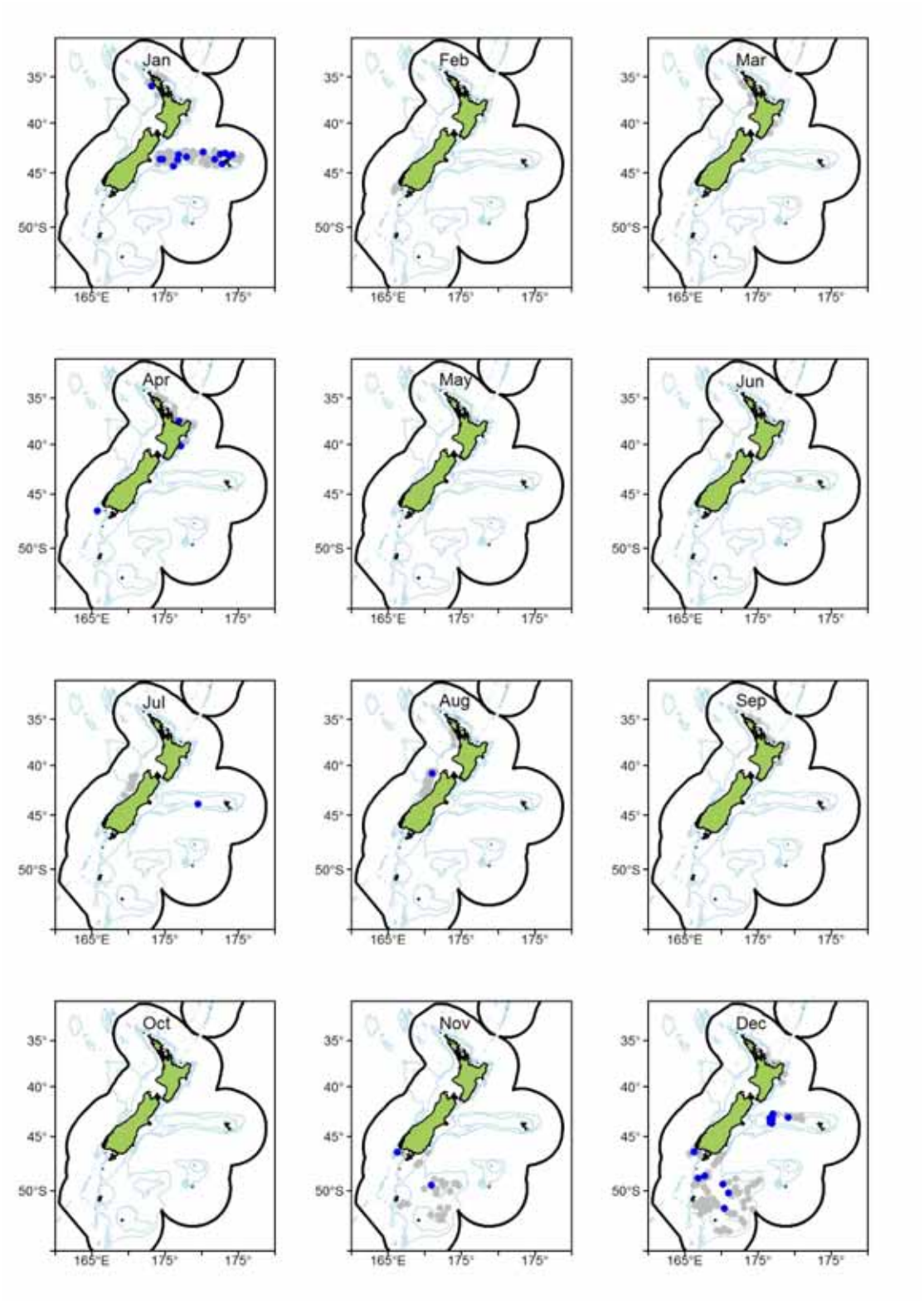


Figure A17: Distribution of female lookdown dory reproductive stage data from trawl surveys, by month. [Grey = immature, resting, maturing or spent; Blue = ripe; and Red = running ripe.]

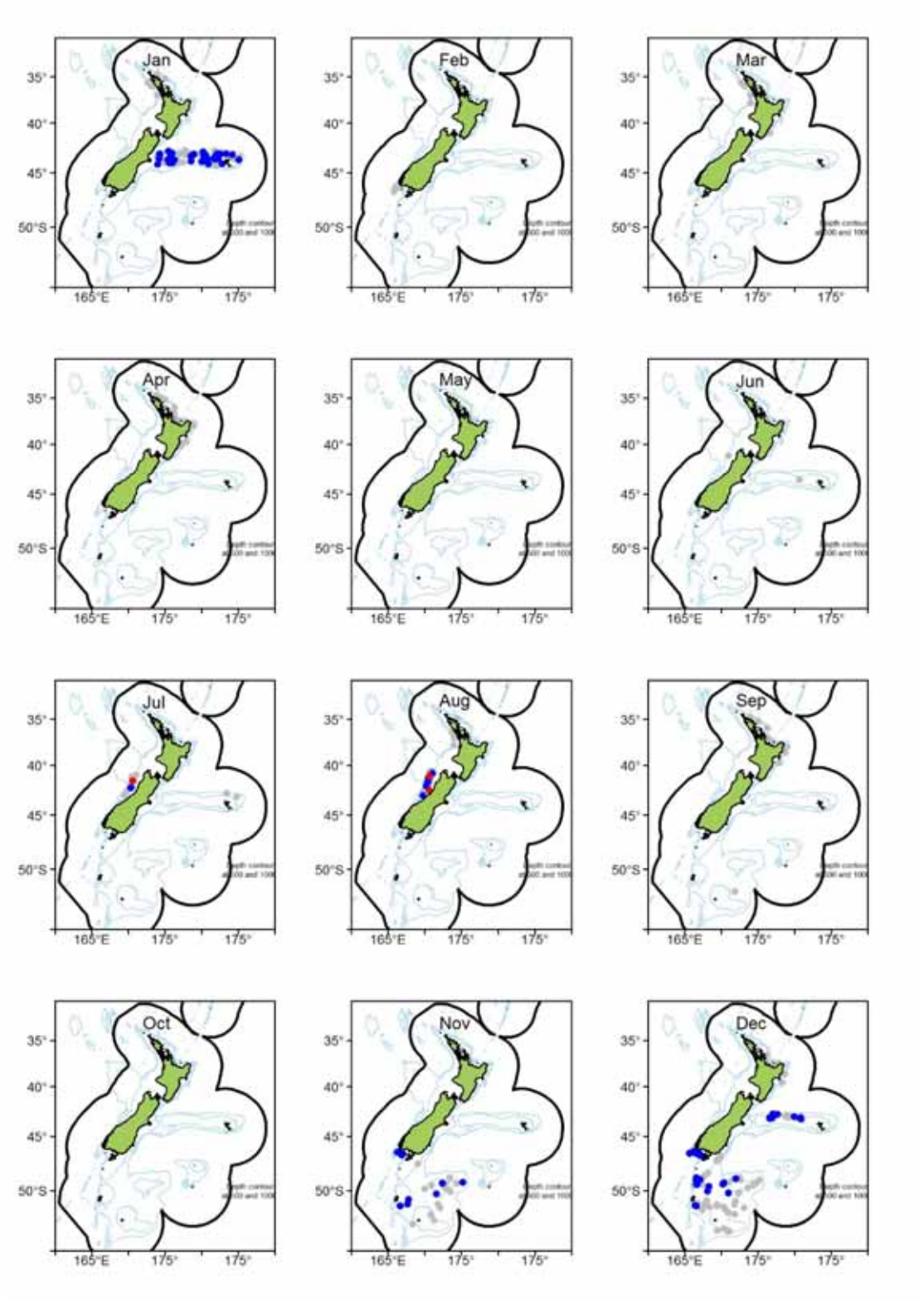


Figure A17: ctd. Distribution of male lookdown dory reproductive stage data from trawl surveys, by month. [Grey = immature, resting, maturing or spent; Blue = ripe; and Red = running ripe.]

APPENDIX B. OBSERVER DATA

Table B1: Total number of observed trawl catches and tows sampled for lookdown dory, by area for fishing years 1990–91 to 2011–12.

(a) Tows

Fishing	Fishery areas				
year	ECNI	CHAT	SUBA	WCSI	Total
1990–91	135	636	95	453	1 319
1991–92	40	494	517	291	1 342
1992–93	66	209	211	418	904
1993–94	78	771	188	378	1 415
1994–95	106	411	96	269	882
1995–96	66	310	115	242	733
1996–97	45	225	164	185	619
1997–98	33	1 041	113	238	1 425
1998–99	87	1 105	152	371	1 715
1999–00	104	641	235	414	1 394
2000–01	55	932	362	374	1 723
2001–02	81	874	318	747	2 020
2002–03	25	805	284	424	1 538
2003–04	1	588	246	666	1 501
2004–05	10	698	75	308	1 091
2005–06	41	626	215	581	1 463
2006–07	47	842	260	247	1 396
2007–08	140	752	353	493	1 738
2008–09	55	560	358	344	1 317
2009–10	78	640	519	421	1 658
2010–11	70	741	386	362	1 559
2011–12	118	875	404	439	1 836
Total	1 481	14 776	5 666	8 665	30 588

(b) Catches

Fishing	Fishery areas				
year	ECNI	CHAT	SUBA	WCSI	Total
1990–91	1	33	1	15	50
1991–92	0	23	7	13	42
1992–93	0	8	3	12	23
1993–94	1	32	2	13	49
1994–95	2	12	1	10	24
1995–96	4	13	1	6	24
1996–97	1	7	3	4	15
1997–98	1	34	2	9	46
1998–99	1	64	5	15	85
1999–00	1	20	4	14	39
2000–01	1	60	7	10	78
2001–02	1	50	5	44	99
2002–03	1	58	5	18	82
2003–04	0	30	4	21	55
2004–05	0	49	2	10	61
2005–06	0	32	4	34	70
2006–07	0	52	6	10	69
2007–08	1	23	7	24	55
2008–09	0	22	7	14	44
2009–10	1	32	9	14	56
2010–11	0	29	7	24	61
2011–12	1	45	10	15	71
Total	17	729	102	350	1 197

Table B2: Total number of observed trawl tows sampled for lookdown dory, by area, for fishing years 2001–02 to 2011–12. Note: Numbers of tows sampled are higher than values on the length frequency plots because this table includes tows where fewer than five fish were sampled. Areas defined in Figure 3.

Fishing	Fishery areas				
year	ECNI	CHAT	SUBA	WCSI	Total
2001–02	3	-	-	3	6
2002–03	-	4	-	-	4
2003–04	-	14	-	8	22
2004–05	-	44	2	15	61
2005–06	-	9	5	21	35
2006–07	-	37	1	9	47
2007–08	4	18	5	14	41
2008–09	-	5	1	3	9
2009–10	-	42	-	1	43
2010–11	-	34	11	5	50
2011–12	-	49	1	2	52
Total	7	256	26	81	370

Table B3: Number of observed tows sampled for lookdown dory, by month, for fishing years 2001–02 to 2011–12 where data exist.

Fishing	Fishery areas												
year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
2001–02	-	-	-	-	-	-	-	-	-	3	3	-	6
2002–03	-	2	2	-	-	-	-	-	-	-	-	-	4
2003–04	-	-	-	-	-	-	-	-	-	-	15	7	22
2004–05	1	5	1	5	16	21	-	-	-	7	3	2	61
2005–06	-	1	2	-	-	-	-	-	14	10	5	3	35
2006–07	2	5	2	10	5	4	1	7	2	4	2	3	47
2007–08	-	6	-	1	5	1	1	11	2	2	7	5	41
2008–09	-	-	5	-	-	-	-	-	1	3	-	-	9
2009–10	4	1	16	21	-	-	-	-	-	-	1	-	43
2010–11	6	1	1	9	14	6	6	1	5	1	-	-	50
2011–12	-	4	33	-	3	7	-	-	2	-	1	2	52
Total	13	25	62	46	43	39	8	19	26	30	37	22	370

Table B4: Number of observed tows sampled for lookdown dory, by month, for fishing years 2001–02 to 2011–12 where data exist. Areas defined in Figure 3.

(a) ECNI

Fishing year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
2001–02	-	-	-	-	-	-	-	-	-	3	-	-	3
2002–03	-	-	-	-	-	-	-	-	-	-	-	-	-
2003–04	-	-	-	-	-	-	-	-	-	-	-	-	-
2004–05	-	-	-	-	-	-	-	-	-	-	-	-	-
2005–06	-	-	-	-	-	-	-	-	-	-	-	-	-
2006–07	-	-	-	-	-	-	-	-	-	-	-	-	-
2007–08	-	2	-	-	-	1	1	-	-	-	-	-	4
2008–09	-	-	-	-	-	-	-	-	-	-	-	-	-
2009–10	-	-	-	-	-	-	-	-	-	-	-	-	-
2010–11	-	-	-	-	-	-	-	-	-	-	-	-	-
2011–12	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	-	2	-	-	-	1	1	-	-	3	-	-	7

(b) CHAT

Fishing year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
2001–02	-	-	-	-	-	-	-	-	-	-	-	-	-
2002–03	-	2	2	-	-	-	-	-	-	-	-	-	4
2003–04	-	-	-	-	-	-	-	-	-	-	9	5	14
2004–05	1	-	1	5	16	21	-	-	-	-	-	-	44
2005–06	-	-	-	-	-	-	-	-	5	4	-	-	9
2006–07	2	5	2	9	5	4	1	7	2	-	-	-	37
2007–08	-	-	-	-	5	-	-	11	2	-	-	-	18
2008–09	-	-	5	-	-	-	-	-	-	-	-	-	5
2009–10	4	1	16	21	-	-	-	-	-	-	-	-	42
2010–11	6	1	-	-	14	6	6	1	-	-	-	-	34
2011–12	-	4	33	-	3	7	-	-	1	-	-	1	49
Total	13	13	59	35	43	38	7	19	10	4	9	6	256

(c) WCSI

Fishing year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
2001–02	-	-	-	-	-	-	-	-	-	-	3	-	3
2002–03	-	-	-	-	-	-	-	-	-	-	-	-	-
2003–04	-	-	-	-	-	-	-	-	-	-	6	2	8
2004–05	-	5	-	-	-	-	-	-	-	7	2	1	15
2005–06	-	-	-	-	-	-	-	-	9	6	3	3	21
2006–07	-	-	-	-	-	-	-	-	-	4	2	3	9
2007–08	-	-	-	-	-	-	-	-	-	2	7	5	14
2008–09	-	-	-	-	-	-	-	-	-	3	-	-	3
2009–10	-	-	-	-	-	-	-	-	-	-	1	-	1
2010–11	-	-	-	-	-	-	-	-	5	-	-	-	5
2011–12	-	-	-	-	-	-	-	-	1	-	1	-	2
Total	-	5	-	-	-	-	-	-	15	22	25	14	81

Table B4: continued.

(c) SUBA

Fishing year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
2001–02	-	-	-	-	-	-	-	-	-	-	-	-	-
2002–03	-	-	-	-	-	-	-	-	-	-	-	-	-
2003–04	-	-	-	-	-	-	-	-	-	-	-	-	-
2004–05	-	-	-	-	-	-	-	-	-	-	1	1	2
2005–06	-	1	2	-	-	-	-	-	-	-	2	-	5
2006–07	-	-	-	1	-	-	-	-	-	-	-	-	1
2007–08	-	4	-	1	-	-	-	-	-	-	-	-	5
2008–09	-	-	-	-	-	-	-	-	1	-	-	-	1
2009–10	-	-	-	-	-	-	-	-	-	-	-	-	-
2010–11	-	-	1	9	-	-	-	-	-	1	-	-	11
2011–12	-	-	-	-	-	-	-	-	-	-	-	1	1
Total	-	5	3	11	-	-	-	-	1	1	3	2	26

Table B5: Total number of lookdown dory measured by fishing year and area sampled from each tow by the observer programme, for fishing years 2001–02 to 2011–12. Note: Numbers measured differ from those on Figures B4, B5 and B6 for some years as scaled length frequencies plots only include tows where more than five individual fish are measured. Areas defined in Figure 3.

Fishing	Fishery areas				
year	ECNI	CHAT	SUBA	WCSI	Total
2001–02	13	-	-	10	23
2002–03	-	50	-	-	50
2003–04	-	108	-	23	131
2004–05	-	261	3	124	388
2005–06	-	157	11	336	504
2006–07	-	517	7	89	613
2007–08	58	227	25	209	519
2008–09	-	44	10	60	114
2009–10	-	500	-	20	520
2010–11	-	413	38	39	490
2011–12	-	710	1	40	751
Total	71	2 987	95	950	4 103

Table B6: Total number of lookdown dory measured, by area, for fishing years 2001–02 to 2011–12. Note: Numbers measured differ from those given in Figures B4–B6 for some years because scaled length frequencies plots only include tows where more than five individual fish are measured. Areas defined in Figure 3.

(a) ECNI

Total numbers

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
2001–02	-	-	-	-	-	-	-	-	-	13	-	-	13
2002–03	-	-	-	-	-	-	-	-	-	-	-	-	-
2003–04	-	-	-	-	-	-	-	-	-	-	-	-	-
2004–05	-	-	-	-	-	-	-	-	-	-	-	-	-
2005–06	-	-	-	-	-	-	-	-	-	-	-	-	-
2006–07	-	-	-	-	-	-	-	-	-	-	-	-	-
2007–08	-	32	-	-	-	15	11	-	-	-	-	-	58
2008–09	-	-	-	-	-	-	-	-	-	-	-	-	-
2009–10	-	-	-	-	-	-	-	-	-	-	-	-	-
2010–11	-	-	-	-	-	-	-	-	-	-	-	-	-
2011–12	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	-	32	-	-	-	15	11	-	-	13	-	-	71

Females (%)

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
2001–02	-	-	-	-	-	-	-	-	-	76.9	-	-	76.9
2002–03	-	-	-	-	-	-	-	-	-	-	-	-	-
2003–04	-	-	-	-	-	-	-	-	-	-	-	-	-
2004–05	-	-	-	-	-	-	-	-	-	-	-	-	-
2005–06	-	-	-	-	-	-	-	-	-	-	-	-	-
2006–07	-	-	-	-	-	-	-	-	-	-	-	-	-
2007–08	-	40.6	-	-	-	66.7	72.7	-	-	-	-	-	53.4
2008–09	-	-	-	-	-	-	-	-	-	-	-	-	-
2009–10	-	-	-	-	-	-	-	-	-	-	-	-	-
2010–11	-	-	-	-	-	-	-	-	-	-	-	-	-
2011–12	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	-	40.6	-	-	-	66.7	72.7	-	-	76.9	-	-	57.7

Table B6: continued.

(b) CHAT

Total numbers

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
2001–02	-	-	-	-	-	-	-	-	-	-	-	-	-
2002–03	-	40	10	-	-	-	-	-	-	-	-	-	50
2003–04	-	-	-	-	-	-	-	-	-	-	83	25	108
2004–05	19	-	6	71	62	103	-	-	-	-	-	-	261
2005–06	-	-	-	-	-	-	-	-	88	69	-	-	157
2006–07	14	78	42	227	40	66	6	35	9	-	-	-	517
2007–08	-	-	-	-	50	-	-	147	30	-	-	-	227
2008–09	-	-	44	-	-	-	-	-	-	-	-	-	44
2009–10	174	16	115	195	-	-	-	-	-	-	-	-	500
2010–11	194	10	-	-	81	19	93	16	-	-	-	-	413
2011–12	-	30	458	-	60	140	-	-	10	-	-	12	710
Total	401	174	675	493	293	328	99	198	137	69	83	37	2 987

Females (%)

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
2001–02	-	-	-	-	-	-	-	-	-	-	-	-	-
2002–03	-	55.0	100.0	-	-	-	-	-	-	-	-	-	64.0
2003–04	-	-	-	-	-	-	-	-	-	-	71.1	76.0	72.2
2004–05	10.5	-	16.7	69.0	46.8	78.6	-	-	-	-	-	-	62.1
2005–06	-	-	-	-	-	-	-	-	83.0	71.0	-	-	77.7
2006–07	78.6	51.3	57.1	49.3	32.5	53.0	33.3	57.1	88.9	-	-	-	51.3
2007–08	-	-	-	-	46.0	-	-	75.5	73.3	-	-	-	68.7
2008–09	-	-	52.3	-	-	-	-	-	-	-	-	-	52.3
2009–10	63.2	62.5	76.5	67.2	-	-	-	-	-	-	-	-	67.8
2010–11	58.8	20.0	-	-	67.9	57.9	52.7	43.8	-	-	-	-	57.6
2011–12	-	83.3	50.2	-	65.0	64.3	-	-	100.0	-	-	91.7	57.0
Total	59.1	56.9	55.7	59.2	54.3	66.2	51.5	69.7	82.5	71.0	71.1	81.1	60.9

Table B6: continued.

(c) WCSI

Total numbers

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
2001–02	-	-	-	-	-	-	-	-	-	-	10	-	10
2002–03	-	-	-	-	-	-	-	-	-	-	-	-	-
2003–04	-	-	-	-	-	-	-	-	-	-	13	10	23
2004–05	-	85	-	-	-	-	-	-	-	30	7	2	124
2005–06	-	-	-	-	-	-	-	-	222	45	41	28	336
2006–07	-	-	-	-	-	-	-	-	-	29	20	40	89
2007–08	-	-	-	-	-	-	-	-	-	40	119	50	209
2008–09	-	-	-	-	-	-	-	-	-	60	-	-	60
2009–10	-	-	-	-	-	-	-	-	-	-	20	-	20
2010–11	-	-	-	-	-	-	-	-	39	-	-	-	39
2011–12	-	-	-	-	-	-	-	-	20	-	20	-	40
Total	-	85	-	-	-	-	-	-	281	204	250	130	950

Females (%)

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
2001–02	-	-	-	-	-	-	-	-	-	-	70.0	-	70.0
2002–03	-	-	-	-	-	-	-	-	-	-	-	-	-
2003–04	-	-	-	-	-	-	-	-	-	-	92.3	100.0	95.7
2004–05	-	63.5	-	-	-	-	-	-	-	76.7	100.0	100.0	69.4
2005–06	-	-	-	-	-	-	-	-	50.0	77.8	48.8	35.7	52.4
2006–07	-	-	-	-	-	-	-	-	-	58.6	55.0	57.5	57.3
2007–08	-	-	-	-	-	-	-	-	-	55.0	40.3	28.0	40.2
2008–09	-	-	-	-	-	-	-	-	-	53.3	-	-	53.3
2009–10	-	-	-	-	-	-	-	-	-	-	90.0	-	90.0
2010–11	-	-	-	-	-	-	-	-	76.9	-	-	-	76.9
2011–12	-	-	-	-	-	-	-	-	75.0	-	30.0	-	52.5
Total	-	63.5	-	-	-	-	-	-	55.5	63.2	51.6	45.4	55.5

Table B6: continued.

(d) SUBA
Total numbers

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
2001–02	-	-	-	-	-	-	-	-	-	-	-	-	-
2002–03	-	-	-	-	-	-	-	-	-	-	-	-	-
2003–04	-	-	-	-	-	-	-	-	-	-	-	-	-
2004–05	-	-	-	-	-	-	-	-	-	-	1	2	3
2005–06	-	3	2	-	-	-	-	-	-	-	6	-	11
2006–07	-	-	-	7	-	-	-	-	-	-	-	-	7
2007–08	-	5	-	20	-	-	-	-	-	-	-	-	25
2008–09	-	-	-	-	-	-	-	-	10	-	-	-	10
2009–10	-	-	-	-	-	-	-	-	-	-	-	-	-
2010–11	-	-	3	22	-	-	-	-	-	13	-	-	38
2011–12	-	-	-	-	-	-	-	-	-	-	-	1	1
Total	-	8	5	49	-	-	-	-	10	13	7	3	95

Females (%)

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
2001–02	-	-	-	-	-	-	-	-	-	-	-	-	-
2002–03	-	-	-	-	-	-	-	-	-	-	-	-	-
2003–04	-	-	-	-	-	-	-	-	-	-	-	-	-
2004–05	-	-	-	-	-	-	-	-	-	-	-	50.0	33.3
2005–06	-	100.0	100.0	-	-	-	-	-	-	-	33.3	-	63.6
2006–07	-	-	-	85.7	-	-	-	-	-	-	-	-	85.7
2007–08	-	100.0	-	65.0	-	-	-	-	-	-	-	-	72.0
2008–09	-	-	-	-	-	-	-	-	40.0	-	-	-	40.0
2009–10	-	-	-	-	-	-	-	-	-	-	-	-	-
2010–11	-	-	100.0	45.5	-	-	-	-	-	69.2	-	-	57.9
2011–12	-	-	-	-	-	-	-	-	-	-	-	100.0	100.0
Total	-	100.0	100.0	59.2	-	-	-	-	40.0	69.2	28.6	66.7	62.1

Table B7: Number of female lookdown dory gonads staged by fishing year and month sampled from each area by the observer programme. Areas defined in Figure 3.

Year	ECNI	CHAT	SUBA	WCSI	Total
2001–02	10	-	-	7	17
2002–03	-	32	-	-	32
2003–04	-	74	-	22	96
2004–05	-	162	1	86	249
2005–06	-	122	7	176	305
2006–07	-	264	6	48	318
2007–08	30	156	18	84	288
2008–09	-	23	-	-	23
2009–10	-	93	-	-	93
2010–11	-	66	9	-	75
2011–12	-	370	-	15	385
Total	40	1 362	41	438	1 881

Table B8: Number of female lookdown dory with reproductive stage data recorded by observers in each area, by month and fishing year.

(a) ECNI

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
2001–02	-	-	-	-	-	-	-	-	-	10	-	-	10
2002–03	-	-	-	-	-	-	-	-	-	-	-	-	-
2003–04	-	-	-	-	-	-	-	-	-	-	-	-	-
2004–05	-	-	-	-	-	-	-	-	-	-	-	-	-
2005–06	-	-	-	-	-	-	-	-	-	-	-	-	-
2006–07	-	-	-	-	-	-	-	-	-	-	-	-	-
2007–08	-	12	-	-	-	10	8	-	-	-	-	-	30
2008–09	-	-	-	-	-	-	-	-	-	-	-	-	-
2009–10	-	-	-	-	-	-	-	-	-	-	-	-	-
2010–11	-	-	-	-	-	-	-	-	-	-	-	-	-
2011–12	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	-	12	-	-	-	10	8	-	-	10	-	-	40

(b) CHAT

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
2001–02	-	-	-	-	-	-	-	-	-	-	-	-	-
2002–03	-	22	10	-	-	-	-	-	-	-	-	-	32
2003–04	-	-	-	-	-	-	-	-	-	-	59	15	74
2004–05	2	-	1	49	29	81	-	-	-	-	-	-	162
2005–06	-	-	-	-	-	-	-	-	73	49	-	-	122
2006–07	11	39	24	112	13	35	2	20	8	-	-	-	264
2007–08	-	-	-	-	23	-	-	111	22	-	-	-	156
2008–09	-	-	23	-	-	-	-	-	-	-	-	-	23
2009–10	93	-	-	-	-	-	-	-	-	-	-	-	93
2010–11	-	-	-	-	55	11	-	-	-	-	-	-	66
2011–12	-	2	229	-	39	90	-	-	10	-	-	-	370
Total	106	63	287	161	159	217	2	131	113	49	59	15	1 362

Table B8: continued.

(c) SUBA

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
2001–02	-	-	-	-	-	-	-	-	-	-	-	-	-
2002–03	-	-	-	-	-	-	-	-	-	-	-	-	-
2003–04	-	-	-	-	-	-	-	-	-	-	-	-	-
2004–05	-	-	-	-	-	-	-	-	-	-	-	1	1
2005–06	-	3	2	-	-	-	-	-	-	-	2	-	7
2006–07	-	-	-	6	-	-	-	-	-	-	-	-	6
2007–08	-	5	-	13	-	-	-	-	-	-	-	-	18
2008–09	-	-	-	-	-	-	-	-	-	-	-	-	-
2009–10	-	-	-	-	-	-	-	-	-	-	-	-	-
2010–11	-	-	-	9	-	-	-	-	-	-	-	-	9
2011–12	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	-	8	2	28	-	-	-	-	-	-	2	1	41

(d) WCSI

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
2001–02	-	-	-	-	-	-	-	-	-	-	7	-	7
2002–03	-	-	-	-	-	-	-	-	-	-	-	-	-
2003–04	-	-	-	-	-	-	-	-	-	-	12	10	22
2004–05	-	54	-	-	-	-	-	-	-	23	7	2	86
2005–06	-	-	-	-	-	-	-	-	111	35	20	10	176
2006–07	-	-	-	-	-	-	-	-	-	14	11	23	48
2007–08	-	-	-	-	-	-	-	-	-	22	48	14	84
2008–09	-	-	-	-	-	-	-	-	-	-	-	-	-
2009–10	-	-	-	-	-	-	-	-	-	-	-	-	-
2010–11	-	-	-	-	-	-	-	-	-	-	-	-	-
2011–12	-	-	-	-	-	-	-	-	15	-	-	-	15
Total	-	54	-	-	-	-	-	-	126	94	105	59	438

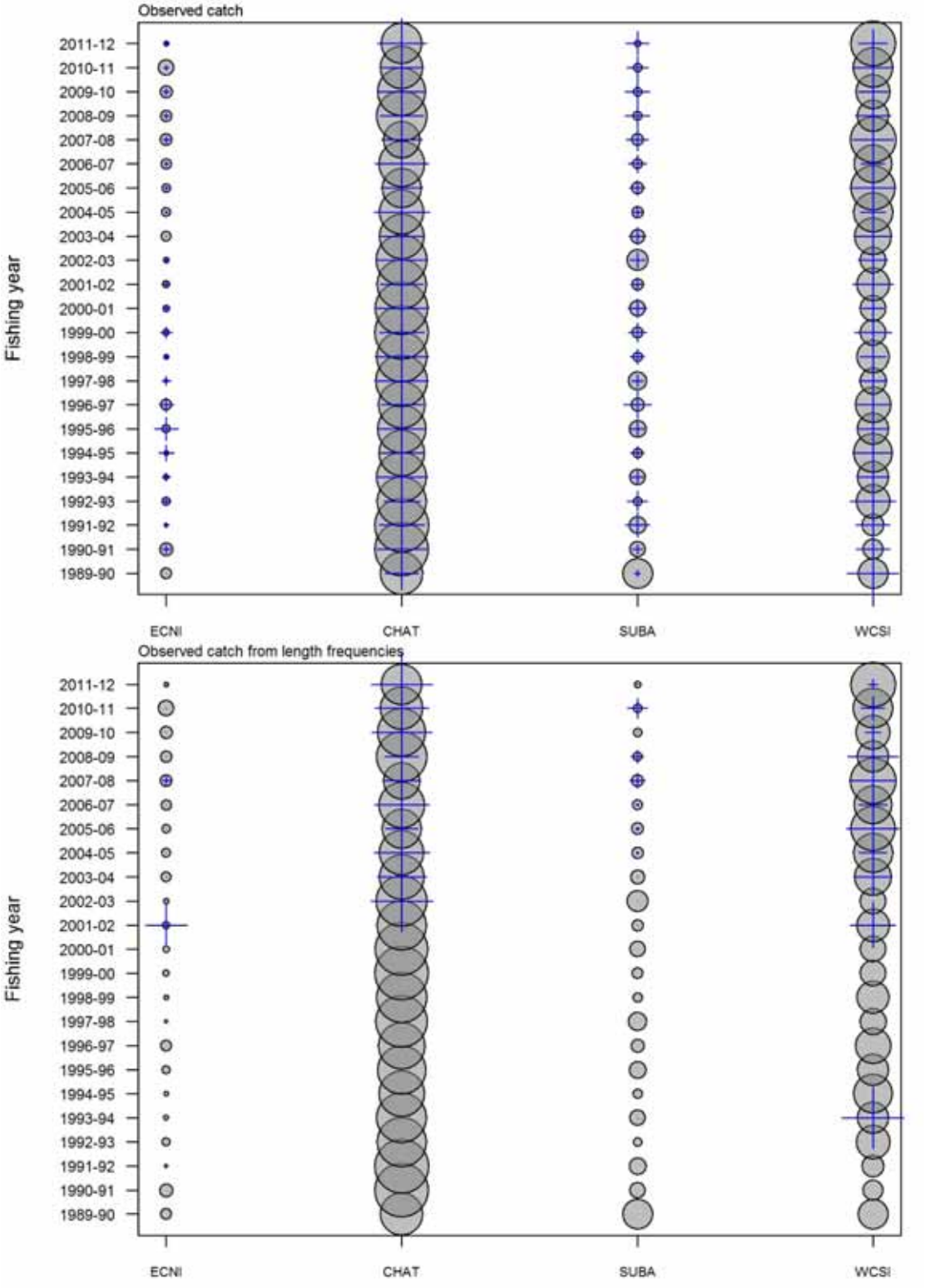


Figure B1: Representativeness of observer sampling of lookdown dory catch by fishing year and area. Circles show the proportion of processed lookdown dory catch by area within a year; crosses show the proportion of observed catch for the same cells. Representation is demonstrated by how closely the cross matches the circle diameter. Top panel is observed lookdown dory catch from all tows, and bottom panel is observed catch from tows where lookdown dory length frequency samples were taken.

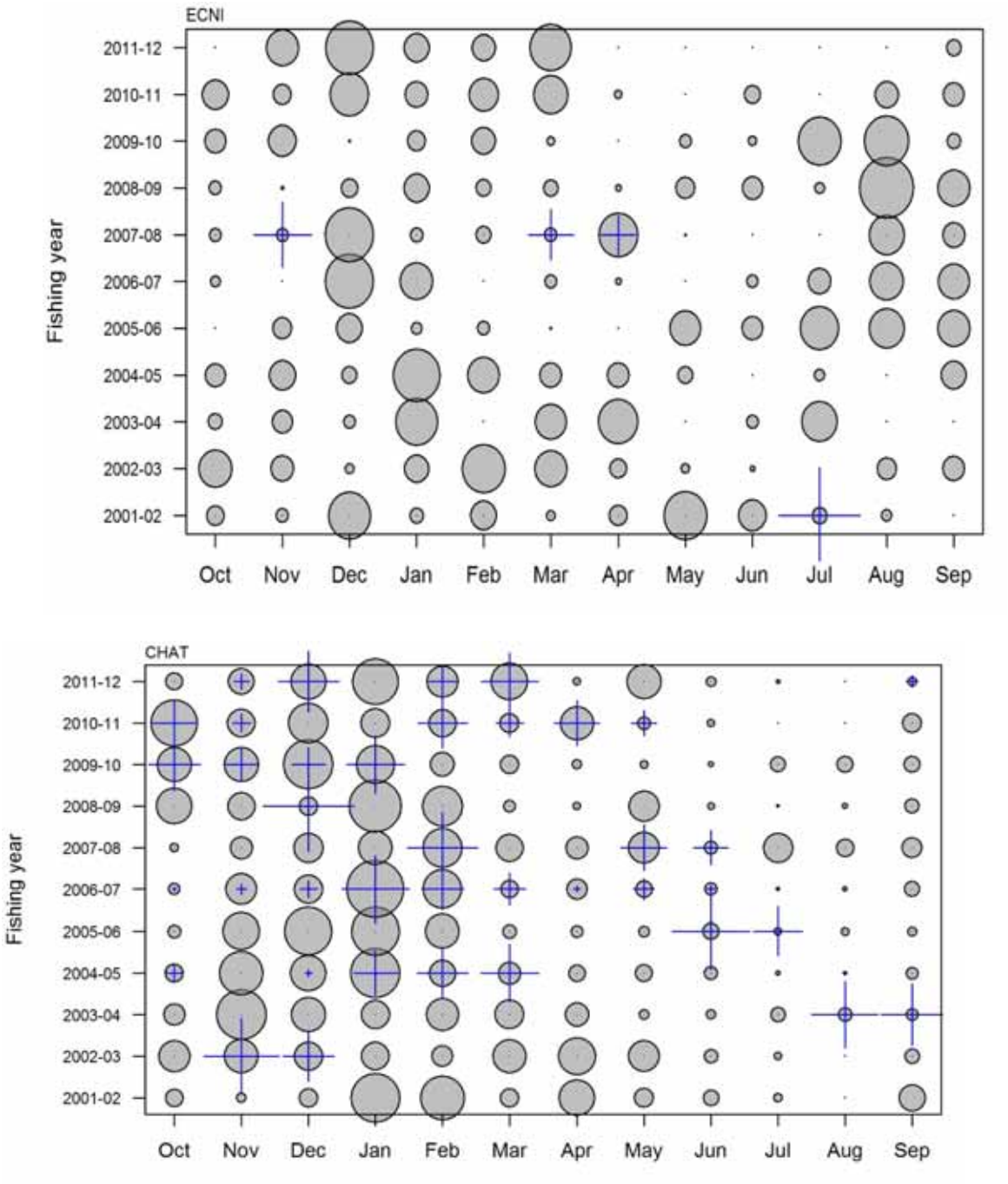


Figure B2: Representativeness of observer sampling of lookdown dory catch by fishing year and month by area for east coast North Island (ECNI), east coast South Island and Chatham Rise (CHAT). Circles show the proportion of catch by month within a year; crosses show the proportion of observed catch for the same cells. Representation is demonstrated by how closely the cross matches the circle diameter.

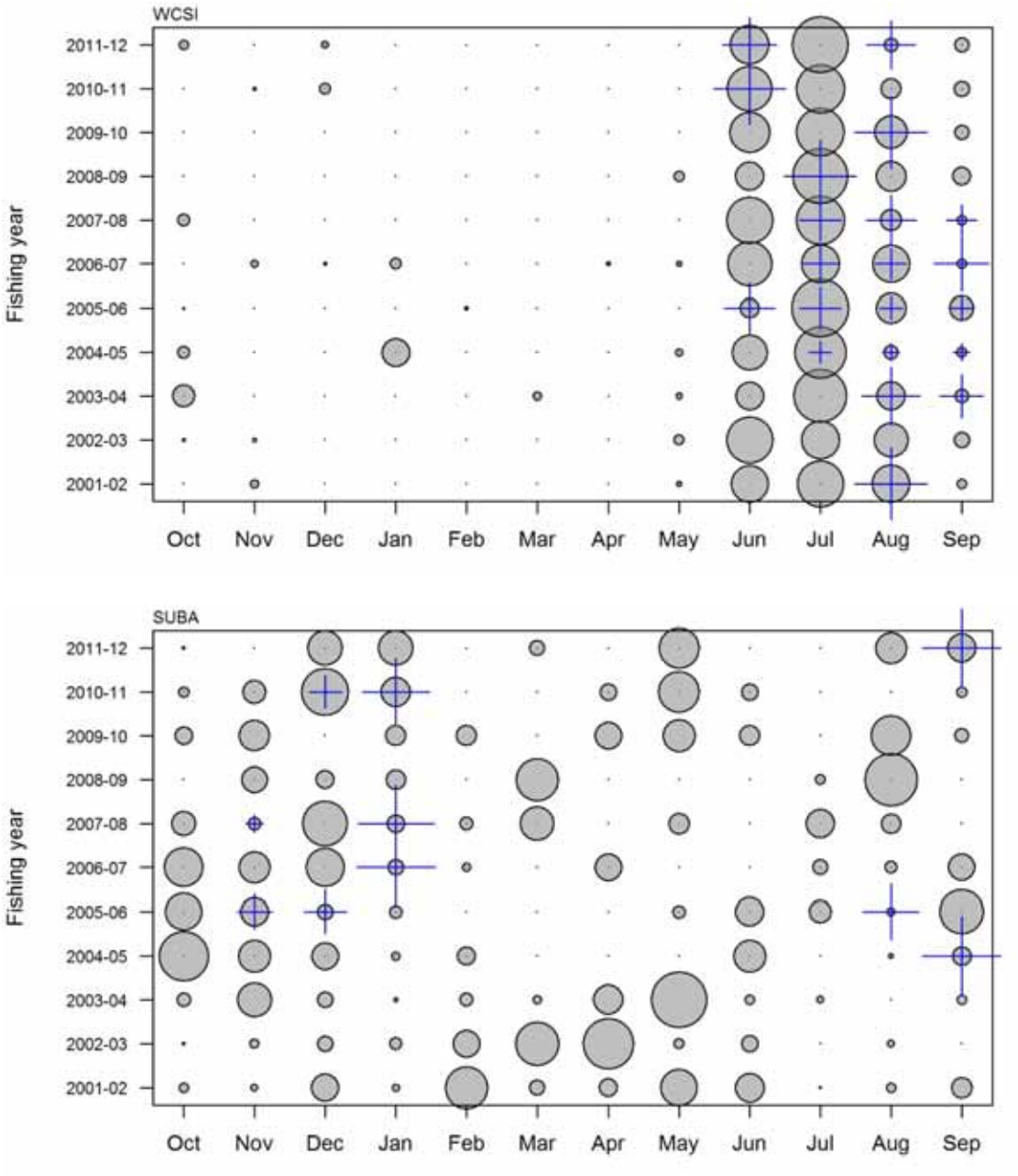


Figure B2 ctd.: Representativeness of observer sampling of lookdown dory catch by fishing year and month by area for WCSI, and Sub-Antarctic (SUBA). Circles show the proportion of catch by month within a year; crosses show the proportion of observed catch for the same cells. Representation is demonstrated by how closely the cross matches the circle diameter.

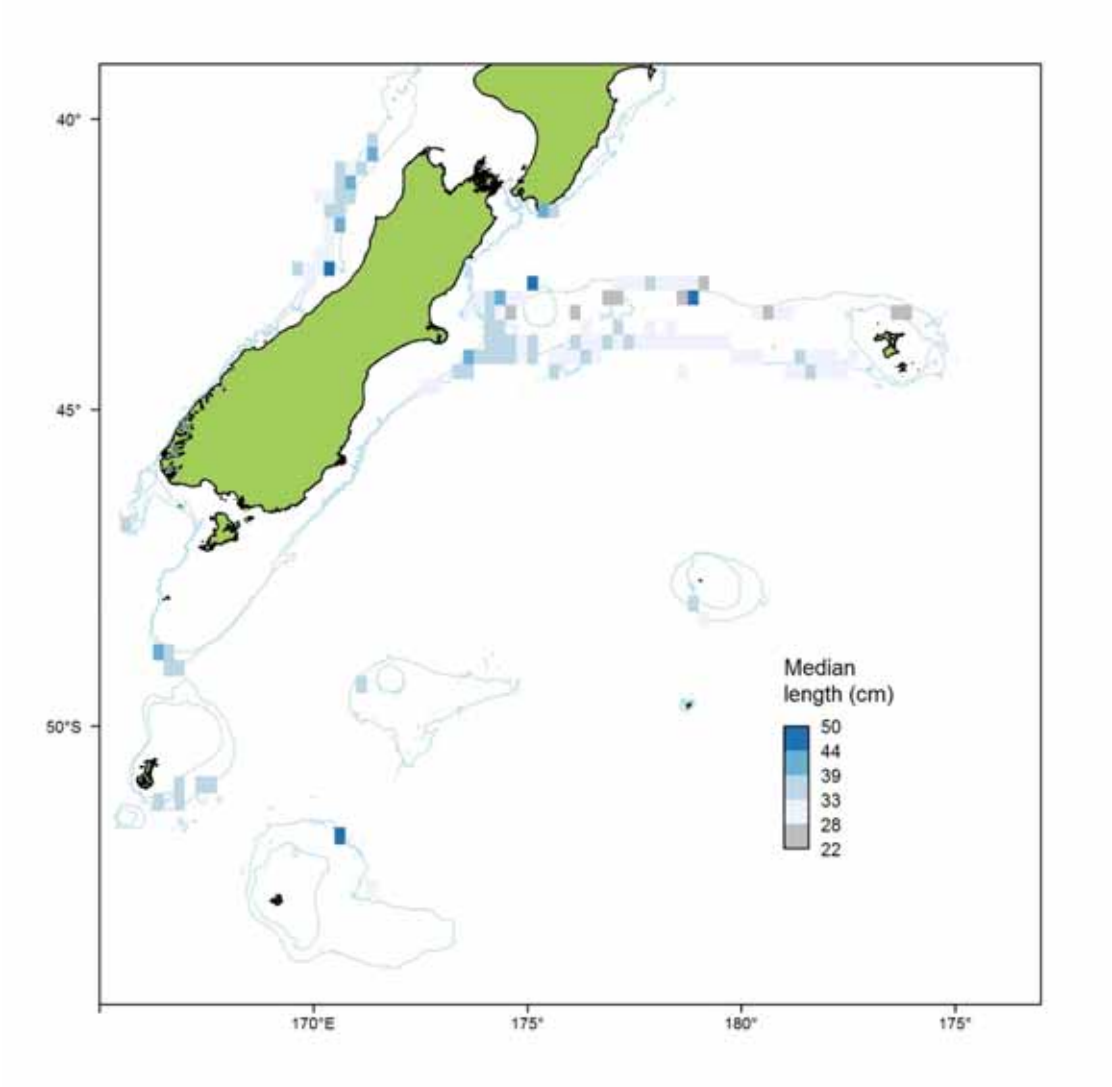


Figure B3: Median length of observed lookdown dory (*n* = 4111) for 0.25° cells (all years combined).

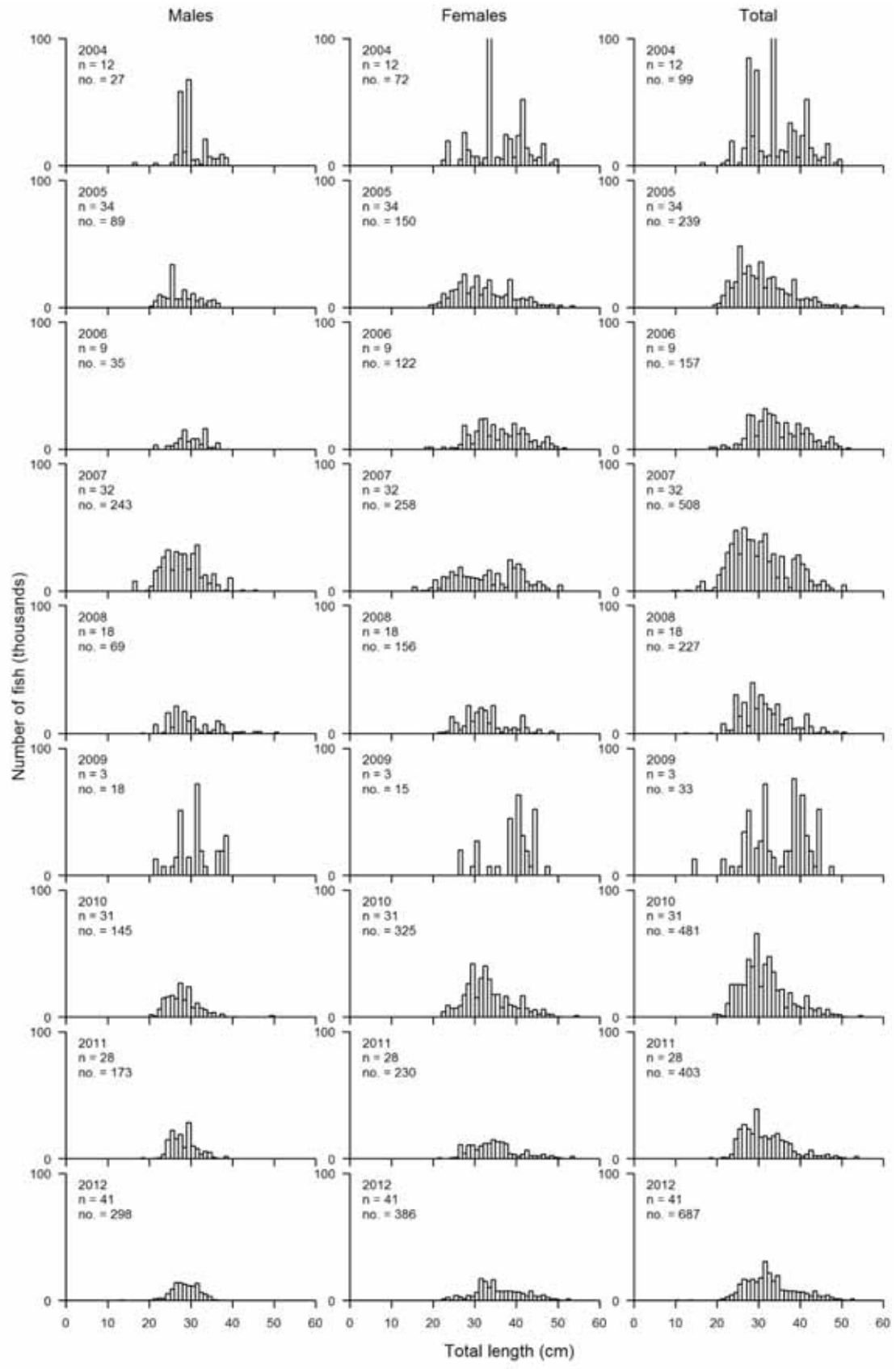


Figure B4: Scaled length frequency of lookdown dory sampled by observers from commercial catches from the CHAT area, where there were more than 3 lookdown dory per tow, for fishing years 2003–04 (2004) to 2011–12 (2012). n, number of tows sampled with more than 3 individual lookdown dory per tow; no., number of lookdown dory sampled.

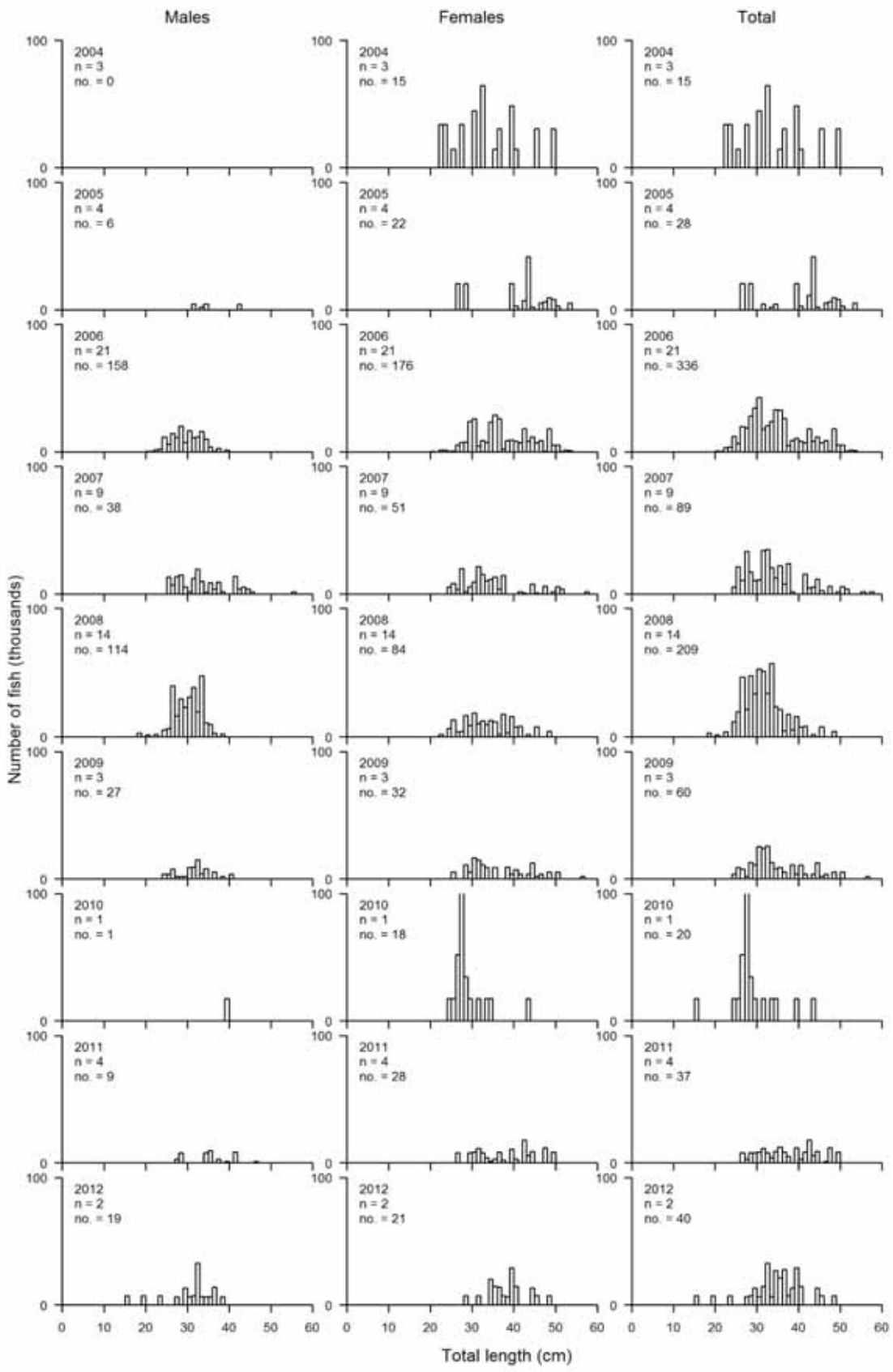


Figure B5: Scaled length frequency of lookdown dory sampled by observers from commercial catches from the WCSI Statistical Areas 033, 034, 035 for months of Jun–Sep, where there were more than 3 lookdown dory per tow, for fishing years 2003–04 (2004) to 2011–12 (2012). n, number of tows sampled with more than 3 individual lookdown dory per tow; no., number of lookdown dory sampled.

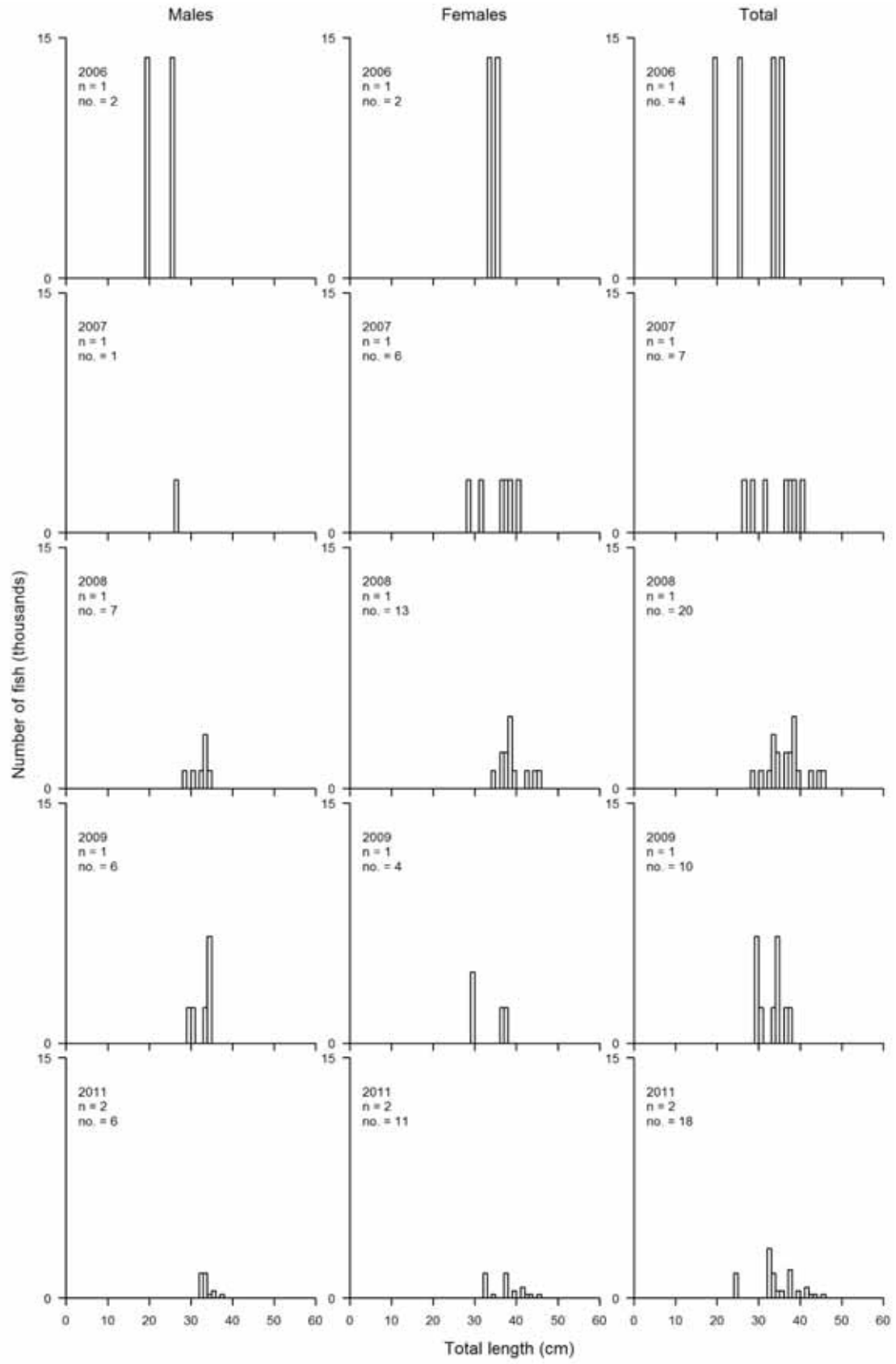


Figure B6: Scaled length frequency of lookdown dory sampled by observers from commercial catches from the SUBA area , where there were more than 3 lookdown dory per tow, for fishing years 2005–06 (2006) to 2008–09 (2009), and 2010–11 (2011). n, number of tows sampled with more than 3 individual lookdown dory per tow; no., number of lookdown dory sampled.

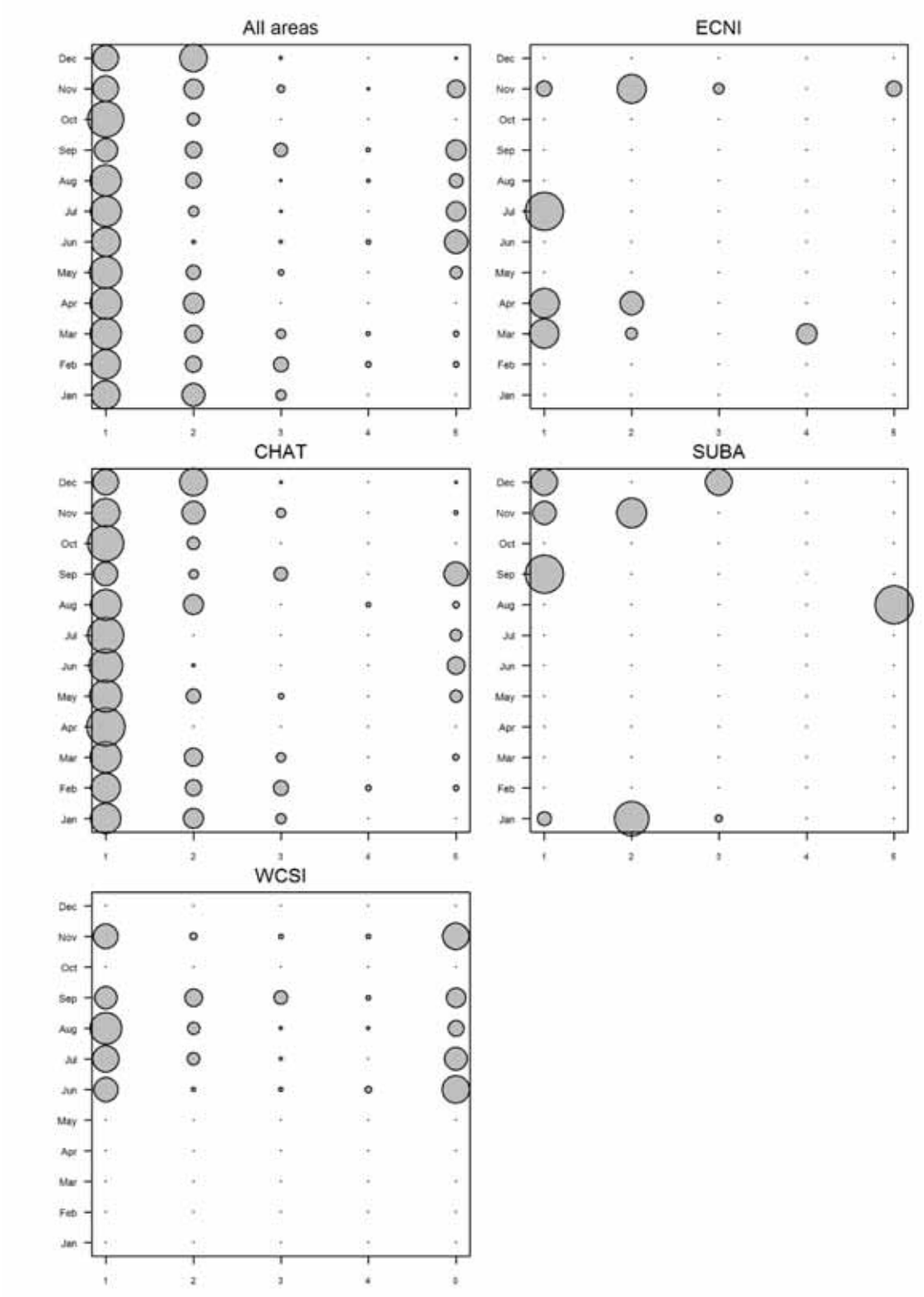


Figure B7: Gonad stages of female lookdown dory taken in commercial catches, by month and area, sampled by the Observer Programme. Stages are: 1, resting/immature; 2, maturing; 3, ripe; red, 4; 5, spent.

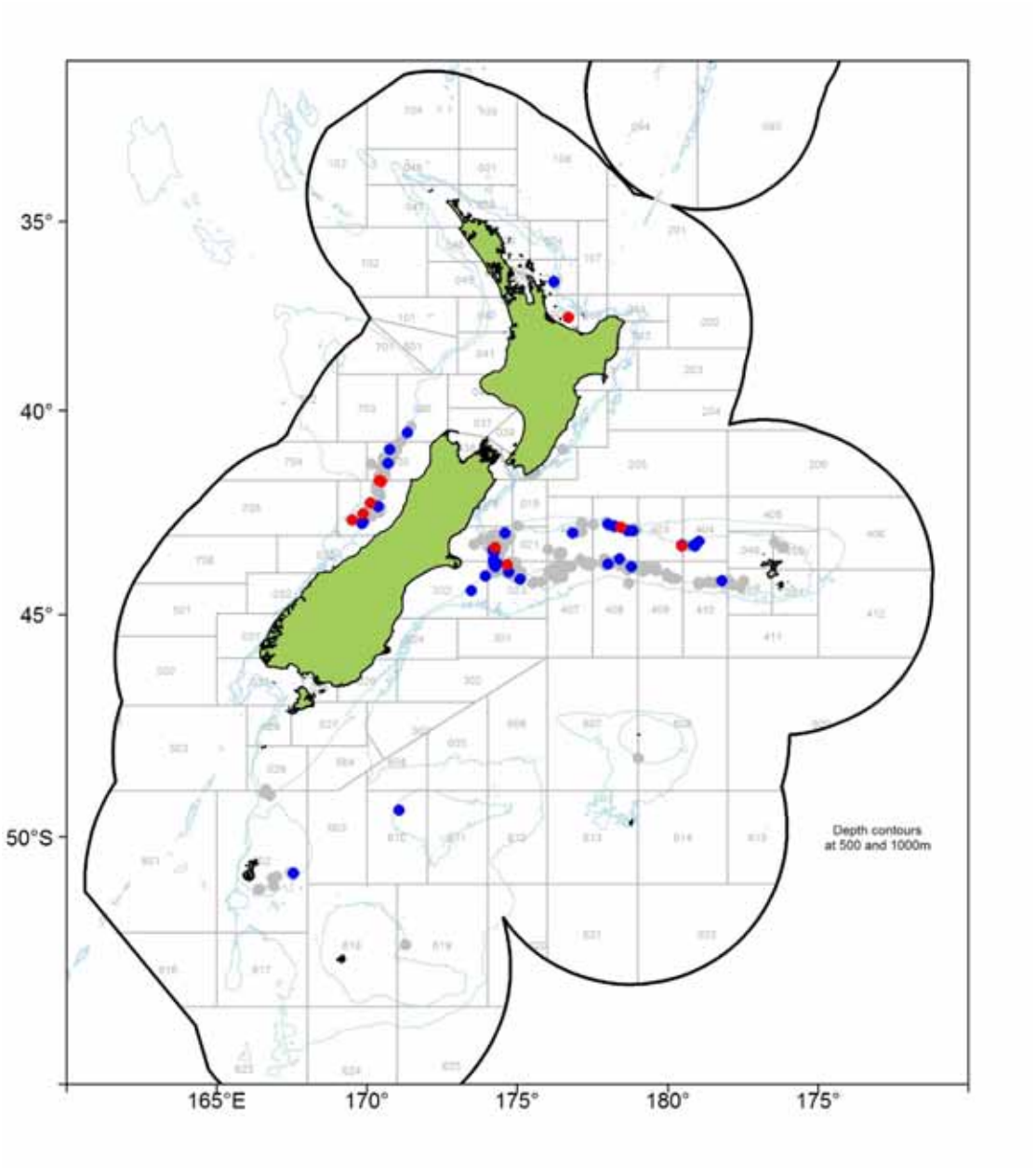


Figure B8a: Location of female lookdown dory gonad stages sampled by the Observer Programme. Grey = stage 1 (immature), stage 2 (maturing), and stage 5 (spent); blue = stage 3 (ripe), red = stage 4 (running ripe).

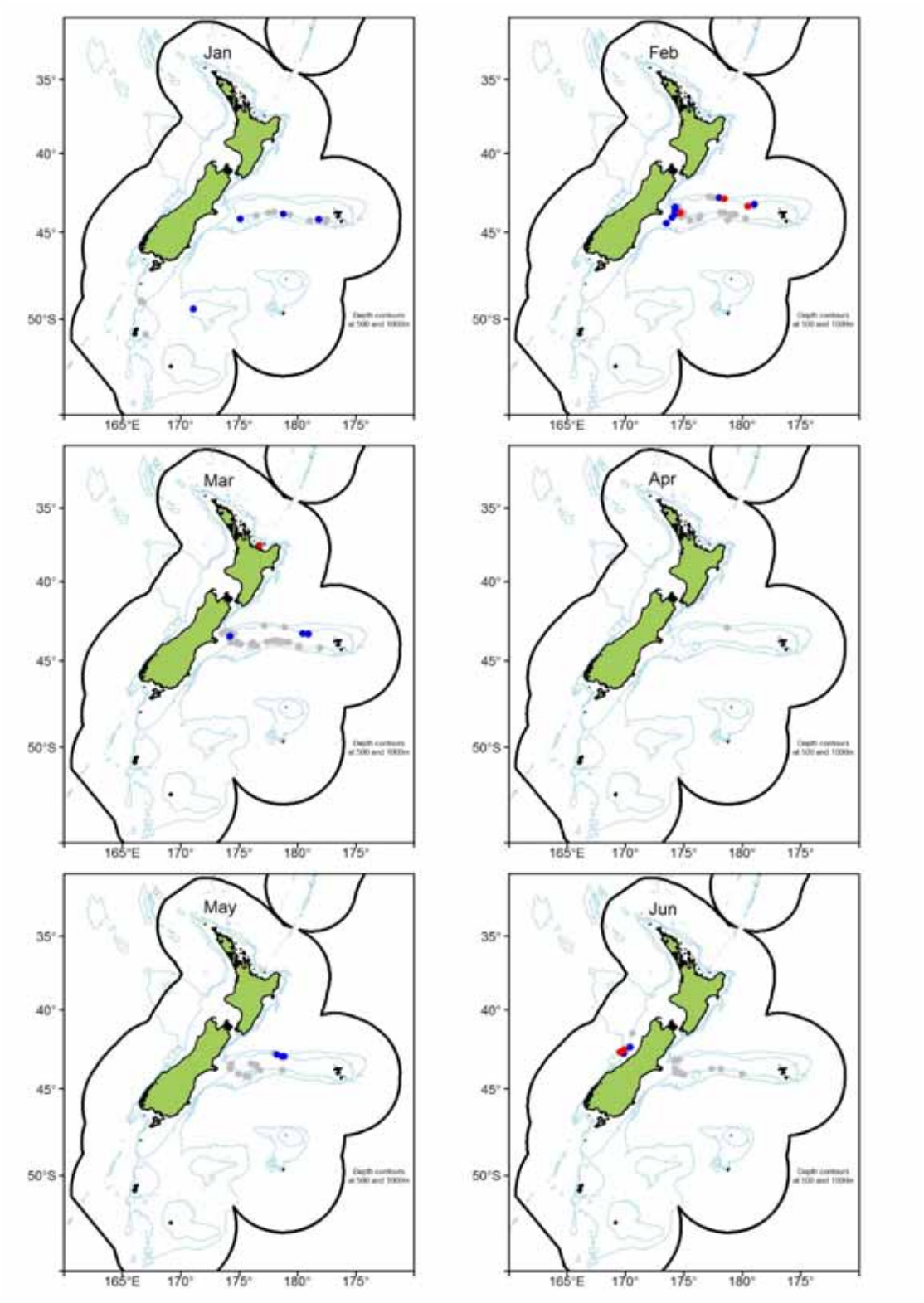


Figure B8b: Location of female lookdown dory gonad stages sampled by the Observer Programme for the months of January to June. Grey = stage 1 (immature), stage 2 (maturing), and stage 5 (spent); blue = stage 3 (ripe), red = stage 4 (running ripe).

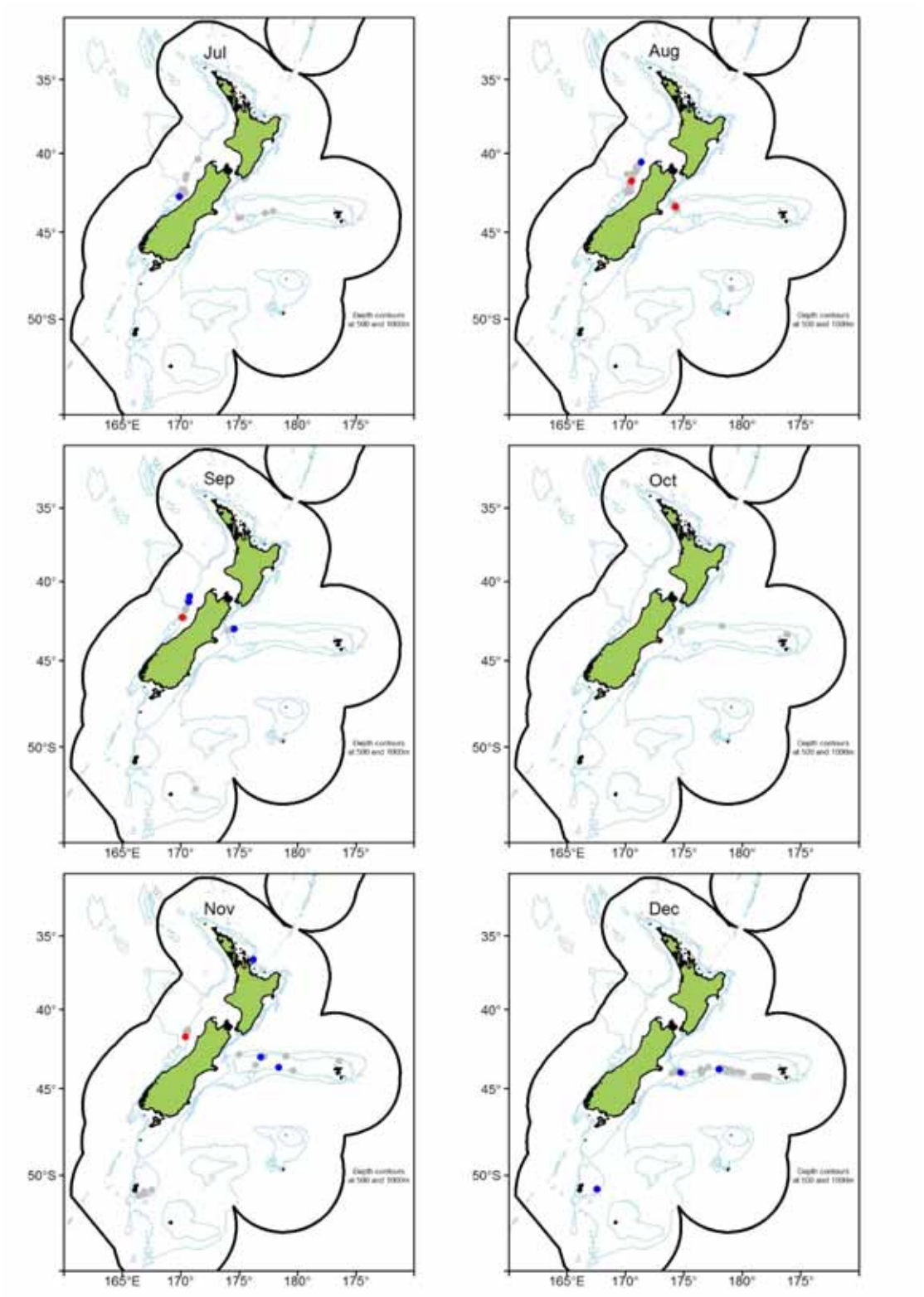


Figure B8b: ctd. Location of female lookdown dory gonad stages sampled by the Observer Programme for the months of July to December. Grey = stage 1 (immature), stage 2 (maturing), and stage 5 (spent); blue = stage 3 (ripe), red = stage 4 (running ripe).

APPENDIX C: CHARACTERISATION

Table C1: List of tables and fields requested in the MPI extract 8961.

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
	Processed_weight_type	
State_code	Form_type	

Estimated subcatch table

Event_Key	Species_code (ALL species for each fishing event)	Literal_yn
Version_seqno		Interp_yn
DCF_key	Catch_weight	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	Engine_kilowatts	History_start_datetime
Flag_nationality_code	Gross_tonnes	History_end_datetime
Built_year	Overall_length_metres	

Table C2: Number of landing events by major destination code and form type for LDO 1 and LDO 3 from 1990 to 2012. L: landed to NZ; E: eaten; R: retained on board; T: transferred to another vessel; D: discarded.

LDO 1

	CLR form						CELR and NCELR form						
	L	**E**	**R**	**T**	**D**	**Total**	**L**	**E**	**R**	**T**	**D**	**Total**	**Total**
1990	35	-	59	19	4	117	30	-	-	-	-	30	147
1991	66	-	35	16	3	120	29	-	-	-	-	29	149
1992	45	1	26	20	-	92	35	-	-	-	-	35	127
1993	49	1	26	28	-	104	32	-	-	-	-	32	136
1994	56	11	32	27	4	130	18	-	-	-	-	18	148
1995	114	6	6	41	1	168	27	-	-	-	-	27	195
1996	159	6	6	31	4	206	10	-	-	-	-	10	216
1997	239	13	25	23	5	305	40	-	-	-	-	40	345
1998	315	20	17	15	6	373	29	-	-	-	-	29	402
1999	312	22	28	8	17	387	87	-	-	-	-	87	474
2000	316	29	24	3	24	396	83	-	-	-	-	83	479
2001	354	30	19	7	19	429	80	-	-	-	1	81	510
2002	391	37	15	5	44	492	78	-	-	-	-	78	570
2003	352	34	21	-	36	443	98	-	-	-	1	99	542
2004	295	32	11	1	36	375	73	-	-	-	1	74	449
2005	234	39	12	-	4	289	47	-	-	-	-	47	336
2006	233	50	22	-	-	305	66	-	1	-	-	67	372
2007	247	48	13	-	-	308	89	-	1	-	-	90	398
2008	372	40	13	-	-	425	1	-	-	-	-	1	426
2009	313	40	11	-	1	365	9	-	-	-	-	9	374
2010	380	38	10	-	-	428	6	-	-	-	-	6	434
2011	393	50	12	-	-	455	4	-	-	-	-	4	459
2012	400	49	20	-	-	469	2	-	-	-	-	2	471
Total	5 670	596	463	244	208	7 181	973	-	2	-	3	978	8 159

LDO 3

	CLR form						CELR and NCELR form						
	L	**E**	**R**	**T**	**D**	**Total**	**L**	**E**	**R**	**T**	**D**	**Total**	**Total**
1990	50	-	18	58	1	127	1	-	-	-	-	1	128
1991	65	-	28	53	-	146	12	-	-	-	-	12	158
1992	120	1	33	83	-	237	24	-	-	-	-	24	261
1993	111	-	37	69	-	217	15	-	-	-	-	15	232
1994	128	8	40	44	7	227	7	-	-	-	-	7	234
1995	190	12	31	77	7	317	7	-	-	-	-	7	324
1996	231	20	33	86	3	373	3	-	-	-	-	3	376
1997	327	13	61	41	6	448	26	-	-	-	-	26	474
1998	384	32	46	15	7	484	44	-	-	-	-	44	528
1999	478	60	65	2	25	630	22	-	-	-	-	22	652
2000	578	73	55	-	45	751	50	-	-	-	-	50	801
2001	680	83	52	-	79	894	56	-	-	-	-	56	950
2002	592	70	68	-	78	808	27	-	-	-	-	27	835
2003	782	85	72	-	88	1 027	38	-	-	-	12	50	1 077
2004	604	66	83	5	86	844	25	-	-	-	6	31	875
2005	432	68	34	-	3	537	29	-	-	-	-	29	566
2006	337	59	37	-	-	433	28	-	-	-	-	28	461
2007	365	81	29	-	-	475	18	-	-	-	-	18	493
2008	332	96	37	-	-	465	4	-	-	-	-	4	469
2009	298	87	31	-	-	416	38	-	8	-	-	46	462
2010	320	97	26	-	-	443	10	-	-	-	-	10	453
2011	328	98	28	-	-	454	31	-	-	-	-	31	485
2012	298	93	26	-	-	417	6	-	-	-	-	6	423
Total	8 030	1 202	970	533	435	11 170	521	-	8	-	18	547	11 717

Table C3: Destination codes, total landing weight, number of landings and if the records were kept or discarded for all lookdown dory catch from 1990–2012 for LDO 1 and 3.

LDO 1

Destination code	Greenweight (t)	No. records	Description	Action
L	2 431.83	6 711	Landed in New Zealand to a Licensed Fish Receiver	Keep
T	333.16	244	Transferred to another vessel	Keep
D	79.78	211	Discarded	Keep
O	37.57	35	Conveyed outside New Zealand	Keep
E	18.56	599	Eaten	Keep
A	5.62	37	Accidental loss	Keep
S	3.89	2	Seized by the Crown	Keep
W	0.24	11	Sold at wharf	Keep
F	0.02	2	Recreational catch	Keep
C	0.00	1	Disposed to the Crown	Keep
R	265.08	466	Retained on board	Drop
Q	0.40	2	Holding receptacle on land	Drop
B	0.11	1	Stored as bait	Drop

LDO 3

Destination code	Greenweight (t)	No. records	Description	Action
L	6 441.81	8 646	Landed in New Zealand to a Licensed Fish Receiver	Keep
T	561.55	533	Transferred to another vessel	Keep
D	111.17	453	Discarded	Keep
O	66.86	53	Conveyed outside New Zealand	Keep
E	30.06	1 231	Eaten	Keep
A	3.53	68	Accidental loss	Keep
S	2.31	5	Seized by the Crown	Keep
C	0.78	3	Disposed to the Crown	Keep
W	0.18	5	Sold at wharf	Keep
R	580.23	984	Retained on board	Drop
Q	3.00	14	Holding receptacle on land	Drop
Null	0.02	4	Missing destination type code	Drop

Table C4: Details of data corrections by imputation and invalid record removal during the grooming process for each QMA. 'Records' is the number of unique records; 'Trips' is the number of unique trips; and 'Catch' is the total greenweight of lookdown dory remaining in the effort and landings datasets after each step in the grooming process. Effort is TCEPR estimated data although Effort "Merge effort and processed catch data" is daily processed data.

LDO 1

	Effort			Landings		
Records removed	**Records**	**Trips**	**Catch**	**Records**	**Trips**	**Catch**
Original extract	235 438	6 718	1 524	10 195	6 609	3 176
Remove missing keys	235 438	6 718	1 524	10 195	6 609	3 176
Remove unmatched trip number	235 438	6 718	1 524	10 142	6 570	3 163
Remove duplicate form number	233 984	6 656	1 520	10 069	6 508	3 151
Remove invalid start date	233 984	6 508	1 520	10 058	6 497	3 151
Remove invalid primary method	233 984	6 508	1 520	10 058	6 497	3 151
Remove invalid target methodA	233 984	6 508	1 520	10 058	6 497	3 151
Remove invalid stats area	228 263	6 422	1 504	9 904	6 411	3 118
Remove BPQR destination types	220 889	6 281	1 468	9 169	6 270	2 854
Remove multiple states	220 889	6 281	1 468	9 168	6 270	2 854
Remove invalid green weight	220 889	6 281	1 468	9 168	6 270	2 854
Remove NA green weight	220 889	6 281	1 468	9 168	6 270	2 854
DQSS	220 889	6 281	1 468	9 168	6 270	2 854
Merge effort and processed catch data	50 711	3 960	2 101	9 168	6 270	2 854

LDO 3

	Effort			Landings		
Records removed	**Records**	**Trips**	**Catch**	**Records**	**Trips**	**Catch**
Original extract	398 311	6 157	2 242	13 361	5 886	7 801
Remove missing keys	398 311	6 157	2 242	13 361	5 886	7 801
Remove unmatched trip number	398 311	6 157	2 242	13 307	5 854	7 783
Remove duplicate form number	397 423	6 110	2 241	13 256	5 807	7 782
Remove invalid start date	397 423	5 807	2 241	13 191	5 745	7 782
Remove invalid primary method	397 340	5 806	2 241	13 188	5 744	7 782
Remove invalid target methodA	397 340	5 806	2 241	13 188	5 744	7 782
Remove invalid stats area	387 883	5 687	2 203	12 892	5 625	7 657
Remove BPQR destination types	379 895	5 579	2 142	11 769	5 517	7 097
Remove multiple states	379 895	5 579	2 142	11 767	5 517	7 096
Remove invalid green weight	379 817	5 578	2 141	11 762	5 516	7 094
Remove NA green weight	379 817	5 578	2 141	11 762	5 516	7 094
DQSS	379 817	5 578	2 141	11 762	5 516	7 094
Merge effort and processed catch data	103 583	4 724	6 965	11 762	5 516	7 094

Table C5: The reported MHR, annual retained landings in the groomed and unmerged dataset, and retained landings in the groomed and merged dataset, and processed catches in the groomed and merged dataset for LDO 1 and LDO 3 from 1990 to 2012.

LDO 1

Year	MHR	Unmerged landings	Merged landings	Merged processed catch	Percent MHR
1990	54	50	37	23	43
1991	41	39	24	20	49
1992	58	57	40	29	50
1993	88	85	68	43	49
1994	71	68	70	56	79
1995	93	85	79	78	84
1996	69	66	57	53	77
1997	119	120	82	75	63
1998	96	95	77	86	90
1999	141	160	109	108	77
2000	143	139	102	96	67
2001	124	121	105	101	81
2002	195	207	174	167	86
2003	186	187	165	162	87
2004	138	147	126	125	91
2005	110	116	92	90	82
2006	180	172	147	148	82
2007	147	144	110	108	73
2008	174	170	129	119	68
2009	144	146	112	108	75
2010	161	158	106	93	58
2011	165	164	121	117	71
2012	153	151	105	97	63
Total	2 850	2 847	2 237	2 102	74

LDO 3

Year	MHR	Unmerged landings	Merged landings	Merged processed catch	Percent MHR
1990	74	73	69	61	82
1991	126	126	123	102	81
1992	191	178	185	155	81
1993	187	196	175	164	88
1994	119	123	115	95	80
1995	191	181	189	168	88
1996	191	187	179	185	97
1997	236	238	228	213	90
1998	467	455	448	443	95
1999	494	463	457	477	97
2000	494	490	494	502	102
2001	570	553	542	529	93
2002	566	564	567	599	106
2003	706	697	684	719	102
2004	391	418	405	446	114
2005	272	262	257	286	105
2006	290	287	288	284	98
2007	284	271	271	270	95
2008	256	236	241	248	97
2009	315	317	307	301	96
2010	274	259	256	278	101
2011	216	213	212	219	101
2012	229	222	234	220	96
Total	7 139	7 009	6 926	6 964	98

Table C6: Total number of trips, number of trips with zero estimated or daily processed catch, and proportion of trips with zero estimated or daily processed catch, by form type for lookdown dory from 1989–90 (1990) to 2011–12 (2012). Areas are shown in Figure 1.

LDO 1

	CELR/TCE estimated catch			TCEPR daily processed catch		
	Total	**Zero**	**Proportion**	**Total**	**Zero**	**Proportion**
1990	29	16	0.55	66	24	0.36
1991	29	14	0.48	69	18	0.26
1992	34	22	0.65	57	16	0.28
1993	31	22	0.71	75	32	0.43
1994	18	13	0.72	94	27	0.29
1995	25	19	0.76	113	44	0.39
1996	9	6	0.67	158	92	0.58
1997	40	19	0.48	171	80	0.47
1998	28	19	0.68	177	75	0.42
1999	84	50	0.60	212	100	0.47
2000	78	54	0.69	250	119	0.48
2001	81	55	0.68	262	120	0.46
2002	77	48	0.62	289	136	0.47
2003	98	77	0.79	269	111	0.41
2004	73	50	0.68	215	99	0.46
2005	47	31	0.66	202	94	0.47
2006	63	38	0.60	214	103	0.48
2007	81	58	0.72	198	80	0.40
2008	139	43	0.31	190	76	0.40
2009	114	35	0.31	173	59	0.34
2010	163	73	0.45	165	52	0.32
2011	157	75	0.48	165	42	0.25
2012	171	72	0.42	176	55	0.31

LDO 3

	CELR/TCE estimated catch			TCEPR daily processed catch		
	Total	**Zero**	**Proportion**	**Total**	**Zero**	**Proportion**
1990	1	1	1	58	20	0.34
1991	12	10	0.83	63	10	0.16
1992	24	18	0.75	101	14	0.14
1993	14	13	0.93	88	18	0.20
1994	7	7	1	105	31	0.30
1995	7	6	0.86	151	30	0.20
1996	3	3	1	188	52	0.28
1997	26	24	0.92	191	39	0.20
1998	42	40	0.95	214	42	0.20
1999	19	19	1	251	60	0.24
2000	49	35	0.71	286	63	0.22
2001	56	46	0.82	297	70	0.24
2002	27	27	1	276	51	0.18
2003	43	40	0.93	316	48	0.15
2004	29	23	0.79	278	50	0.18
2005	28	25	0.89	274	51	0.19
2006	28	27	0.96	244	53	0.22
2007	17	17	1	253	34	0.13
2008	30	25	0.83	245	29	0.12
2009	26	19	0.73	219	37	0.17
2010	47	28	0.60	199	17	0.09
2011	50	29	0.58	219	21	0.10
2012	38	20	0.53	208	29	0.14

Table C7: Total catch (t) for each region from groomed and merged data for fishing years 1990–2012.

Year	ECNI	CHAT	SUBA	West Coast	Total
1990	3	49	20	34	106
1991	6	108	15	18	147
1992	1	160	25	39	225
1993	4	164	11	64	243
1994	2	101	15	68	185
1995	2	182	8	77	268
1996	1	161	19	55	236
1997	6	204	24	76	310
1998	2	410	37	75	525
1999	2	435	22	107	566
2000	4	454	40	98	596
2001	7	493	49	98	647
2002	12	509	58	162	740
2003	14	603	81	151	849
2004	8	352	54	119	532
2005	6	227	31	86	349
2006	8	263	26	139	436
2007	7	240	31	103	381
2008	9	210	31	120	370
2009	7	281	26	105	420
2010	7	230	26	99	362
2011	7	192	20	114	333
2012	4	218	17	101	339
Total	128	6 244	684	2 109	9 165

Table C8: Total catch (t) by vessel nationality from groomed and merged data for fishing years 1990–2012.

Year	NZ	Korea	Japan	Panama	Norway	Russian	Cyprus	Other	Total
1990	4	2	98	-	1	2	-	-	106
1991	6	15	116	-	7	2	-	0	147
1992	5	15	184	-	15	7	-	0	225
1993	15	37	166	-	25	0	-	0	243
1994	16	48	88	-	26	0	-	8	185
1995	69	82	95	-	18	2	-	2	268
1996	51	91	69	-	10	12	-	3	236
1997	114	77	77	4	20	10	-	8	310
1998	227	84	135	25	26	16	1	12	525
1999	279	74	73	56	29	19	23	13	566
2000	283	90	82	34	23	11	19	54	596
2001	305	91	136	47	32	9	19	6	647
2002	349	94	60	63	72	38	35	28	740
2003	421	133	53	51	43	68	46	34	849
2004	298	103	23	67	-	13	2	26	532
2005	213	58	19	49	-	2	-	8	349
2006	245	117	21	38	-	2	-	12	436
2007	217	142	14	-	-	2	-	6	381
2008	154	199	9	-	-	1	-	8	370
2009	179	231	6	-	-	0	-	3	420
2010	187	167	4	-	-	1	-	2	362
2011	150	176	3	-	-	2	-	3	333
2012	192	140	4	-	-	1	-	2	339
Total	3 979	2 264	1 536	434	348	221	145	238	9 165

Table C9a: Proportion of lookdown dory catch reported each month from the CHAT area for fishing years 1990–2012.

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1990	0.02	0.04	0.03	-	0.02	0.05	0.20	0.24	0.03	0.01	0.01	0.34	49
1991	0.07	0.03	0.11	0.13	0.09	0.06	0.19	0.09	0.12	0.01	0.02	0.08	108
1992	0.22	0.10	0.02	0.08	0.14	0.11	0.10	0.09	0.03	0.02	0.01	0.08	160
1993	0.11	0.15	0.12	0.08	0.09	0.10	0.08	0.05	0.18	0.02	0.01	0.03	164
1994	0.22	0.14	0.18	0.14	0.01	0.01	0.01	0.01	0.10	0.07	-	0.09	101
1995	0.20	0.13	0.09	0.06	0.06	0.10	0.04	0.10	0.03	0.03	0.01	0.14	182
1996	0.11	0.08	0.17	0.15	0.06	0.03	0.05	0.07	0.11	0.02	0.02	0.15	161
1997	0.17	0.13	0.09	0.10	0.06	0.12	0.07	0.08	0.04	0.04	-	0.09	204
1998	0.19	0.10	0.10	0.12	0.06	0.10	0.08	0.04	0.10	0.05	-	0.06	410
1999	0.07	0.17	0.12	0.18	0.13	0.10	0.06	0.06	0.06	0.02	-	0.04	435
2000	0.13	0.12	0.10	0.18	0.07	0.17	0.07	0.03	0.06	0.02	-	0.05	454
2001	0.11	0.12	0.08	0.15	0.10	0.18	0.08	0.04	0.08	0.02	-	0.05	493
2002	0.08	0.03	0.07	0.21	0.12	0.12	0.13	0.11	0.04	0.01	-	0.07	509
2003	0.15	0.15	0.11	0.10	0.09	0.11	0.10	0.10	0.03	0.02	-	0.03	603
2004	0.09	0.14	0.13	0.12	0.06	0.12	0.09	0.06	0.05	0.06	0.03	0.03	352
2005	0.07	0.14	0.11	0.18	0.14	0.11	0.04	0.09	0.07	0.02	0.01	0.03	227
2006	0.06	0.13	0.16	0.19	0.09	0.06	0.07	0.10	0.08	0.04	0.01	0.01	263
2007	0.04	0.10	0.13	0.20	0.13	0.08	0.09	0.07	0.04	0.03	0.02	0.06	240
2008	0.04	0.07	0.10	0.17	0.12	0.07	0.07	0.11	0.06	0.06	0.06	0.06	210
2009	0.16	0.12	0.13	0.24	0.11	0.06	0.04	0.06	0.04	0.01	0.02	0.01	281
2010	0.16	0.12	0.17	0.20	0.12	0.05	0.02	0.04	0.04	0.03	0.02	0.03	230
2011	0.14	0.16	0.23	0.09	0.11	0.07	0.07	0.04	0.04	0.01	-	0.03	192
2012	0.06	0.11	0.17	0.23	0.11	0.08	0.02	0.06	0.05	0.01	0.02	0.08	218
Total	0.12	0.12	0.11	0.15	0.10	0.10	0.08	0.07	0.06	0.03	0.01	0.06	6 244

Table C9b: Proportion of lookdown dory catch reported for each statistical area from the CHAT area for fishing years 1990–2012.

Year	020	021	022	023	052	401	402	403	404	407	408	409	410	Other	Total
1990	0.24	0.09	0.10	0.21	0.01	0.08	0.21	0.02	-	-	0.01	0.01	0.02	0.02	49
1991	0.18	0.08	0.06	0.11	-	0.09	0.26	0.01	0.03	-	0.12	0.03	-	0.01	108
1992	0.24	0.02	0.12	0.22	-	0.11	0.11	-	-	0.01	0.10	0.03	0.02	0.01	160
1993	0.13	0.04	0.07	0.11	-	0.14	0.23	0.04	0.02	0.01	0.10	0.02	0.06	0.01	164
1994	0.17	0.13	0.11	0.19	-	0.07	0.04	-	0.02	0.02	0.15	0.06	0.02	0.01	101
1995	0.10	0.12	0.08	0.05	0.05	0.09	0.06	0.03	0.05	0.02	0.17	0.04	0.07	0.07	182
1996	0.22	0.11	0.08	0.17	0.03	0.07	0.04	0.01	0.08	0.03	0.09	0.02	0.03	0.03	161
1997	0.20	0.07	0.10	0.14	0.02	0.08	0.06	0.01	0.06	0.03	0.08	0.04	0.07	0.03	204
1998	0.15	0.04	0.06	0.11	0.09	0.08	0.11	0.02	0.02	0.03	0.15	0.05	0.07	0.01	410
1999	0.13	0.03	0.05	0.12	0.09	0.06	0.11	0.01	0.02	0.08	0.11	0.10	0.07	0.01	435
2000	0.14	0.03	0.05	0.11	0.06	0.07	0.10	0.04	0.01	0.04	0.11	0.09	0.05	0.10	454
2001	0.09	0.04	0.04	0.19	0.04	0.07	0.09	0.05	0.05	0.08	0.10	0.07	0.06	0.03	493
2002	0.10	0.02	0.05	0.14	0.06	0.05	0.07	0.01	0.02	0.10	0.15	0.08	0.11	0.02	509
2003	0.12	0.03	0.10	0.13	0.05	0.07	0.09	0.03	0.03	0.08	0.12	0.08	0.05	0.02	603
2004	0.19	0.02	0.04	0.13	0.06	0.06	0.09	0.05	0.02	0.03	0.12	0.08	0.08	0.03	352
2005	0.14	0.01	0.06	0.11	0.09	0.06	0.07	0.02	0.02	0.07	0.17	0.08	0.08	0.03	227
2006	0.16	0.03	0.11	0.16	0.02	0.05	0.07	-	0.01	0.06	0.18	0.06	0.07	0.01	263
2007	0.11	0.02	0.08	0.17	0.04	0.07	0.09	0.05	0.06	0.04	0.09	0.07	0.08	0.03	240
2008	0.16	0.03	0.05	0.12	0.06	0.06	0.09	0.05	0.09	0.02	0.08	0.05	0.05	0.10	210
2009	0.23	0.01	0.09	0.15	-	0.04	0.06	0.04	0.09	0.02	0.12	0.07	0.05	0.03	281
2010	0.22	0.01	0.09	0.18	0.03	0.06	0.05	0.01	0.02	0.04	0.13	0.08	0.06	0.02	230
2011	0.20	0.04	0.09	0.16	0.01	0.12	0.18	0.03	0.01	0.02	0.06	0.02	0.03	0.03	192
2012	0.10	0.03	0.03	0.12	0.04	0.12	0.12	0.01	-	0.06	0.15	0.08	0.07	0.07	218
Total	0.15	0.04	0.07	0.14	0.05	0.07	0.10	0.03	0.03	0.05	0.12	0.07	0.06	0.03	6 244

Table C9c: Proportion of lookdown dory catch reported by gear type from the CHAT area for fishing years 1990–2012.

Year	BT	MB	MW	Mixed	Total
1990	1	-	-	-	49
1991	0.69	0.31	-	-	108
1992	0.95	0.02	0.03	-	160
1993	0.99	0.01	-	-	164
1994	0.92	0.02	0.03	0.03	101
1995	0.97	0.01	0.01	-	182
1996	0.97	0.01	0.02	-	161
1997	0.96	0.02	-	0.01	204
1998	0.97	0.03	-	-	410
1999	0.99	0.01	-	-	435
2000	0.91	0.09	-	-	454
2001	0.99	-	-	-	493
2002	0.95	0.01	0.03	-	509
2003	0.91	0.08	-	-	603
2004	0.99	-	-	-	352
2005	0.99	0.01	-	-	227
2006	1	-	-	-	263
2007	1	-	-	-	240
2008	1	-	-	-	210
2009	1	-	-	-	281
2010	1	-	-	-	230
2011	1	-	-	-	192
2012	1	-	-	-	218
Total	0.96	0.03	0.01	-	6 244

Table C9d: Proportion of lookdown dory catch reported by target species from the CHAT area for fishing years 1990–2012.

Year	BAR	HAK	HOK	JMA	LIN	SCI	SPE	SQU	SWA	Other	Mixed	Total
1990	0.01	-	0.70	-	-	-	-	-	0.23	0.04	0.02	49
1991	0.01	0.02	0.80	-	0.11	-	-	0.01	0.02	0.01	0.03	108
1992	-	-	0.95	-	0.01	0.02	-	-	0.01	-	-	160
1993	-	0.03	0.91	-	-	0.03	-	0.01	0.03	-	-	164
1994	0.01	0.02	0.82	0.01	-	0.06	-	-	0.01	0.02	0.04	101
1995	0.01	0.03	0.85	-	-	0.02	-	0.02	0.03	0.02	0.02	182
1996	0.01	0.07	0.83	-	-	-	-	0.01	0.03	0.02	0.02	161
1997	-	0.06	0.90	-	0.01	-	-	0.01	-	0.01	0.01	204
1998	-	0.02	0.96	-	-	-	-	-	-	0.01	0.01	410
1999	-	0.03	0.96	-	-	-	-	-	-	0.01	0.01	435
2000	0.08	0.02	0.88	-	0.01	-	-	-	-	-	0.01	454
2001	-	0.03	0.95	-	-	-	-	-	-	-	0.01	493
2002	0.02	0.02	0.90	0.02	0.01	0.01	-	-	-	-	-	509
2003	0.04	0.03	0.84	-	-	0.01	0.03	0.03	-	0.01	0.01	603
2004	-	0.05	0.91	-	-	0.01	0.01	-	-	-	0.01	352
2005	-	0.02	0.91	-	-	0.04	-	-	0.01	-	0.01	227
2006	-	-	0.88	-	0.01	0.04	-	0.01	0.03	0.01	0.01	263
2007	-	0.10	0.72	-	0.06	0.05	0.02	0.02	0.01	0.01	0.02	240
2008	-	0.10	0.59	-	0.15	0.03	0.02	-	0.05	0.01	0.04	210
2009	-	0.12	0.60	-	0.07	0.02	-	-	0.11	-	0.07	281
2010	-	0.01	0.78	-	0.05	0.02	0.01	-	0.07	-	0.06	230
2011	-	-	0.76	-	0.01	0.02	0.02	-	0.13	0.01	0.05	192
2012	0.01	-	0.90	-	0.02	0.03	-	-	0.03	0.01	0.01	218
Total	0.01	0.03	0.86	-	0.02	0.02	0.01	0.01	0.02	0.01	0.02	6 244

Table C10a: Proportion of lookdown dory catch each form type from the West Coast area for fishing years 1990–2012.

Daily processed catch		Merged estimated catch					Daily processed catch and merged TCER and CELR estimated catch				
Year	Total	Year	CEL	TCP	TCE	Total	Year	CEL	TCP	TCE	Total
1990	34	1990	0.55	0.45	-	29	1990	0.43	0.57	-	38
1991	18	1991	0.18	0.82	-	15	1991	0.14	0.86	-	19
1992	39	1992	0.41	0.59	-	38	1992	0.35	0.65	-	44
1993	64	1993	0.01	0.99	-	63	1993	0.02	0.98	-	40
1994	68	1994	-	1	-	29	1994	-	1	-	55
1995	77	1995	-	1	-	48	1995	-	1	-	76
1996	55	1996	-	1	-	45	1996	-	1	-	52
1997	76	1997	0.27	0.73	-	83	1997	0.24	0.76	-	94
1998	75	1998	-	1	-	65	1998	-	1	-	85
1999	107	1999	0.40	0.60	-	103	1999	0.28	0.72	-	148
2000	98	2000	0.29	0.71	-	75	2000	0.19	0.81	-	115
2001	98	2001	0.12	0.88	-	51	2001	0.06	0.94	-	103
2002	162	2002	0.23	0.77	-	95	2002	0.12	0.88	-	182
2003	151	2003	0.15	0.85	-	70	2003	0.06	0.94	-	164
2004	119	2004	0.24	0.76	-	75	2004	0.13	0.87	-	137
2005	86	2005	0.26	0.74	-	47	2005	0.12	0.88	-	97
2006	139	2006	0.32	0.68	-	78	2006	0.15	0.85	-	170
2007	103	2007	0.35	0.65	-	70	2007	0.20	0.80	-	126
2008	120	2008	-	0.56	0.44	76	2008	-	0.77	0.23	147
2009	105	2009	-	0.62	0.38	52	2009	-	0.84	0.16	123
2010	99	2010	-	0.44	0.56	75	2010	-	0.68	0.32	131
2011	114	2011	-	0.42	0.58	65	2011	-	0.75	0.25	148
2012	101	2012	-	0.49	0.51	76	2012	-	0.71	0.29	134
Total	2 109	Total	0.17	0.71	0.12	1 423	Total	0.10	0.83	0.07	2 425

Table C10b: Proportion of lookdown dory catch each month from the West Coast area for fishing years 1990–2012.

Daily processed catch

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1990	-	-	-	-	0.01	-	-	-	0.24	0.36	0.29	0.10	34
1991	-	-	-	-	-	-	-	-	0.32	0.39	0.25	0.03	18
1992	-	-	-	-	-	-	-	-	0.19	0.42	0.09	0.30	39
1993	0.01	0.02	-	-	-	0.01	-	0.04	0.16	0.66	0.05	0.05	64
1994	0.01	-	-	-	-	-	-	0.01	0.27	0.49	0.12	0.11	68
1995	0.02	-	-	-	-	-	-	-	0.29	0.52	0.14	0.04	77
1996	0.06	-	-	-	-	-	-	-	0.08	0.72	0.05	0.09	55
1997	0.01	-	-	-	-	-	-	-	0.22	0.59	0.10	0.07	76
1998	-	0.02	-	-	-	-	-	-	0.28	0.51	0.17	0.02	75
1999	0.02	0.03	-	-	-	-	-	0.01	0.26	0.40	0.20	0.06	107
2000	0.12	-	-	-	0.02	-	0.01	0.04	0.20	0.41	0.09	0.11	98
2001	0.04	-	-	-	-	0.01	-	0.03	0.26	0.50	0.09	0.05	98
2002	0.01	0.01	-	-	-	-	-	-	0.27	0.44	0.22	0.03	162
2003	0.01	-	0.01	-	-	-	-	0.03	0.35	0.40	0.14	0.05	151
2004	0.03	-	-	-	-	0.01	-	0.01	0.12	0.60	0.16	0.07	119
2005	0.03	0.03	-	0.05	-	-	-	-	0.21	0.52	0.12	0.04	86
2006	0.02	0.01	-	-	0.01	-	-	-	0.16	0.57	0.15	0.09	139
2007	-	0.01	-	0.02	-	-	-	0.02	0.42	0.26	0.18	0.10	103
2008	0.02	-	-	-	-	-	-	0.01	0.36	0.39	0.14	0.08	120
2009	-	-	-	-	-	-	-	0.06	0.25	0.44	0.17	0.08	105
2010	0.05	-	-	-	-	-	-	-	0.25	0.42	0.22	0.06	99
2011	0.03	-	0.01	-	-	-	-	-	0.34	0.38	0.13	0.11	114
2012	0.01	-	-	-	-	-	-	-	0.23	0.55	0.11	0.10	101
Total	0.02	0.01	-	-	-	-	-	0.01	0.25	0.47	0.15	0.07	2 109

Merged estimated catch

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1990	-	-	-	-	-	0.25	0.29	-	0.24	0.17	0.04	-	29
1991	0.01	0.01	-	-	-	-	0.15	-	0.42	0.34	0.04	0.03	15
1992	-	-	-	-	-	-	0.40	-	0.14	0.42	-	0.04	38
1993	-	-	-	-	-	0.01	-	0.05	0.15	0.70	-	0.07	63
1994	-	-	-	-	-	-	-	0.04	0.43	0.40	0.08	0.04	29
1995	-	-	-	-	-	-	-	-	0.44	0.48	0.03	0.03	48
1996	0.07	-	-	-	-	-	-	-	0.28	0.56	0.03	0.05	45
1997	-	-	-	-	-	-	-	0.17	0.36	0.40	0.04	0.02	83
1998	-	0.04	-	-	-	-	0.02	-	0.36	0.46	0.08	0.05	65
1999	0.01	-	0.01	-	-	0.03	0.14	0.19	0.28	0.17	0.14	0.03	103
2000	0.15	-	-	-	0.04	0.07	0.09	0.22	0.20	0.16	0.01	0.05	75
2001	0.05	-	-	-	-	0.03	0.05	0.14	0.31	0.31	0.06	0.05	51
2002	-	0.02	-	-	-	-	0.10	0.11	0.20	0.36	0.20	0.01	95
2003	-	-	-	-	-	0.02	0.05	0.06	0.38	0.26	0.16	0.06	70
2004	0.08	0.01	-	-	0.01	0.01	0.10	0.10	0.18	0.39	0.10	0.02	75
2005	0.03	-	-	0.09	-	-	0.01	0.23	0.24	0.33	0.04	0.02	47
2006	-	-	-	-	-	0.02	0.03	0.22	0.09	0.47	0.12	0.05	78
2007	-	0.01	-	0.01	-	-	0.05	0.21	0.30	0.19	0.18	0.05	70
2008	0.02	-	-	-	0.01	0.02	0.22	0.09	0.27	0.27	0.07	0.02	76
2009	0.10	0.01	-	-	-	0.01	-	0.08	0.25	0.40	0.11	0.04	52
2010	0.01	0.01	-	0.01	0.20	0.10	0.10	0.03	0.26	0.17	0.08	0.03	75
2011	0.02	0.02	0.02	0.01	0.01	0.01	0.06	0.31	0.29	0.20	0.05	0.01	65
2012	0.01	0.01	0.01	-	0.01	0.03	0.24	0.15	0.15	0.32	0.02	0.04	76
Total	0.03	0.01	-	-	0.01	0.02	0.09	0.12	0.26	0.34	0.08	0.04	1 423

Table C10c: Proportion of lookdown dory catch for each statistical area from the West Coast area for fishing years 1990–2012.

Daily processed catch

Year	033	034	035	036	037	039	040	041	042	045	046	047	703	Other	Total
1990	-	0.83	0.14	-	-	-	-	-	-	-	0.01	-	-	0.01	34
1991	-	0.69	0.28	0.01	-	-	-	-	-	-	-	-	0.02	-	18
1992	-	0.68	0.25	0.07	-	-	-	-	-	-	-	-	-	-	39
1993	-	0.54	0.38	0.03	0.01	-	0.01	0.03	-	-	-	-	-	-	64
1994	-	0.61	0.34	0.04	-	-	-	-	-	-	-	-	0.01	-	68
1995	0.01	0.45	0.42	0.11	-	-	-	-	-	-	-	-	-	-	77
1996	-	0.48	0.48	-	0.04	-	-	-	-	-	-	-	-	-	55
1997	-	0.58	0.36	0.04	-	-	-	-	-	-	-	-	0.01	-	76
1998	-	0.67	0.32	0.01	-	-	-	-	-	-	-	-	-	-	75
1999	-	0.72	0.25	0.02	-	-	-	-	-	-	-	-	0.01	-	107
2000	-	0.57	0.37	0.01	-	-	-	-	-	0.01	0.04	-	-	-	98
2001	0.01	0.63	0.32	0.01	-	-	-	-	-	0.01	0.01	-	-	-	98
2002	-	0.54	0.38	0.04	0.01	-	-	-	-	0.01	-	-	0.01	-	162
2003	-	0.57	0.30	0.10	-	-	0.01	-	-	-	-	0.01	0.01	-	151
2004	0.01	0.62	0.31	0.02	-	-	0.02	0.01	-	-	-	0.01	-	-	119
2005	-	0.64	0.27	0.03	-	0.05	-	-	-	-	-	-	0.01	-	86
2006	-	0.66	0.27	0.05	-	-	-	0.01	-	-	-	-	-	0.01	139
2007	0.01	0.64	0.34	-	-	-	-	-	-	-	-	-	-	-	103
2008	-	0.71	0.26	0.01	-	-	0.01	-	-	-	-	-	0.01	-	120
2009	-	0.80	0.18	-	-	-	-	-	-	0.01	-	-	-	-	105
2010	-	0.61	0.36	0.01	0.01	-	-	-	-	-	-	-	-	-	99
2011	0.01	0.68	0.30	0.01	-	-	-	-	-	-	-	-	-	-	114
2012	-	0.63	0.34	0.01	-	-	-	-	-	0.01	-	-	-	-	101
Total	-	0.63	0.32	0.03	-	-	-	-	-	-	-	-	-	-	2 109

Merged estimated catch

Year	033	034	035	036	039	040	041	045	046	047	101	703	801	Other	Total
1990	0.13	0.85	0.03	-	-	-	-	-	-	-	-	-	-	-	29
1991	0.09	0.73	0.13	-	0.01	-	-	-	-	-	-	0.03	-	-	15
1992	0.15	0.57	0.18	0.11	-	-	-	-	-	-	-	-	-	-	38
1993	0.05	0.42	0.32	0.20	-	-	-	-	-	-	-	0.01	-	-	63
1994	0.03	0.70	0.25	0.01	-	-	-	-	-	-	-	0.01	-	-	29
1995	0.03	0.45	0.31	0.13	-	-	-	-	-	-	-	0.07	-	0.01	48
1996	-	0.59	0.39	0.01	-	-	-	-	-	-	-	0.01	-	-	45
1997	0.24	0.47	0.24	0.04	-	-	-	-	-	-	-	0.02	-	-	83
1998	-	0.54	0.38	0.06	-	-	-	-	-	-	-	0.01	-	-	65
1999	0.31	0.43	0.24	0.02	-	-	-	-	-	-	-	0.01	-	-	103
2000	0.20	0.33	0.32	0.01	-	-	-	-	0.14	-	-	-	-	-	75
2001	0.06	0.56	0.31	-	-	-	-	0.02	0.05	-	-	-	-	-	51
2002	0.11	0.50	0.33	0.02	-	-	-	0.01	-	0.01	-	0.02	-	-	95
2003	0.06	0.46	0.26	0.17	-	-	-	0.02	0.01	-	-	0.01	-	-	70
2004	0.16	0.43	0.24	0.05	-	0.02	0.03	-	0.01	0.01	0.01	0.01	0.03	-	75
2005	0.23	0.50	0.15	0.03	0.09	-	-	-	-	-	-	0.01	-	-	47
2006	0.23	0.46	0.26	0.04	-	-	-	0.01	-	-	-	-	-	-	78
2007	0.34	0.34	0.29	0.01	-	-	-	-	-	-	-	-	0.01	-	70
2008	0.24	0.47	0.26	0.01	-	-	-	0.01	-	-	-	0.01	-	-	76
2009	0.19	0.50	0.29	-	-	-	-	-	-	-	-	0.01	-	-	52
2010	0.14	0.61	0.24	0.01	-	-	-	-	-	-	-	-	-	-	75
2011	0.34	0.42	0.23	-	-	-	-	-	-	-	-	-	-	-	65
2012	0.32	0.35	0.30	0.02	-	-	-	-	0.01	-	-	-	-	-	76
Total	0.18	0.48	0.27	0.04	-	-	-	-	0.01	-	-	0.01	-	-	1 423

Table C10d: Proportion of lookdown dory catch by gear type from the West Coast area for fishing years 1990–2012.

Daily processed catch

Year	BT	MB	MW	Mixed	Total
1990	0.34	0.25	0.35	0.06	34
1991	0.39	0.12	0.46	0.02	18
1992	0.58	0.15	0.22	0.05	39
1993	0.78	0.08	0.11	0.04	64
1994	0.67	0.13	0.16	0.03	68
1995	0.65	0.07	0.27	0.02	77
1996	0.78	0.05	0.13	0.04	55
1997	0.60	0.10	0.25	0.05	76
1998	0.53	0.14	0.25	0.08	75
1999	0.41	0.17	0.35	0.07	107
2000	0.56	0.16	0.17	0.11	98
2001	0.78	0.09	0.09	0.04	98
2002	0.68	0.12	0.18	0.03	162
2003	0.82	0.09	0.04	0.05	151
2004	0.76	0.13	0.05	0.06	119
2005	0.87	0.05	0.04	0.04	86
2006	0.87	0.06	0.06	0.02	139
2007	0.91	0.03	0.03	0.03	103
2008	0.98	0.02	-	-	120
2009	0.95	0.04	-	0.01	105
2010	0.91	0.04	0.04	0.01	99
2011	0.94	0.04	0.01	0.01	114
2012	0.95	0.03	0.01	0.01	101
Total	0.77	0.08	0.11	0.04	2 109

Merged estimated catch

Year	BT	MB	MW	Total
1990	0.76	0.15	0.09	29
1991	0.44	0.06	0.51	15
1992	0.70	0.12	0.17	38
1993	0.90	0.02	0.08	63
1994	0.68	0.17	0.15	29
1995	0.61	0.14	0.25	48
1996	0.64	0.08	0.28	45
1997	0.74	0.03	0.23	83
1998	0.63	0.12	0.24	65
1999	0.61	0.12	0.27	102
2000	0.67	0.15	0.18	75
2001	0.85	0.08	0.07	51
2002	0.72	0.07	0.20	94
2003	0.89	0.08	0.03	70
2004	0.82	0.14	0.03	74
2005	0.89	0.05	0.06	47
2006	0.91	0.03	0.06	78
2007	0.93	0.03	0.03	70
2008	0.99	0.01	-	76
2009	0.96	0.03	0.01	52
2010	0.98	0.02	-	75
2011	0.99	0.01	-	65
2012	0.99	0.01	-	76
Total	0.81	0.07	0.12	1 420

Table C10e: Proportion of lookdown dory catch by target species from the West Coast area for fishing years 1990–2012.

Daily processed catch

Year	BAR	HAK	HOK	JMA	LIN	SKI	SQU	SWA	TAR	Other	Mixed	Total
1990	0.06	-	0.92	0.01	-	-	-	-	-	0.01	0.01	34
1991	-	-	0.94	0.03	-	0.01	-	-	-	-	0.02	18
1992	-	0.16	0.73	-	-	0.01	-	-	-	0.03	0.08	39
1993	0.05	0.03	0.84	0.06	-	0.01	-	-	-	-	0.02	64
1994	0.02	0.12	0.83	0.01	-	-	-	0.01	-	0.01	0.01	68
1995	0.02	0.08	0.84	0.01	0.01	-	-	0.01	-	-	0.03	77
1996	-	0.06	0.88	0.05	-	-	-	-	-	-	0.01	55
1997	-	0.02	0.94	0.01	-	0.01	-	-	-	-	0.03	76
1998	-	0.03	0.86	0.09	-	-	-	-	-	-	0.02	75
1999	0.01	0.05	0.88	0.03	-	-	-	-	-	0.01	0.01	107
2000	-	0.07	0.77	0.10	-	-	0.01	0.01	-	-	0.04	98
2001	0.01	0.04	0.89	0.01	-	0.01	-	0.01	-	0.01	0.03	98
2002	-	0.05	0.85	0.05	-	-	-	0.02	-	-	0.02	162
2003	-	0.09	0.81	0.03	-	0.01	0.02	-	-	-	0.04	151
2004	-	0.11	0.78	0.04	-	-	0.01	0.01	-	-	0.05	119
2005	-	0.18	0.61	-	-	-	0.04	-	0.05	0.01	0.11	86
2006	-	0.44	0.44	0.02	-	-	-	-	-	-	0.10	139
2007	-	0.40	0.37	0.01	0.02	-	-	0.02	-	0.01	0.16	103
2008	-	0.65	0.22	0.01	0.01	-	-	0.01	-	0.01	0.10	120
2009	0.01	0.72	0.13	-	0.01	-	-	0.01	-	0.01	0.10	105
2010	0.03	0.48	0.28	0.01	-	-	-	0.04	-	-	0.15	99
2011	-	0.56	0.30	0.01	-	-	-	0.01	-	0.01	0.12	114
2012	0.01	0.22	0.53	-	-	-	-	-	-	0.01	0.24	101
Total	0.01	0.23	0.64	0.03	-	-	-	0.01	-	-	0.07	2 109

Merged estimated catch

Year	BAR	HAK	HOK	JMA	LDO	LIN	SKI	SQU	SWA	TAR	Other	Total
1990	0.01	-	0.44	-	0.54	0.01	-	-	-	-	-	29
1991	-	-	0.80	0.01	0.08	0.02	0.01	-	-	0.07	0.01	15
1992	-	0.02	0.70	-	0.26	0.01	0.01	-	-	-	-	38
1993	-	0.07	0.85	-	0.06	-	0.02	-	-	-	0.01	63
1994	-	0.17	0.78	-	0.04	-	-	-	-	-	-	29
1995	0.01	0.14	0.83	-	-	0.01	-	-	-	-	0.01	48
1996	-	0.10	0.90	-	-	-	-	-	-	-	-	45
1997	0.02	-	0.98	-	-	-	-	-	-	-	-	83
1998	-	0.05	0.90	0.02	-	-	0.02	-	-	-	0.01	65
1999	0.03	0.02	0.90	0.04	-	-	-	-	-	-	0.01	103
2000	0.01	0.06	0.78	0.14	-	-	0.01	-	-	-	-	75
2001	-	0.02	0.91	-	-	0.01	0.02	-	0.04	-	-	51
2002	0.01	0.01	0.93	-	-	0.01	-	-	0.03	-	-	95
2003	-	0.06	0.87	0.01	-	0.02	-	0.02	-	-	0.01	70
2004	0.13	0.02	0.75	0.06	-	0.02	-	0.01	0.01	0.01	-	75
2005	-	0.13	0.51	-	0.22	-	-	0.03	0.01	0.09	0.01	47
2006	-	0.31	0.66	-	-	0.02	-	-	-	-	0.01	78
2007	-	0.22	0.55	0.01	0.14	0.04	-	-	0.02	-	0.03	70
2008	0.01	0.36	0.24	-	0.21	0.16	-	-	0.01	-	0.01	76
2009	-	0.45	0.25	-	0.07	0.18	0.01	-	0.04	0.01	-	52
2010	-	0.29	0.13	-	0.24	0.13	-	0.02	0.04	0.14	0.01	75
2011	-	0.24	0.22	-	0.44	0.07	-	-	-	0.01	0.01	65
2012	-	0.15	0.36	-	0.43	0.03	0.01	-	0.01	-	0.01	76
Total	0.01	0.13	0.67	0.02	0.11	0.03	-	-	0.01	0.01	0.01	1 423

Table C11a: Proportion of lookdown dory catch reported each month from the SUBA area for fishing years 1990–2012.

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1990	0.01	0.10	0.05	0.27	0.08	0.08	0.08	0.13	0.07	-	0.05	0.08	20
1991	0.11	0.19	0.03	0.05	0.04	0.02	0.10	0.18	0.14	-	0.01	0.14	15
1992	0.09	0.02	0.13	0.09	0.02	0.15	0.12	0.12	0.06	0.01	0.08	0.11	25
1993	0.14	0.01	0.13	0.13	0.06	0.06	0.13	0.12	0.15	0.01	0.04	0.01	11
1994	-	0.03	0.07	0.16	0.14	0.10	0.02	-	0.28	0.01	0.06	0.11	15
1995	0.12	0.26	0.17	0.16	0.08	0.03	0.01	0.04	0.01	-	-	0.11	8
1996	0.08	0.39	0.16	0.03	0.02	0.06	0.01	0.04	0.03	0.06	0.01	0.11	19
1997	0.07	0.13	0.13	0.15	0.08	0.03	0.02	0.08	0.14	0.05	0.01	0.10	24
1998	0.10	0.02	0.08	0.04	0.09	0.04	0.09	0.33	0.14	0.01	-	0.06	37
1999	0.12	0.10	0.08	0.06	0.01	0.04	0.11	0.11	0.21	0.03	0.01	0.12	22
2000	0.10	0.08	0.13	0.16	0.10	0.08	0.03	0.08	0.08	0.04	0.02	0.09	40
2001	0.11	0.10	0.14	0.14	0.05	0.09	0.08	0.15	0.07	0.02	-	0.04	49
2002	0.06	0.09	0.14	0.12	0.08	0.06	0.05	0.06	0.06	0.18	0.02	0.06	58
2003	0.06	0.12	0.10	0.12	0.02	0.17	0.24	0.05	0.08	-	0.02	0.02	81
2004	0.17	0.13	0.13	0.11	0.08	0.01	0.10	0.19	0.05	0.01	0.01	0.02	54
2005	0.16	0.13	0.13	0.10	0.09	0.01	0.03	0.04	0.08	0.07	0.04	0.13	31
2006	0.19	0.08	0.07	0.01	-	0.02	0.02	0.24	0.09	0.07	0.05	0.16	26
2007	0.15	0.17	0.22	0.09	0.03	0.04	0.05	0.04	0.02	0.08	0.07	0.04	31
2008	0.11	0.17	0.21	0.05	0.07	0.02	0.09	0.06	0.01	0.09	0.07	0.05	31
2009	0.09	0.13	0.14	0.07	0.13	0.11	0.02	0.06	0.08	0.04	0.06	0.08	26
2010	0.11	0.09	0.23	0.14	0.03	0.04	0.04	0.08	0.10	0.05	0.06	0.03	26
2011	0.11	0.21	0.22	0.10	0.03	0.01	0.05	0.09	0.05	0.04	0.03	0.05	20
2012	0.21	0.11	0.13	0.14	0.05	0.06	0.05	0.09	0.03	0.04	0.04	0.06	17
Total	0.10	0.12	0.13	0.11	0.06	0.07	0.08	0.11	0.08	0.04	0.03	0.07	684

Table C11b: Proportion of catch reported for each statistical area from the SUBA area for fishing years 1990–2012.

Year	025	026	027	028	029	030	504	602	603	608	610	618	619	Other	Total
1990	-	0.27	0.19	0.13	0.02	0.23	0.06	0.08	0.01	-	-	-	-	-	20
1991	-	0.26	0.22	0.06	-	0.29	0.06	0.08	0.02	-	-	-	-	-	15
1992	-	0.25	0.22	0.26	0.03	0.12	0.02	0.02	0.03	0.01	0.01	-	0.01	0.03	25
1993	0.01	0.19	0.36	0.02	-	0.25	0.05	0.06	0.06	-	-	-	-	-	11
1994	-	0.17	0.21	0.03	-	0.32	0.02	0.15	0.03	0.03	-	-	-	0.04	15
1995	0.01	0.09	0.19	0.11	-	0.32	0.04	0.19	0.05	-	-	-	-	-	8
1996	-	0.08	0.21	0.04	-	0.34	0.06	0.22	0.03	-	-	-	-	-	19
1997	-	0.06	0.11	0.15	-	0.22	0.05	0.37	0.03	-	-	-	-	0.01	24
1998	-	0.05	0.04	0.16	-	0.15	0.01	0.56	0.01	-	-	-	-	-	37
1999	-	0.06	0.09	0.08	-	0.23	0.02	0.49	0.01	-	0.01	-	-	0.01	22
2000	-	0.06	0.09	0.14	0.01	0.27	0.04	0.29	0.01	-	0.06	0.03	-	-	40
2001	-	0.08	0.07	0.13	-	0.23	0.01	0.32	0.03	-	0.11	0.02	-	0.01	49
2002	-	0.02	0.04	0.27	0.01	0.17	0.01	0.34	0.02	-	0.05	0.02	0.04	0.01	58
2003	-	0.02	0.05	0.14	0.21	0.12	0.01	0.24	0.07	-	0.07	0.04	0.01	-	81
2004	-	0.01	0.03	0.36	-	0.13	0.01	0.23	0.08	0.01	0.06	0.06	0.02	0.01	54
2005	-	0.02	0.03	0.21	-	0.34	0.01	0.20	0.05	-	0.06	0.02	-	0.05	31
2006	-	0.04	0.10	0.20	-	0.48	-	0.12	0.01	-	0.02	-	-	0.02	26
2007	0.03	0.08	0.20	0.26	0.02	0.22	0.01	0.11	0.03	-	0.04	-	-	0.01	31
2008	0.01	0.08	0.10	0.21	0.01	0.19	0.02	0.18	0.03	-	0.08	0.09	-	-	31
2009	-	0.11	0.14	0.28	-	0.23	0.02	0.13	0.02	0.01	0.03	-	-	0.02	26
2010	-	0.13	0.18	0.25	-	0.22	0.03	0.14	0.03	-	0.02	-	-	-	26
2011	0.01	0.27	0.15	0.15	-	0.19	0.02	0.16	0.02	-	-	-	0.01	-	20
2012	0.01	0.17	0.16	0.23	-	0.18	0.02	0.14	0.02	0.02	0.02	-	-	0.02	17
Total	-	0.08	0.11	0.19	0.03	0.21	0.02	0.24	0.03	-	0.04	0.02	0.01	0.01	684

Table C11c: Proportion of lookdown dory catch reported by gear type from the SUBA area for fishing years 1990–2012.

Year	BT	MB	MW	Mixed	Total
1990	0.98	-	0.02	-	20
1991	1	-	-	-	15
1992	0.90	0.10	-	-	25
1993	1	-	-	-	11
1994	0.98	0.02	-	0.01	15
1995	1	-	-	-	8
1996	1	-	-	-	19
1997	0.98	-	0.02	-	24
1998	1	-	-	-	37
1999	0.97	-	0.01	0.02	22
2000	0.98	-	-	0.01	40
2001	0.99	-	0.01	-	49
2002	0.89	0.07	0.02	0.02	58
2003	0.70	0.28	0.01	0.01	81
2004	0.78	0.06	0.11	0.04	54
2005	0.94	0.03	0.02	0.01	31
2006	0.98	0.01	-	0.01	26
2007	0.99	-	-	-	31
2008	0.97	-	0.02	0.01	31
2009	0.98	-	-	0.01	26
2010	0.99	-	-	-	26
2011	0.97	0.02	-	-	20
2012	0.97	0.01	0.01	0.01	17
Total	0.92	0.05	0.02	0.01	684

Table C11d: Proportion of lookdown dory catch reported by target species from the SUBA area for fishing years 1990–2012.

Year	HAK	HOK	LIN	RCO	SBW	SCI	SQU	SWA	WWA	Other	Mixed	Total
1990	0.01	0.38	0.17	-	-	-	0.02	0.10	0.15	0.08	0.08	20
1991	-	0.44	0.38	-	-	-	0.11	0.04	-	0.01	0.02	15
1992	-	0.53	0.05	-	0.04	-	0.21	0.14	-	0.02	0.01	25
1993	-	0.60	0.13	-	-	0.02	0.05	0.06	-	0.03	0.10	11
1994	-	0.45	-	-	0.05	0.08	0.04	0.32	-	-	0.06	15
1995	-	0.37	0.06	0.09	0.01	0.15	0.02	0.21	-	0.02	0.07	8
1996	-	0.56	0.13	0.06	-	0.05	-	0.12	-	0.01	0.07	19
1997	-	0.73	0.03	0.03	-	0.12	0.05	0.02	-	-	0.03	24
1998	-	0.90	0.02	0.01	-	0.01	0.01	0.03	-	-	0.02	37
1999	0.01	0.74	0.06	0.01	0.02	0.04	0.04	0.03	0.01	-	0.05	22
2000	0.02	0.74	0.09	-	-	0.02	0.03	0.03	0.01	0.01	0.04	40
2001	0.02	0.73	0.08	0.01	-	0.01	0.04	0.04	0.02	-	0.05	49
2002	0.03	0.49	0.04	-	0.04	0.05	0.05	0.06	0.16	0.04	0.04	58
2003	0.02	0.44	0.03	-	0.01	0.06	0.31	0.01	0.05	-	0.07	81
2004	0.03	0.37	0.09	-	0.02	0.06	0.24	0.01	0.11	-	0.06	54
2005	0.03	0.45	0.17	-	-	0.01	0.04	0.01	0.19	0.02	0.07	31
2006	0.01	0.18	0.30	-	0.01	0.02	0.08	0.08	0.22	0.01	0.10	26
2007	0.05	0.26	0.22	0.01	-	0.02	0.08	0.08	0.13	0.02	0.13	31
2008	0.09	0.13	0.31	-	0.09	0.02	0.02	0.10	0.14	0.01	0.08	31
2009	0.14	0.19	0.24	-	0.03	0.01	0.05	0.09	0.16	-	0.08	26
2010	0.07	0.34	0.18	-	0.01	0.01	0.05	0.09	0.14	0.01	0.11	26
2011	0.05	0.39	0.24	-	0.02	0.01	0.05	0.07	0.08	0.01	0.09	20
2012	0.08	0.38	0.16	-	0.05	0.01	0.03	0.07	0.10	0.02	0.11	17
Total	0.03	0.48	0.12	0.01	0.02	0.03	0.09	0.06	0.08	0.01	0.06	684

Table C12a: Proportion of lookdown dory catch reported by form type from the ECNI area for fishing years 1990–2012.

Merged estimated catch

Year	CEL	TCP	TCE	Total
1990	0.76	0.24	-	6
1991	0.24	0.76	-	4
1992	0.25	0.75	-	1
1993	0.05	0.95	-	3
1994	0.13	0.87	-	1
1995	0.20	0.80	-	2
1996	0.01	0.99	-	4
1997	0.01	0.99	-	14
1998	0.02	0.98	-	5
1999	-	1	-	5
2000	0.09	0.91	-	5
2001	0.05	0.95	-	3
2002	-	1	-	10
2003	-	1	-	3
2004	-	1	-	6
2005	-	1	-	3
2006	0.11	0.89	-	4
2007	0.20	0.80	-	5
2008	-	0.40	0.60	8
2009	-	0.54	0.46	8
2010	0.02	0.56	0.43	6
2011	-	0.65	0.35	8
2012	-	0.26	0.74	5
Total	0.07	0.78	0.15	119

Daily processed catch (TCP)

Year	Total
1990	3
1991	6
1992	1
1993	4
1994	2
1995	2
1996	1
1997	6
1998	2
1999	2
2000	4
2001	7
2002	12
2003	14
2004	8
2005	6
2006	8
2007	7
2008	9
2009	7
2010	7
2011	7
2012	4
Total	128

Table C12b: Proportion of lookdown dory catch reported each month from the ECNI area for fishing years 1990–2012.

Daily processed catch:

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1990	0.17	0.31	0.11	0.09	0.02	0.03	0.03	0.03	0.04	0.02	0.06	0.10	3
1991	0.13	0.03	0.04	0.05	0.05	0.02	0.01	0.05	0.14	0.22	0.22	0.05	6
1992	0.19	0.57	0.07	0.08	-	-	-	-	-	0.02	0.02	0.05	1
1993	-	0.04	0.04	0.04	0.04	0.01	-	0.11	0.34	0.37	0.02	-	4
1994	-	0.38	0.02	0.01	-	0.02	-	0.14	0.39	0.03	-	-	2
1995	-	-0.01	-	0.05	0.01	0.23	0.11	0.05	0.25	0.16	0.15	-	2
1996	0.24	0.04	0.20	0.19	0.03	-0.01	-0.01	-0.01	0.01	-	0.31	0.01	1
1997	0.08	0.28	0.03	0.07	0.01	0.13	0.26	-	0.09	0.03	-	-	6
1998	0.05	0.23	0.01	0.01	0.15	0.06	0.08	0.09	0.20	0.01	0.10	0.02	2
1999	0.13	0.12	-	0.27	0.03	0.25	0.03	-0.01	-0.01	0.10	0.09	-	2
2000	0.04	0.01	0.20	0.01	0.18	-	0.23	0.07	0.02	0.08	0.07	0.09	4
2001	0.09	0.21	0.07	0.21	0.12	0.08	0.02	0.07	0.07	0.01	0.02	0.03	7
2002	0.04	0.02	0.12	0.09	0.23	0.14	0.05	0.13	0.06	0.07	0.05	-	12
2003	0.07	0.40	0.05	0.19	0.13	0.10	-	-	0.01	-	0.02	0.02	14
2004	0.05	0.10	0.02	0.24	0.10	0.13	0.15	-	0.07	0.12	-	0.01	8
2005	0.07	0.20	0.09	0.18	0.13	0.12	0.05	0.01	-	0.02	0.03	0.09	6
2006	0.01	0.05	0.16	0.03	0.02	0.03	0.02	0.07	0.11	0.15	0.24	0.11	8
2007	0.08	0.08	0.04	0.11	0.01	0.09	0.03	0.11	0.03	0.04	0.09	0.27	7
2008	0.09	0.09	0.19	0.05	0.05	0.07	0.16	0.02	0.03	0.01	0.14	0.10	9
2009	0.05	0.03	0.12	0.12	0.03	0.03	0.01	0.05	0.07	0.02	0.32	0.14	7
2010	0.11	0.13	0.04	0.11	0.10	0.02	0.01	0.02	0.18	0.10	0.13	0.05	7
2011	0.13	0.04	0.08	0.22	0.16	0.14	0.02	0.03	0.03	0.02	0.09	0.05	7
2012	0.17	0.05	0.16	0.05	0.17	0.13	0.05	0.05	0.04	0.08	0.02	0.03	4
Total	0.07	0.14	0.08	0.12	0.09	0.08	0.06	0.05	0.08	0.07	0.09	0.06	128

Merged estimated catch:

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1990	0.02	0.06	0.04	0.03	0.01	0.01	0.01	-	0.18	0.57	0.04	0.02	6
1991	0.05	0.02	0.04	0.05	0.04	0.02	0.01	0.05	0.16	0.16	0.16	0.24	4
1992	0.19	0.39	0.10	0.07	-	-	-	-	-	0.17	0.02	0.06	1
1993	0.01	0.04	0.05	0.03	0.03	0.01	-	0.05	0.38	0.34	0.05	-	3
1994	0.03	0.53	0.09	0.01	-	0.01	-	0.09	0.12	-	-	0.12	1
1995	-	0.08	0.24	0.03	0.06	0.17	0.17	0.01	0.10	0.01	0.08	0.03	2
1996	0.41	0.02	0.09	0.16	0.09	0.12	0.02	-	-	-	0.08	0.01	4
1997	0.03	0.10	0.01	0.05	-	0.15	0.57	0.03	0.03	-	0.02	0.01	14
1998	0.21	0.07	0.04	0.15	0.10	0.01	0.05	0.09	0.08	0.11	0.04	0.05	5
1999	0.08	0.16	0.02	0.18	0.05	0.10	0.03	0.04	-	0.16	0.17	-	5
2000	0.09	0.36	0.14	-	0.07	-	0.14	0.03	0.04	0.09	0.02	0.01	5
2001	0.04	0.10	0.11	0.16	0.16	0.09	-	0.17	0.09	0.01	-	0.07	3
2002	0.06	0.02	0.10	0.01	0.06	0.02	0.02	0.10	0.20	0.25	0.15	0.01	10
2003	0.20	0.08	0.01	0.08	0.22	0.13	0.04	0.01	0.02	0.05	0.09	0.08	3
2004	0.04	0.03	0.01	0.14	0.04	0.20	0.16	0.06	0.05	0.24	0.04	-	6
2005	0.05	0.10	0.03	0.27	0.09	0.04	0.04	0.37	-	0.01	-	-	3
2006	-	0.02	0.04	0.02	0.01	-	-	0.11	0.03	0.23	0.27	0.26	4
2007	0.04	-	0.35	0.11	-	0.03	-	-	0.03	0.10	0.24	0.10	5
2008	0.01	0.01	0.22	0.03	0.08	0.05	0.08	0.09	-	0.02	0.35	0.06	8
2009	0.01	0.07	0.15	0.07	0.02	0.03	0.06	0.06	0.08	0.01	0.37	0.08	8
2010	0.08	0.14	0.06	0.03	0.04	0.09	0.08	0.02	0.07	0.19	0.17	0.03	6
2011	0.06	0.03	0.10	0.11	0.10	0.16	0.01	-	0.05	0.13	0.21	0.04	8
2012	0.02	0.07	0.03	0.06	0.15	0.05	-	0.02	0.09	0.23	0.19	0.08	5
Total	0.06	0.08	0.09	0.07	0.06	0.07	0.11	0.05	0.07	0.14	0.14	0.05	119

Table C12c: Proportion of lookdown dory catch reported for each statistical area from the ECNI area for fishing years 1990–2012.

Daily processed catch:

Year	002	003	004	008	009	010	011	012	013	014	015	016	204	Other	Total
1990	-	-	-	0.30	0.49	0.02	-	0.01	-	0.18	-	-	-	-	3
1991	-	-	0.01	0.29	0.11	-	-	-	-	0.54	0.06	-	-	-	6
1992	-	-	-	0.10	0.25	0.08	-	0.03	-	0.55	-	-	-	-	1
1993	-	-	-	0.02	0.01	-	-	0.04	-	0.87	0.07	-	-	-	4
1994	-	-	-	-	-	-	0.01	-	-	0.91	0.08	-	-	-	2
1995	-	-	-	0.16	-	-	-	0.03	-	0.67	0.09	0.05	-	-	2
1996	-	-	-	0.37	0.02	-	-	-	-	0.52	0.13	-0.04	-	-	1
1997	-	-	-	0.02	0.01	0.01	-	0.01	-	0.84	0.04	0.06	-	-	6
1998	-	-	0.02	0.19	0.05	0.03	0.01	0.12	-	0.42	0.10	-0.02	-	0.07	2
1999	-	0.08	-	0.05	0.02	-	-	-	-	0.57	0.24	0.03	-	-	2
2000	-	0.01	-	0.13	-	-	-	-	0.06	0.74	0.06	-	-	-	4
2001	0.06	0.01	-	0.09	0.02	0.02	0.07	-	0.02	0.63	0.08	0.01	-	-	7
2002	-	0.01	-	0.11	0.07	0.05	-	0.02	-	0.64	0.10	-	-	0.01	12
2003	-	-	0.01	0.32	0.14	-	0.01	-	-	0.41	0.09	-	-	-	14
2004	-	0.01	-	0.10	0.03	-	-	-	-	0.74	0.12	-	-	-	8
2005	0.01	0.01	-	0.06	0.01	0.01	-	0.01	0.03	0.65	0.18	-0.01	0.02	0.03	6
2006	0.02	0.05	0.04	0.28	0.11	0.05	0.02	0.01	-	0.30	0.07	0.01	-	0.03	8
2007	-	-	0.03	0.12	0.03	0.02	0.04	-	-	0.51	0.22	-	0.01	-	7
2008	-	-	-	0.21	0.10	0.02	-	-	-	0.51	0.16	0.01	-	-	9
2009	-	-	0.01	0.13	0.02	-	-	0.03	-	0.65	0.11	0.02	0.01	-	7
2010	-	-	0.01	0.04	0.01	-	-	0.01	0.01	0.55	0.20	0.16	0.01	0.01	7
2011	-	-	0.01	0.02	0.01	-	-	-	0.03	0.64	0.26	0.04	0.01	-	7
2012	0.02	0.06	0.01	0.36	0.12	0.02	0.01	-	-	0.19	0.15	0.05	0.01	0.01	4
Total	0.01	0.01	0.01	0.15	0.07	0.02	0.01	0.01	0.01	0.57	0.12	0.02	-	0.01	128

Merged estimated catch:

Year	002	003	004	008	009	010	011	012	013	014	015	016	204	Other	Total
1990	-	-	-	0.07	0.13	0.01	-	-	-	0.79	-	-	-	-	6
1991	-	-	0.01	0.23	0.14	0.10	0.10	-	0.01	0.30	0.08	-	0.02	-	4
1992	-	-	-	0.08	0.06	0.04	-	-	-	0.73	0.10	-	-	-	1
1993	-	-	-	0.01	-	-	-	0.03	-	0.83	0.13	-	-	-	3
1994	-	-	-	-	-	-	0.01	-	-	0.80	0.07	-	-	0.12	1
1995	-	-	-	0.10	0.13	-	-	0.12	0.02	0.29	0.23	0.09	-	0.02	2
1996	-	-	0.14	0.32	0.04	-	-	0.01	0.01	0.34	0.14	0.01	-	-	4
1997	-	-	0.13	0.37	0.07	0.03	-	-	0.03	0.32	0.04	-	-	-	14
1998	-	-	-	0.16	0.16	0.10	0.07	0.03	-	0.44	0.04	-	-	-	5
1999	0.01	0.02	0.02	0.31	0.07	0.02	0.03	0.17	-	0.22	0.12	0.02	-	-	5
2000	0.01	0.10	-	0.45	0.03	-	-	-	-	0.36	0.05	-	-	-	5
2001	-	-	-	0.31	0.05	-	-	-	-	0.62	0.03	-	-	-	3
2002	-	-	0.01	0.54	0.22	0.02	0.01	-	-	0.20	0.01	-	-	0.01	10
2003	0.01	-	-	0.39	0.04	-	0.05	-	-	0.34	0.14	-	-	0.01	3
2004	-	-	0.01	0.39	0.13	-	-	-	-	0.43	0.01	-	-	0.03	6
2005	-	-	-	0.53	0.06	-	-	0.04	-	0.30	0.06	0.01	-	-	3
2006	0.02	-	0.20	0.32	0.06	0.18	-	-	-	0.17	0.04	0.01	-	-	4
2007	-	-	0.02	0.08	0.08	0.09	-	0.13	0.04	0.50	0.04	-	-	0.01	5
2008	-	-	0.01	0.17	0.21	0.13	0.07	-	-	0.36	0.04	-	-	-	8
2009	-	-	-	0.30	0.05	0.13	0.04	-	-	0.38	0.09	-	0.01	-	8
2010	0.01	0.02	-	0.17	0.09	0.17	0.06	-	-	0.35	0.11	0.02	0.01	-	6
2011	-	-	0.04	0.12	0.09	0.11	0.02	-	0.01	0.43	0.16	0.01	0.01	-	8
2012	-	-	-	0.24	0.07	0.09	0.12	-	-	0.43	0.03	-	0.01	-	5
Total	-	0.01	0.03	0.27	0.10	0.06	0.03	0.02	0.01	0.39	0.07	0.01	-	-	119

Table C12d: Proportion of lookdown dory catch reported by gear type from the ECNI area for fishing years 1990–2012.

Daily processed catch:

Year	BT	MB	MW	Mixed	Total
1990	1	-	-	-	3
1991	1	-	-	-	6
1992	1	-	-	-	1
1993	1	-	-	-	4
1994	1.01	-	-	-	2
1995	1.01	-0.01	-	-	2
1996	1.04	-	-0.01	-0.03	1
1997	1	-	-	-	6
1998	1.01	0.01	-0.01	-0.01	2
1999	0.96	0.04	0.02	-0.02	2
2000	1.01	-0.01	-0.01	-	4
2001	0.98	0.01	0.01	-	7
2002	1	-	-	-	12
2003	1	-	-	-	14
2004	0.97	0.01	-	0.02	8
2005	0.98	0.01	-	0.01	6
2006	0.99	0.01	-	-	8
2007	0.98	0.01	-	0.01	7
2008	0.95	0.04	0.01	-	9
2009	0.94	0.02	0.01	0.04	7
2010	0.73	0.02	0.19	0.06	7
2011	0.91	0.01	0.05	0.03	7
2012	0.92	0.02	0.03	0.03	4
Total	0.97	0.01	0.02	0.01	128

Merged estimated catch:

Year	BT	DS	MB	MW	SN	Total
1990	0.97	-	-	-	0.03	6
1991	0.97	-	-	-	0.03	4
1992	0.96	-	-	-	0.04	1
1993	0.99	-	-	-	0.01	3
1994	1	-	-	-	-	1
1995	1	-	-	-	-	2
1996	0.76	-	0.24	-	-	4
1997	0.99	-	-	-	-	14
1998	0.98	-	0.01	-	0.01	5
1999	0.97	-	0.02	0.01	-	5
2000	0.98	-	0.01	0.01	-	5
2001	1	-	-	-	-	3
2002	0.99	-	0.01	-	-	10
2003	1	-	-	-	-	3
2004	1	-	-	-	-	6
2005	0.95	-	0.04	0.01	-	3
2006	0.98	-	0.01	-	0.02	4
2007	1	-	-	-	-	5
2008	0.99	-	0.01	0.01	-	8
2009	0.99	-	0.01	-	-	8
2010	0.91	0.02	0.02	0.06	-	6
2011	0.98	-	-	0.02	-	8
2012	1	-	-	-	-	5
Total	0.97	-	0.01	0.01	-	119

Table C12e: Proportion of lookdown dory catch reported by target species from the ECNI area for fishing years 1990–2012.

Daily processed catch:

Year	BYX	CDL	HOK	LIN	ORH	SCI	SKI	SNA	TAR	Other	Mixed	Total
1990	-	-	-	-	-	1	-	-	-	-	-	3
1991	-	-	-	-	-	1	-	-	-	-	-	6
1992	-	-	-	-	-	1	-	-	-	-	-	1
1993	-	-	0.01	-	-	0.99	-	-	-	-	-	4
1994	-	-	0.01	-	-	0.99	-	-	-	-	-	2
1995	-	-	0.06	-	-	0.94	-	-	-	-	-	2
1996	-	-	0.07	-	-	0.93	-	-	-	-	-	1
1997	-	-	0.42	-	-	0.54	0.01	0.01	-	-	0.01	6
1998	-	-	0.31	-	0.01	0.51	-	0.01	0.01	0.10	0.05	2
1999	-	-	0.51	-	-	0.47	-	0.01	-	-	0.01	2
2000	-	-	0.70	-	-	0.28	0.01	-	-	-	-	4
2001	0.07	-	0.29	0.01	-	0.36	0.05	0.02	0.12	0.02	0.07	7
2002	0.03	-	0.18	-	-	0.71	0.02	0.01	0.01	-	0.05	12
2003	-	-	0.07	0.01	-	0.88	0.01	-	-	0.01	0.02	14
2004	0.01	-	0.21	-	-	0.66	-	0.01	-	0.03	0.08	8
2005	0.04	0.01	0.22	0.01	-	0.63	-	0.01	0.02	0.02	0.04	6
2006	0.05	0.02	0.16	0.06	-	0.39	-	0.14	0.05	0.02	0.11	8
2007	0.02	0.02	0.05	0.26	0.01	0.37	0.04	-	0.07	0.01	0.16	7
2008	0.03	0.01	0.11	0.07	-	0.48	0.01	0.03	0.05	0.03	0.18	9
2009	0.02	0.01	0.08	0.32	-	0.33	-	0.01	0.09	0.02	0.12	7
2010	0.09	0.01	0.19	0.12	0.01	0.38	-	0.01	0.09	0.08	0.04	7
2011	0.04	-	0.33	0.07	0.03	0.39	-	-	0.07	0.01	0.05	7
2012	0.02	0.02	0.47	-	0.04	0.37	-	0.01	0.04	0.01	0.03	4
Total	0.02	-	0.19	0.05	-	0.59	0.01	0.01	0.03	0.02	0.06	128

Merged estimated catch:

	BNS	BYX	HOK	LDO	LIN	MOK	SCI	SKI	SWA	TAR	Other	Total
1990	-	-	-	-	0.76	-	0.24	-	-	-	-	6
1991	-	0.01	-	-	0.04	0.20	0.75	-	-	-	-	4
1992	-	-	-	-	0.21	-	0.75	-	-	0.05	-	1
1993	-	-	0.01	-	0.04	-	0.94	-	-	-	0.01	3
1994	-	-	0.14	-	0.13	-	0.72	-	-	-	0.01	1
1995	-	-	0.30	-	0.03	-	0.54	0.06	-	0.08	-	2
1996	-	-	0.61	0.01	-	-	0.37	-	-	-	-	4
1997	-	0.01	0.76	-	0.01	-	0.19	0.03	-	-	-	14
1998	-	-	0.76	-	0.01	-	0.09	0.13	-	0.01	-	5
1999	-	-	0.69	-	-	-	0.09	0.22	-	-	-	5
2000	-	-	0.82	-	0.02	-	0.14	0.02	-	-	-	5
2001	-	0.22	0.57	-	-	-	0.12	0.08	-	-	-	3
2002	-	0.07	0.24	0.43	-	-	0.13	0.12	-	-	0.01	10
2003	-	-	0.25	-	0.17	-	0.54	0.03	-	-	0.01	3
2004	-	-	0.53	-	0.06	-	0.41	-	-	-	-	6
2005	-	-	0.42	0.01	0.22	-	0.31	-	-	-	0.04	3
2006	-	0.01	0.10	-	0.59	-	0.22	0.07	-	-	-	4
2007	0.13	0.03	0.16	-	0.36	-	0.24	0.01	0.04	-	0.02	5
2008	0.01	-	0.20	-	0.60	-	0.13	0.01	0.02	-	0.02	8
2009	-	0.01	0.21	-	0.56	-	0.18	-	-	0.03	0.01	8
2010	0.04	0.05	0.33	-	0.45	-	0.08	0.02	0.01	0.02	0.01	6
2011	-	0.01	0.51	-	0.33	-	0.08	-	0.04	0.01	0.03	8
2012	-	0.01	0.48	-	0.32	-	0.03	-	0.15	0.01	-	5
Total	0.01	0.02	0.40	0.04	0.23	0.01	0.23	0.04	0.01	0.01	0.01	119

Table C13: Species codes used in the report.

Code	Common name	Scientific name
BAR	Barracouta	*Thyrsites atun*
BNS	Bluenose	*Hyperoglyphe antarctica*
BYX	Alfonsino	*Beryx splendens, B. decadactylus*
CDL	Cardinalfish	Apogonidae
EMA	Blue mackerel	*Scomber australasicus*
FRO	Frostfish	*Lepidopus caudatus*
GUR	Red gurnard	*Chelidonichthyes kumu*
HAK	Hake	*Merluccius australis*
HOK	Hoki	*Macruronus novaezelandiae*
JDO	John dory	*Zeus faber*
JMA	Jack mackerels	*Trachurus declivis*, *T. novaezelandiae*, *T. symmetricus murphyi*
LIN	Ling	*Genypterus blacodes*
LDO	Lookdown dory	*Cyttus traversi*
MOK	Moki	*Latridopsis ciliaris*
ORH	Orange roughy	*Hoplostethus atlanticus*
RBY	Rubyfish	*Plagiogeneion rubiginosum*
RCO	Red cod	*Pseudophycis bachus*
SBW	Southern blue whiting	*Micromesistius australi*
SCI	Scampi	*Metanephrops challengeri*
SKI	Gemfish	*Rexea solandri*
SNA	Snapper	*Pagrus auratus*
SPE	Sea perch	*Helicolenus percoides*
SPO	Rig	*Mustelus lenticulatus*
SQU	Arrow squid	*Nototodarus gouldi*, *N. sloanni*
STA	Stargazers	*Kathestoma giganteum*
SWA	Silver warehou	*Seriolella punctata*
TAR	Tarakihi	*Nemadactylus macropterus*
TRE	Trevally	*Pseudocaranx dentex*
WAR	Blue warehou	*Seriolella brama*
WWA	White warehou	*Seriolella caerulea*

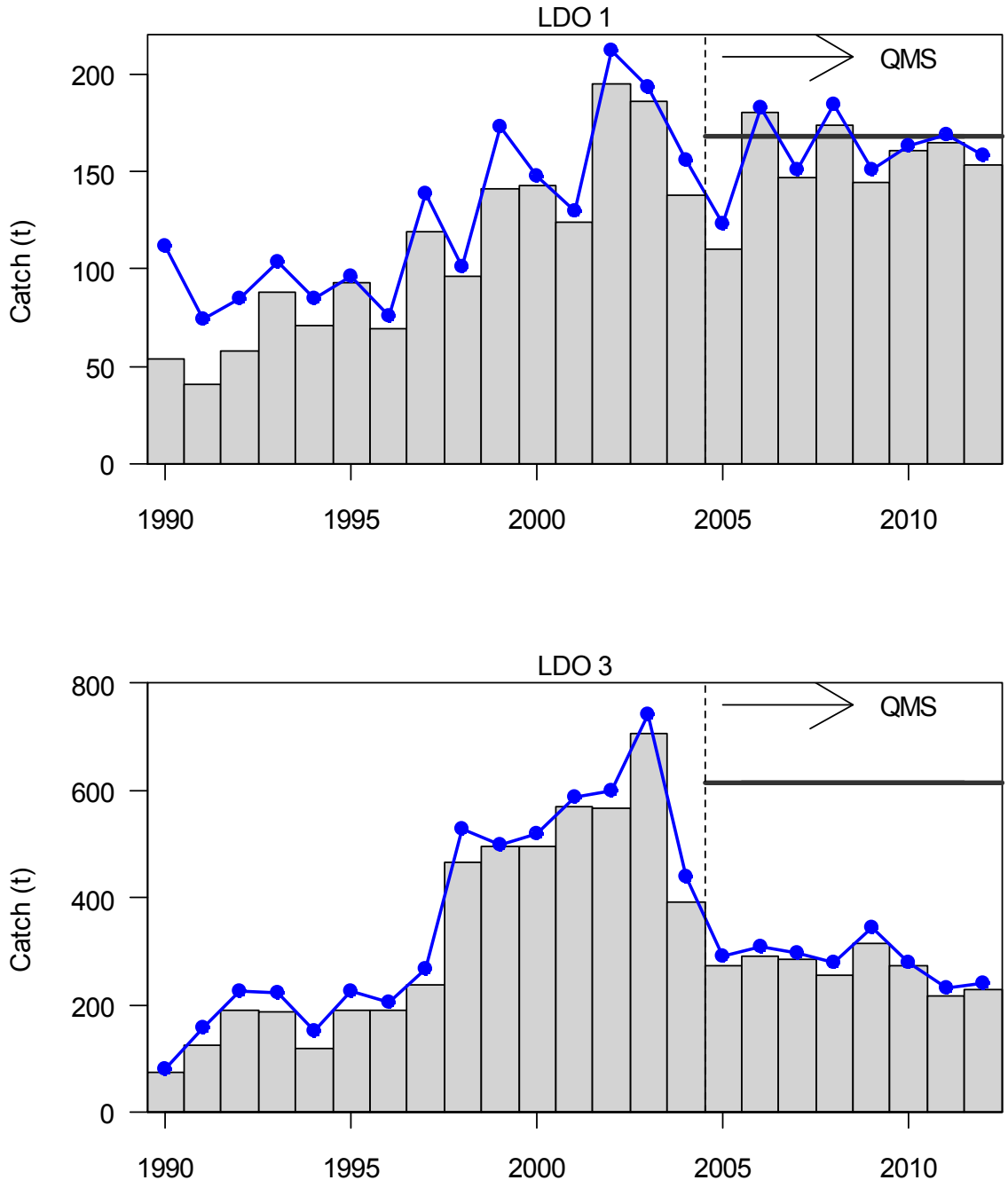


Figure C1: The QMR/MHR landings (grey bars), un-groomed catch effort landings (blue line), and TACC (black line) for LDO 1 and LDO 3 from the 1990 to 2012 fishing year.

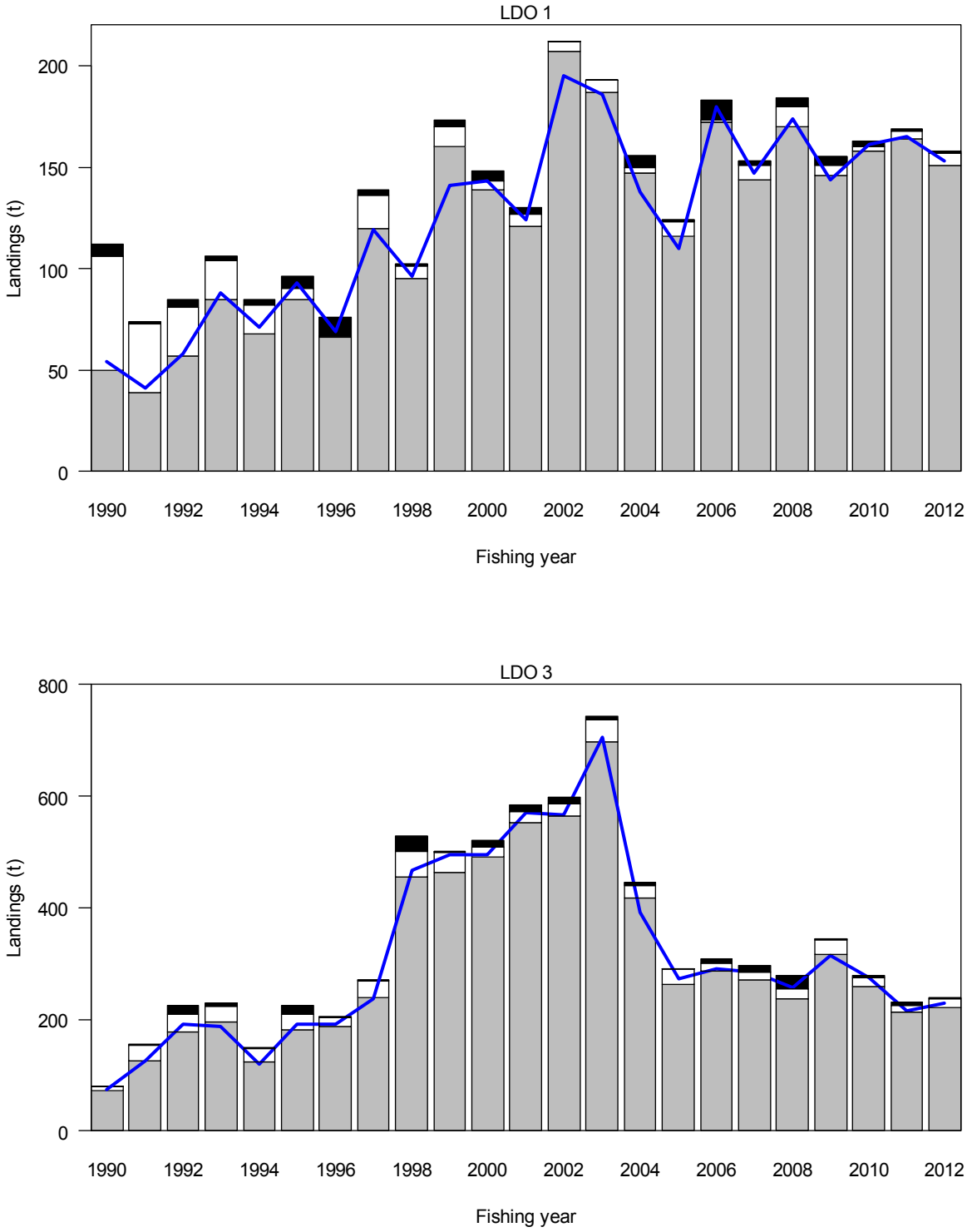


Figure C2: The retained landings (grey bars), interim landings (white bars), and landings dropped during data grooming (black bars), and MHR landings (blue line) for LDO 1 and LDO 3 from the 1990 to 2012 fishing year.

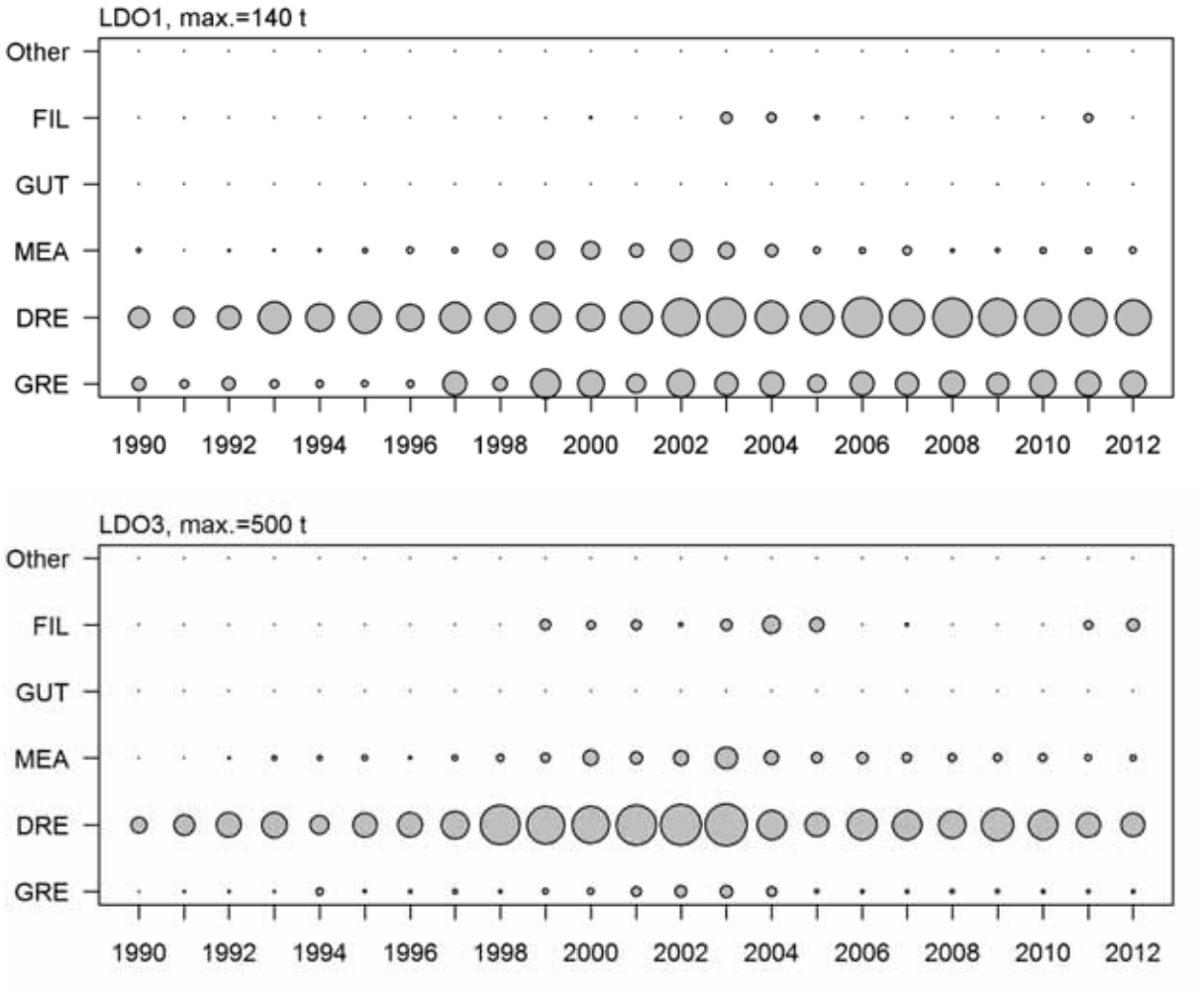


Figure C3: Retained landings (greenweight in tonnes) by processed state for LDO stocks for 1989–90 (1990) to 2011–12 (2012) in the groomed and unmerged dataset. GRE, Green; DRE, dressed or headed, gutted, and tailed; GUT, gutted; FIL, filleted or skin off filleted, and MEA, mealed;

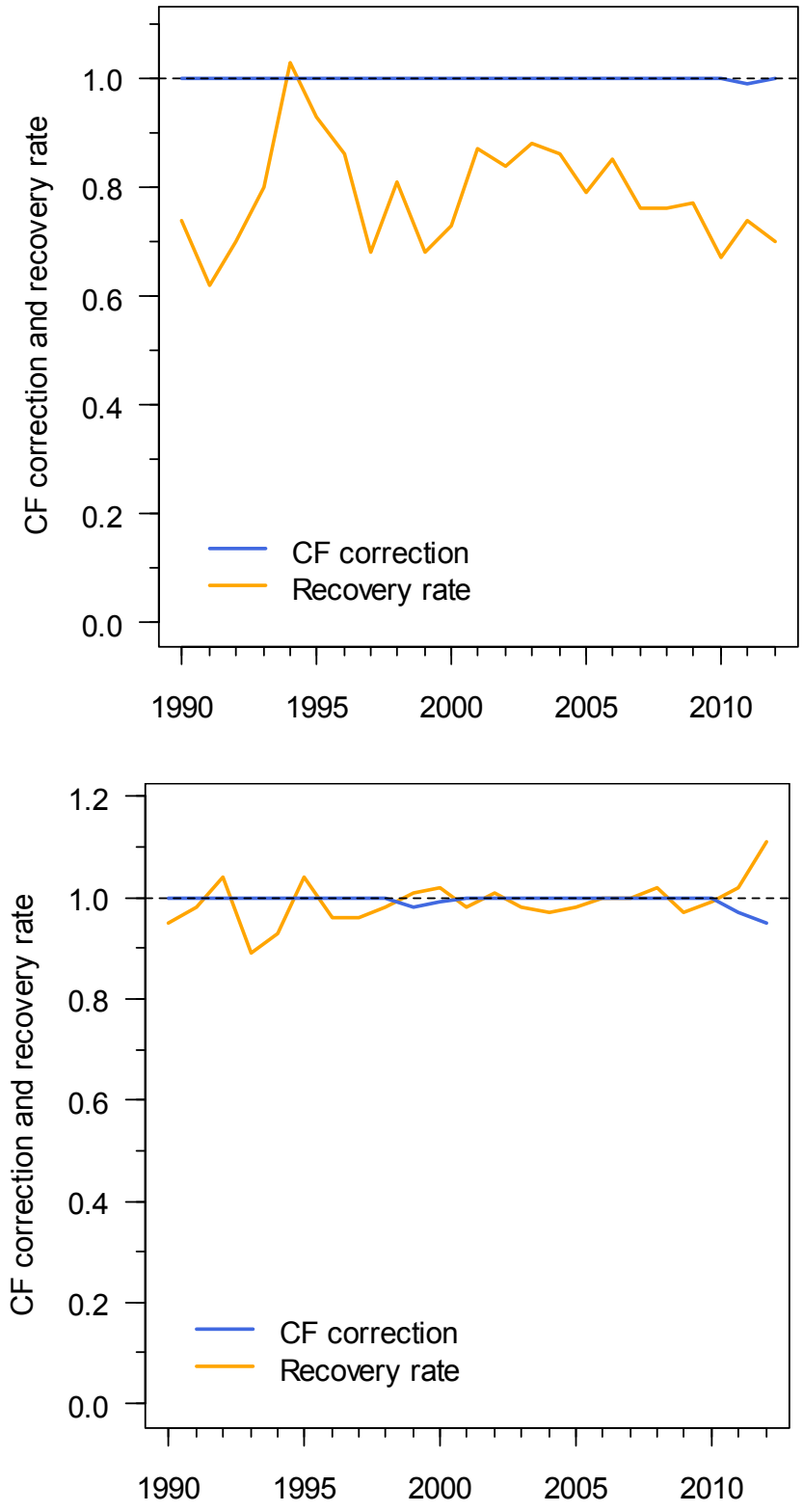


Figure C4: Conversion factor (CF) corrections (by the centroid method), defined as the ratio of annual green weight recalculated using the most recent correction factors for each processed state to the reported green weight, and the recovery rate, defined as the ratio of annual landings in the groomed and merged dataset to those in the groomed and unmerged dataset, for LDO 1 and LDO 3 from the 1990 to 2012 fishing year.

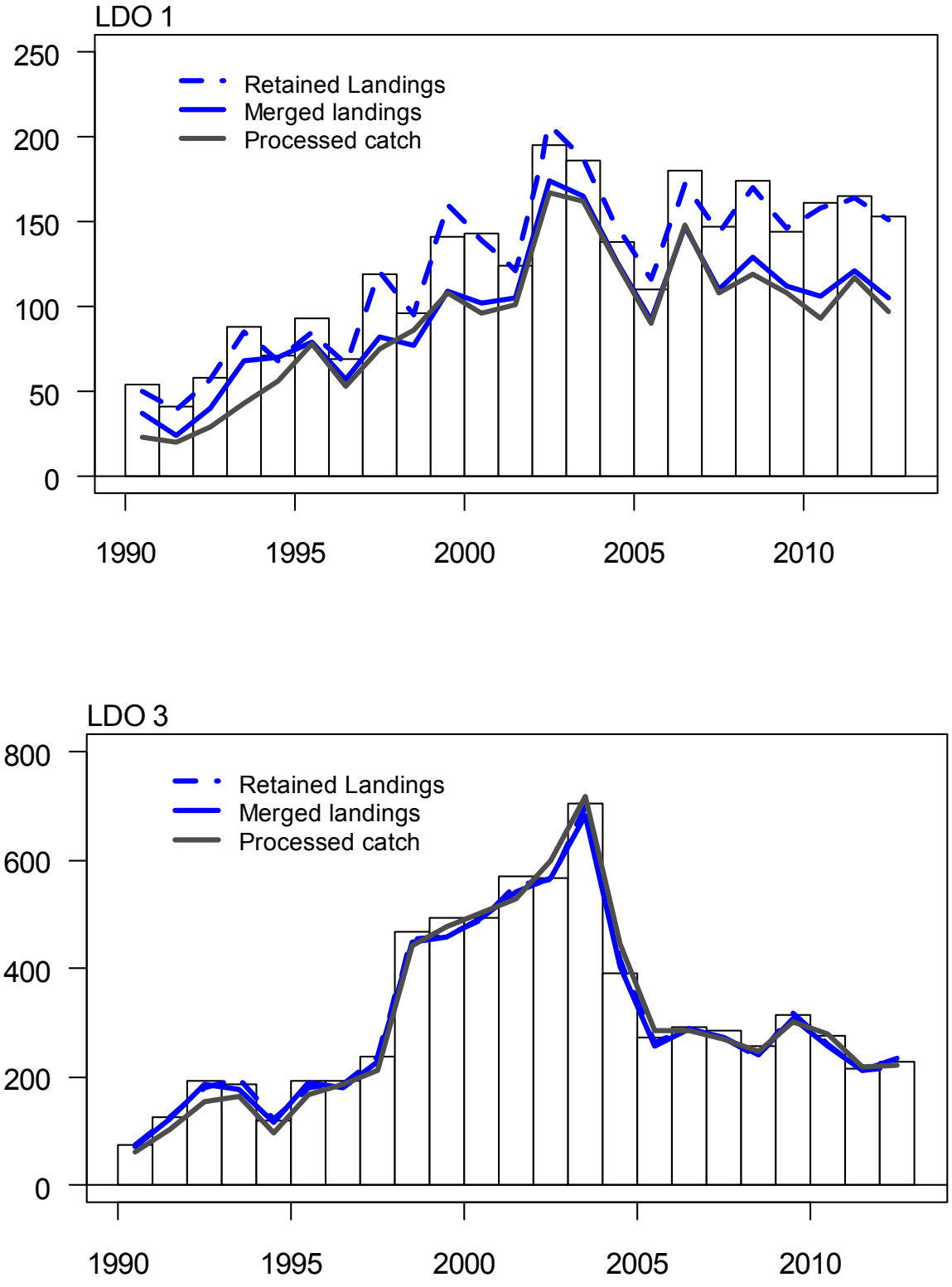


Figure C5: The QMR/MHR landings (white bars), retained landings in the groomed and unmerged dataset (blue dashed line), retained landings in groomed and merged dataset (blue solid line), and daily processed catch in the groomed and merged dataset (grey solid line), using the centroid method, for LDO 1 and LDO 3 from the 1990 to 2012 fishing year.

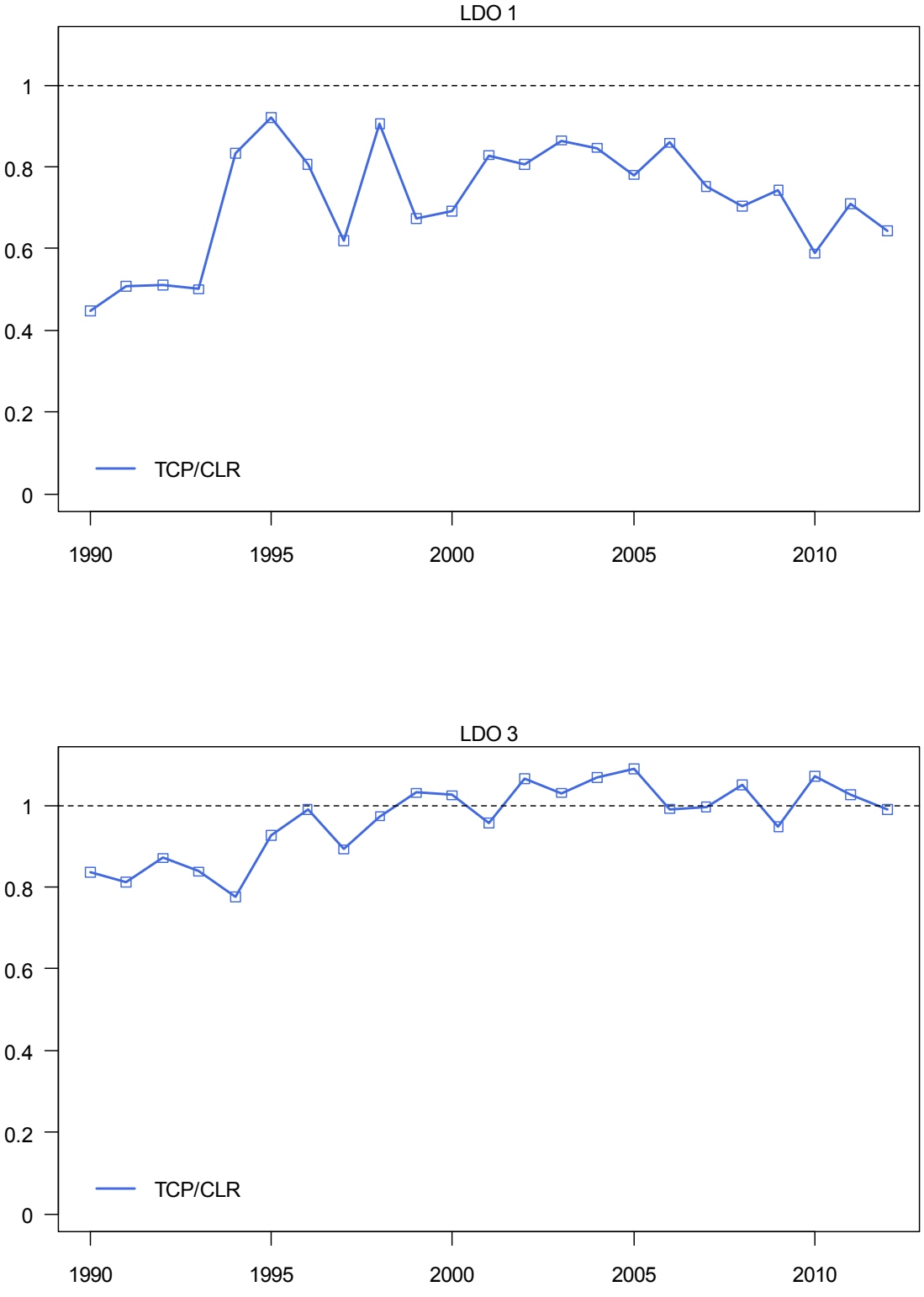


Figure C6: The reporting rate, defined as the ratio of greenweight calculated from annual processed catch as a proportion of retained landings in the groomed and merged dataset, for LDO 1 and LDO 3 from the 1990 to 2012 fishing year.

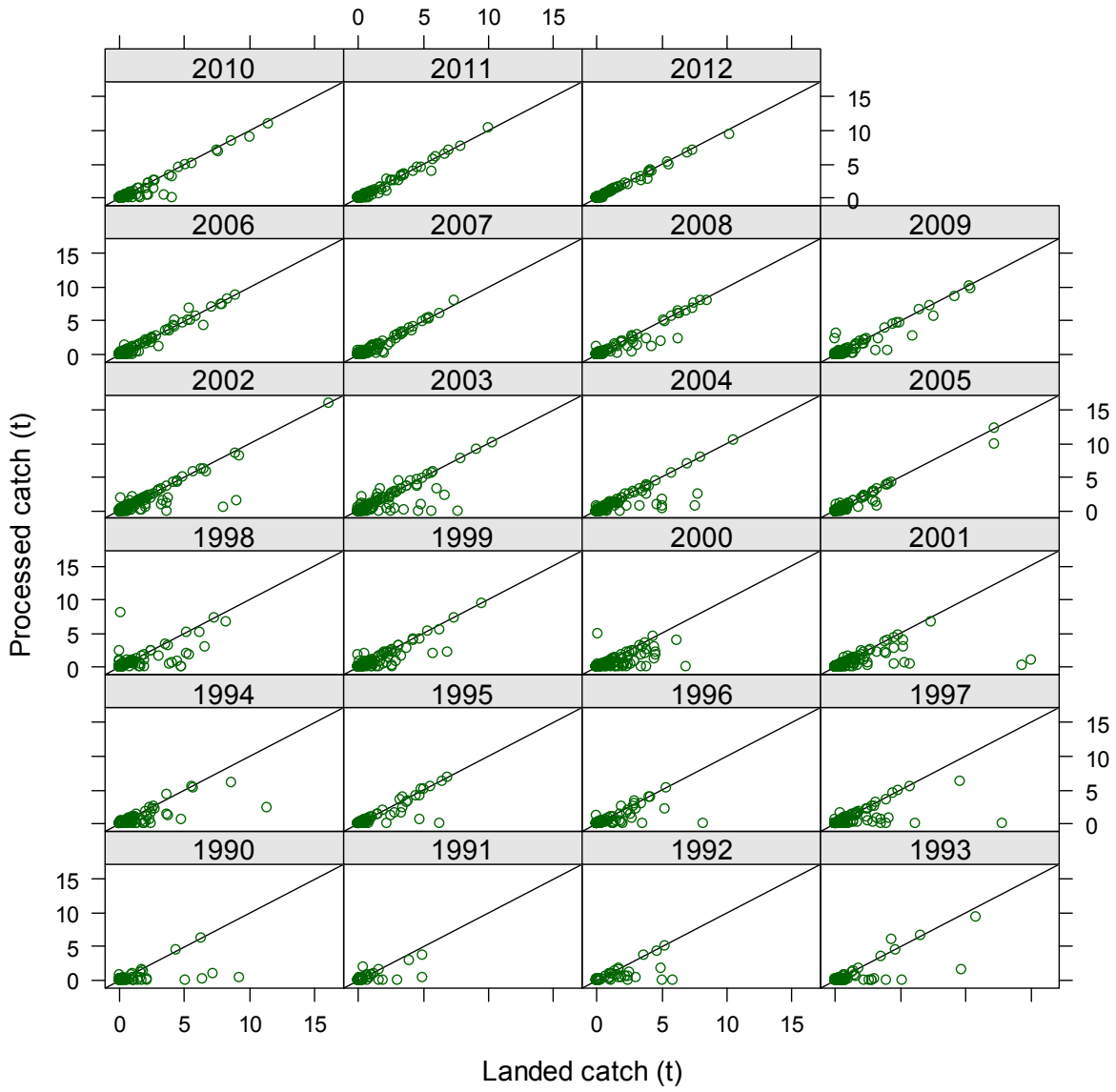


Figure C7a: Processed catch versus reported landings on a trip basis in the groomed and merged dataset, for LDO 1 from the 1990 to 2012 fishing year.

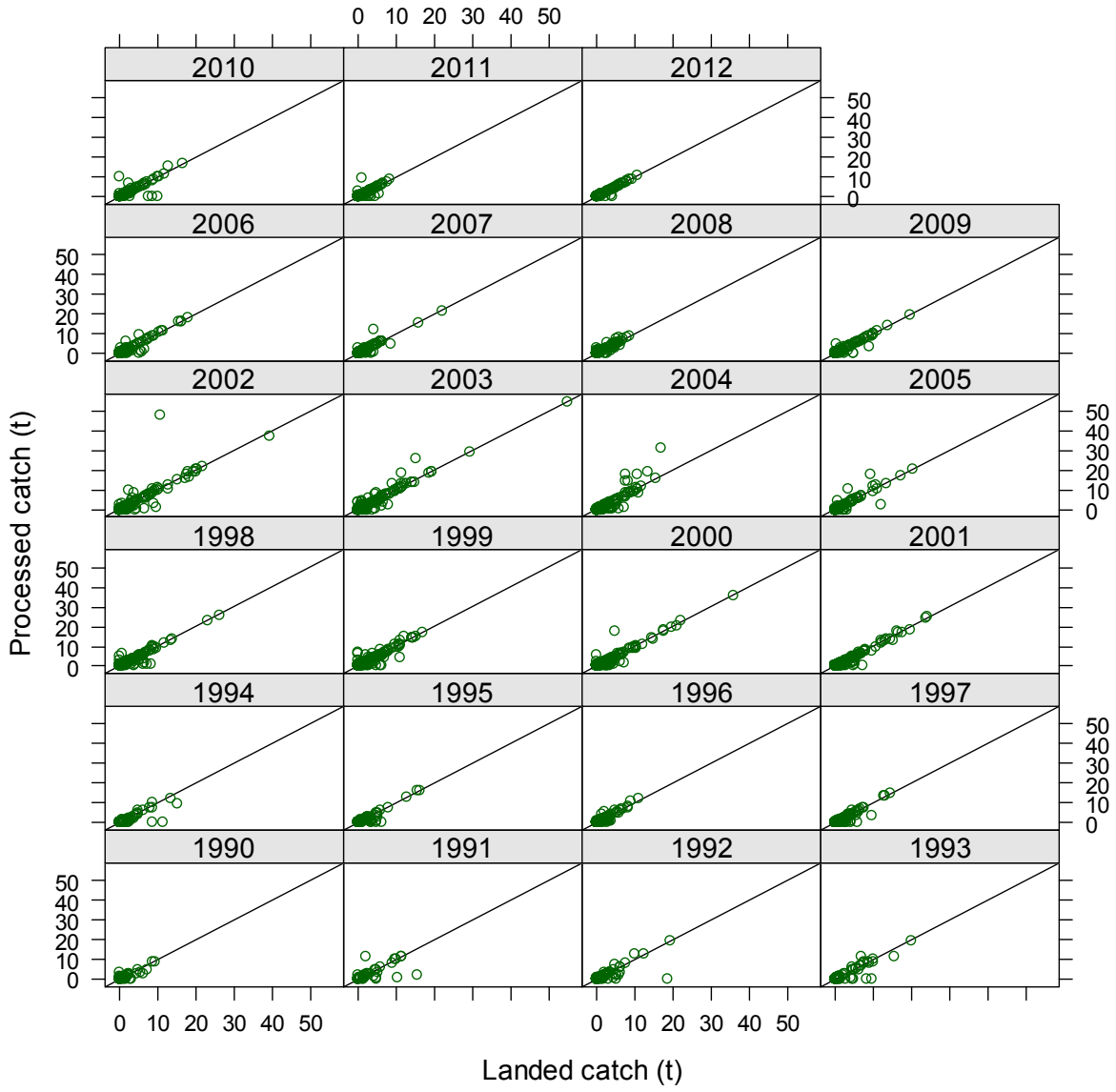


Figure C7b: Processed catch versus reported landings on a trip basis in the groomed and merged dataset, for LDO 3 from the 1990 to 2012 fishing year.

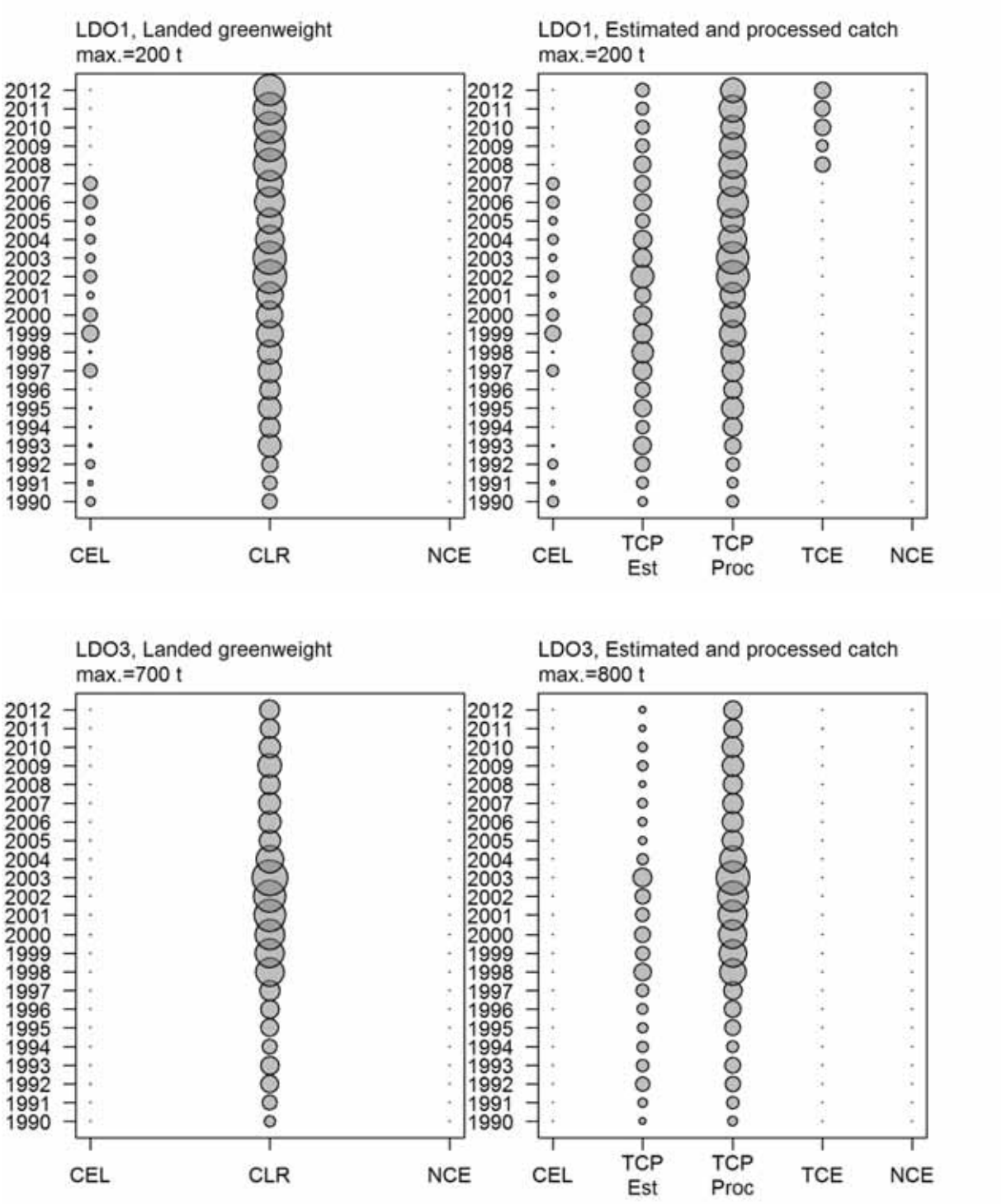


Figure C8: Proportion of landings by form type in the groomed and unmerged dataset, and proportion of estimated catches by form type in the groomed and merged dataset, for LDO stocks from 1989–90 (1990) to 2011–12 (2012), where CEL is Catch, Effort, Landing Return; CLR is Catch Landing Return; TCP Est is Estimated data from the Trawl, Catch, Effort, and Processing Return; TCP Proc is daily processed data from the Trawl, Catch, Effort, and Processing Return; TCE is Trawl, Catch, Effort Return; NCE is Netting Catch Effort Return. The area of the circle is proportional to the annual catches (only comparable within each panel).

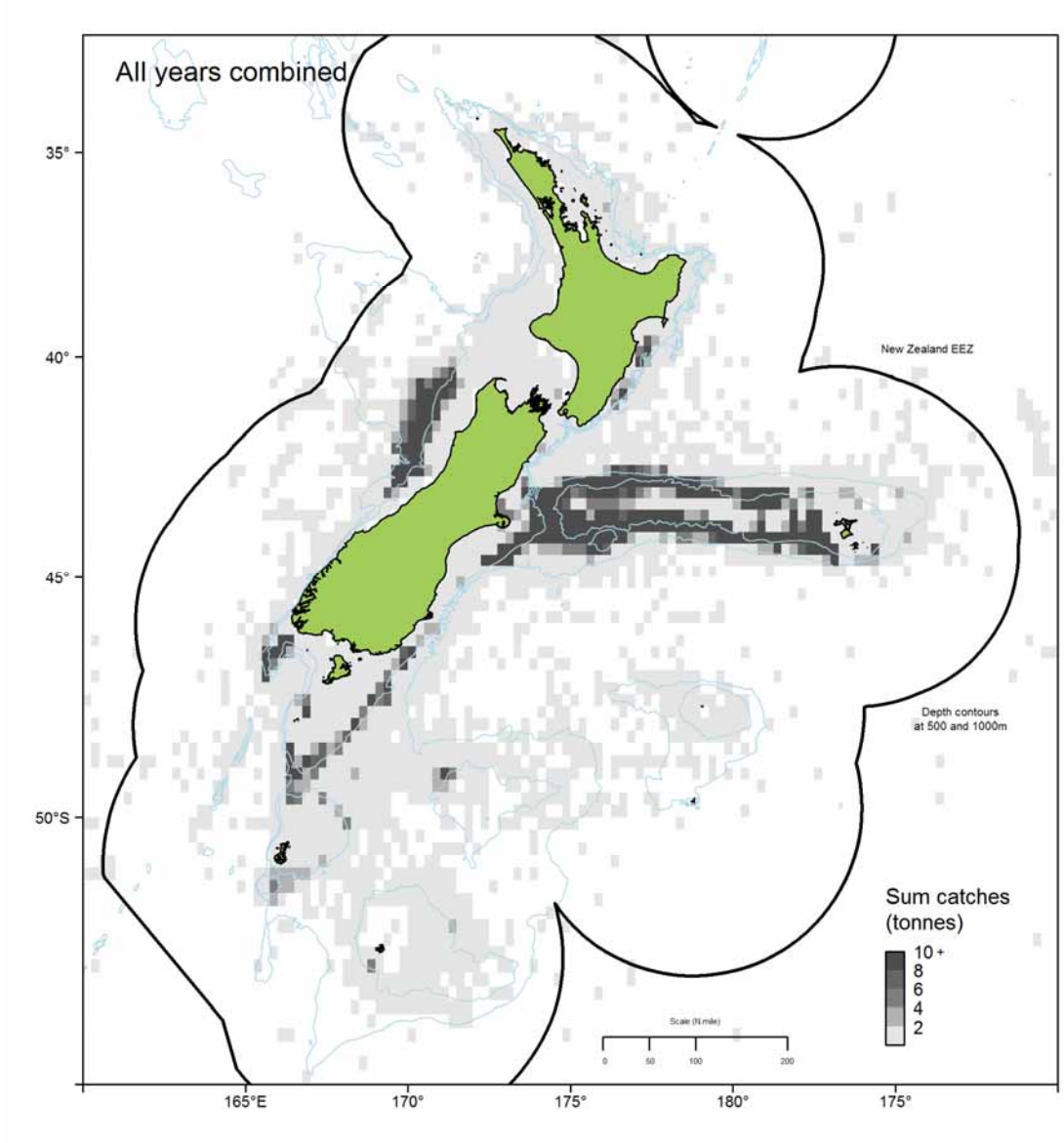


Figure C9a: Annual catch (in tonnes) of all commercial lookdown dory catches from TCEPR daily processed data for all years combined (1990 to 2012).

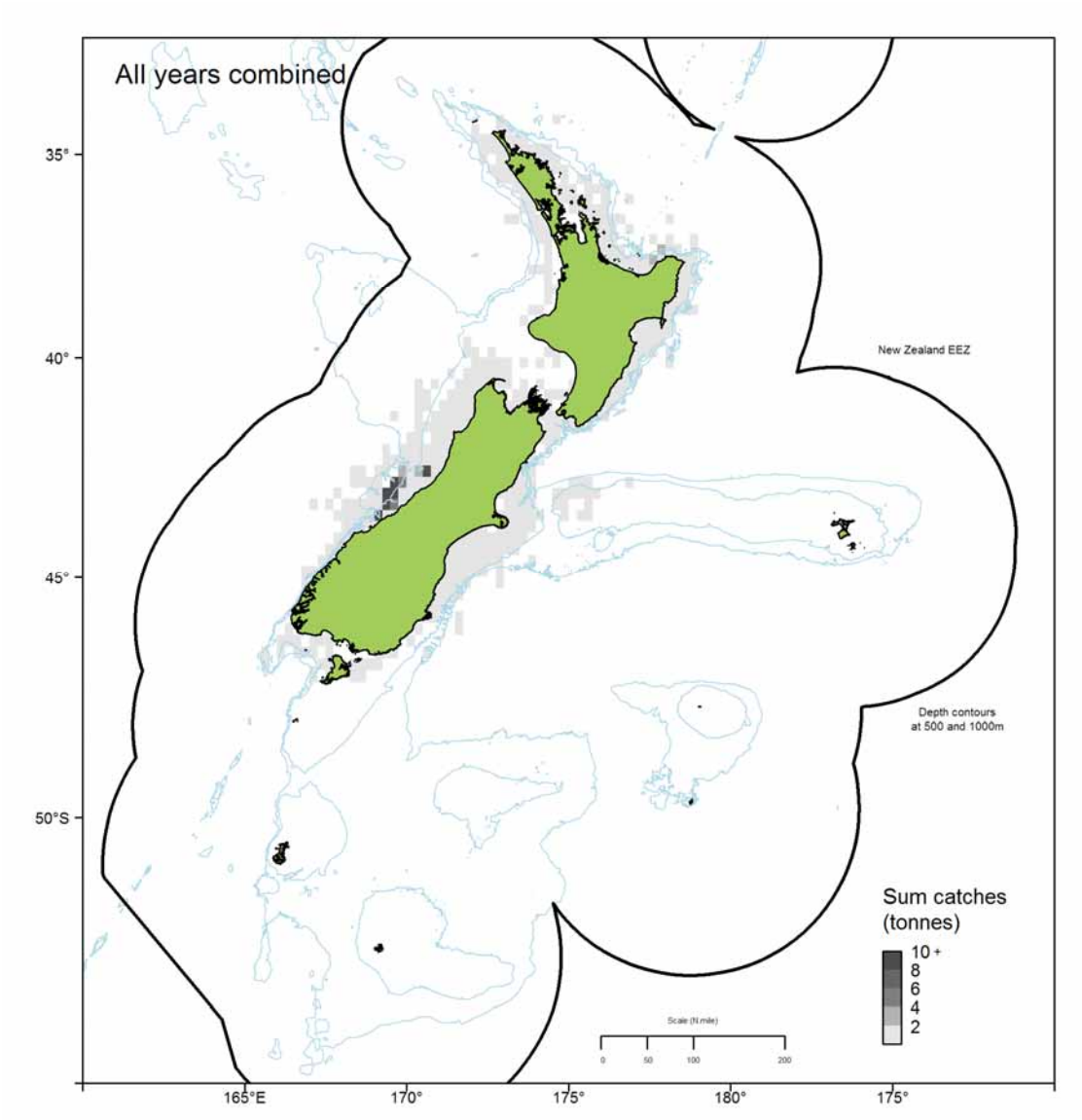


Figure C9b: Annual catch (in tonnes) of all commercial lookdown dory catches from TCER estimated data for all years combined (2008 to 2012).

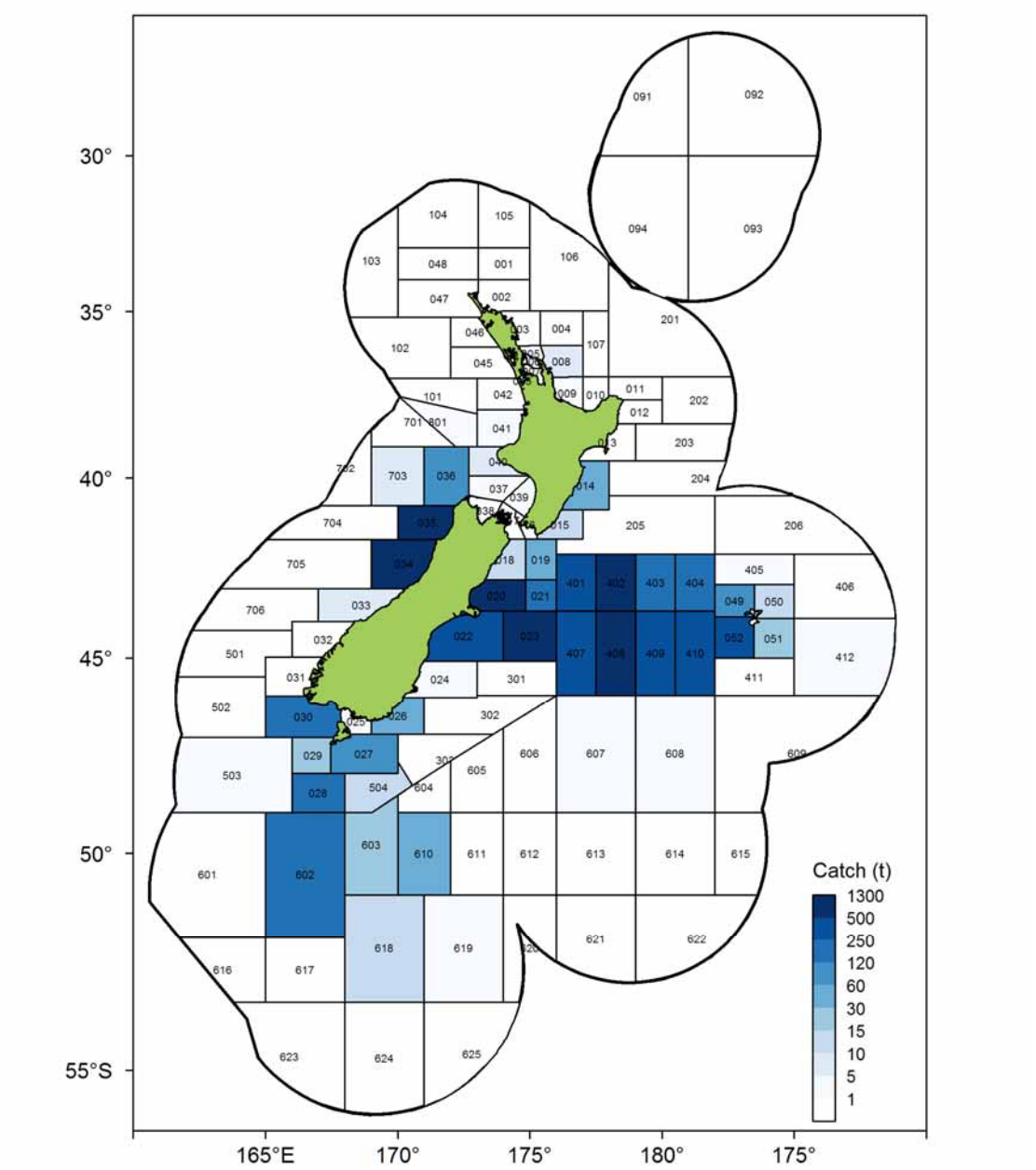


Figure C9c: Annual catch (in tonnes) of all commercial lookdown dory catches from TCEPR daily processed data for all years combined by statistical area (1990 to 2012).

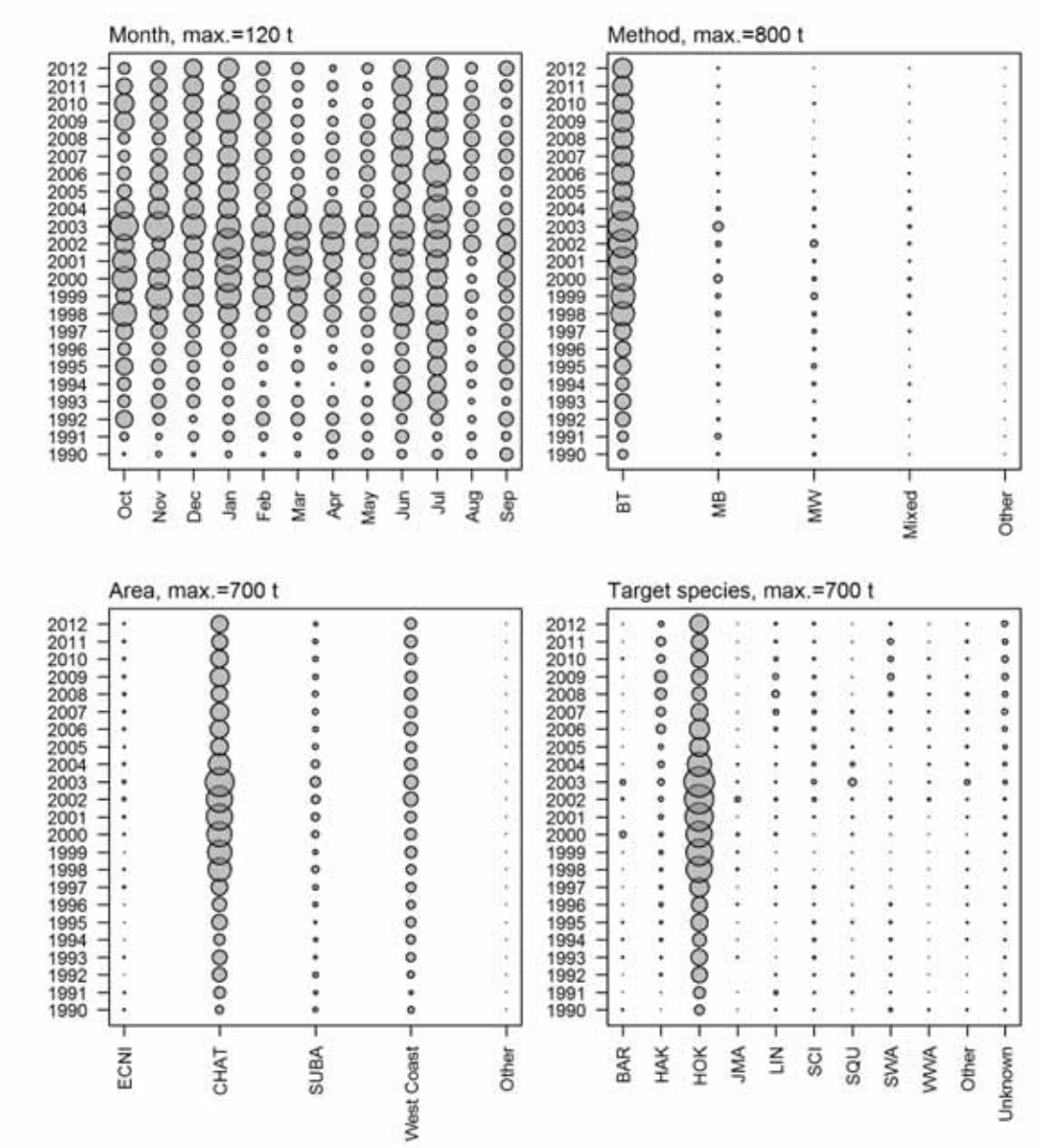


Figure C10: Distribution of annual catch by month, area, method, and target species for all merged data. Circle size is proportional to catch; maximum circle size is indicated on each plot. Statistical areas are shown in Figure 1, and areas in Figure 2. BT is bottom trawl; MB is midwater trawl within 5 m of the seabed; MW is midwater trawl; Mixed is a mix of bottom and midwater tows. Target species codes are defined in Table C13.

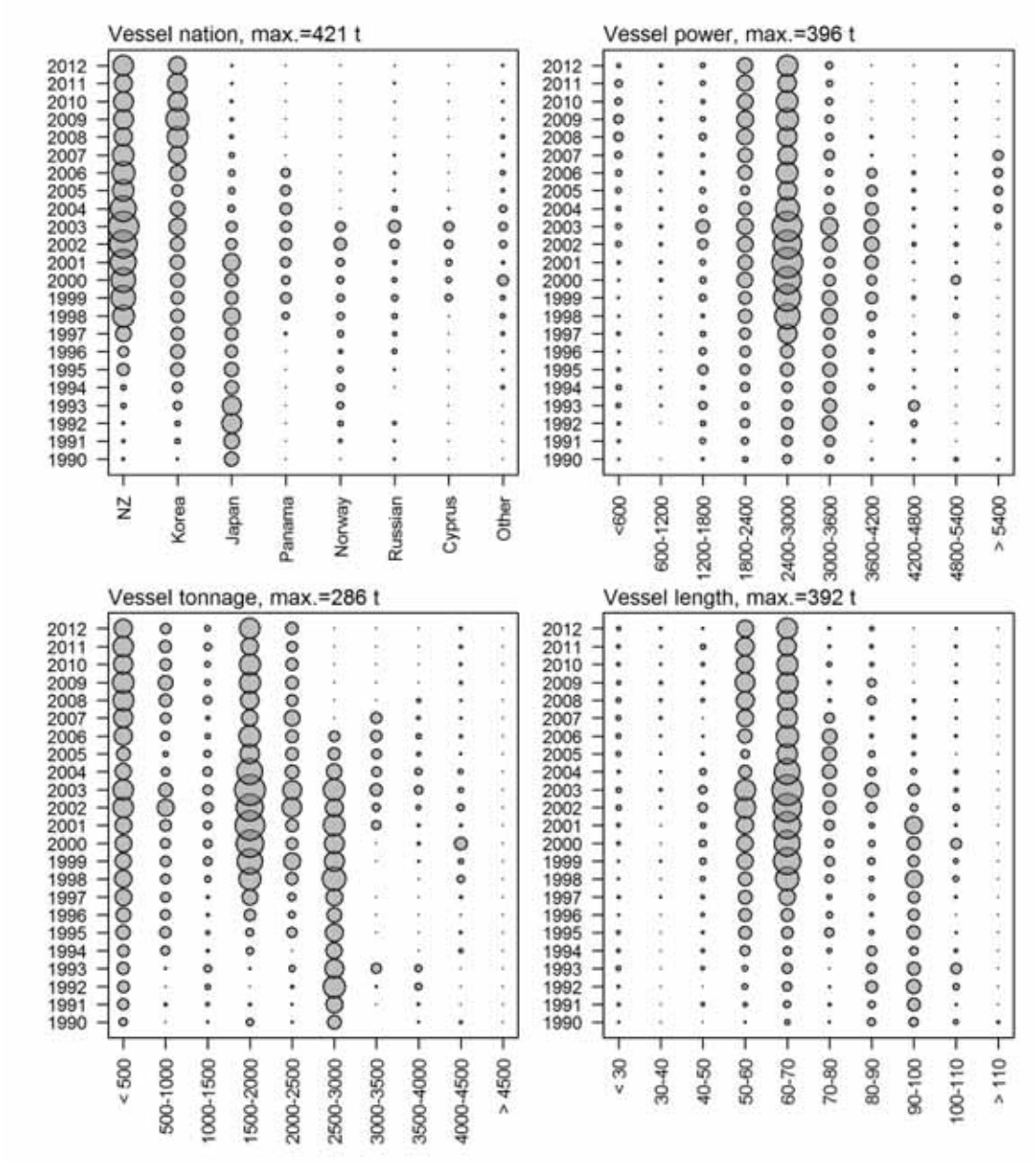


Figure C11: Distribution of annual catch by nationality, vessel power, gross tonnage, and length (m) for all merged data. Circle size is proportional to catch; maximum circle size is indicated on each plot.

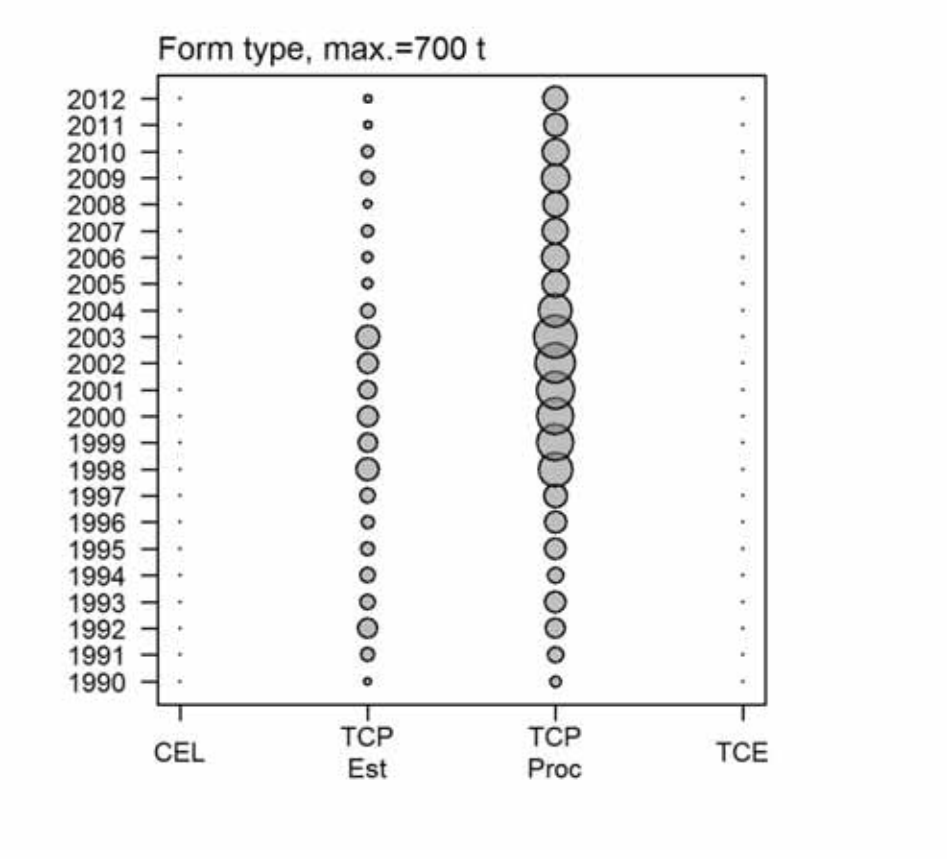


Figure C12a: Distribution of annual catch by form type for CHAT estimated and merged daily processed data. Circle size is proportional to catch; maximum circle size is indicated on each plot. TCP Est is estimated data from the Trawl, Catch, Effort, and Processing Return; TCP Proc is daily processed data from the Trawl, Catch, Effort, and Processing Return; TCE is Trawl, Catch, Effort Return.

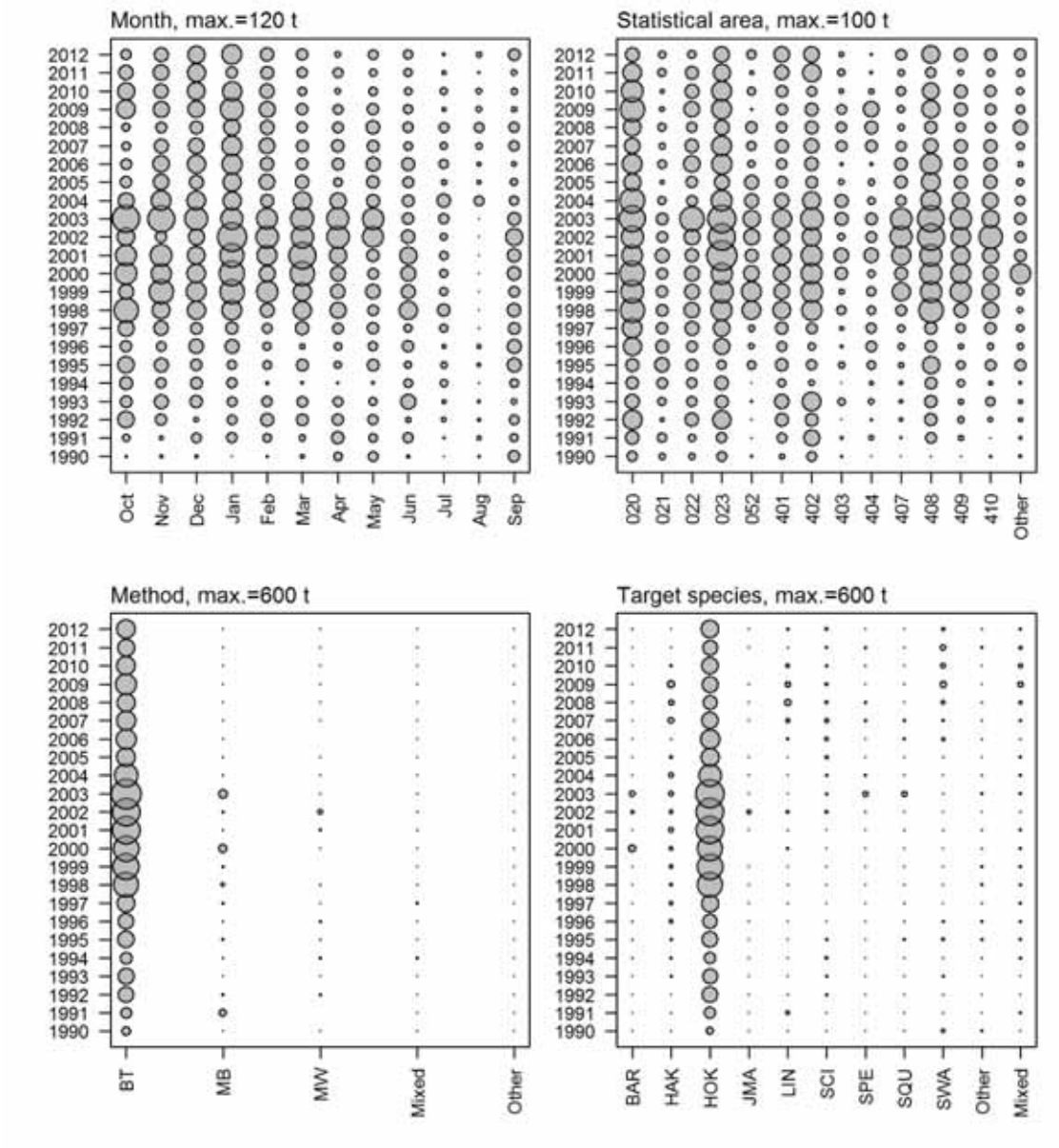


Figure C12b: Distribution of annual catch by month, statistical area, method, and target species for CHAT merged TCEPR daily processed data. Circle size is proportional to catch; maximum circle size is indicated on each plot. Statistical areas are shown in Figure 1. BT is bottom trawl; MB is midwater trawl within 5 m of the seabed; MW is midwater trawl; Mixed is a mix of bottom and midwater tows. Target species codes are defined in Table C13.

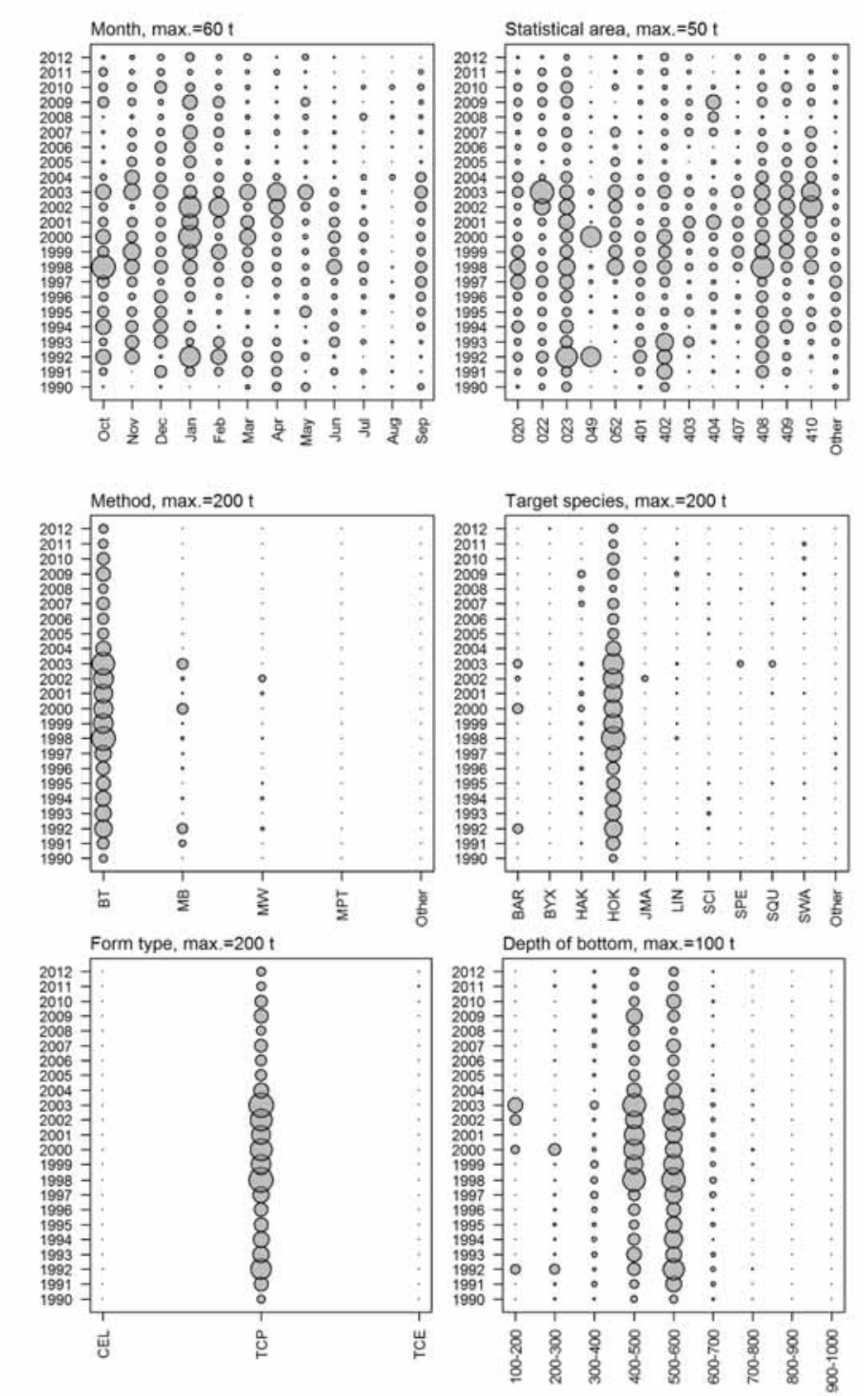


Figure C12c: Distribution of annual catch by month, statistical area, method, and target species for CHAT estimated TCEPR (TCP), TCER (TCE), and CELR (CEL) data. Circle size is proportional to catch; maximum circle size is indicated on each plot. Statistical areas are shown in Figure 1. BT is bottom trawl; MB is midwater trawl within 5 m of the seabed; MW is midwater trawl; Mixed is a mix of bottom and midwater tows. Target species codes are defined in Table C13.

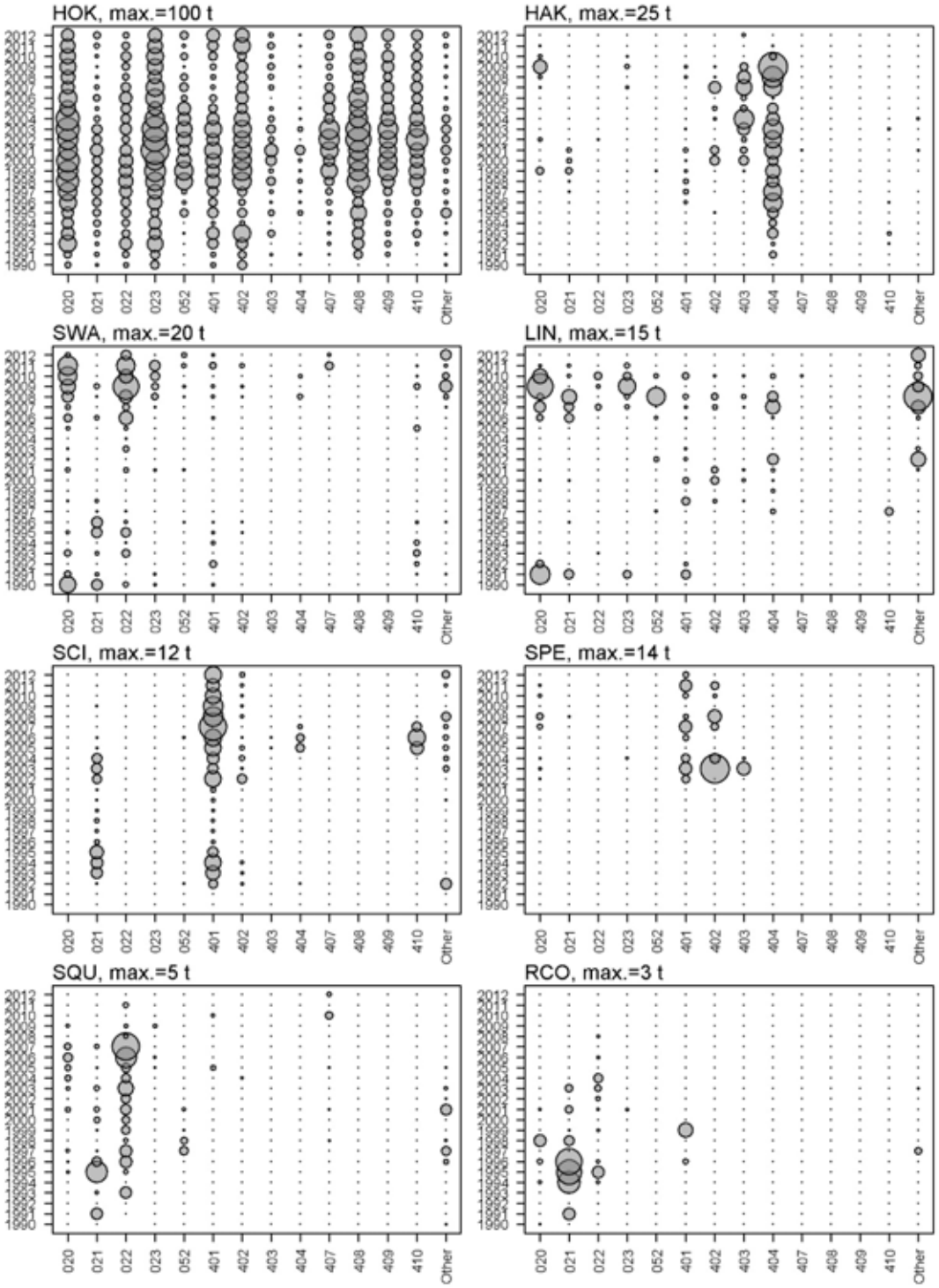


Figure C13: Distribution of lookdown dory annual catch (t) by statistical area for CHAT merged daily processed data by main target species for all TCEPR bottom trawl tows. Circle size is proportional to catch; maximum circle size is indicated on the top left hand corner of each plot. Statistical areas are shown in Figure 1 and target species codes are defined in Table C13.

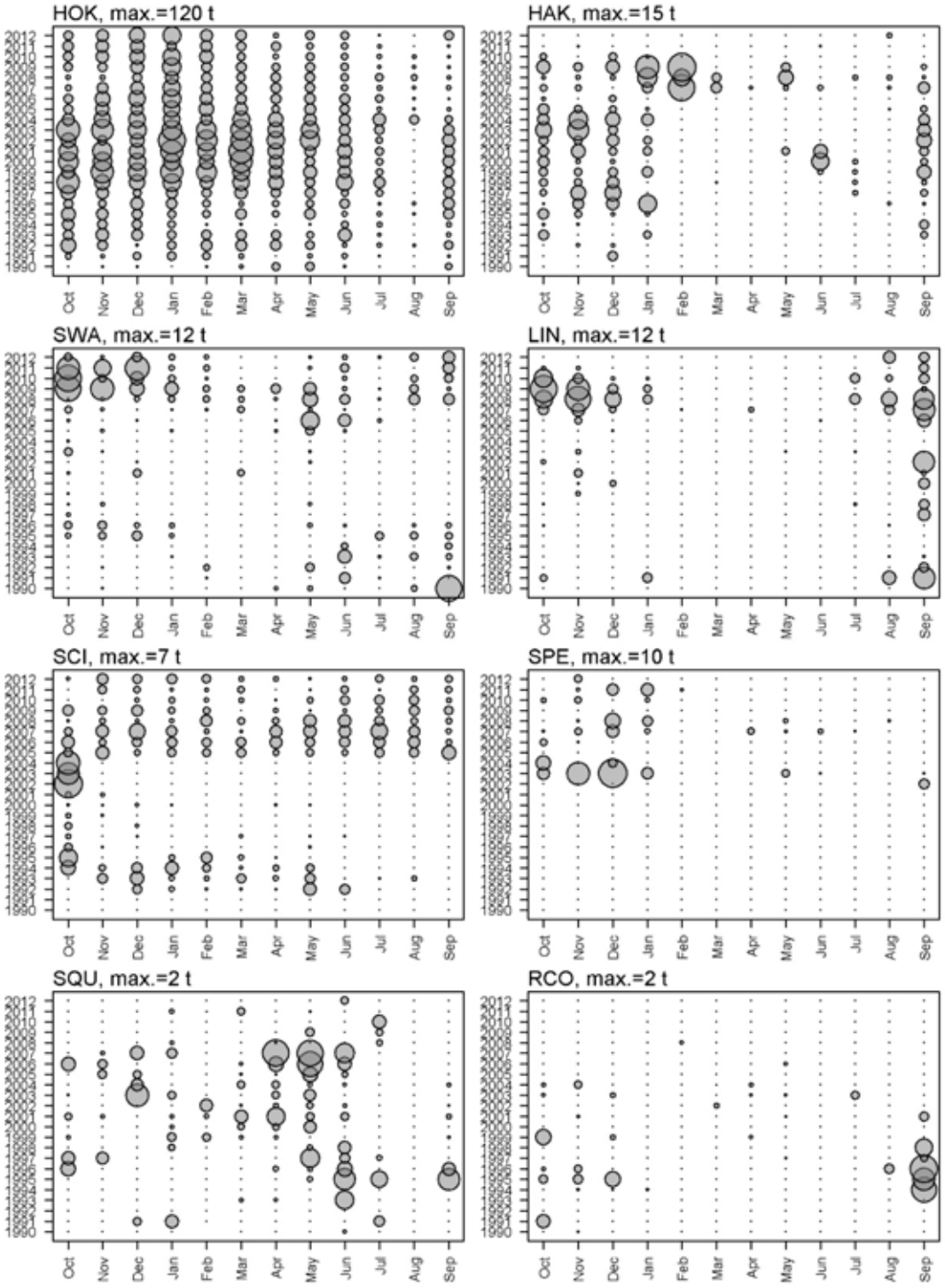


Figure C14: Distribution of lookdown dory annual catch (t) by month for CHAT merged data by main target species for all TCEPR bottom trawl tows. Circle size is proportional to catch; maximum circle size is indicated on the top left hand corner of each plot. Target species codes are defined in Table C13.

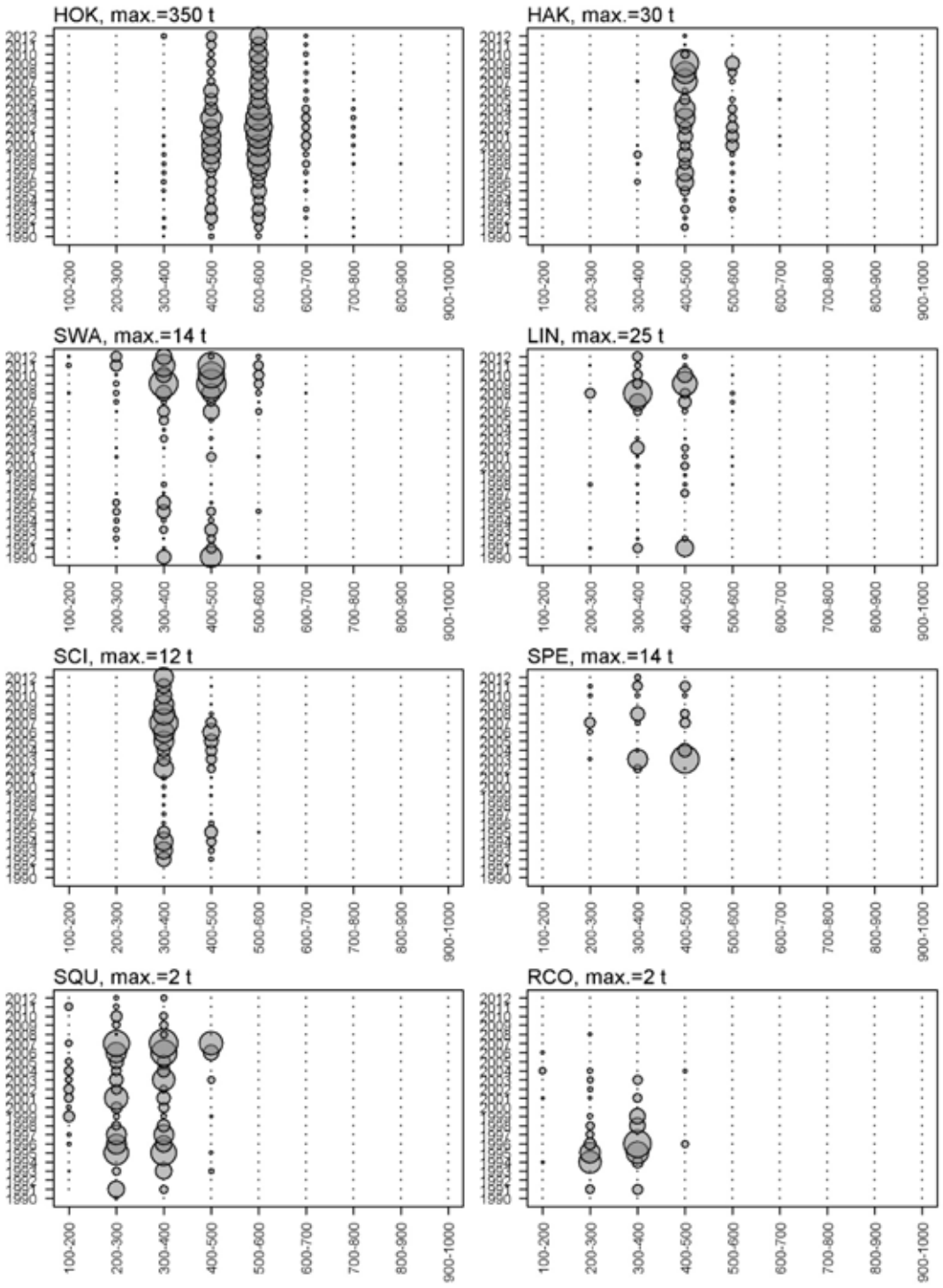


Figure C15: Distribution of lookdown dory annual catch (t) by mean depth for CHAT merged TCEPR daily processed data by main target species for all TCEPR bottom trawl tows. Circle size is proportional to catch; maximum circle size is indicated on the top left hand corner of each plot. Target species codes are defined in Table C13.

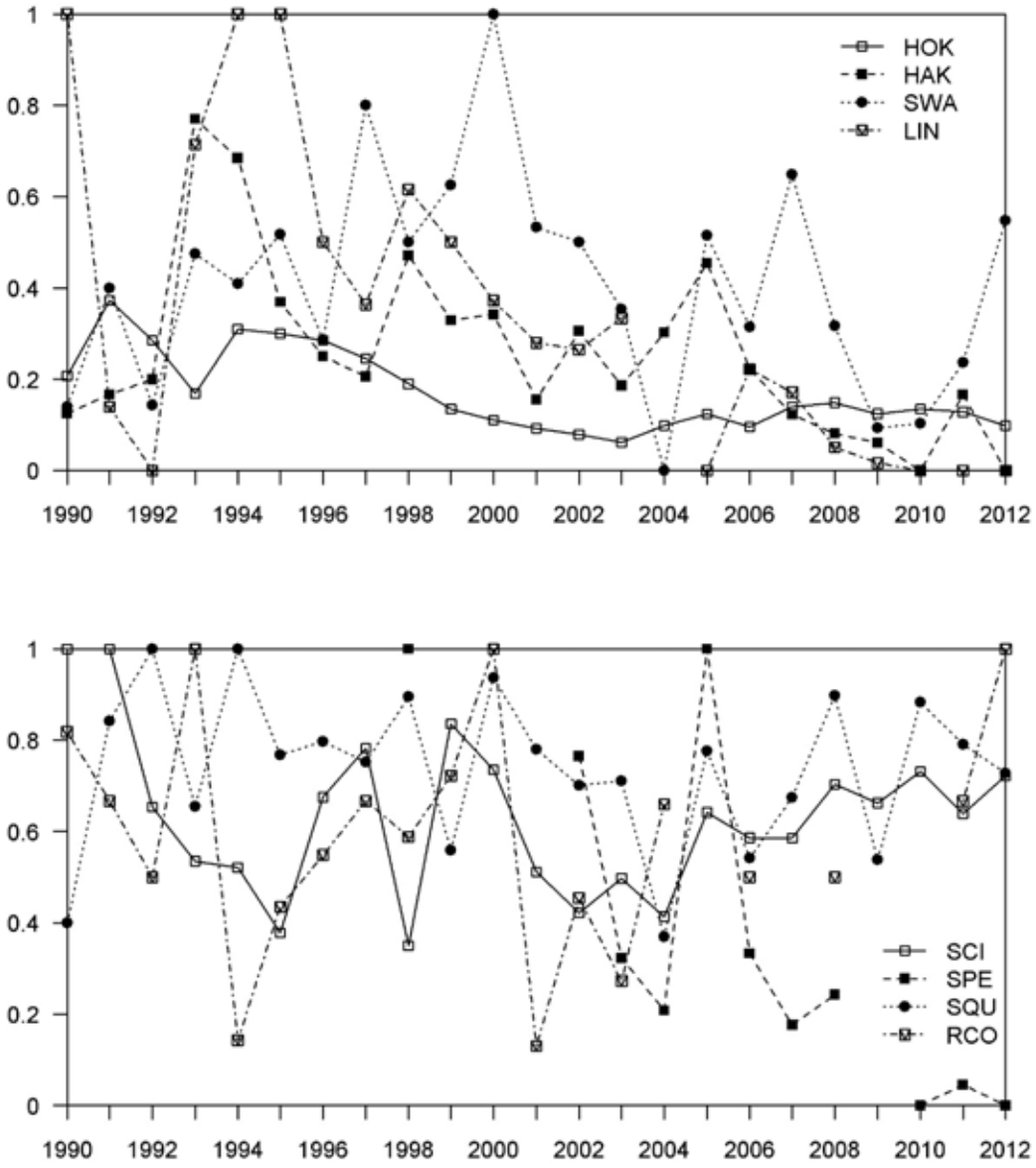


Figure C16: Proportion of zeros in merged daily processed data by main target species in the CHAT region for all TCEPR bottom tows. Target species codes are defined in Table C13.

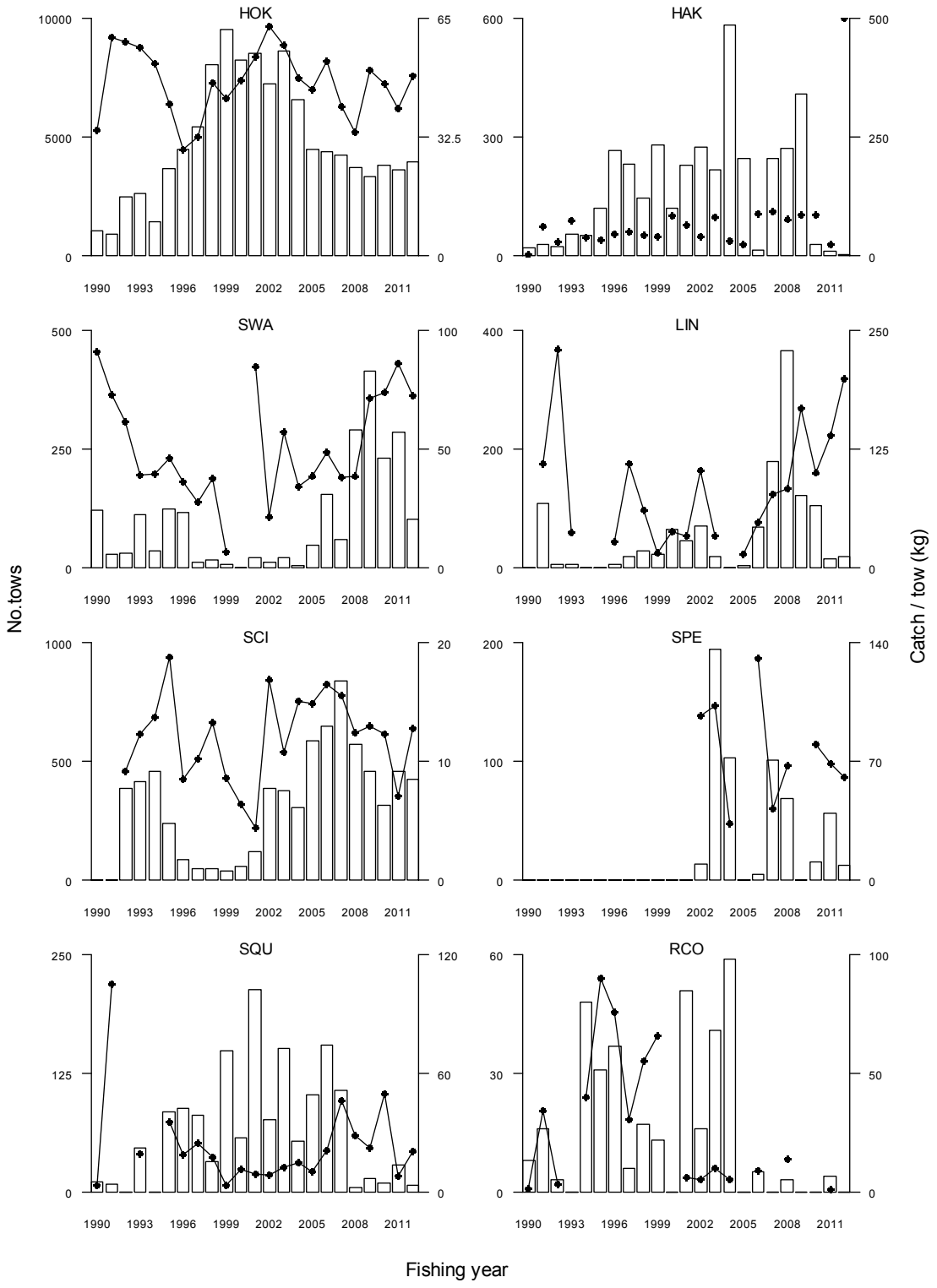


Figure C17: Unstandardised catch rate of LDO by main target species (kg/tow) and the number of tows for the CHAT region taken by main target species for bottom trawl gear. Target species codes are defined in Table C13.

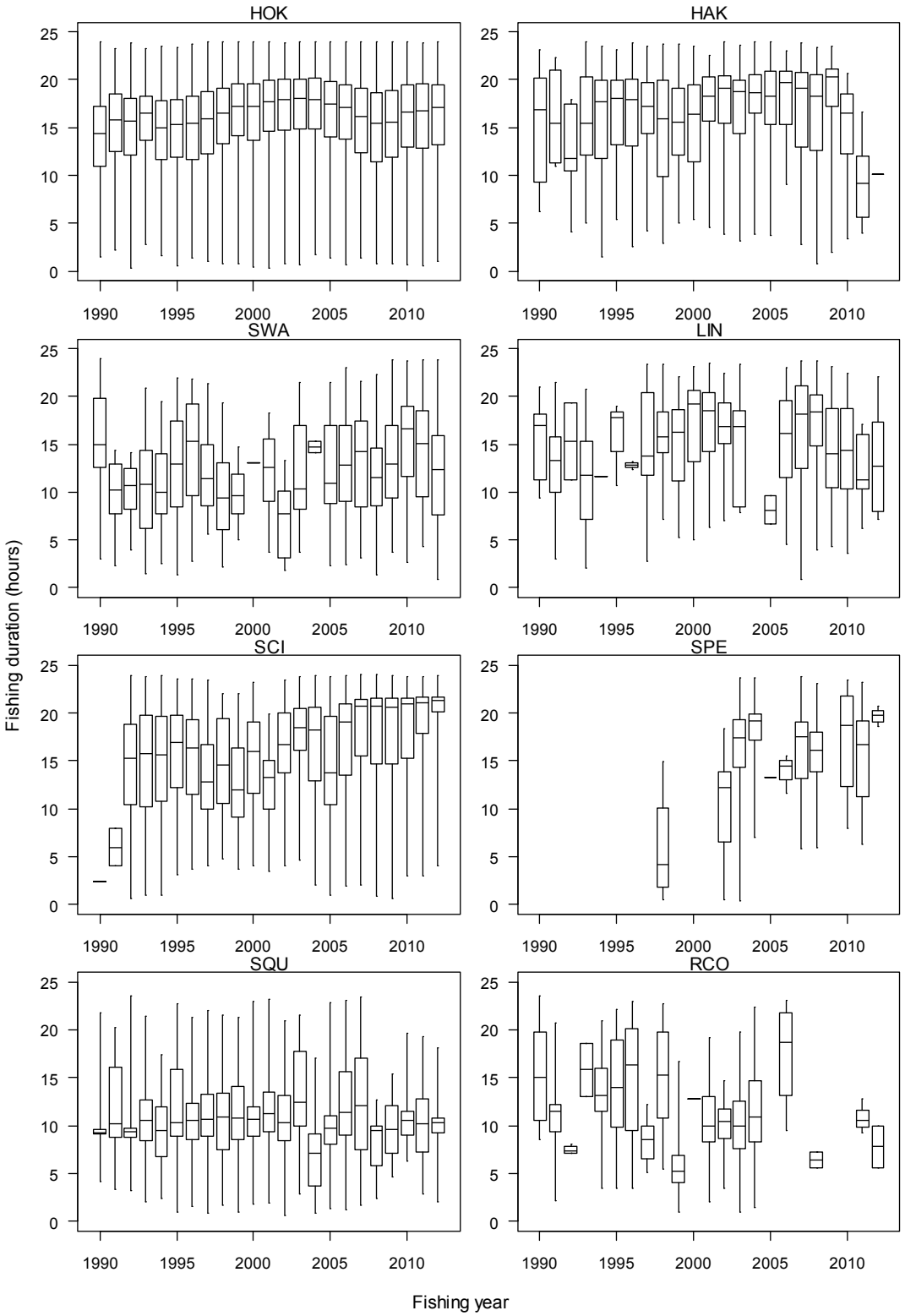


Figure C18: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) for summed daily tow durations (hours) reported by main target species of tows capturing lookdown dory in the CHAT region using bottom trawl gear. Target species codes are defined in Table C13.

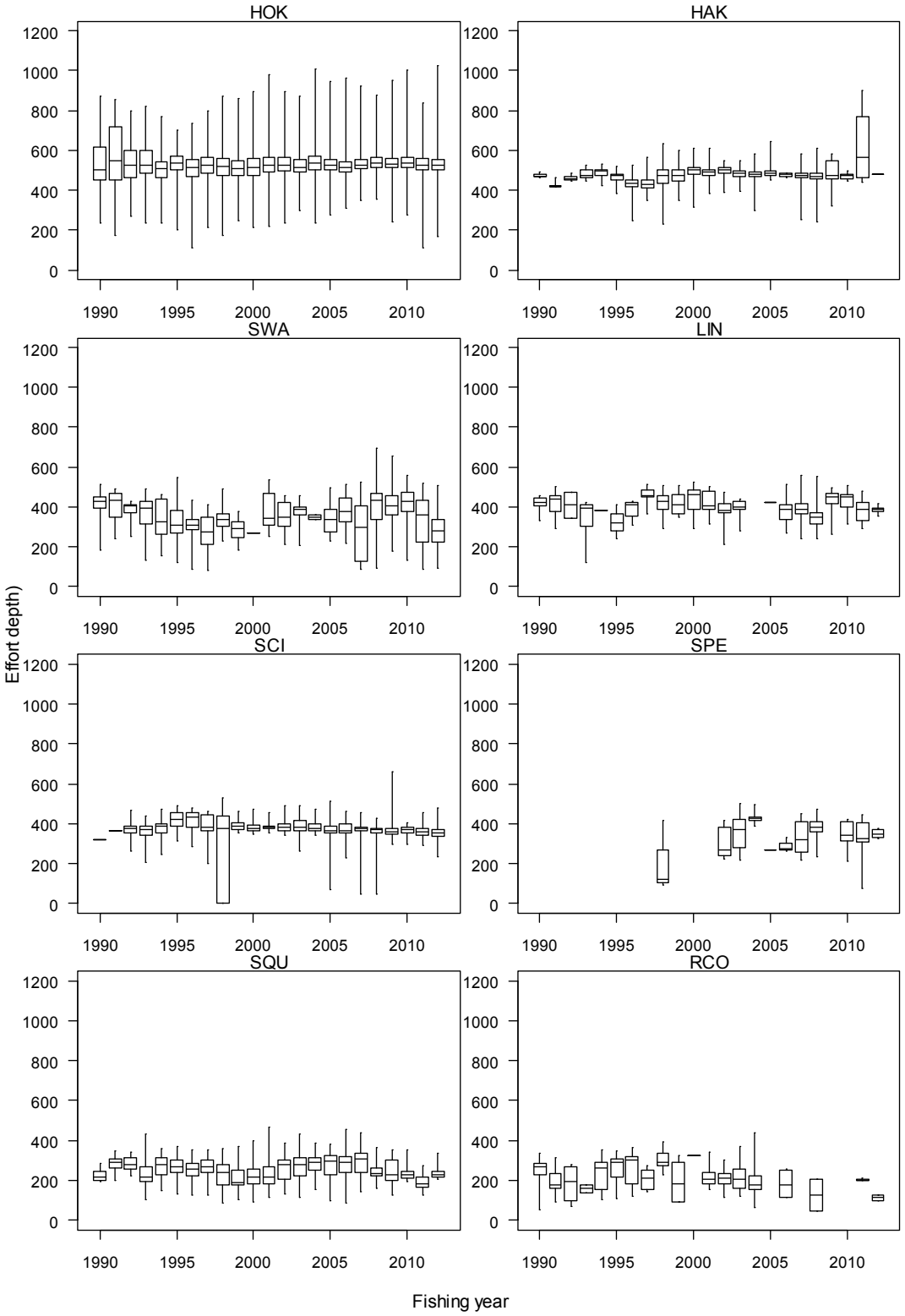


Figure C19: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) for depths (m) fished reported by main target species of tows capturing lookdown dory in the CHAT region using bottom trawling gear. Target species codes are defined in Table C13.

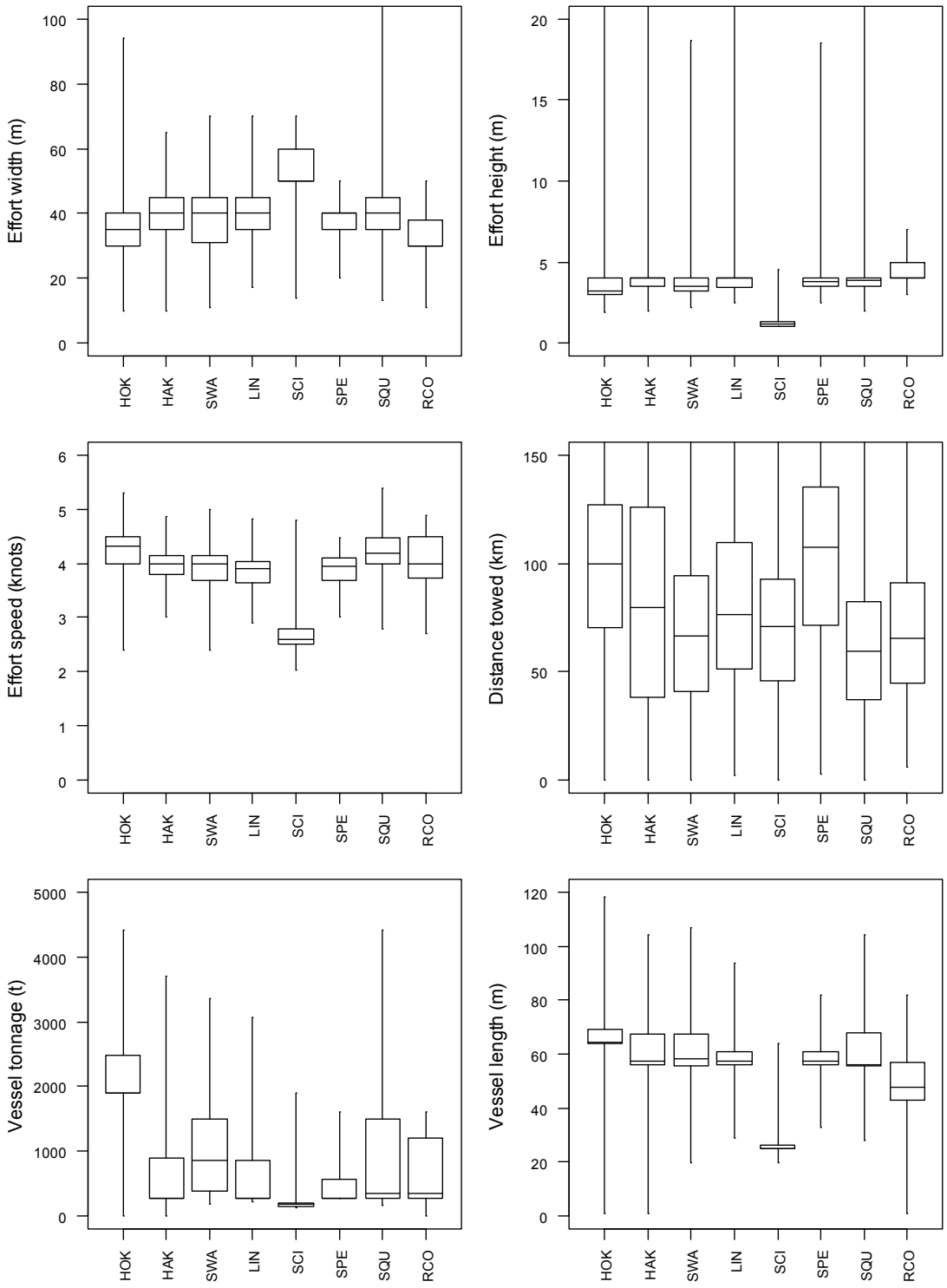


Figure C20: Median (horizontal line), inter-quartile ranges (box), and range (vertical lines) for distribution of fishing effort variables and vessel characteristics for the CHAT area by main target species of tows catching lookdown dory using bottom trawl gear. Target species codes are defined in Table C13.

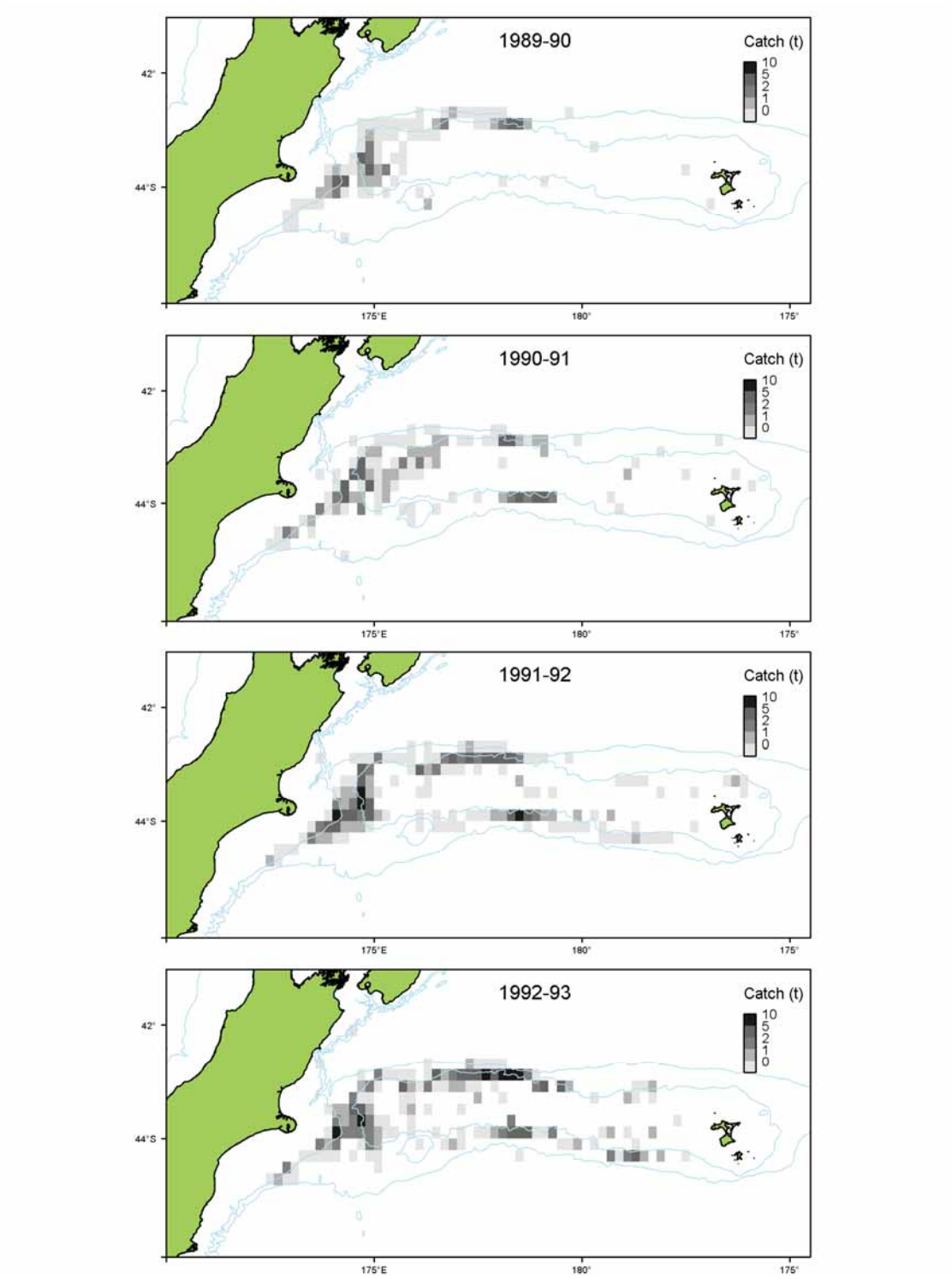


Figure C21: Distribution of lookdown dory catch taken by bottom trawl gear within the CHAT region aggregated into 0.2 degree spatial blocks for fishing years 1990–1993 for tows on the TCEPR form.

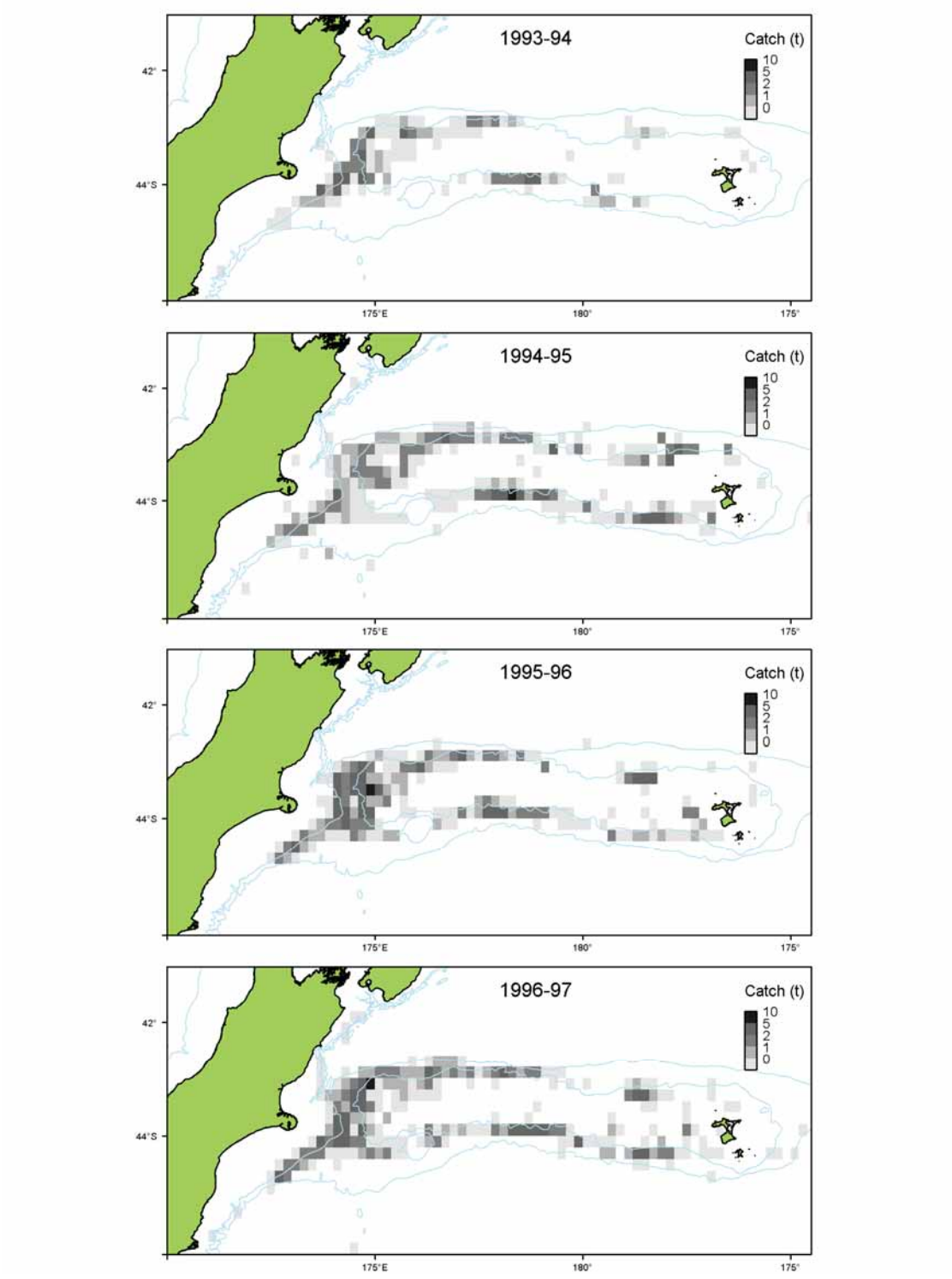


Figure C21 ctd. Distribution of lookdown dory catch taken by bottom trawl gear within the CHAT region aggregated into 0.2 degree spatial blocks for fishing years 1994–1997 for tows on the TCEPR form.

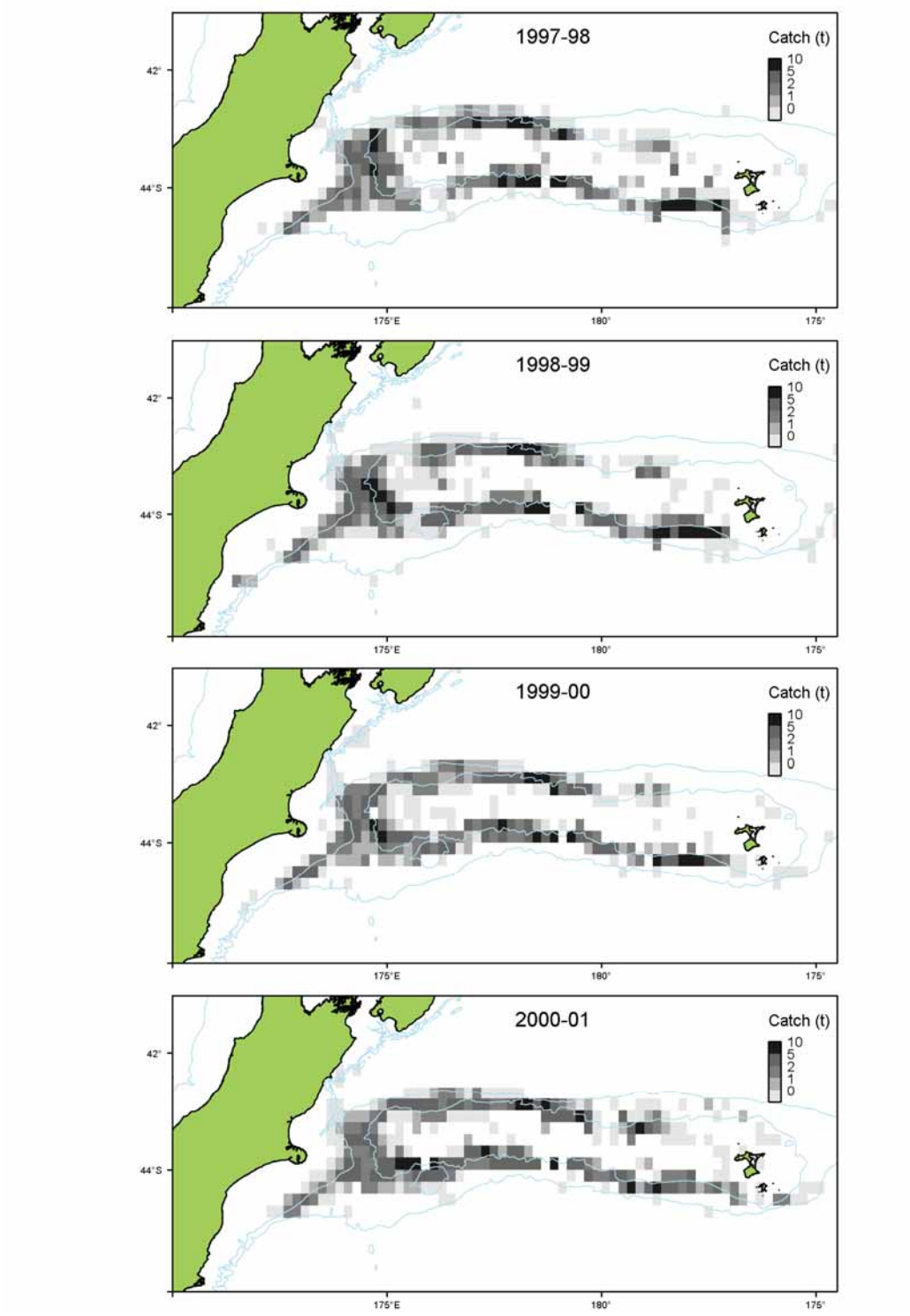


Figure C21 ctd Distribution of lookdown dory catch taken by bottom trawl gear within the CHAT region aggregated into 0.2 degree spatial blocks for fishing years 1998–2001 for tows on the TCEPR form.

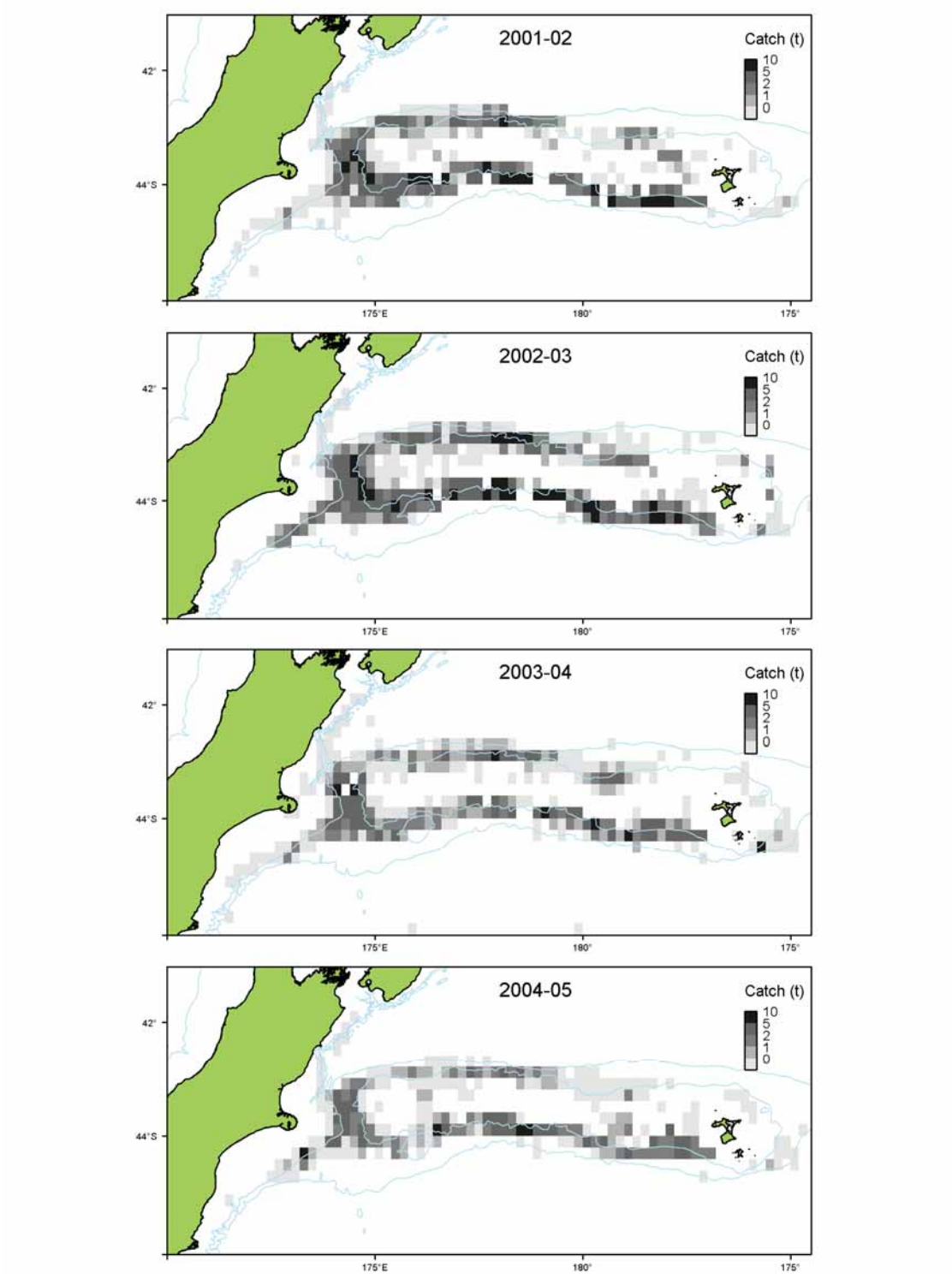


Figure C21 ctd. Distribution of lookdown dory catch taken by bottom trawl gear within the CHAT region aggregated into 0.2 degree spatial blocks for fishing years 2002–2005 for tows on the TCEPR form.

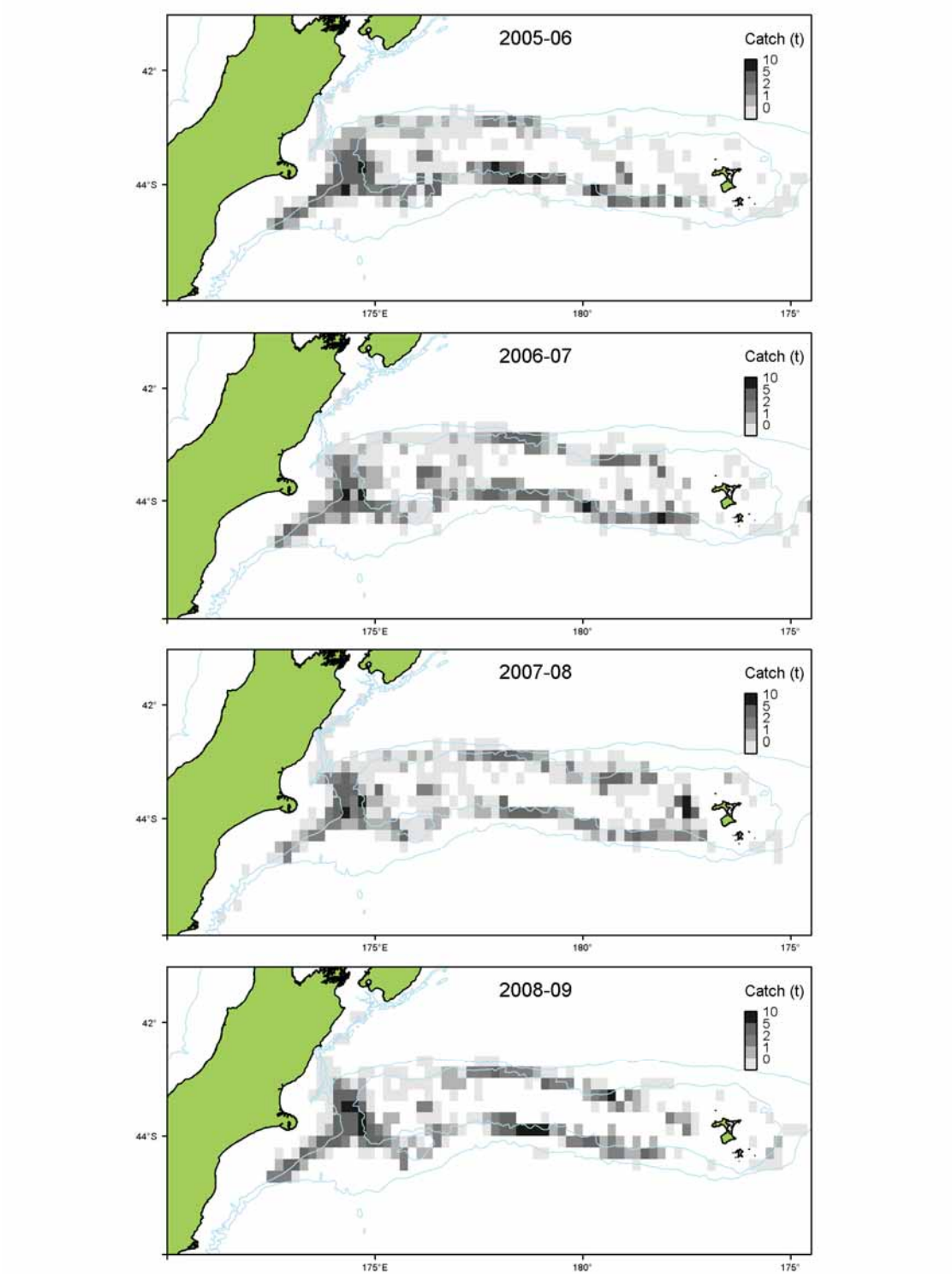


Figure C21 ctd. Distribution of lookdown dory catch form taken by bottom trawl gear within the CHAT region aggregated into 0.2 degree spatial blocks for fishing years 2006–2009 for tows on the TCEPR.

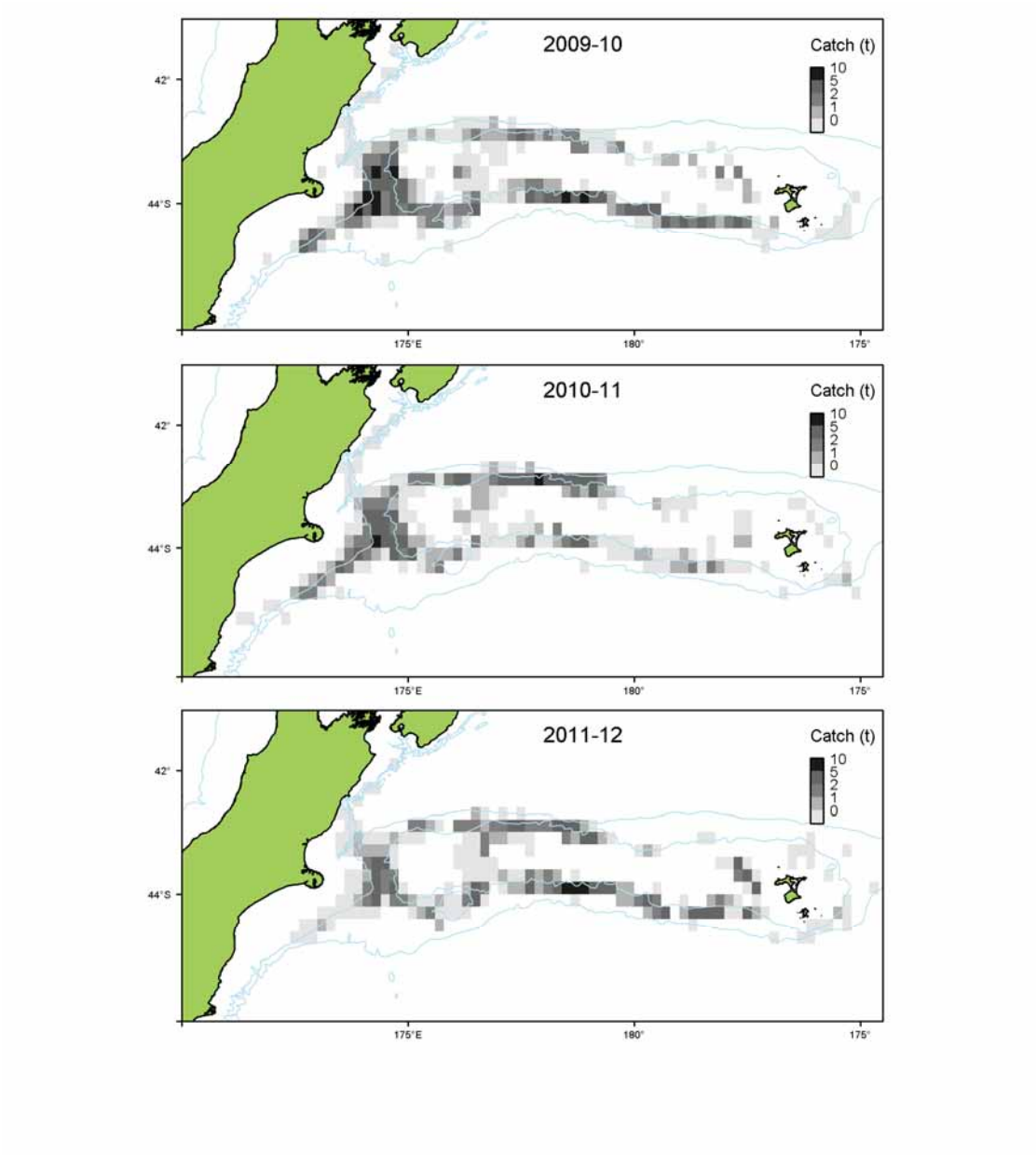


Figure C21 ctd. Distribution of lookdown dory catch form taken by bottom trawl gear within the CHAT region aggregated into 0.2 degree spatial blocks for fishing years 2010–2012 for tows on the TCEPR form.

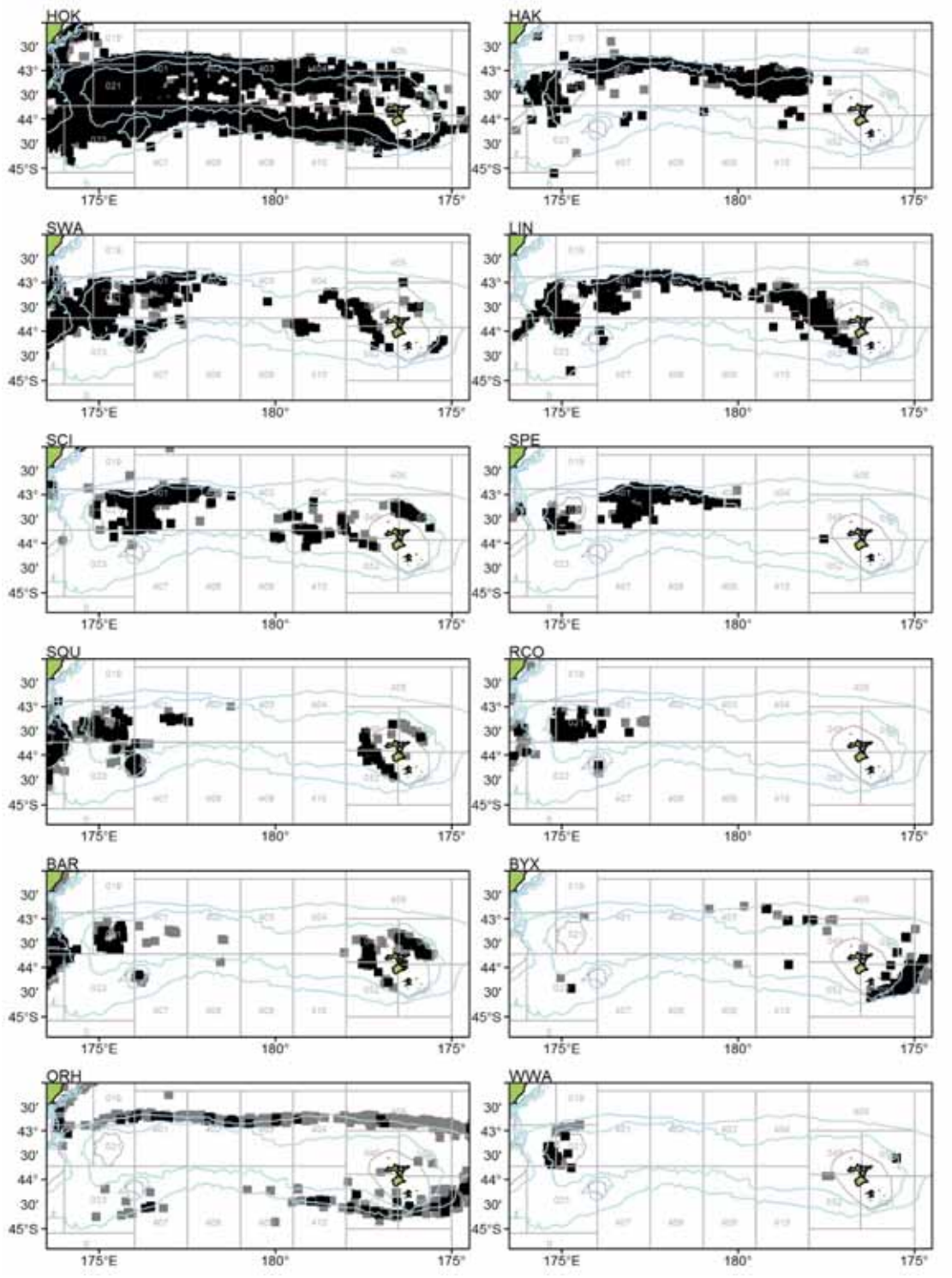


Figure C22: CHAT statistical areas and bathymetry showing the distribution of bottom trawls by target species (grey) in the merged processed data and bottom trawls by target species where lookdown dory was caught (black) for the main target species for all years combined. Target species are defined in Table 13.

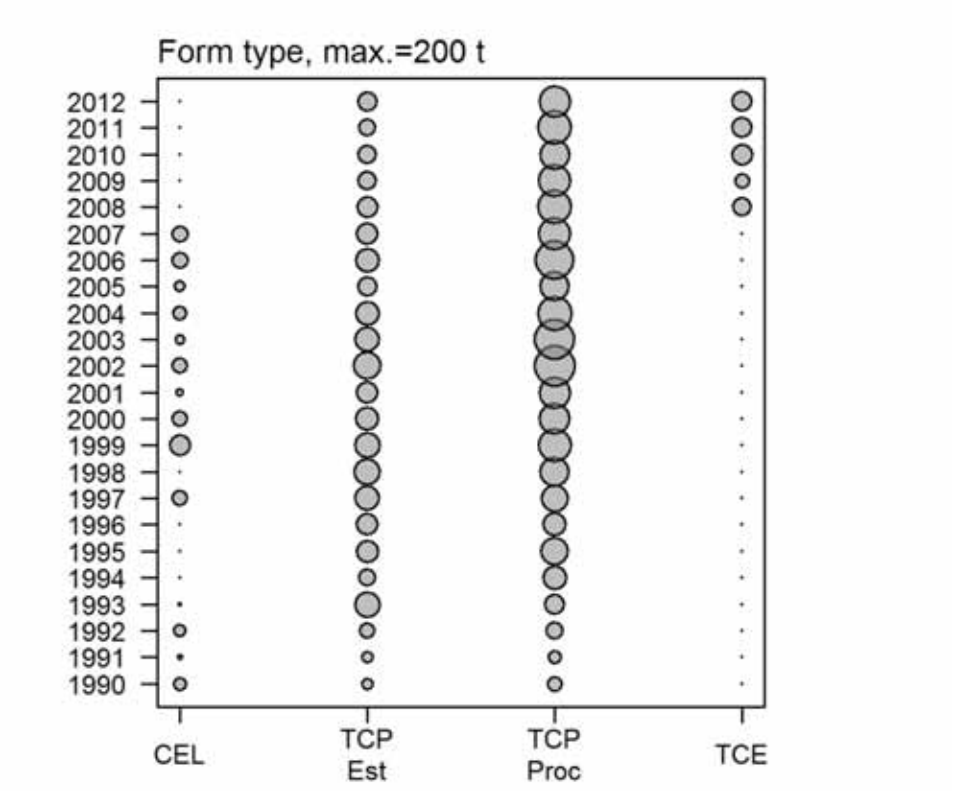


Figure C23a: Distribution of annual catch by form type for West Coast estimated and merged daily processed data. Circle size is proportional to catch; maximum circle size is indicated on each plot. TCP Est is estimated data from the Trawl, Catch, Effort, and Processing Return; TCP Proc is daily processed data from the Trawl, Catch, Effort, and Processing Return; TCE is Trawl, Catch, Effort Return.

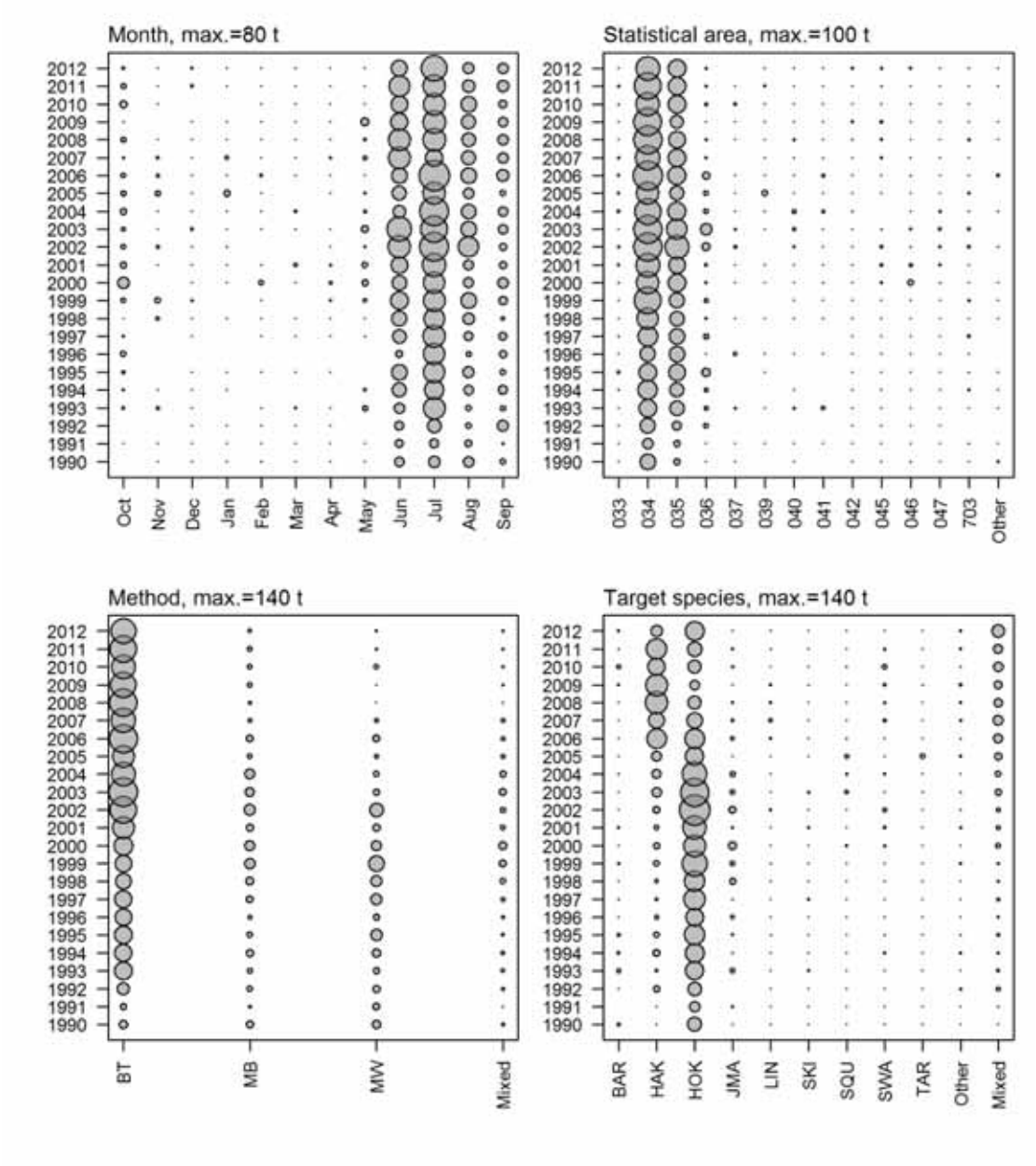


Figure C23b: Distribution of annual catch by month, statistical area, method, and target species for West Coast merged daily processed data. Circle size is proportional to catch; maximum circle size is indicated on each plot. Statistical areas are shown in Figure 1. BT is bottom trawl; MB is midwater trawl within 5 m of the seabed; MW is midwater trawl; Mixed is a mix of bottom and midwater tows. Target species codes are defined in Table C13.

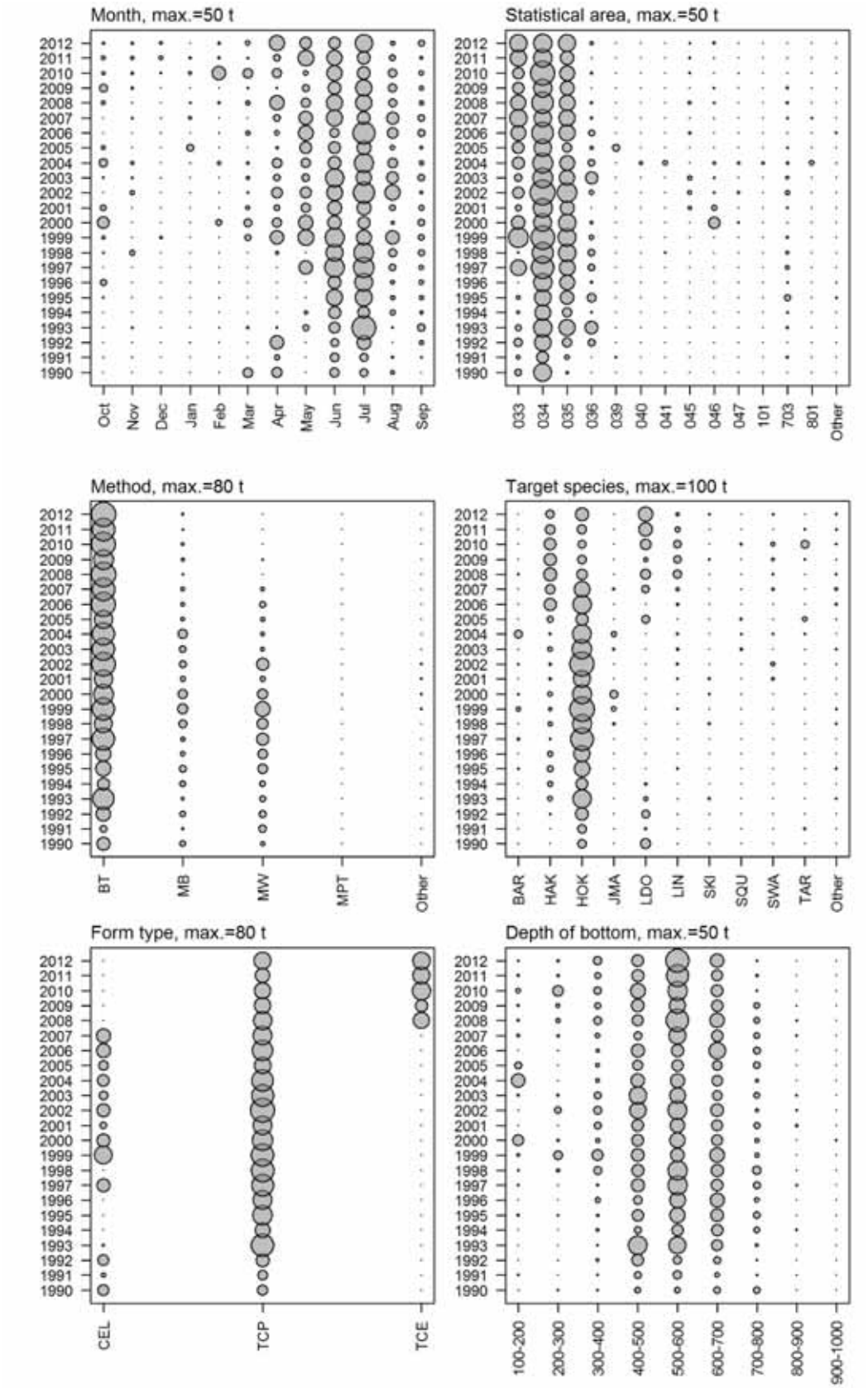


Figure C23c: Distribution of estimated TCEPR (TCP), TCER (TCE), and CELR (CEL) annual catch by month, statistical area, method, and target species for West Coast. Circle size is proportional to catch; maximum circle size is indicated on each plot. Statistical areas are shown in Figure 1. BT is bottom trawl; MB is midwater trawl within 5 m of the seabed; MW is midwater trawl; Target species codes are defined in Table C13.

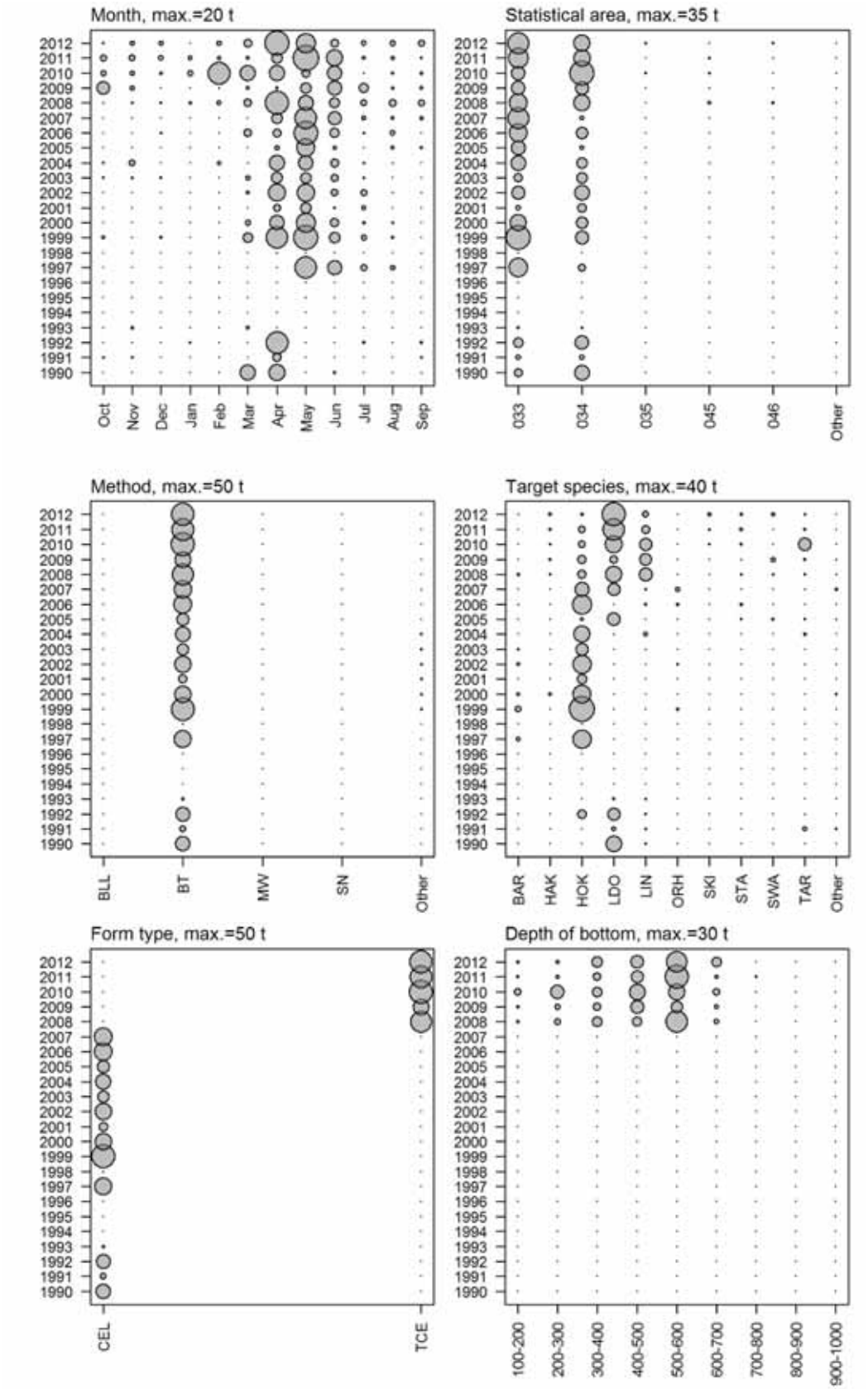


Figure C23d: Distribution of annual catch by month, statistical area, method, and target species for West Coast estimated TCER (TCE) and CELR (CEL) data. Circle size is proportional to catch; maximum circle size is indicated on each plot. Statistical areas are shown in Figure 1. BT is bottom trawl; MB is midwater trawl within 5 m of the seabed; MW is midwater trawl; Mixed is a mix of bottom and midwater tows. Target species codes are defined in Table C13.

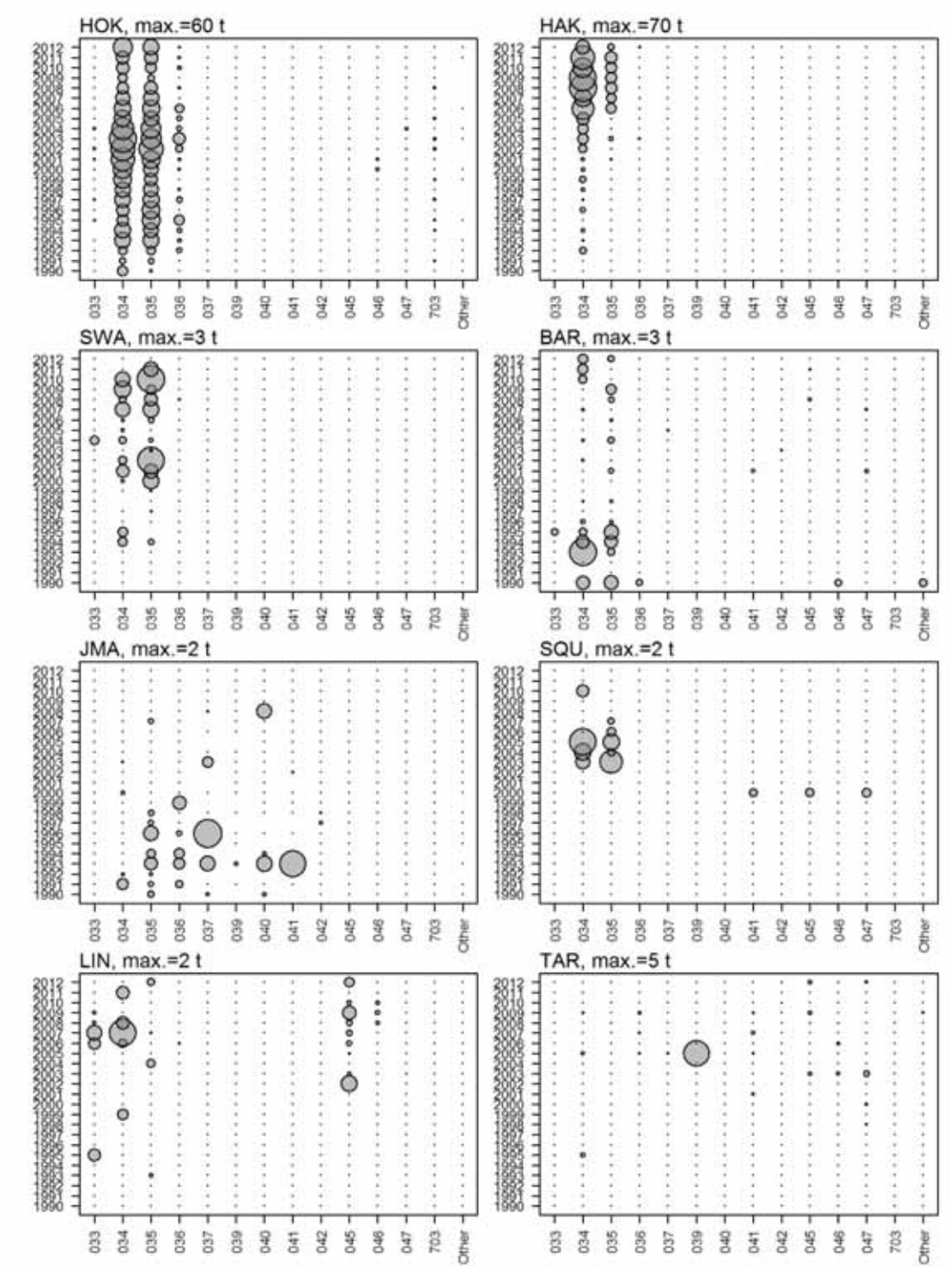


Figure C24: Distribution of lookdown dory annual catch (t) by statistical area for West Coast merged daily processed data by main target species for all TCEPR bottom trawl tows. Circle size is proportional to catch; maximum circle size is indicated on the top left hand corner of each plot. Statistical areas are shown in Figure 1 and target species codes are defined in Table C13.

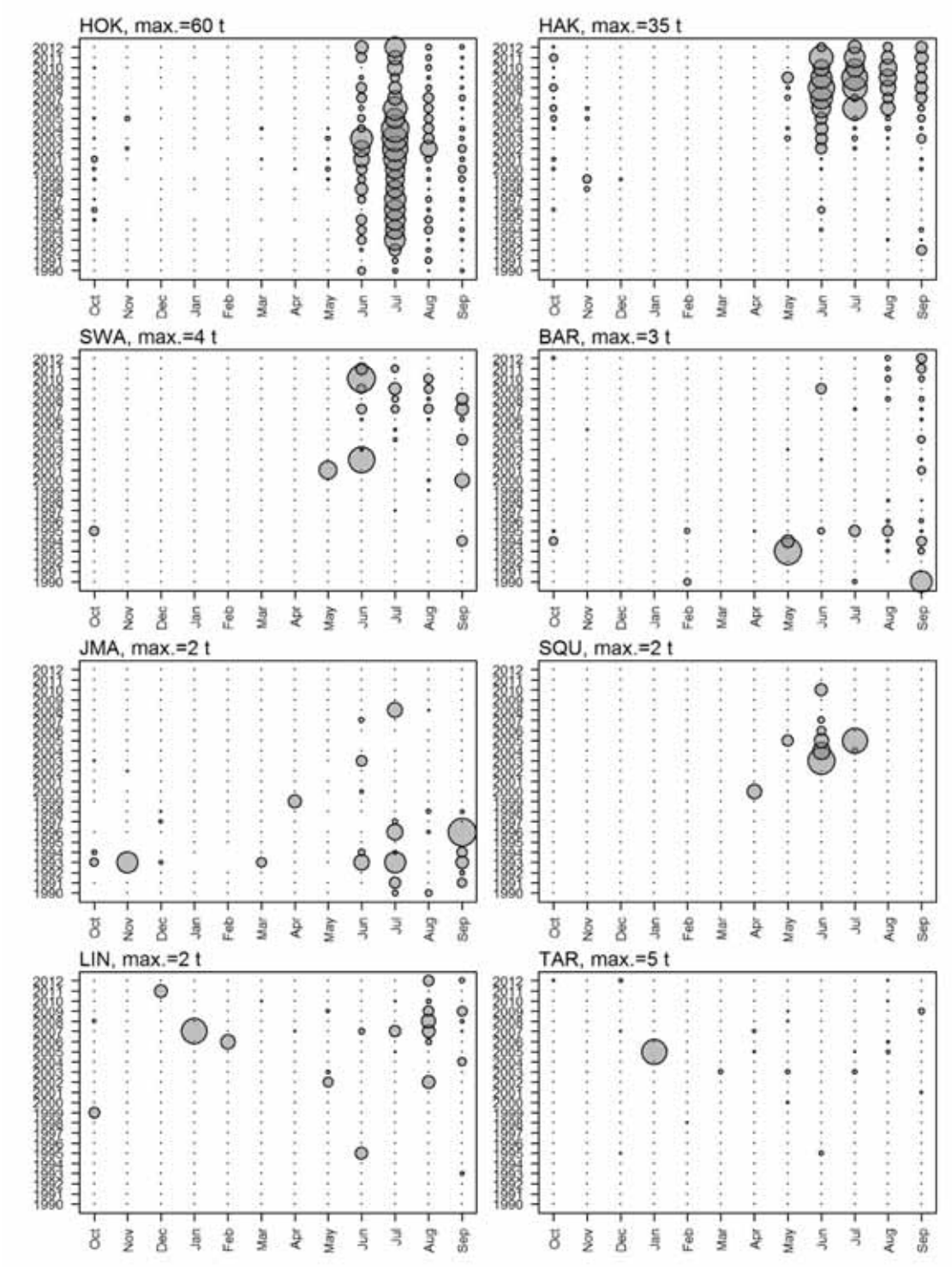


Figure C25: Distribution of lookdown dory annual catch (t) by month for West Coast merged data by main target species for all TCEPR bottom trawl tows. Circle size is proportional to catch; maximum circle size is indicated on the top left hand corner of each plot. Target species codes are defined in Table C13.

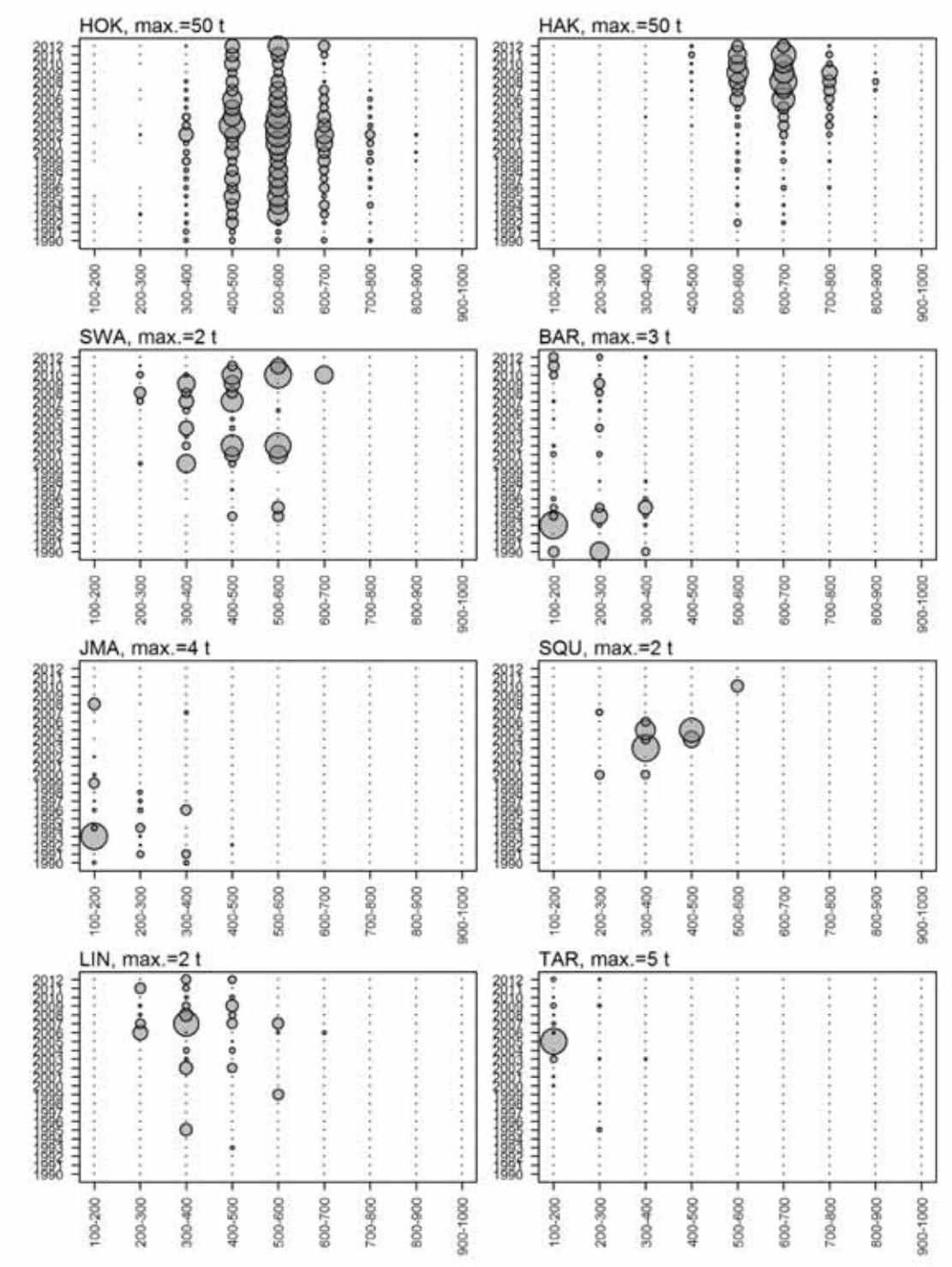


Figure C26: Distribution of lookdown dory annual catch (t) by mean depth for West Coast merged TCEPR daily processed data by main target species for all TCEPR bottom trawl tows. Circle size is proportional to catch; maximum circle size is indicated on the top left hand corner of each plot. Target species codes are defined in Table C13.

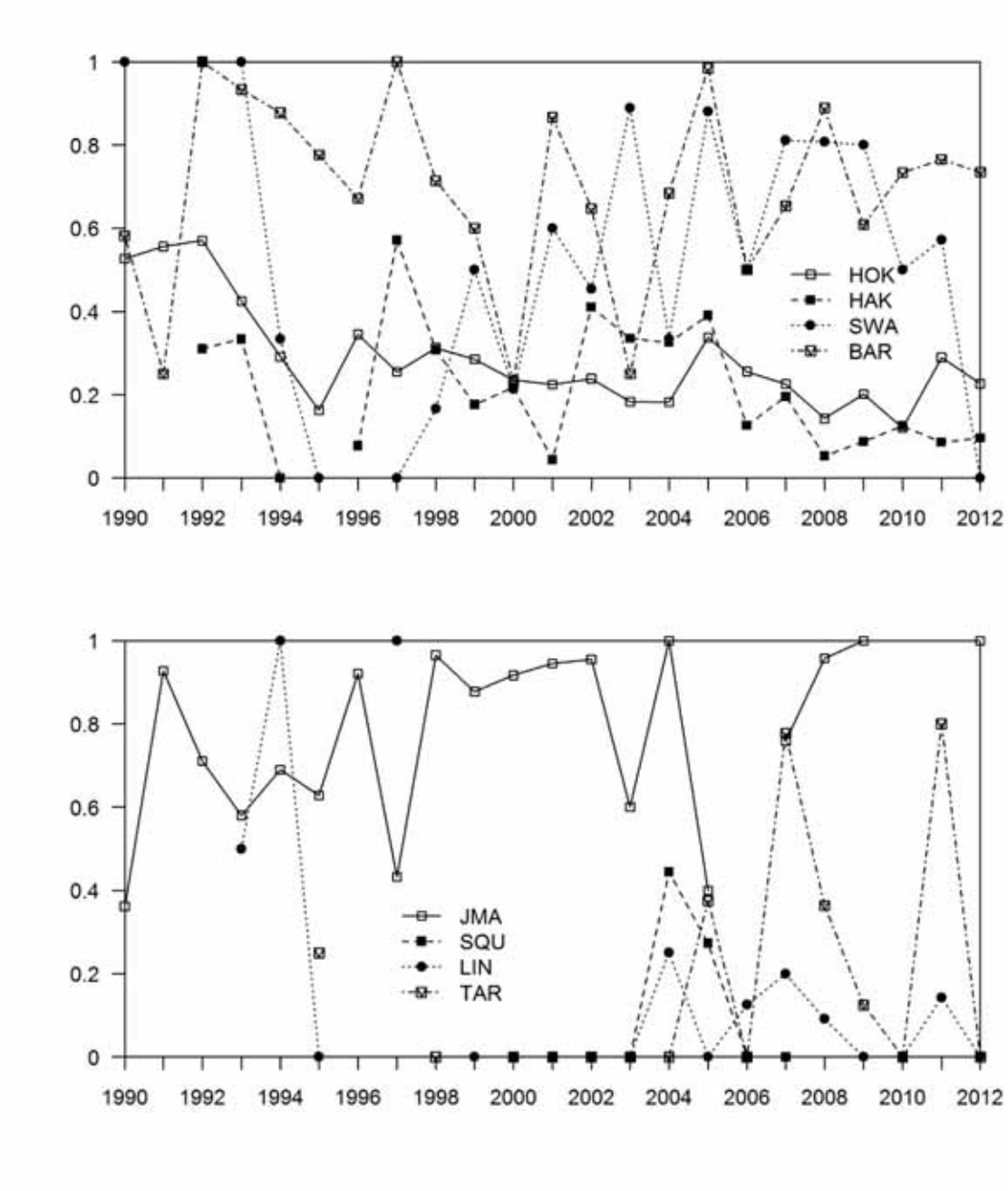


Figure C27a: Proportion of zeros in merged daily processed data by main target species in the West Coast for all bottom trawl tows. Target species codes are defined in Table C13.

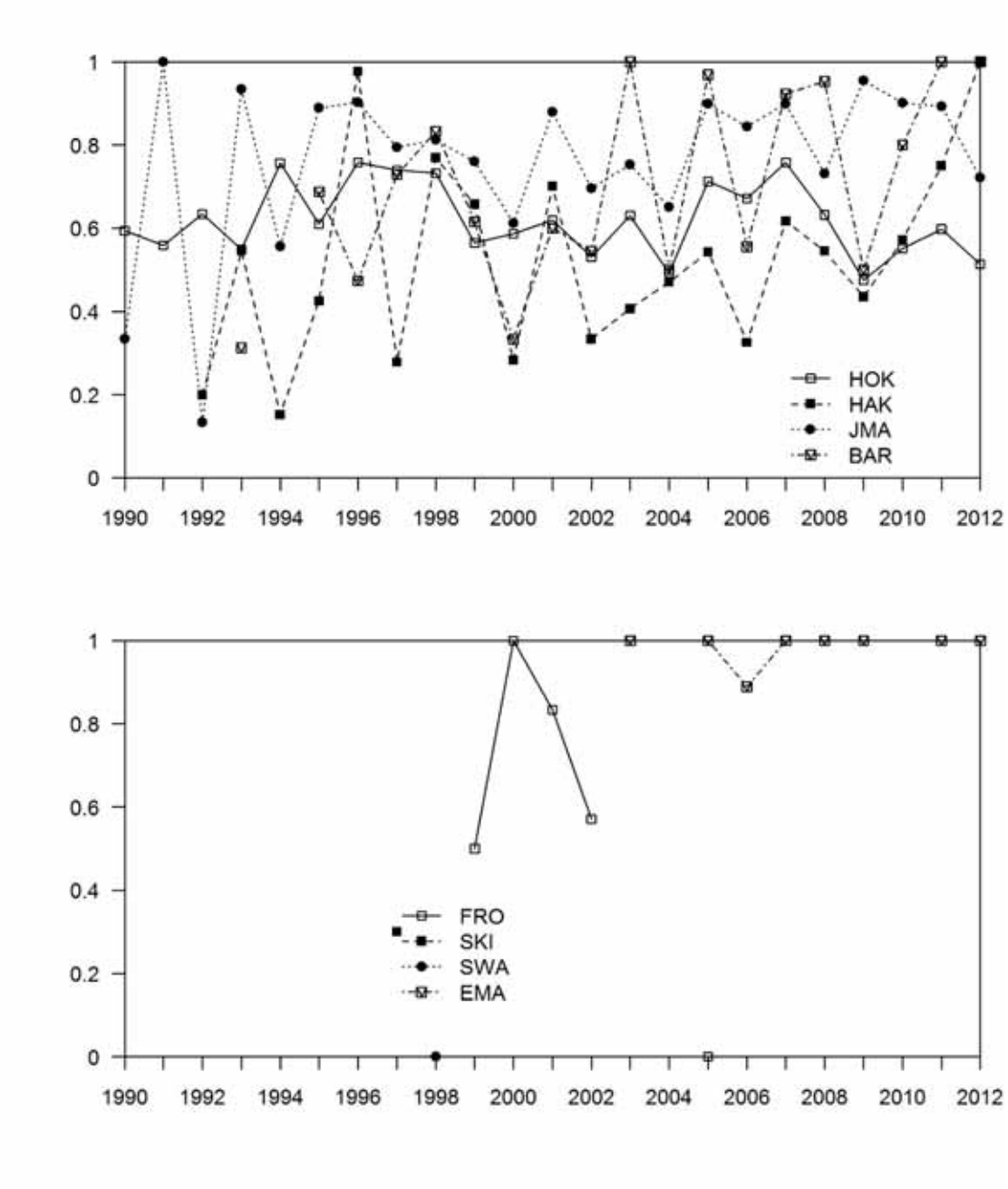


Figure C27b: Proportion of zeros in merged daily processed data by main target species in the West Coast for all midwater trawl tows. Target species codes are defined in Table C13.

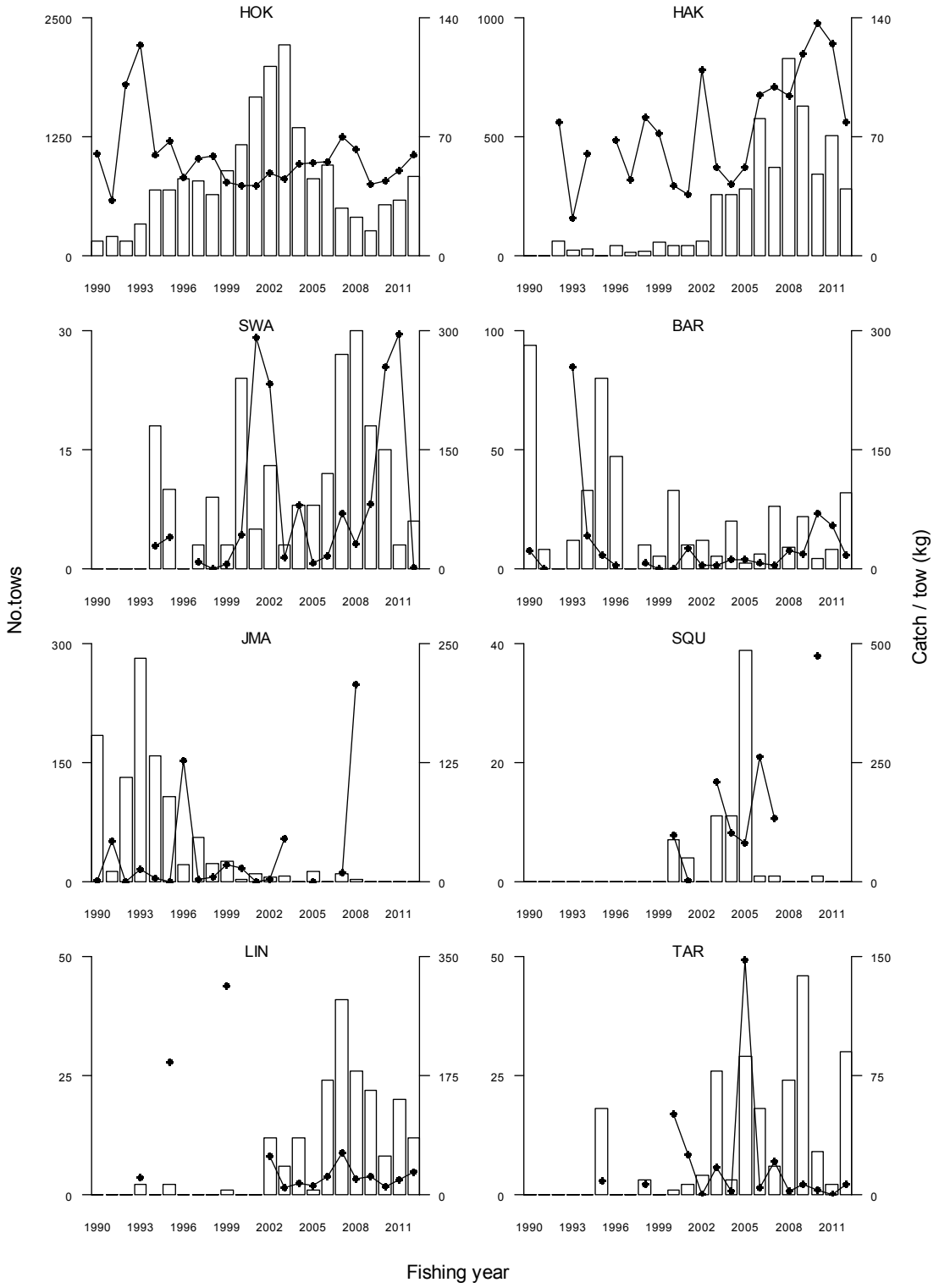


Figure C28a: Unstandardised catch rate of LDO by main target species (kg/tow) and the number of tows for the West Coast region taken by bottom trawl gear. Target species codes are defined in Table C13.

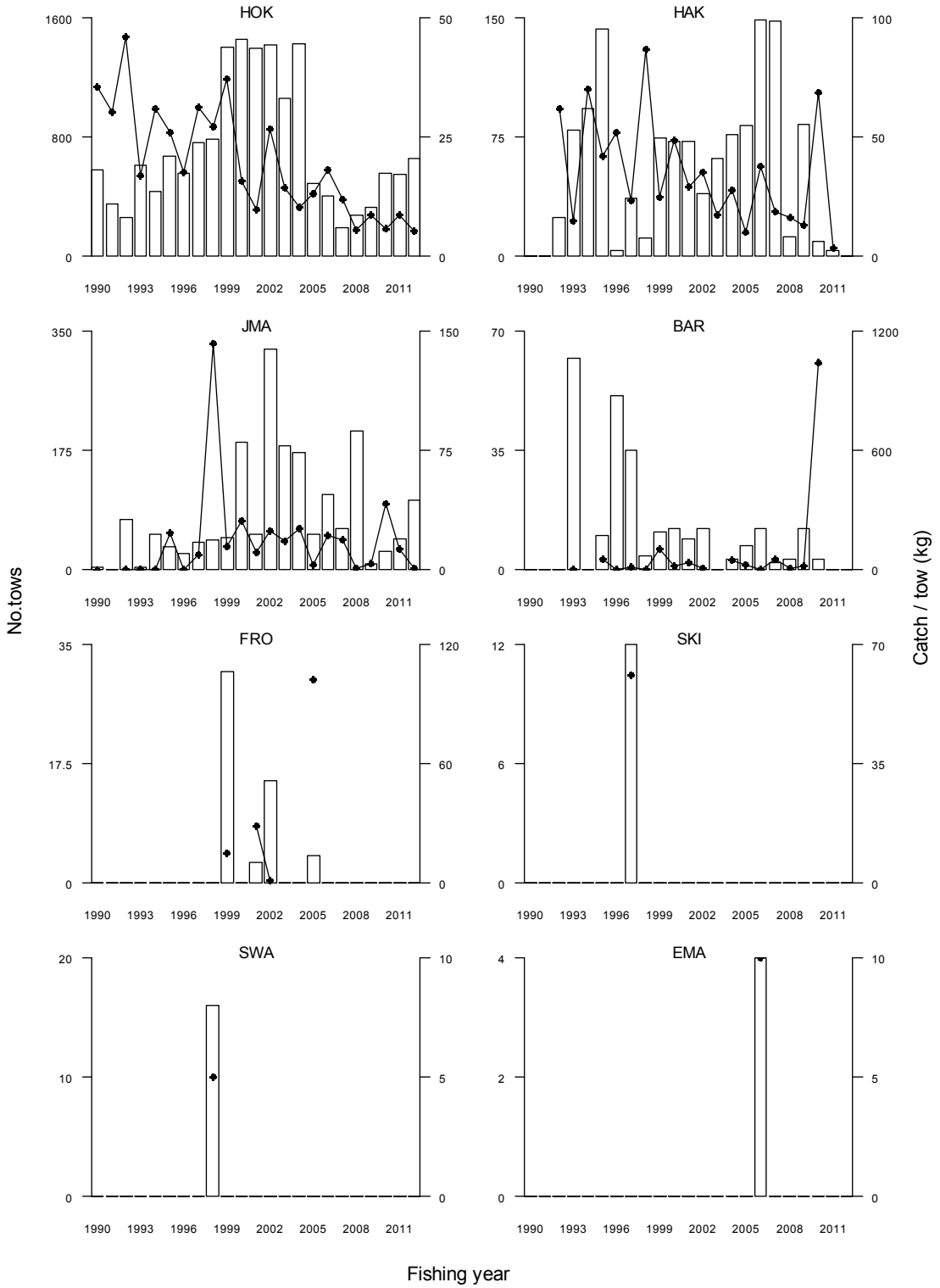


Figure C28b: Unstandardised catch rate of LDO by main target species (kg/tow) and the number of tows for the West Coast region taken by midwater trawl gear. Target species codes are defined in Table C13.

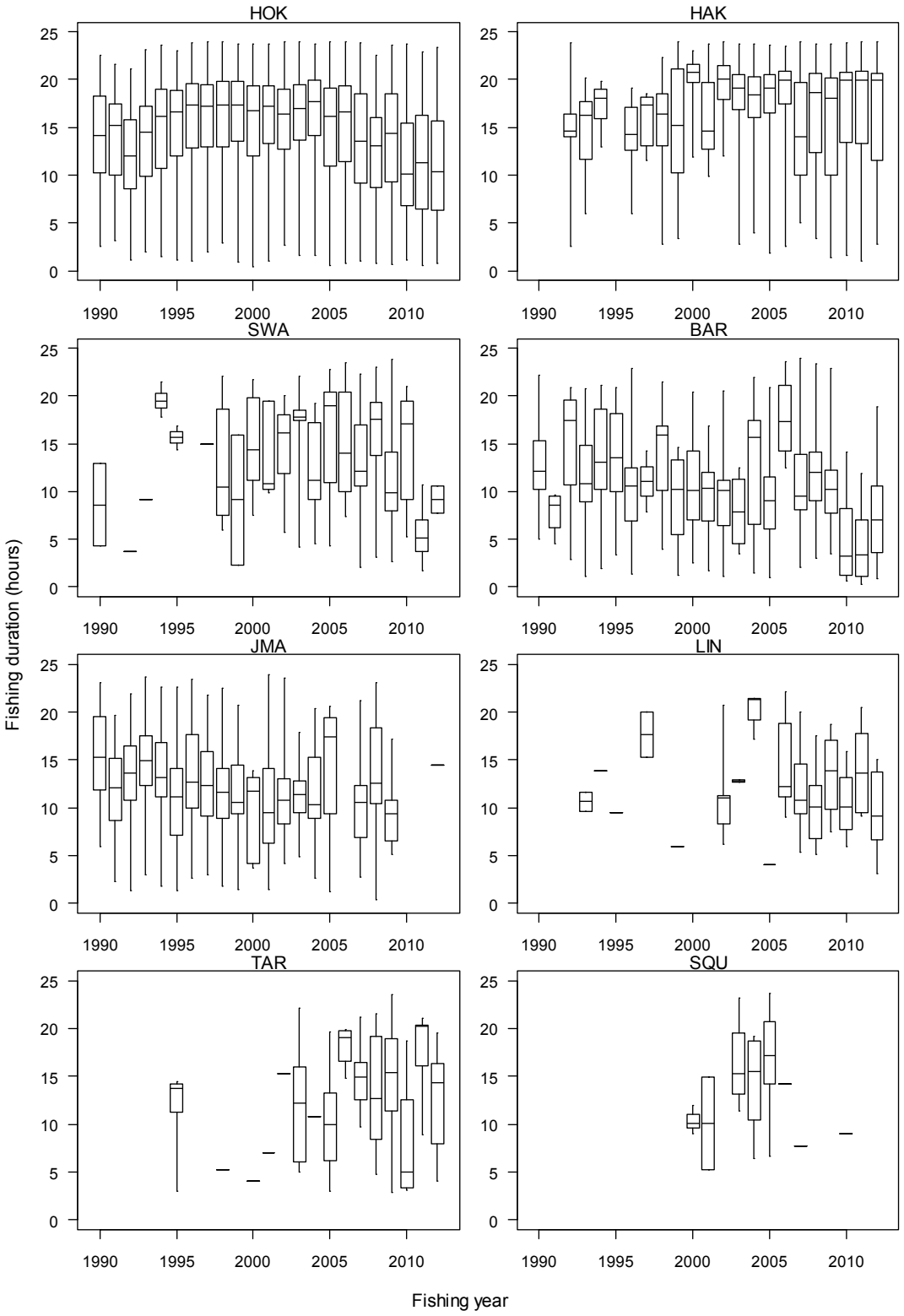


Figure C29a: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) for summed daily tow durations (hours) reported by main target species of tows capturing lookdown dory in the West Coast region using bottom trawl gear. Target species codes are defined in Table C13.

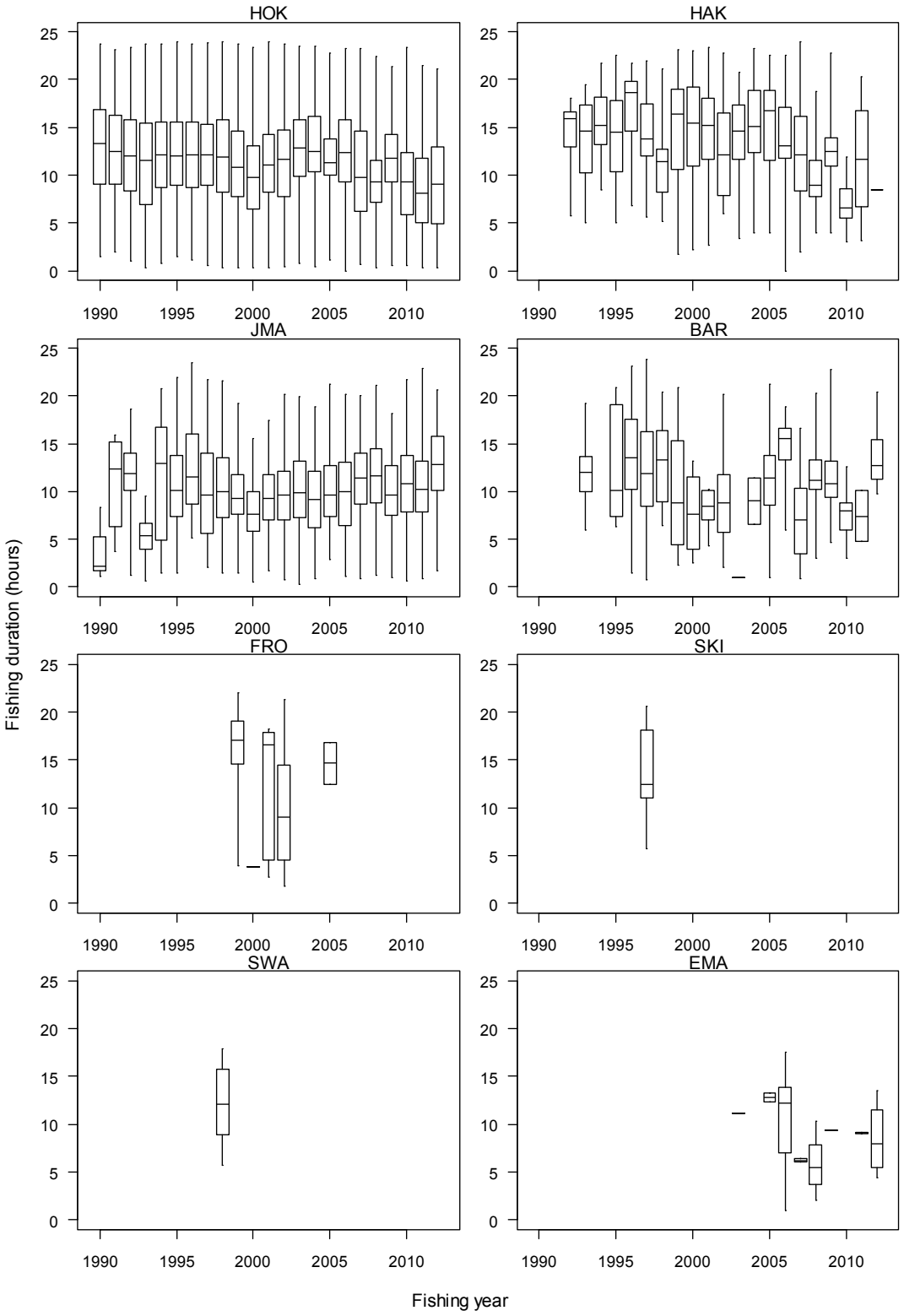


Figure C29b: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) for summed daily tow durations (hours) reported by main target species of tows capturing lookdown dory in the West Coast region using midwater trawl gear. Target species codes are defined in Table C13.

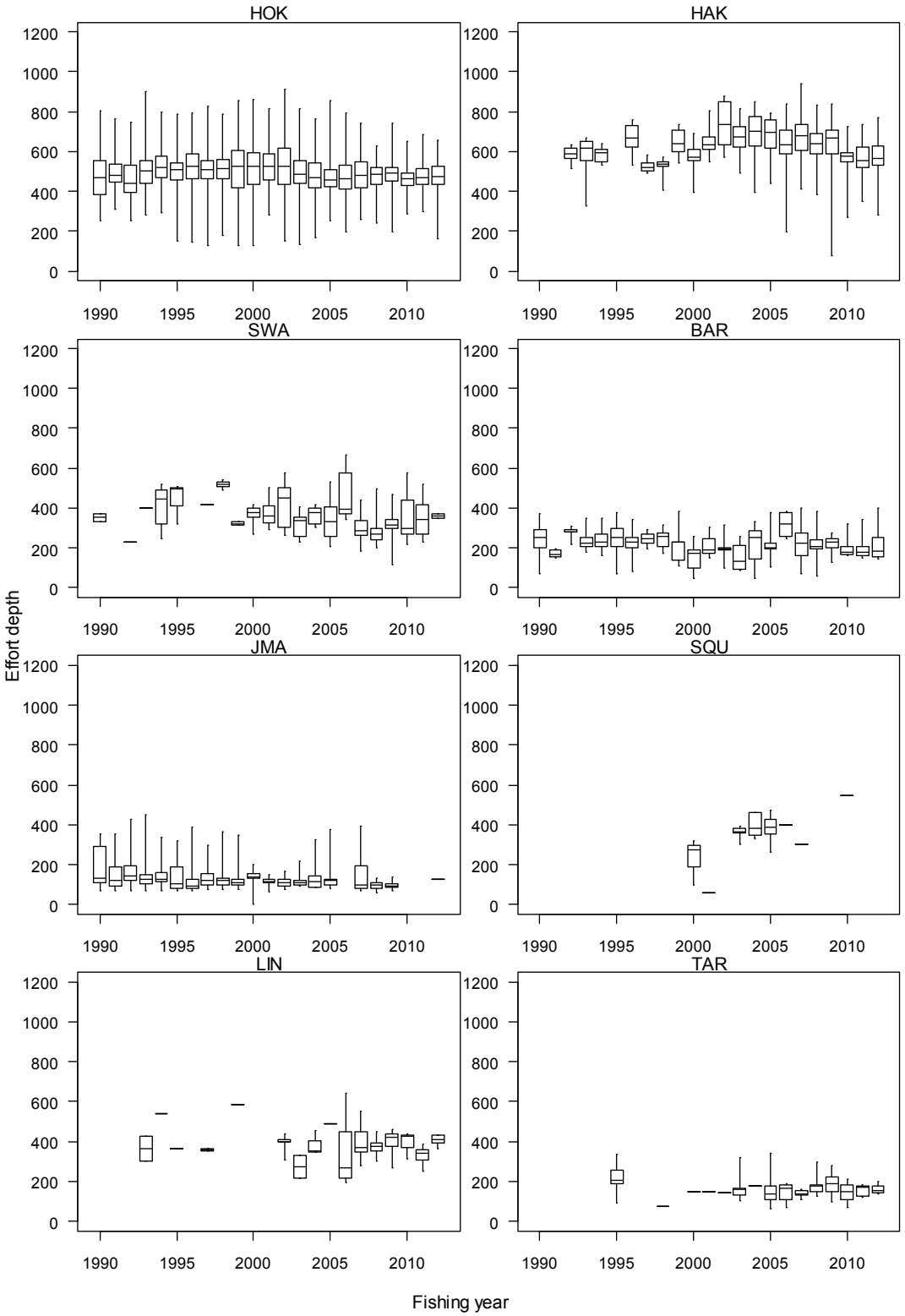


Figure C30a: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) for depths (m) fished by main target species of tows capturing lookdown dory in the West Coast region using bottom trawling. Target species codes are defined in Table C13.

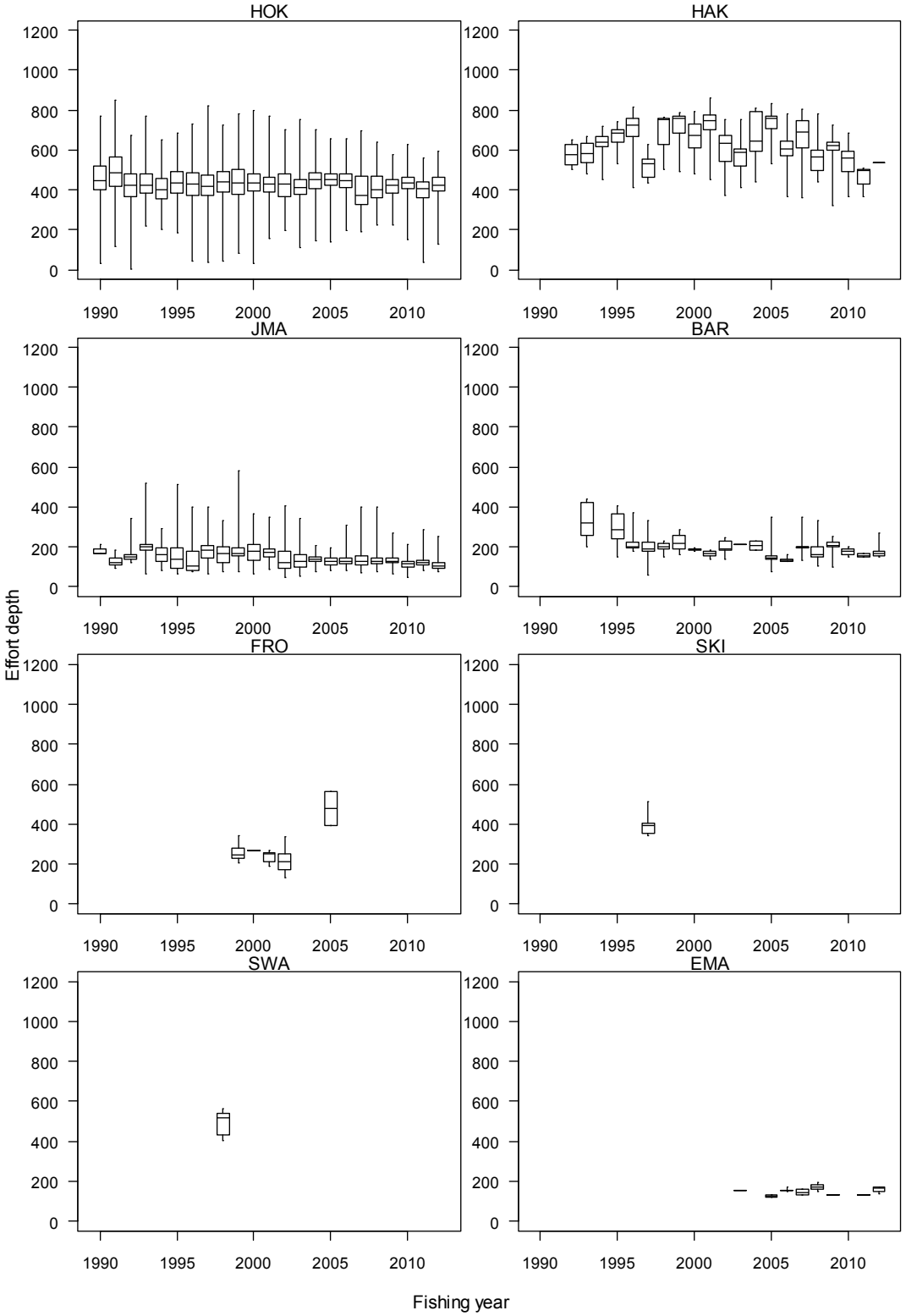


Figure C30b: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) for depths (m) fished by main target species of tows capturing lookdown dory in the West Coast region using midwater trawling. Target species codes are defined in Table C13.

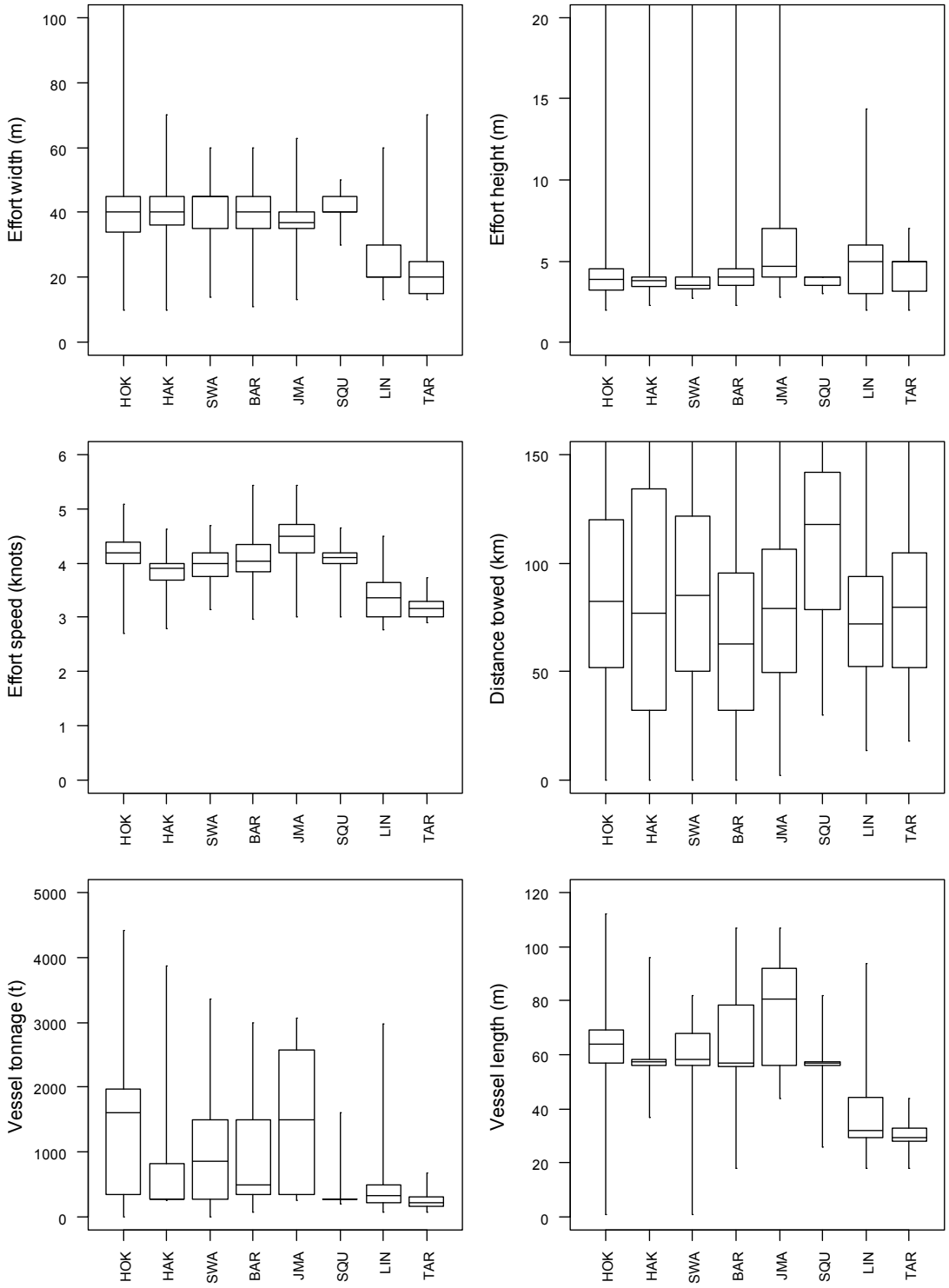


Figure C31a: Median (horizontal line), inter-quartile ranges (box), and range (vertical lines) distribution of fishing effort variables and vessel characteristics for the West Coast area by main target species of tows catching lookdown dory using bottom trawl gear. Target species codes are defined in Table C13.

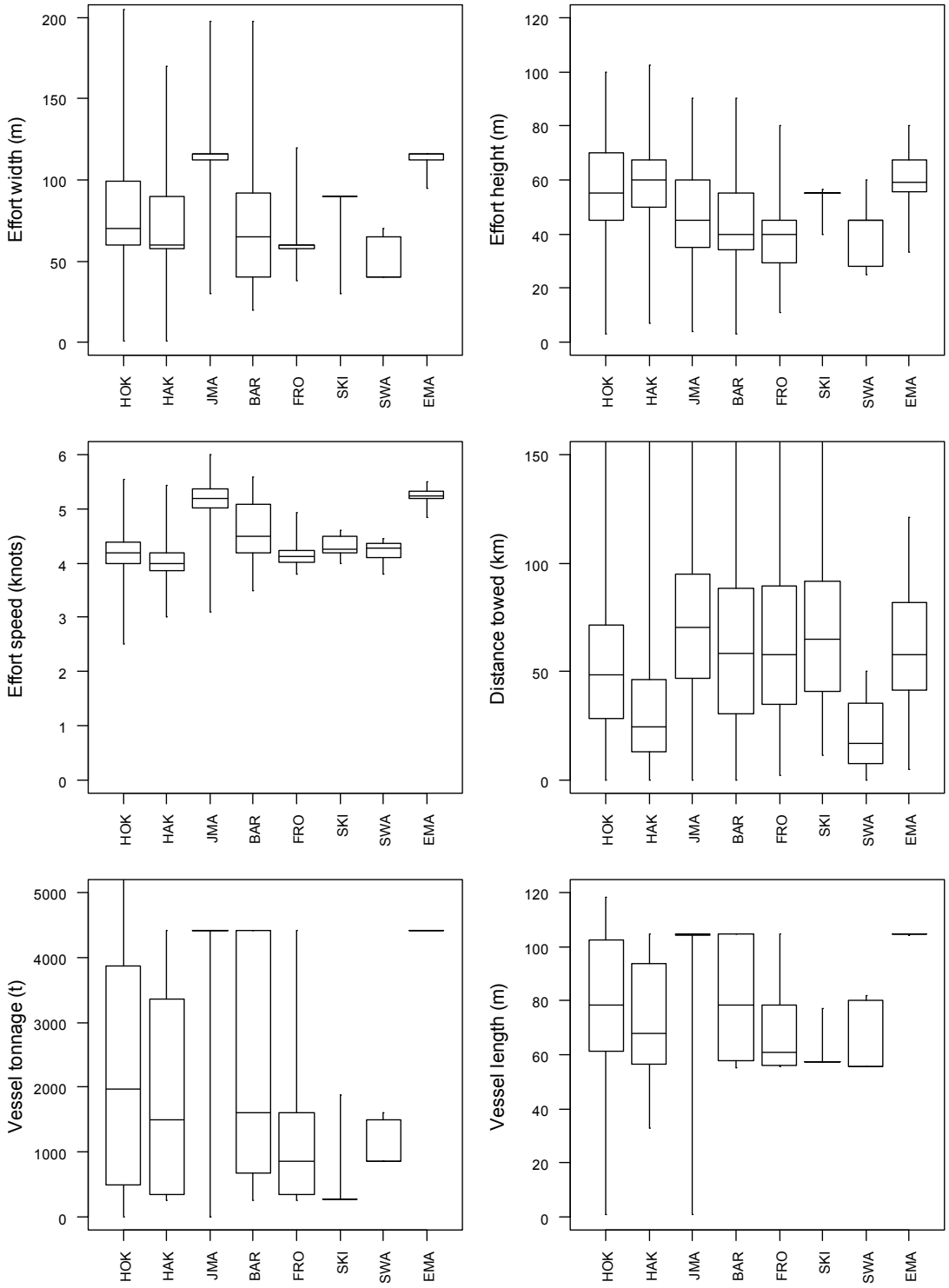


Figure C31b: Median (horizontal line), inter-quartile ranges (box), and range (vertical lines) distribution of fishing effort variables and vessel characteristics for the West Coast area by main target species of tows catching lookdown dory using midwater trawl gear. Target species codes are defined in Table C13.

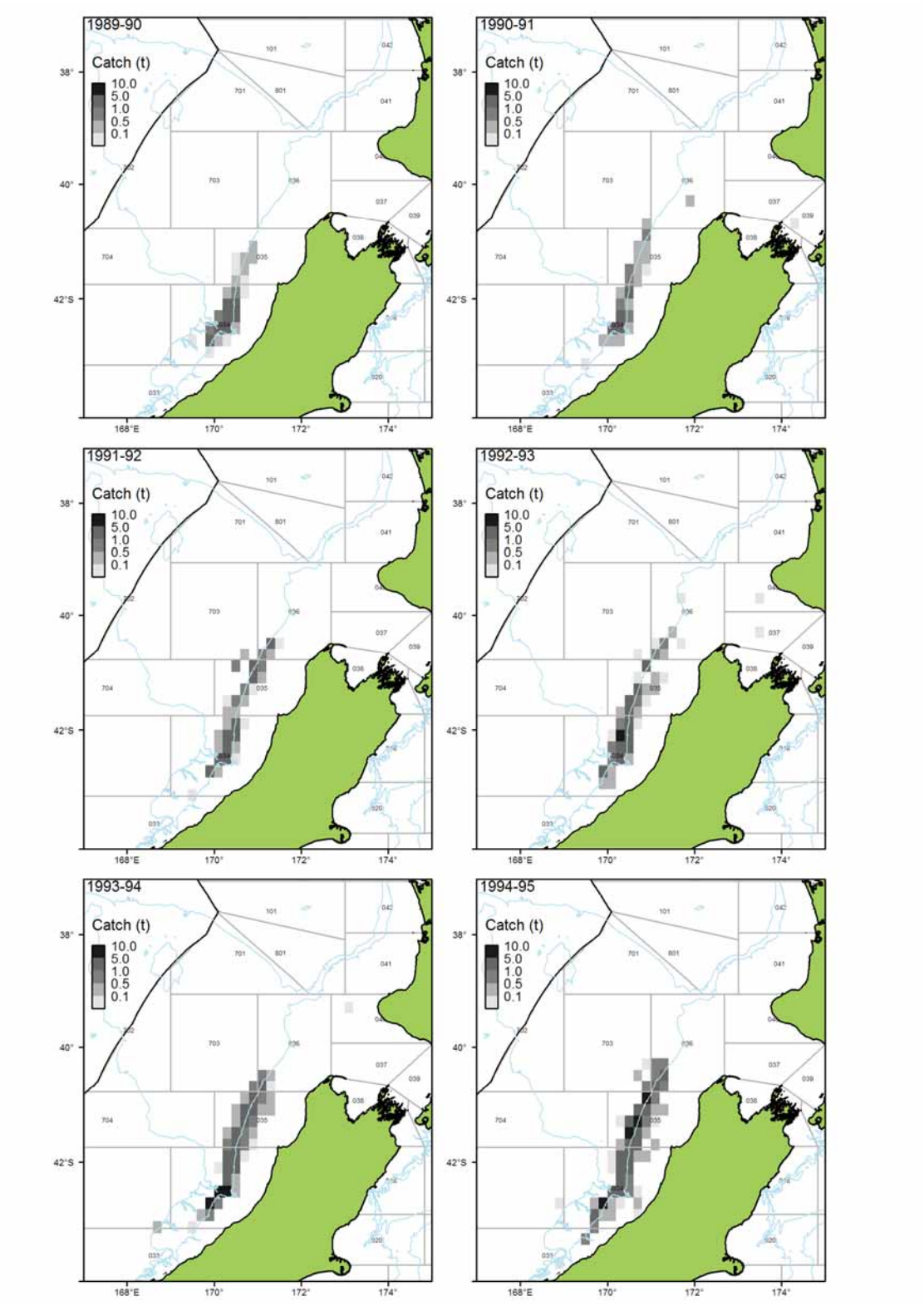


Figure C32a: Distribution of lookdown dory processed catch taken by bottom and midwater trawl gear within the West Coast region aggregated into 0.2 degree spatial blocks for fishing years 1990–1995 for tows on the TCEPR form.

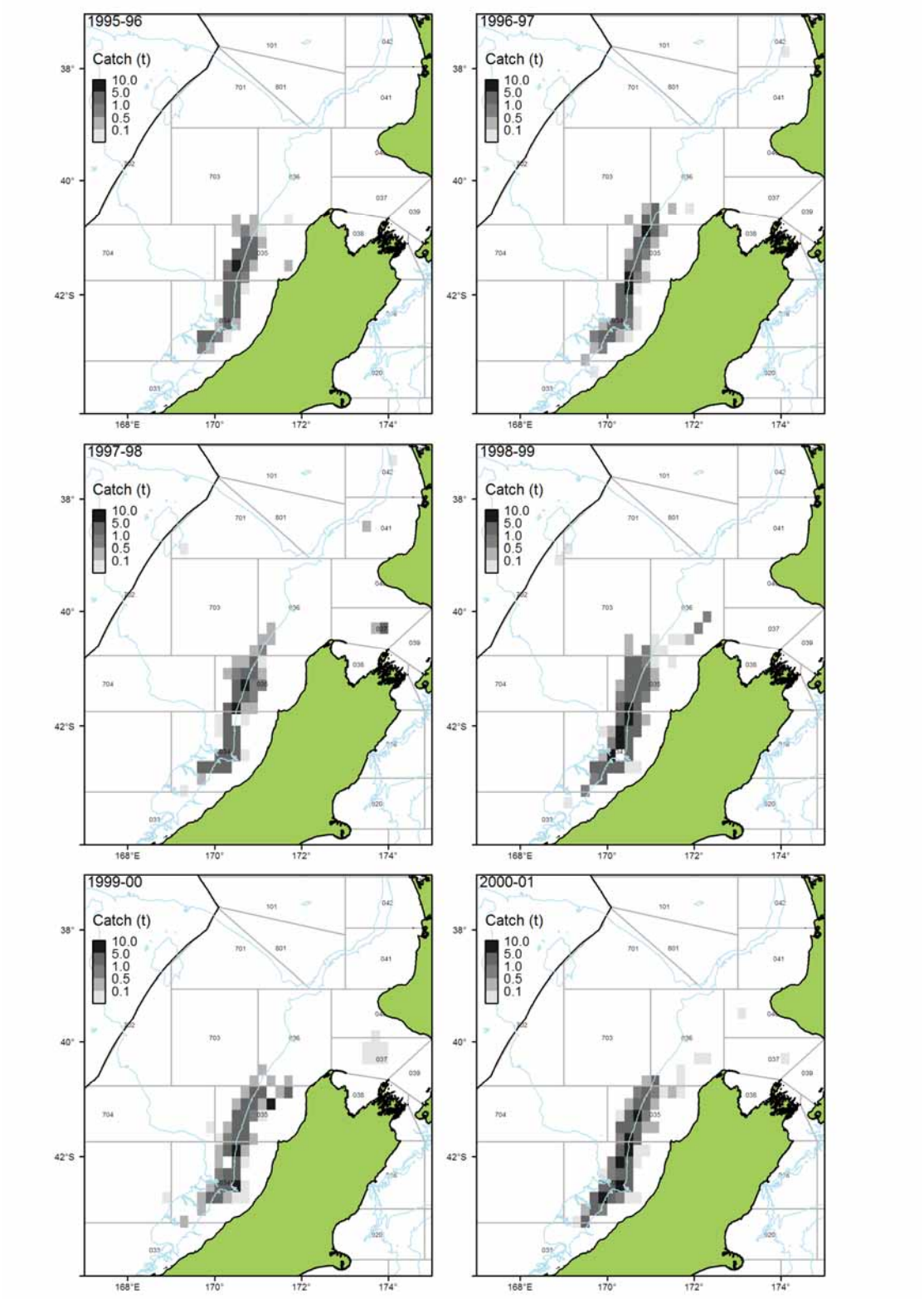


Figure C32a: ctd. Distribution of lookdown dory processed catch taken by bottom and midwater trawl gear within the West Coast region aggregated into 0.2 degree spatial blocks for fishing years 1996–2001 for tows on the TCEPR form.

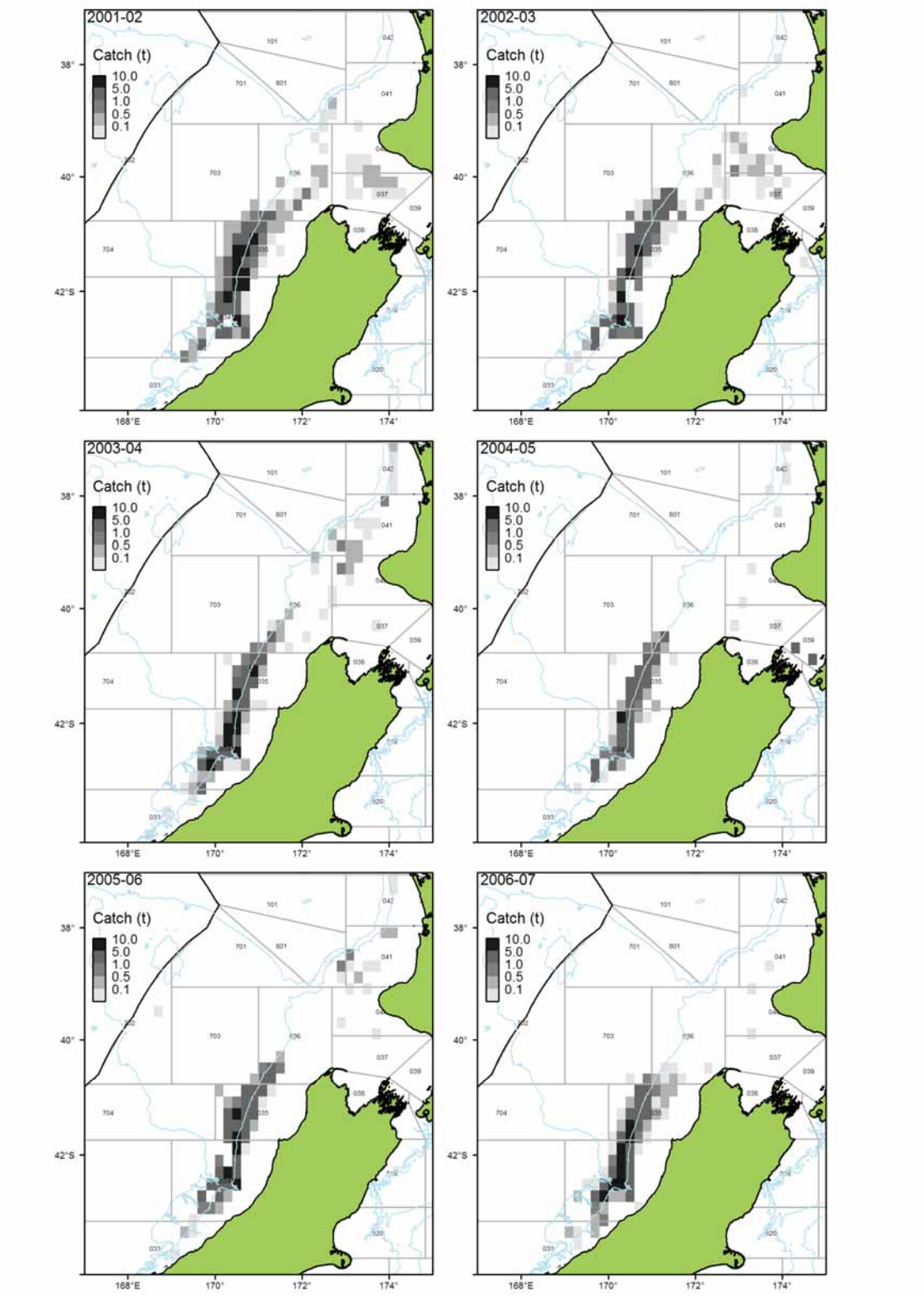


Figure C32a: ctd. Distribution of lookdown dory processed catch taken by bottom and midwater trawl gear within the West Coast region aggregated into 0.2 degree spatial blocks for fishing years 2002–2007 for tows on the TCEPR form.

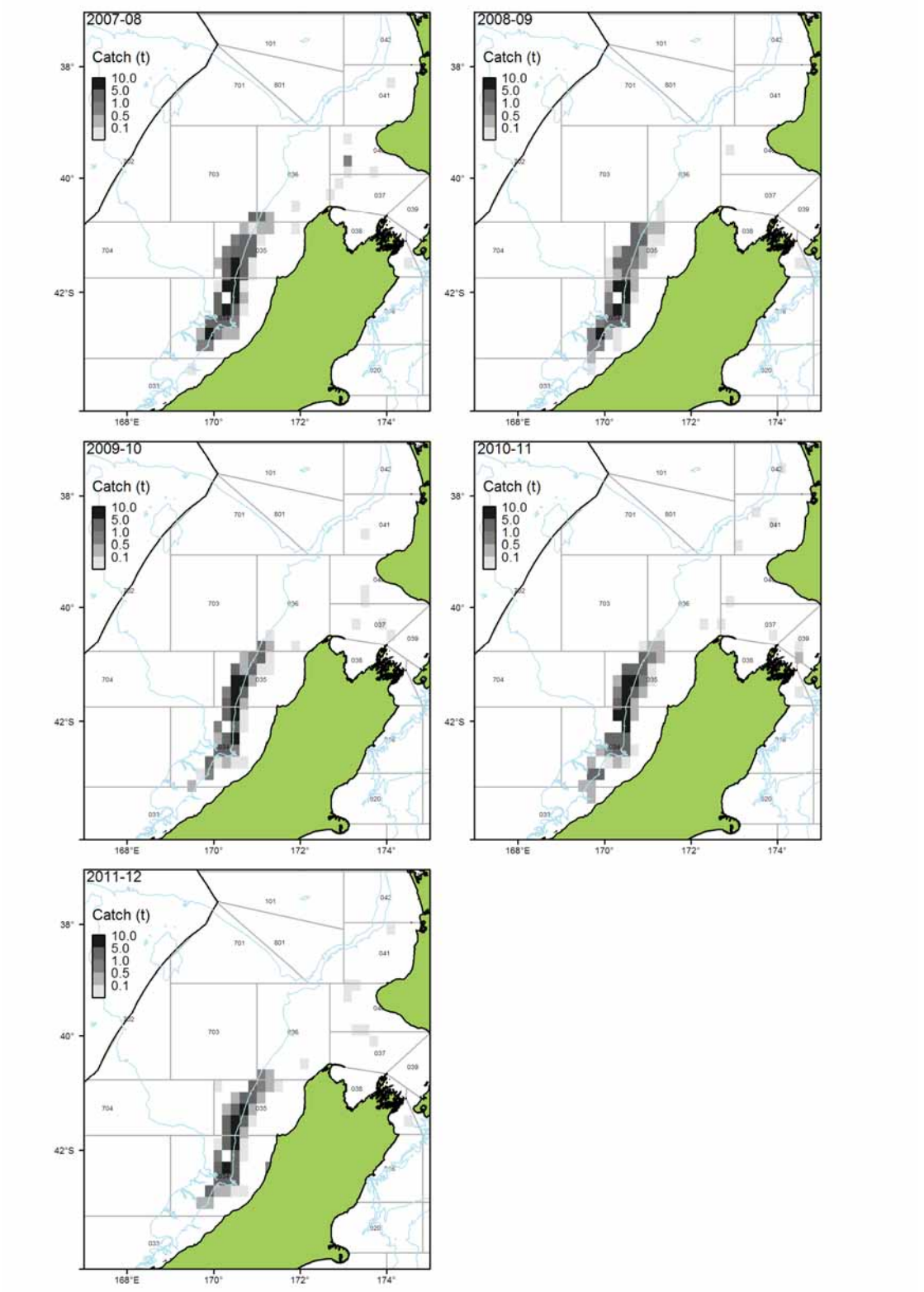


Figure C32a: ctd. Distribution of lookdown dory processed catch taken by bottom trawl gear within the West Coast region aggregated into 0.2 degree spatial blocks for fishing years 2008–2012 for tows on the TCEPR form.

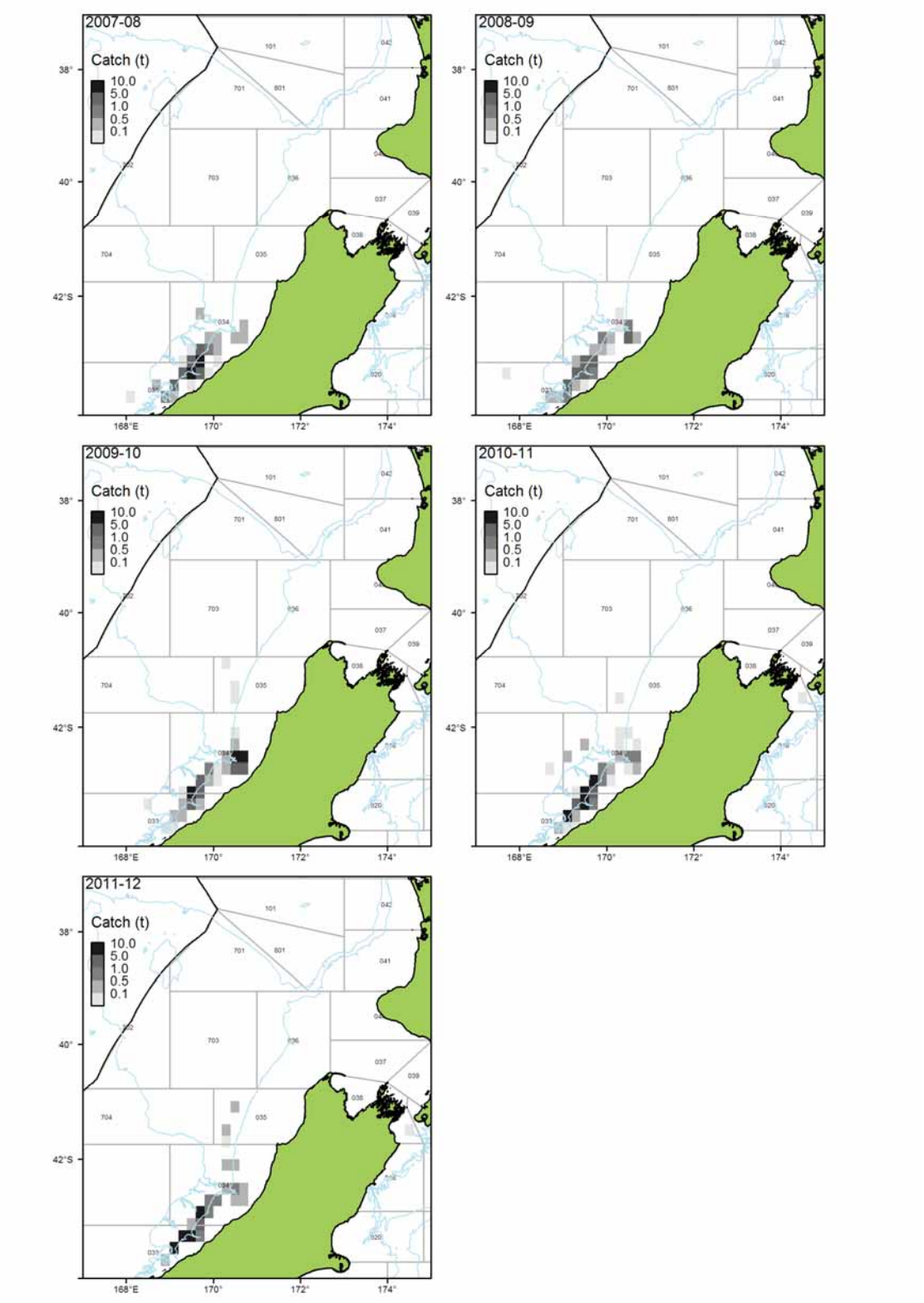


Figure C32b: Distribution of lookdown dory estimated TCER catch taken by bottom trawl gear within the West Coast region aggregated into 0.2 degree spatial blocks for fishing years 2008–2012 for tows on the TCER form.

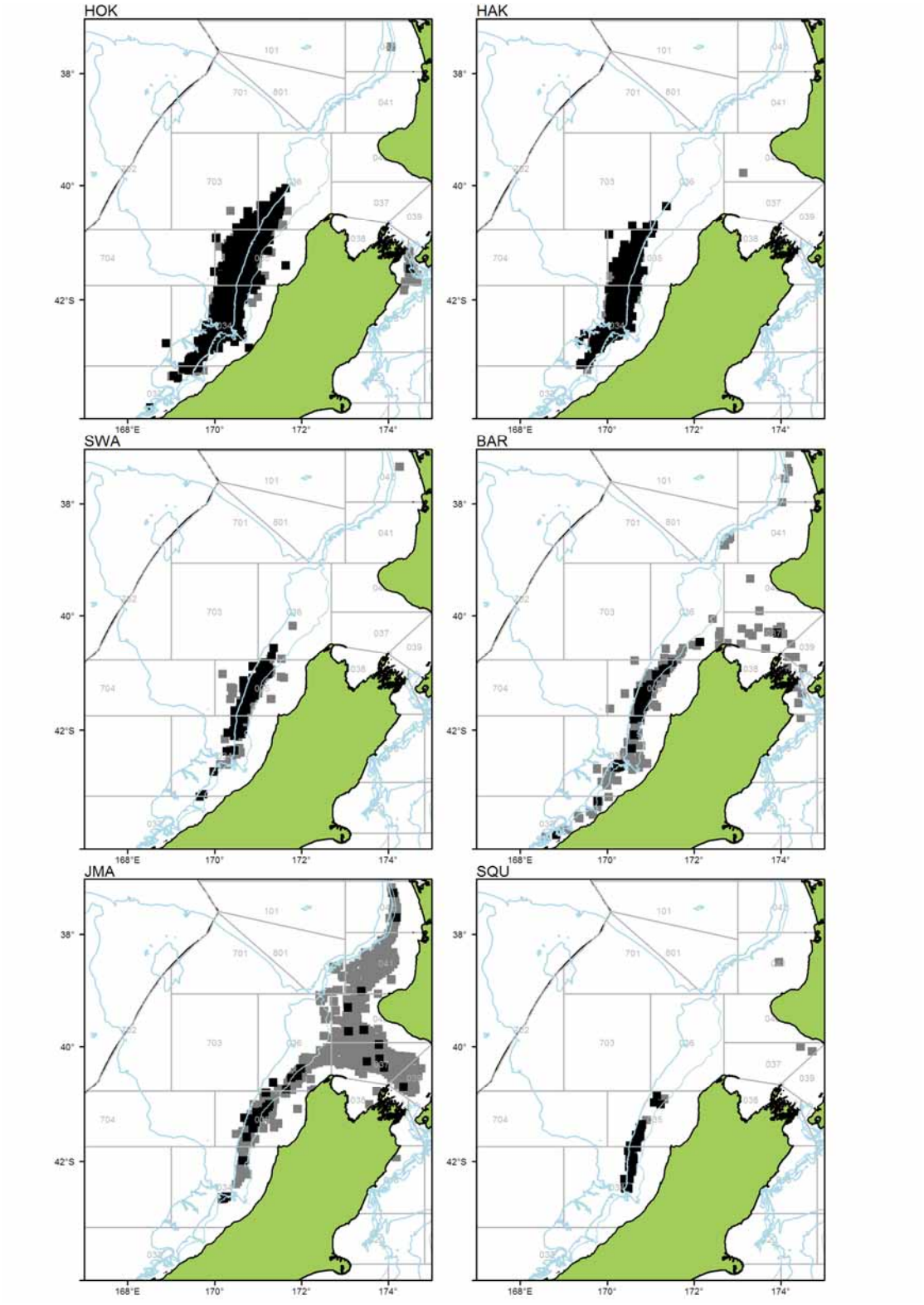


Figure C33: West Coast statistical areas and bathymetry showing the distribution of midwater and bottom trawls by target species (grey) and midwater and bottom trawls by target species in the merged processed data where lookdown dory was caught (black) for the main target species for all years combined. Target species are defined in Table 13.

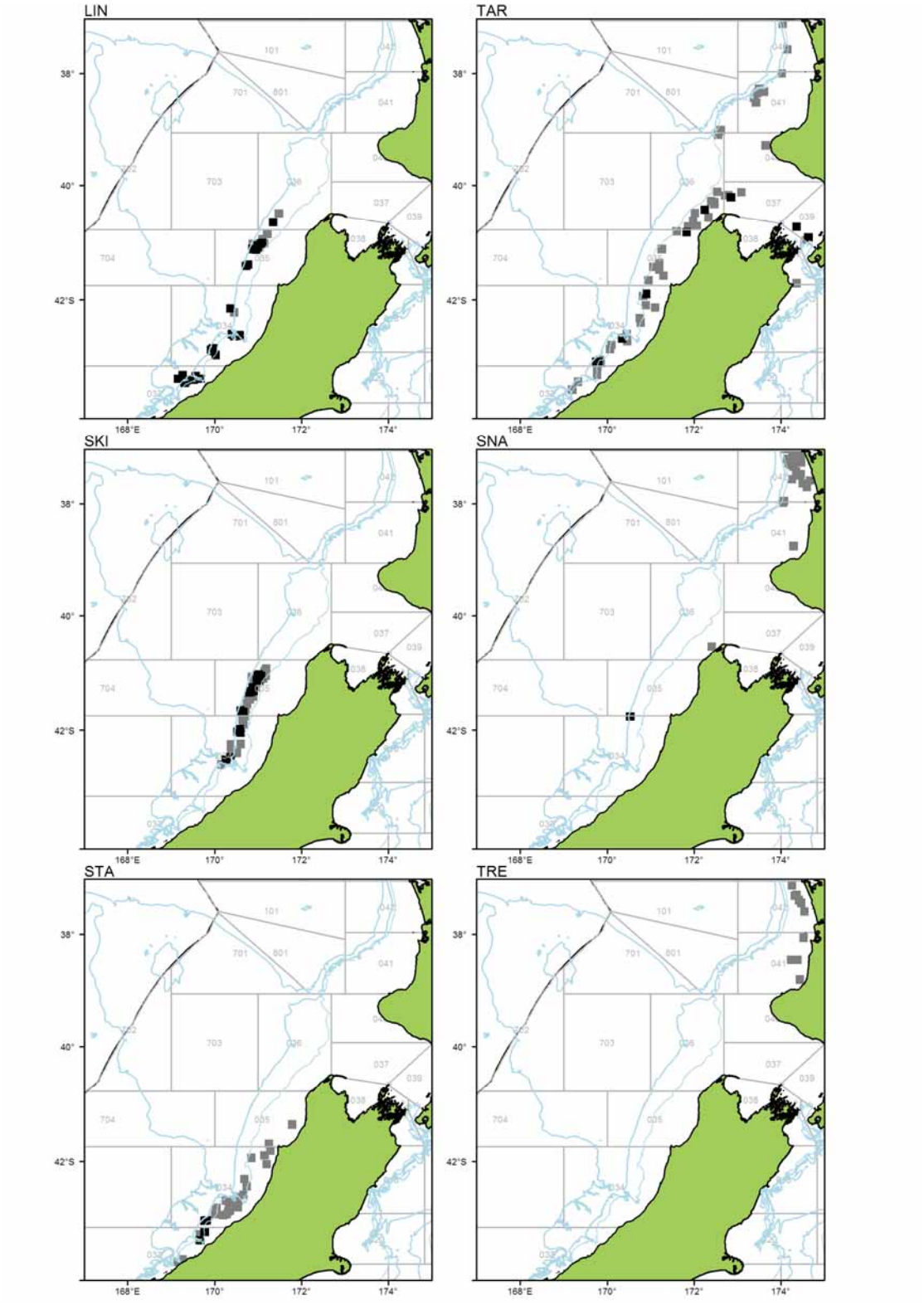


Figure C33: ctd. West Coast statistical areas and bathymetry showing the distribution of midwater and bottom trawls by target species in the merged processed data (grey) and midwater and bottom trawls by target species where lookdown dory was caught (black) for the main target species for all years combined. Target species are defined in Table 13.

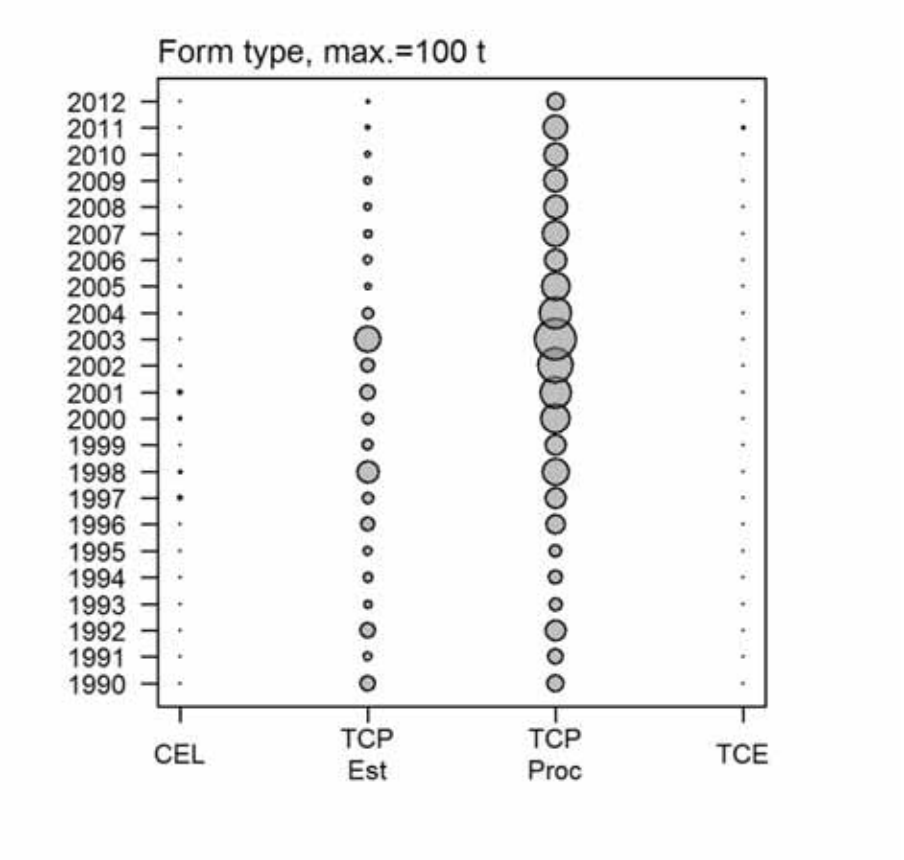


Figure C34a: Distribution of annual catch by month, statistical area, method, and target species for SUBA estimated and merged daily processed data. TCP Est is estimated data from the Trawl, Catch, Effort, and Processing Return; TCP Proc is daily processed data from the Trawl, Catch, Effort, and Processing Return; TCE is Trawl, Catch, Effort Return. Circle size is proportional to catch; maximum circle size is indicated on each plot.

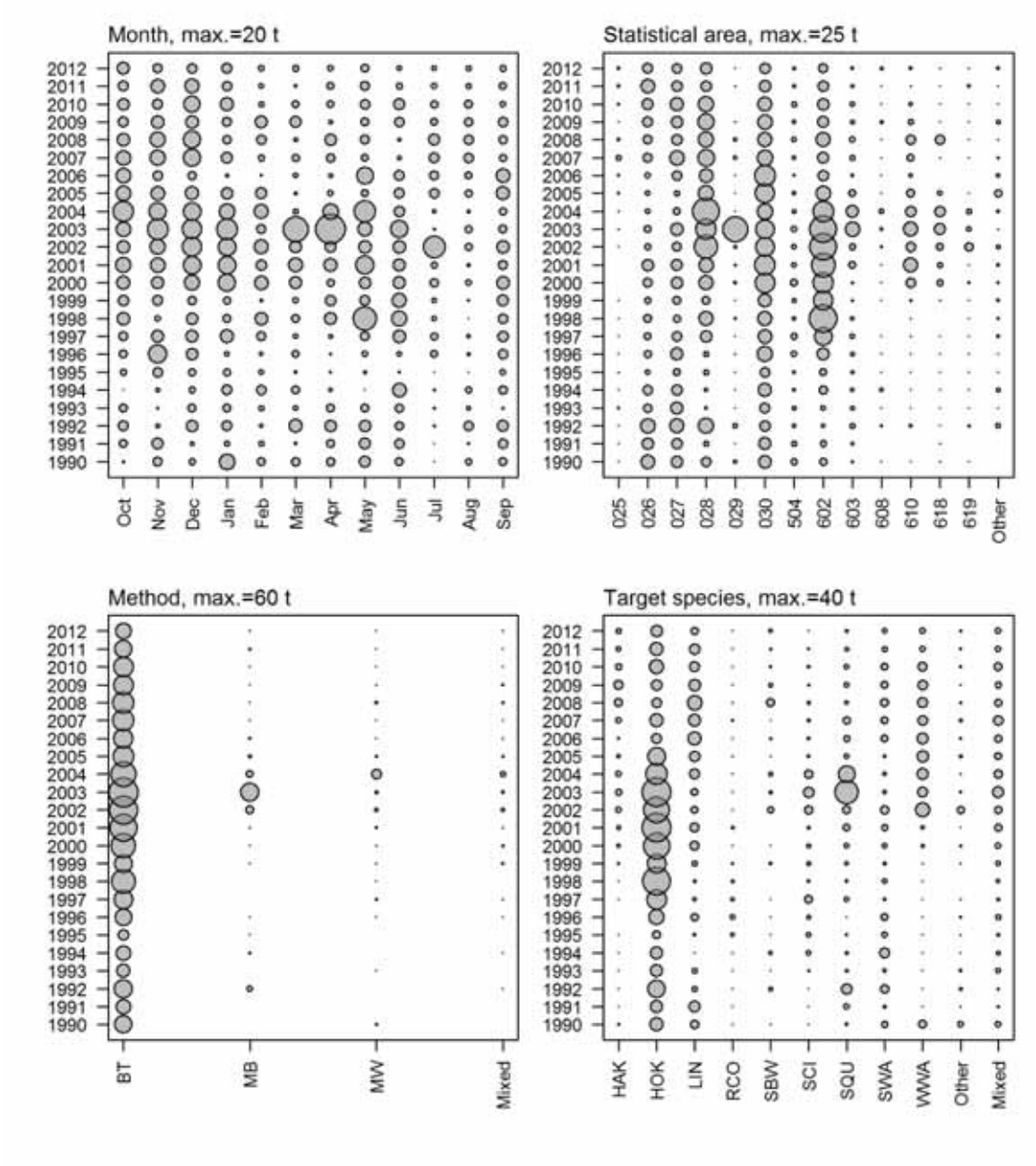


Figure C34b: Distribution of annual catch by month, statistical area, method, and target species for SUBA merged daily processed data. Circle size is proportional to catch; maximum circle size is indicated on each plot. Statistical areas are shown in Figure 1. BT is bottom trawl; MB is midwater trawl within 5 m of the seabed; MW is midwater trawl; Mixed is a mix of bottom and midwater tows. Target species codes are defined in Table C13.

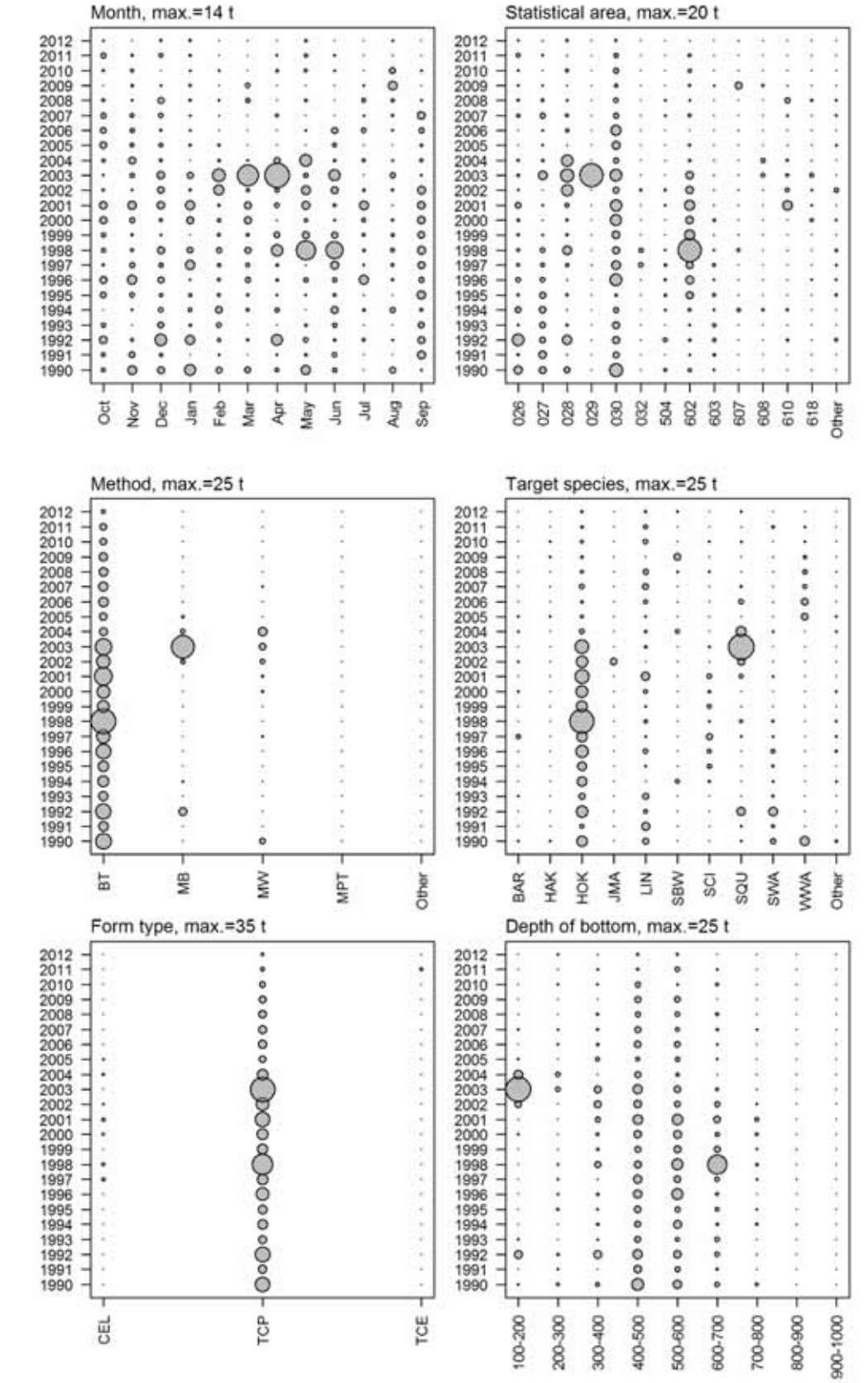


Figure C34c: Distribution of estimated TCEPR (TCP), TCER (TCE), and CELR (CEL) annual catch by month, statistical area, method, and target species for SUBA. Circle size is proportional to catch; maximum circle size is indicated on each plot. Statistical areas are shown in Figure 1. BT is bottom trawl; MB is midwater trawl within 5 m of the seabed; MW is midwater trawl; Mixed is a mix of bottom and midwater tows. Target species codes are defined in Table C13.

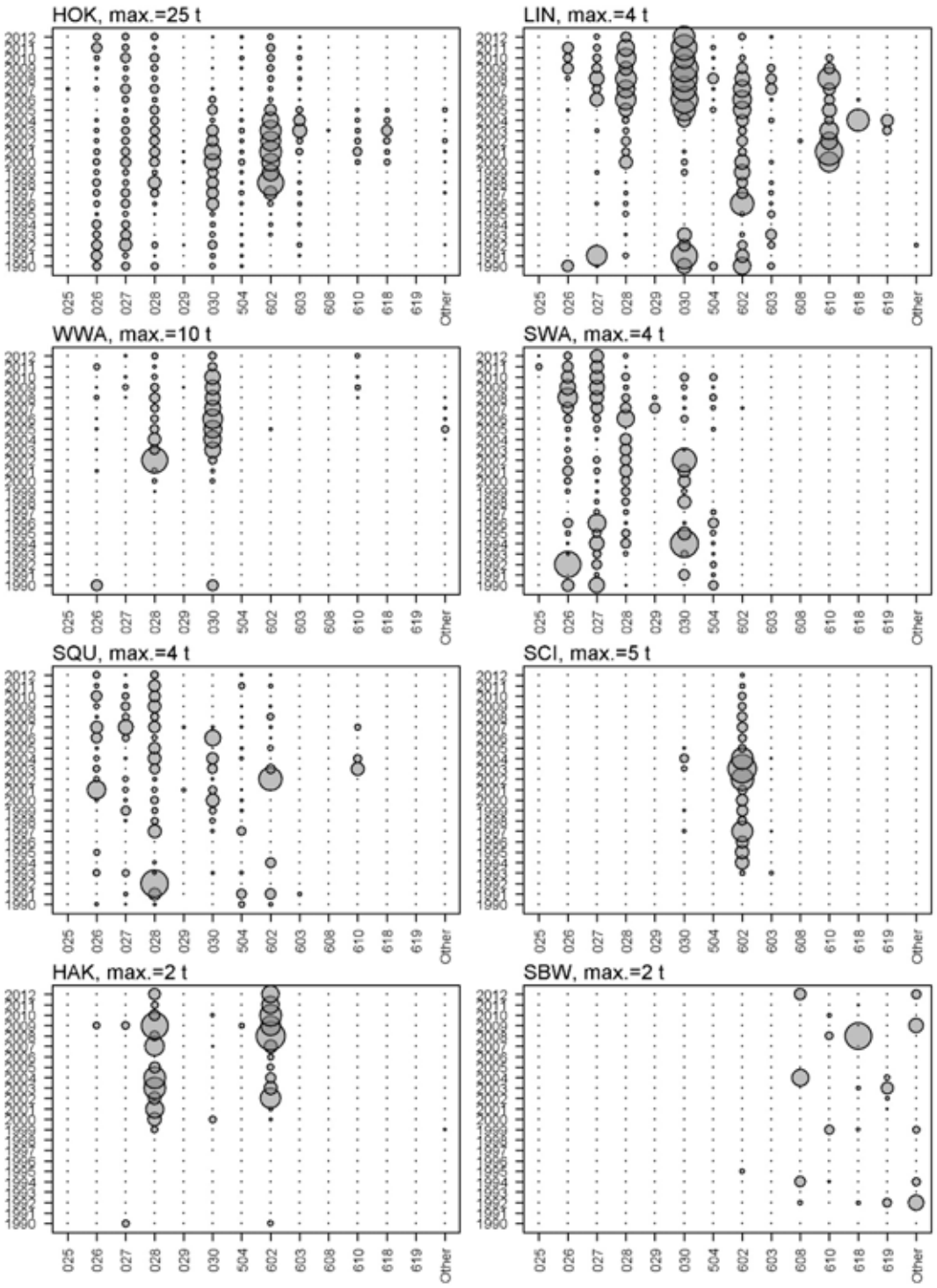


Figure C35: Distribution of lookdown dory annual catch (t) by statistical area for SUBA for merged daily processed data by main target species for all TCEPR bottom trawl tows. Circle size is proportional to catch; maximum circle size is indicated on the top left hand corner of each plot.

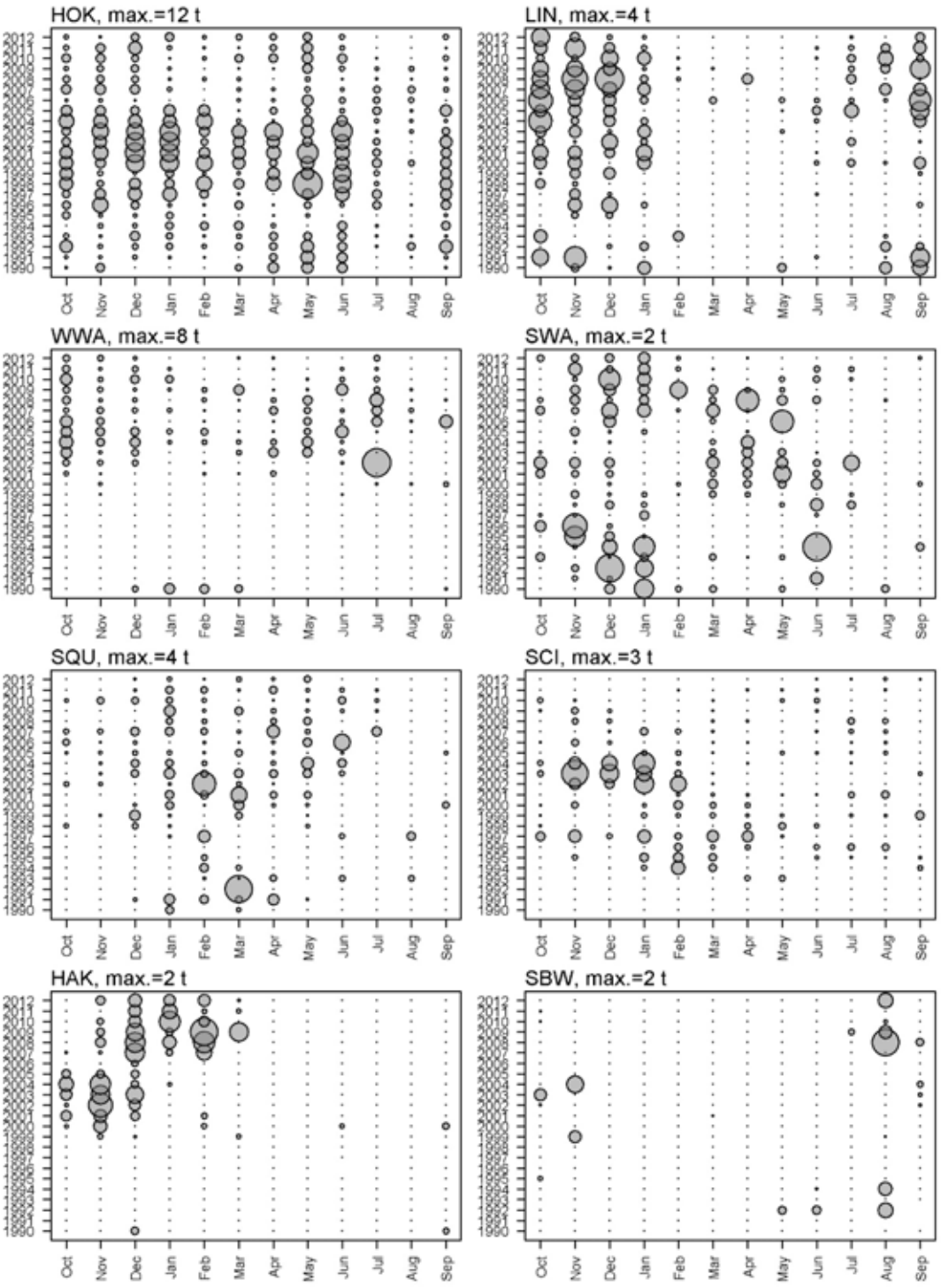


Figure C36: Distribution of lookdown dory annual catch (t) by month for SUBA merged data by main target species for all TCEPR bottom trawl tows. Circle size is proportional to catch; maximum circle size is indicated on the top left hand corner of each plot. Target species codes are defined in Table C13.

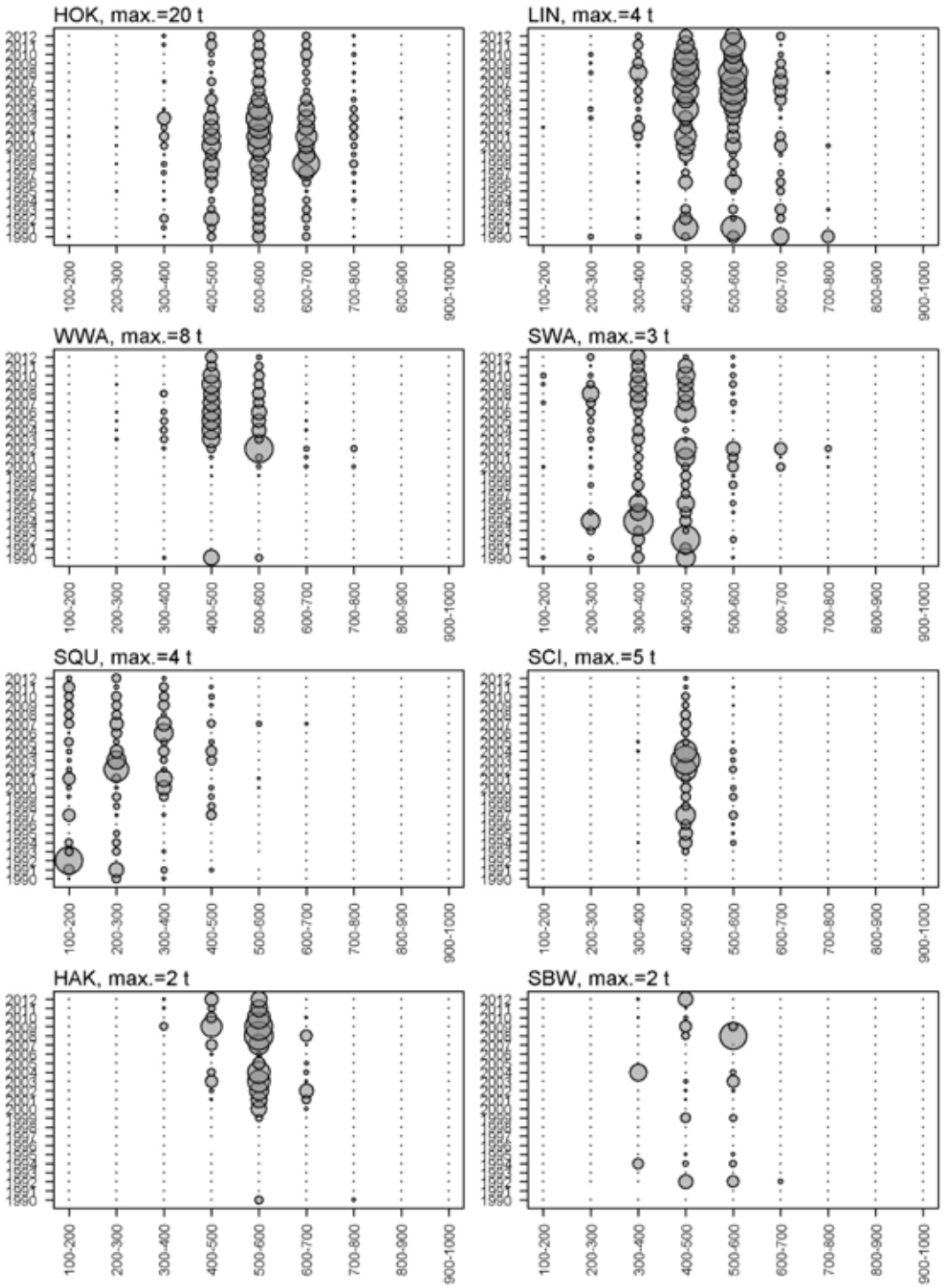


Figure C37: Distribution of lookdown dory annual catch (t) by mean depth for SUBA merged TCEPR daily processed data by main target species for all TCEPR bottom trawl tows. Circle size is proportional to catch; maximum circle size is indicated on the top left hand corner of each plot. Target species codes are defined in Table C13.

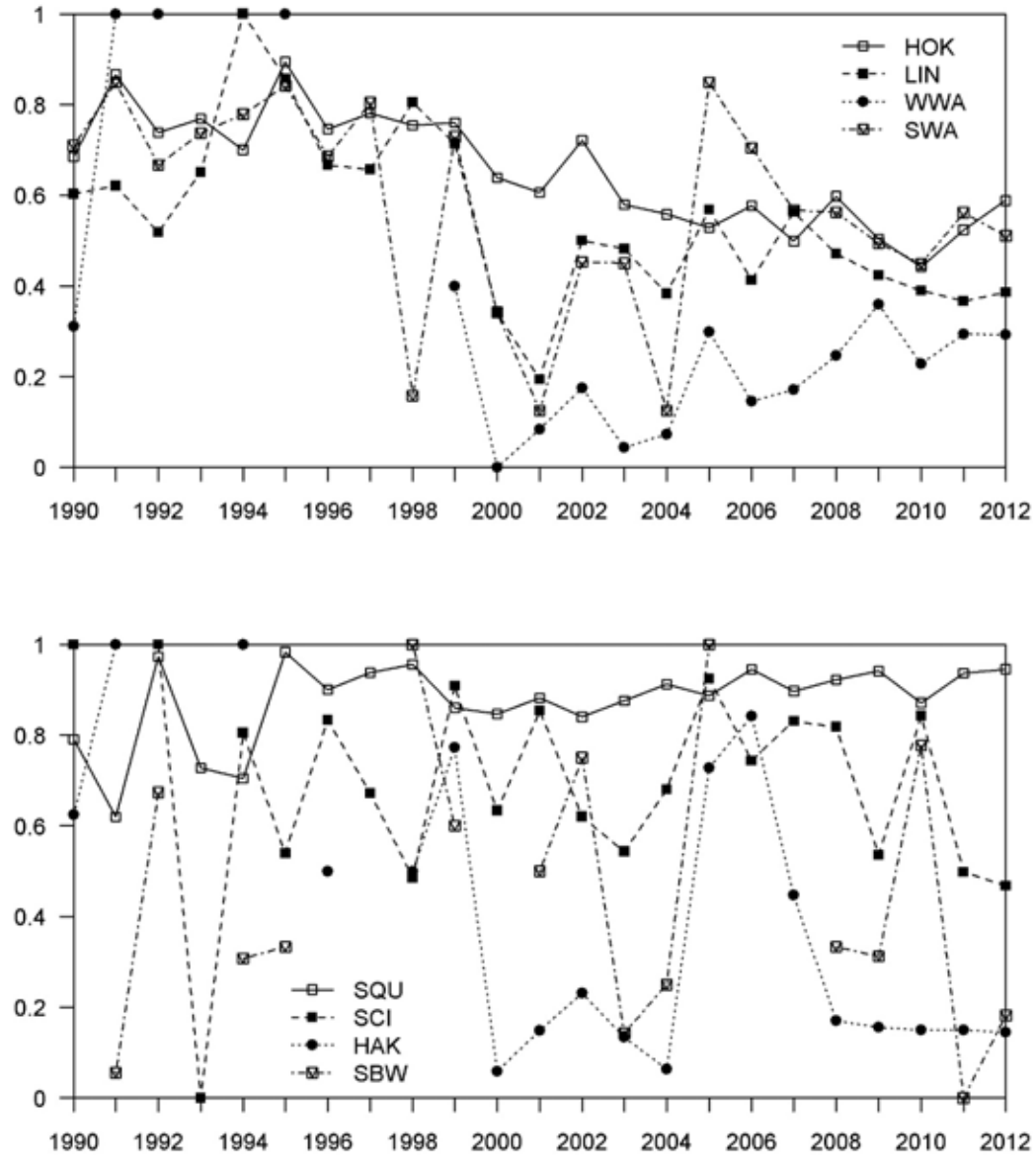


Figure C38: Proportion of zeros in merged daily processed data by main target species in the SUBA region. Target species codes are defined in Table C13.

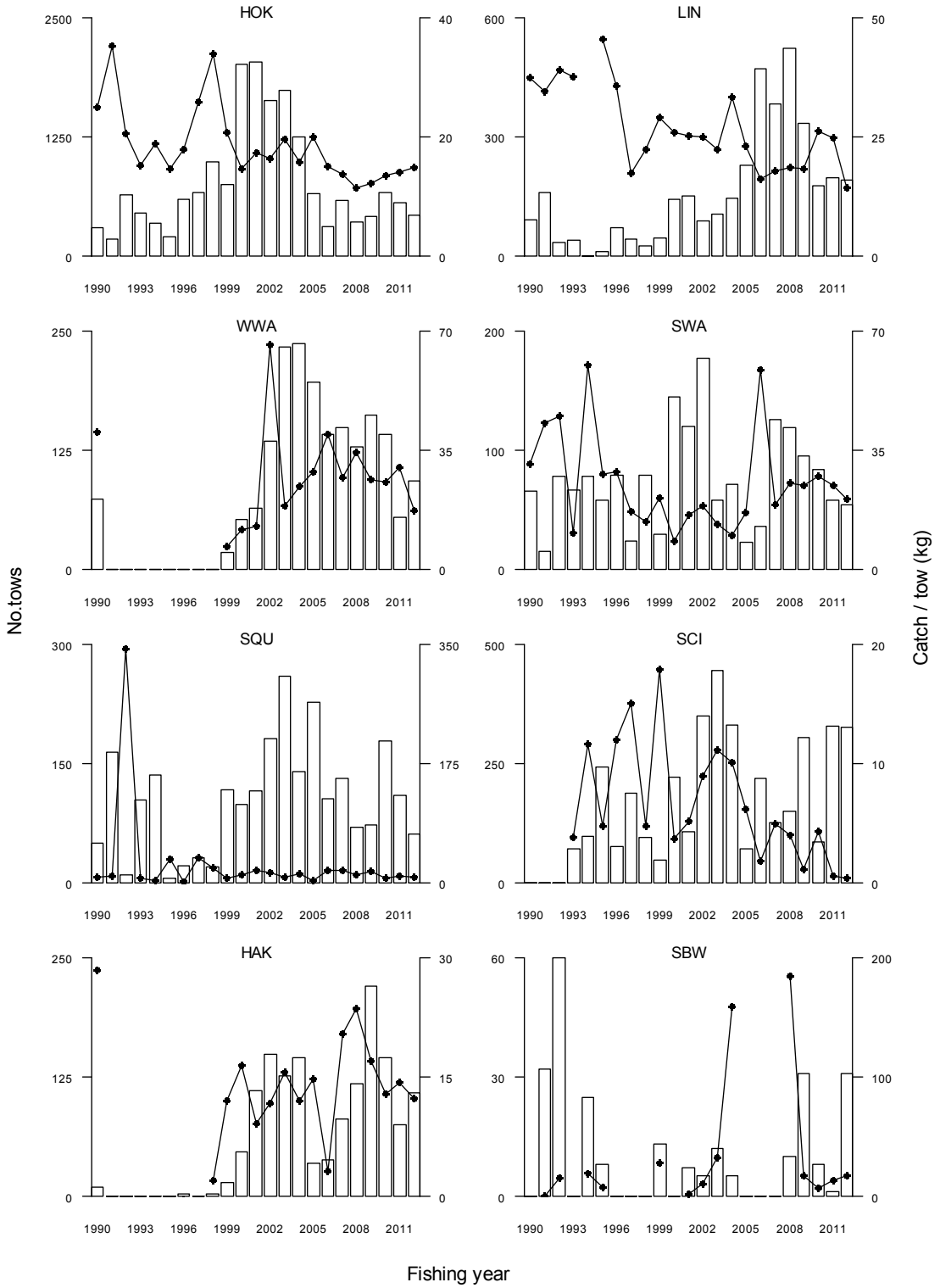


Figure C39: Unstandardised catch rate of LDO by main target species (kg/tow) and the number of tows for the SUBA region taken by bottom trawl gear. Target species codes are defined in Table C13.

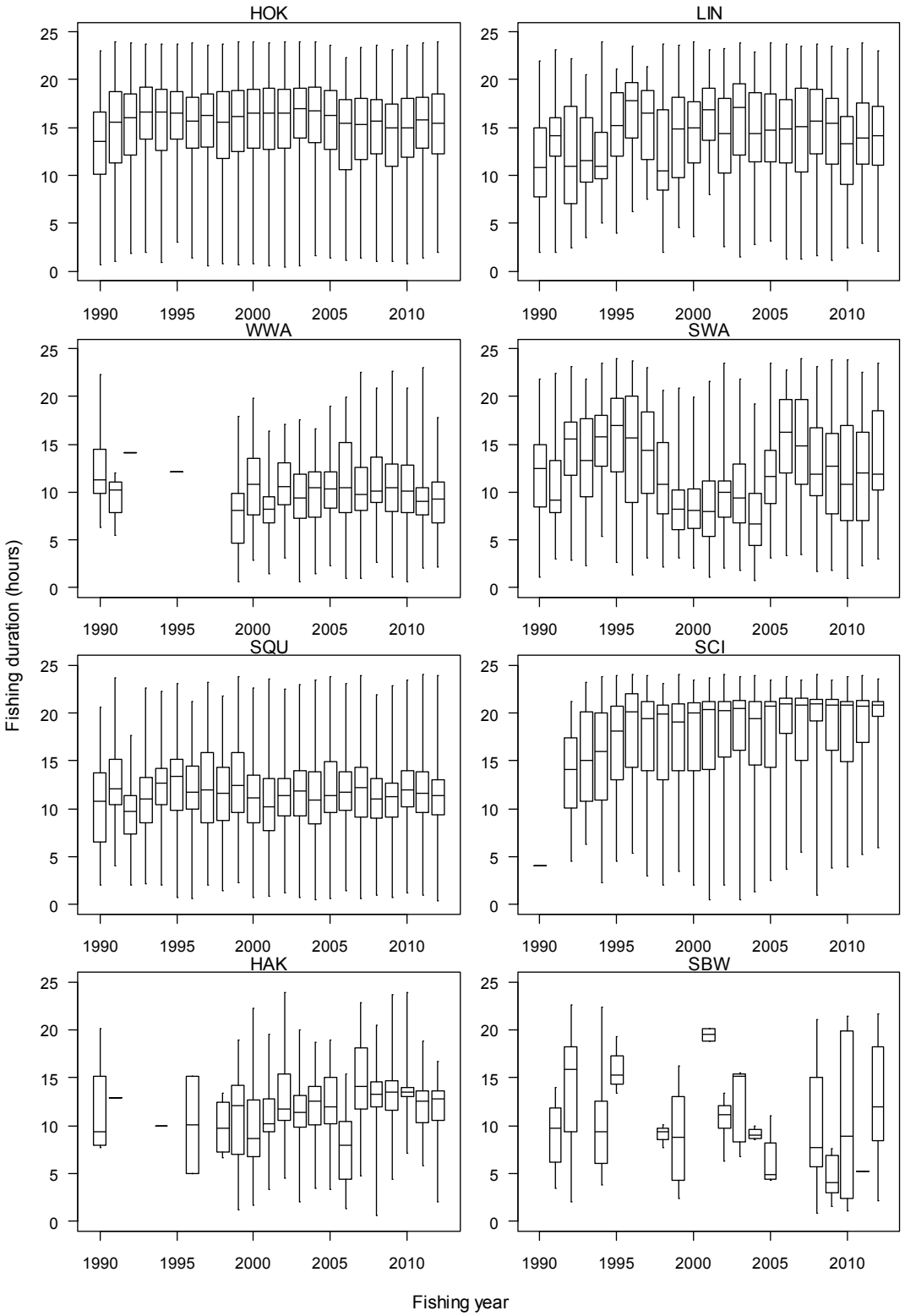


Figure C40: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) for summed daily tow durations (hours) reported by main target species of tows capturing lookdown dory in the SUBA region using bottom trawl gear. Target species codes are defined in Table C13.

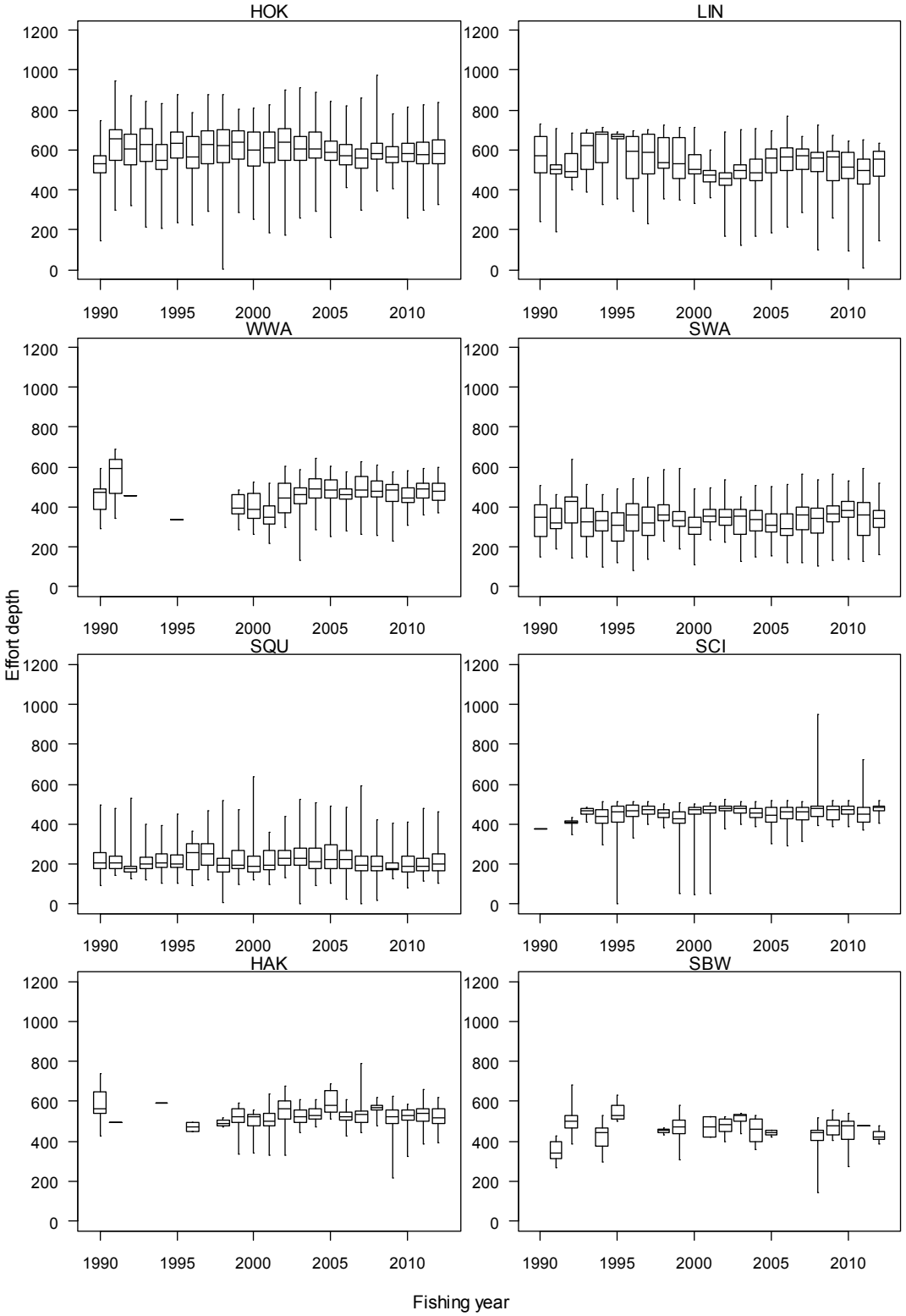


Figure C41: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) for depths (m) fished by main target species of tows capturing lookdown dory in the SUBA region using bottom trawling. Target species codes are defined in Table C13.

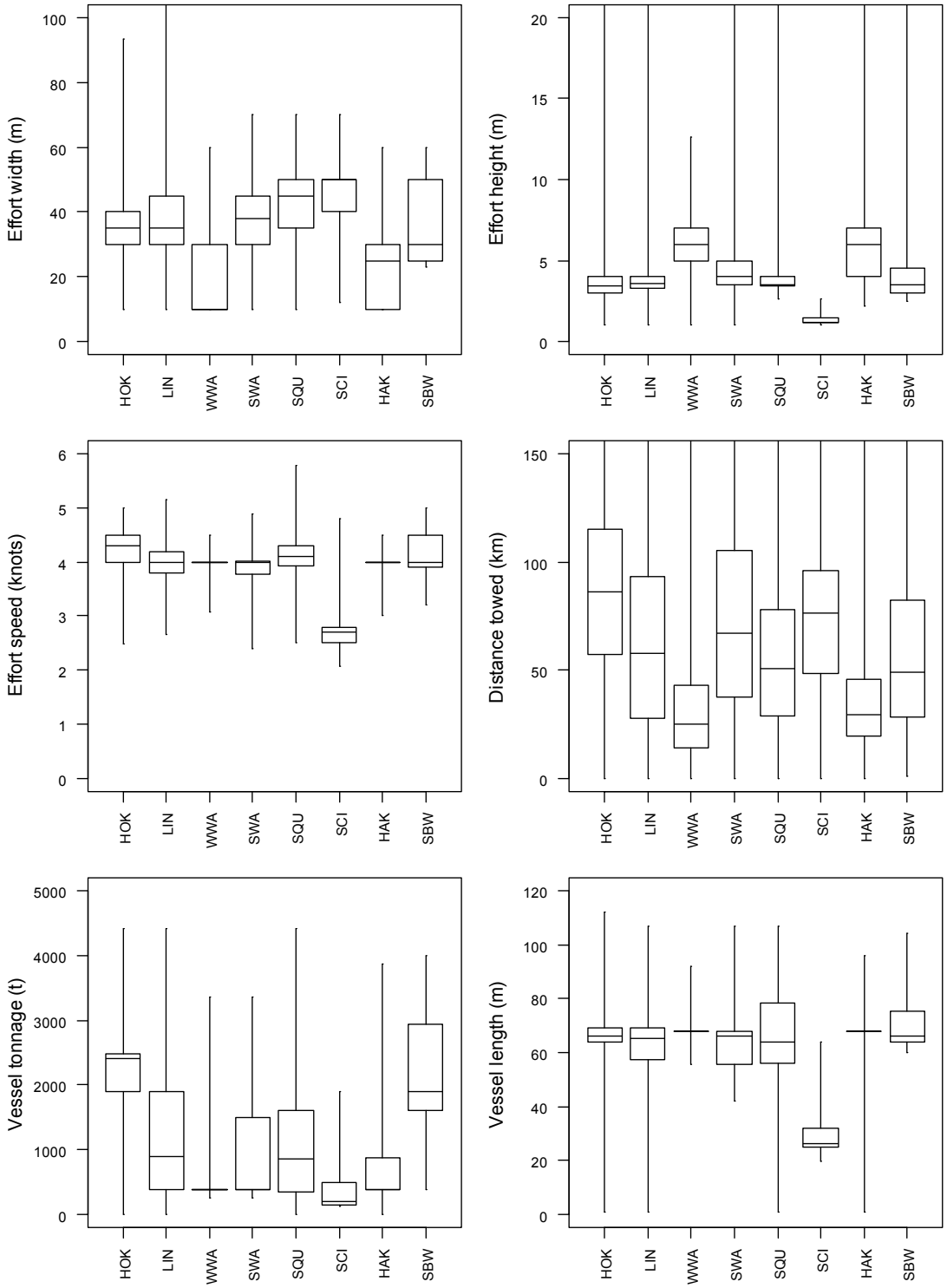


Figure C42: Median (horizontal line), inter-quartile ranges (box), and range (vertical lines) distribution of fishing effort variables and vessel characteristics for the SUBA area by main target species of tows catching lookdown dory using bottom trawl gear. Target species codes are defined in Table C13.

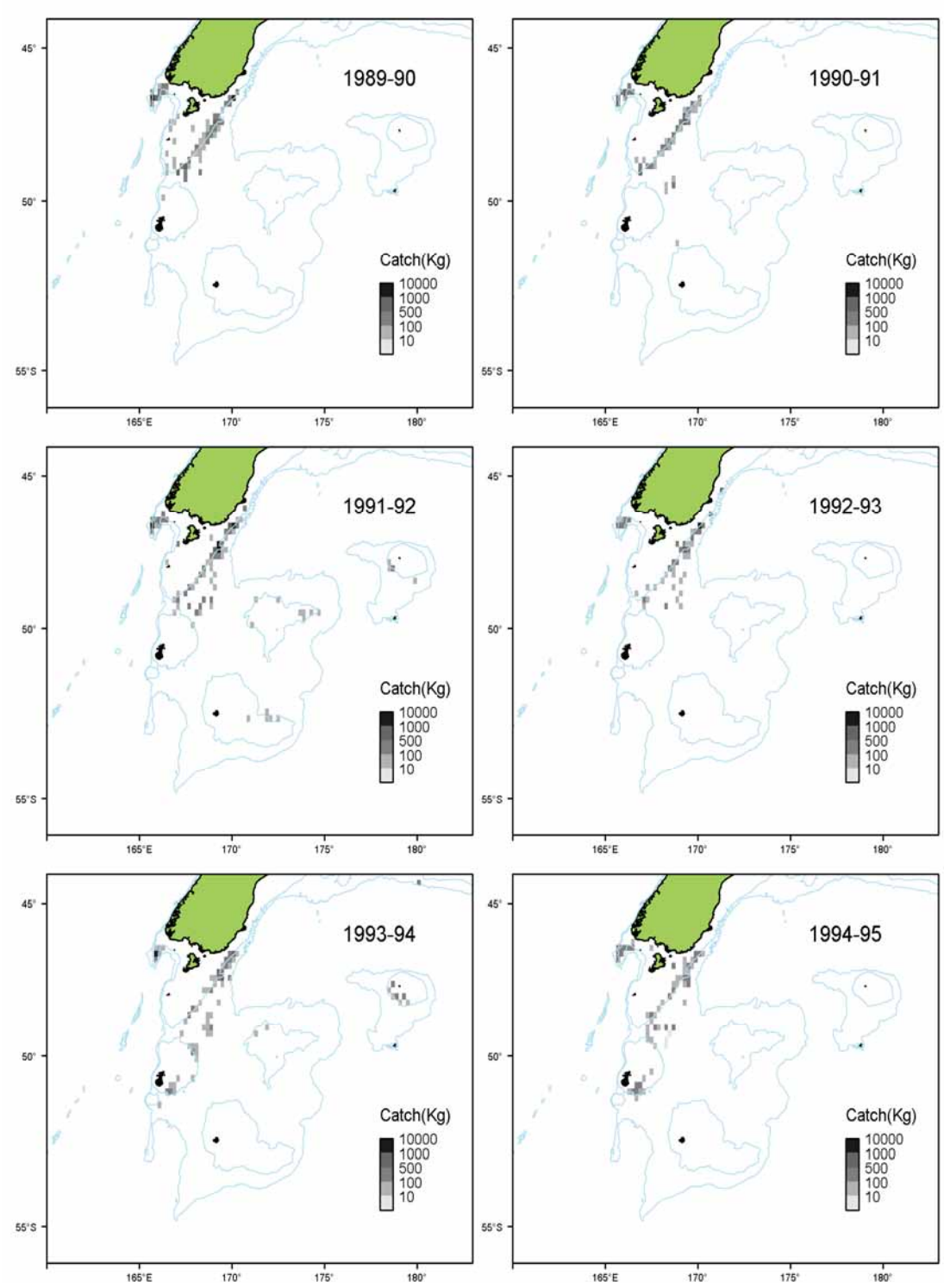


Figure C43: Distribution of lookdown dory catch taken by bottom trawl gear within the SUBA region aggregated into 0.2 degree spatial blocks for fishing years 1990–1995 for tows on the TCEPR form.

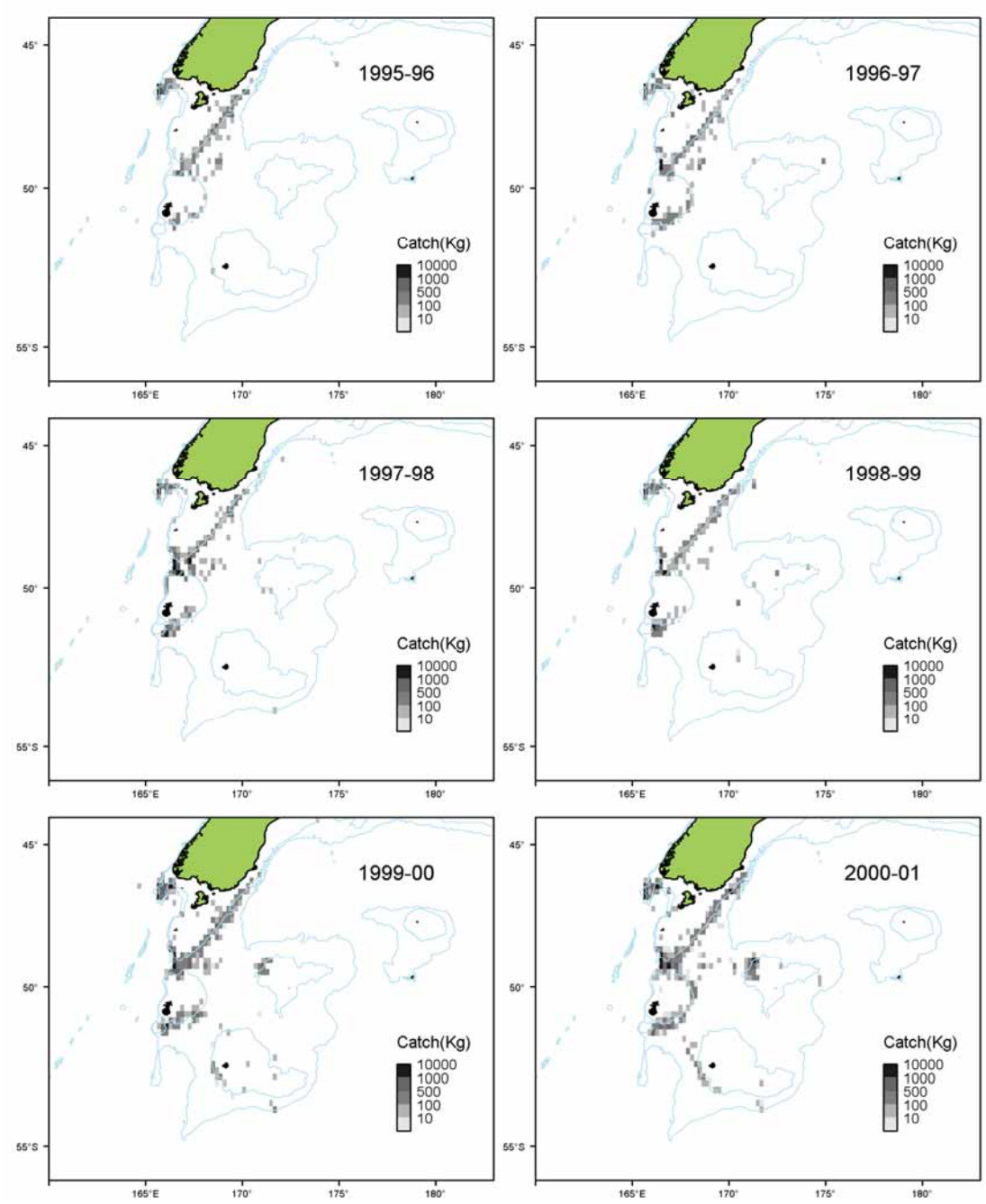


Figure C43: ctd. Distribution of lookdown dory catch taken by bottom trawl gear within the SUBA region aggregated into 0.2 degree spatial blocks for fishing years 1996–2001 for tows on the TCEPR form.

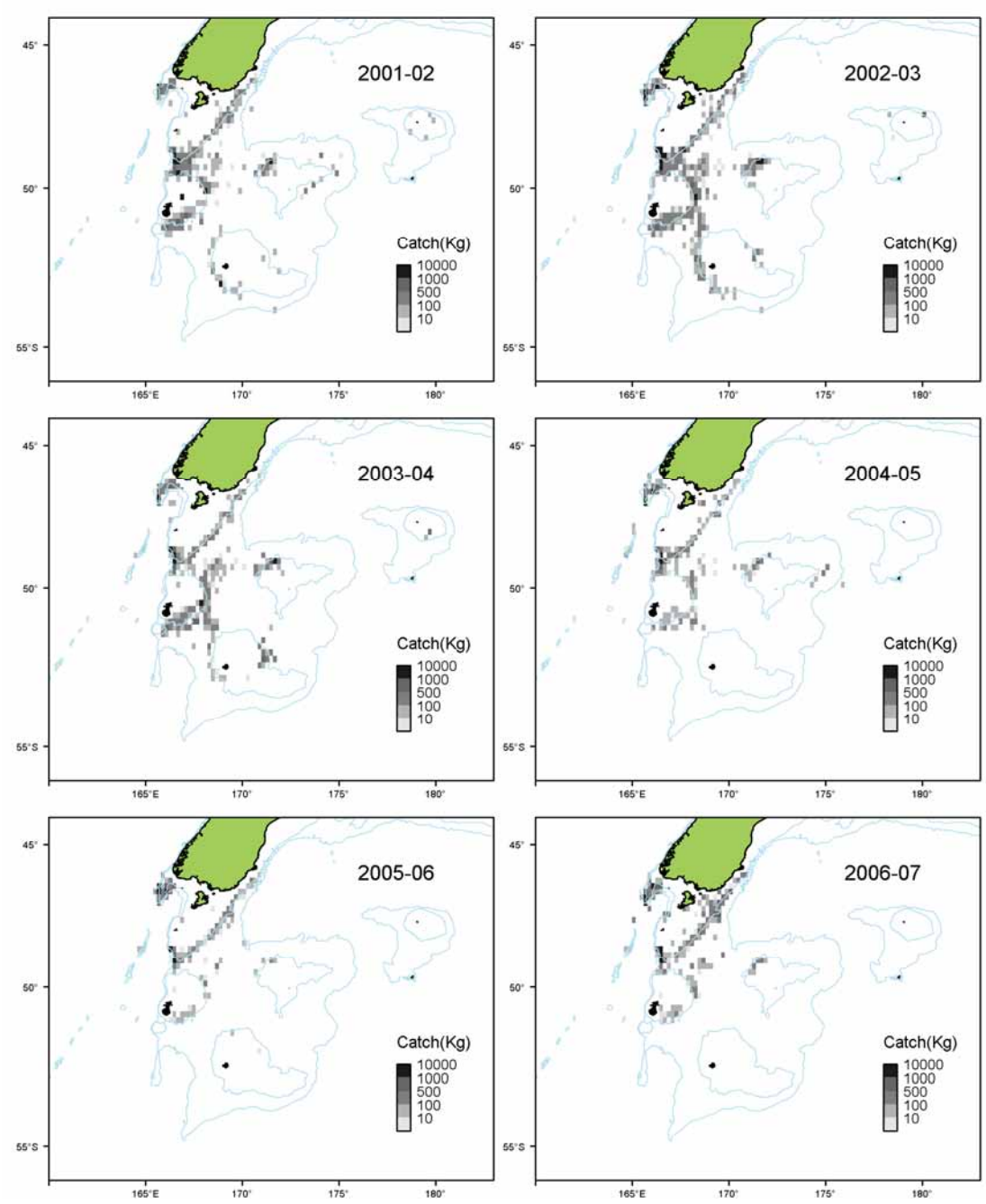


Figure C43: ctd. Distribution of lookdown dory catch taken by bottom trawl gear within the ECNI region aggregated into 0.2 degree spatial blocks for fishing years 2002–2007 for tows on the TCEPR form.

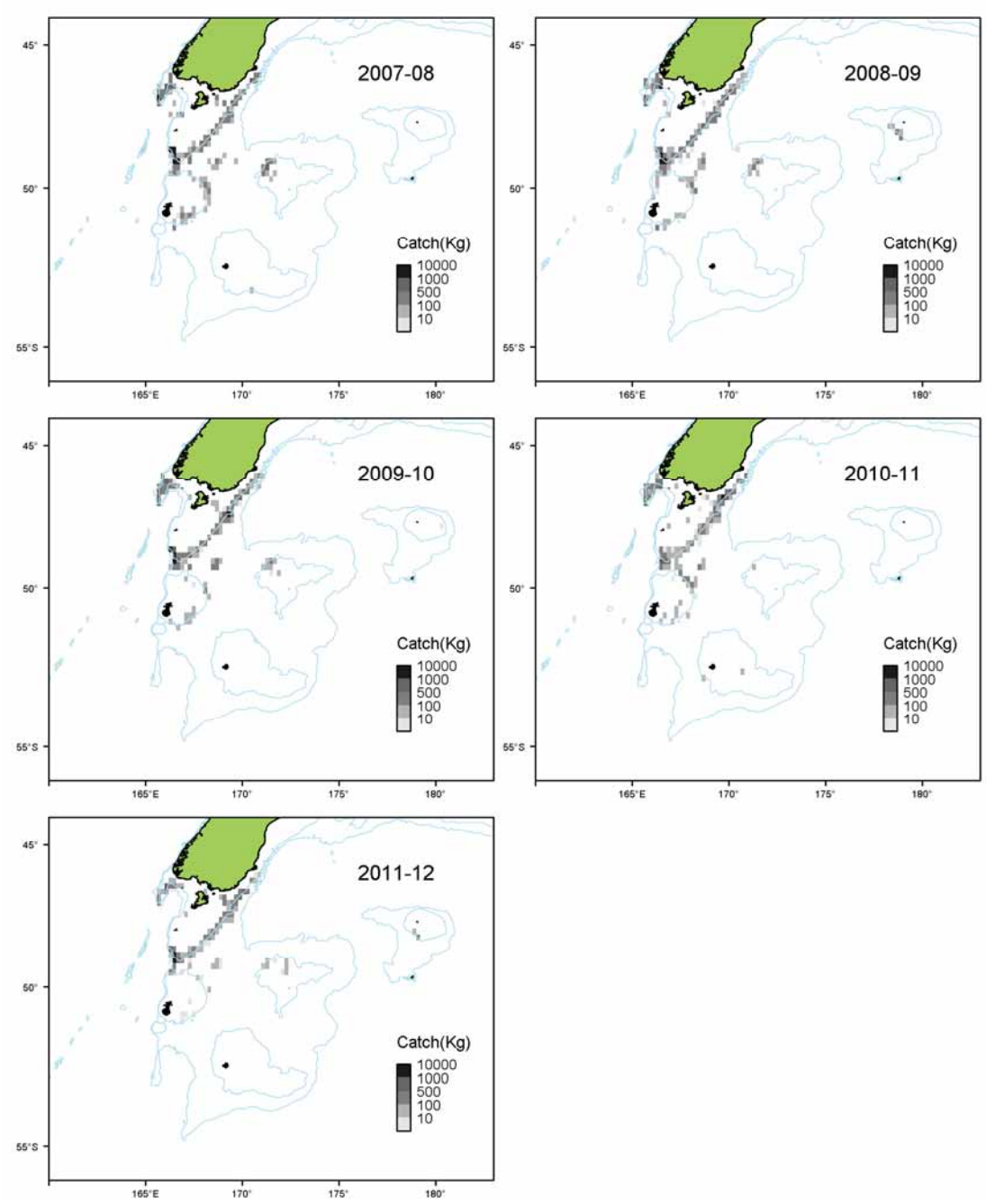


Figure C43: ctd. Distribution of lookdown dory catch taken by bottom trawl gear within the SUBA region aggregated into 0.2 degree spatial blocks for fishing years 2008–2012 for tows on the TCEPR form.

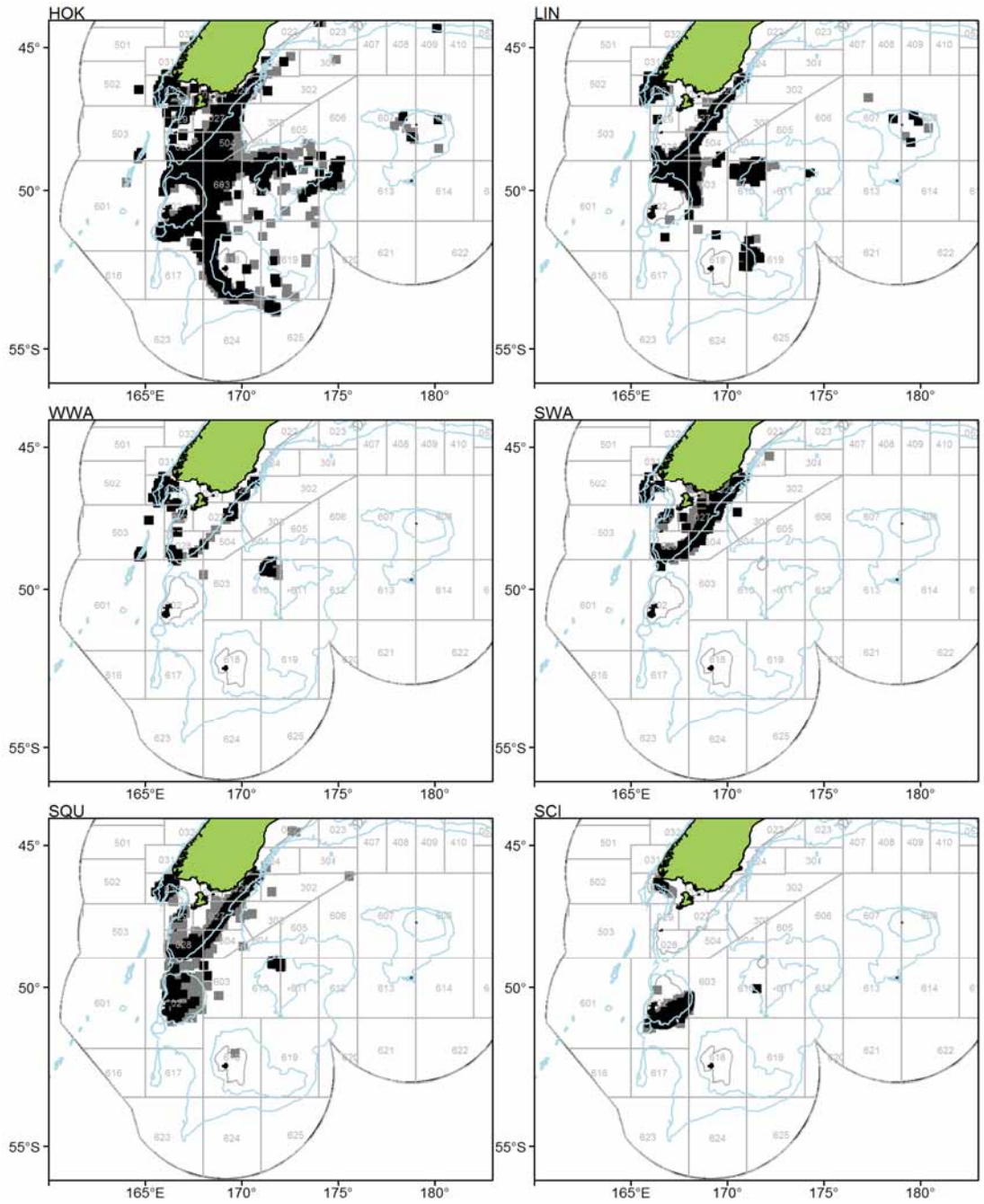


Figure C44: SUBA statistical areas and bathymetry showing the distribution of bottom trawls by target species in the merged processed data (grey) and bottom trawls by target species where lookdown dory was caught (black) for the main target species for all years combined. Target species are defined in Table 13.

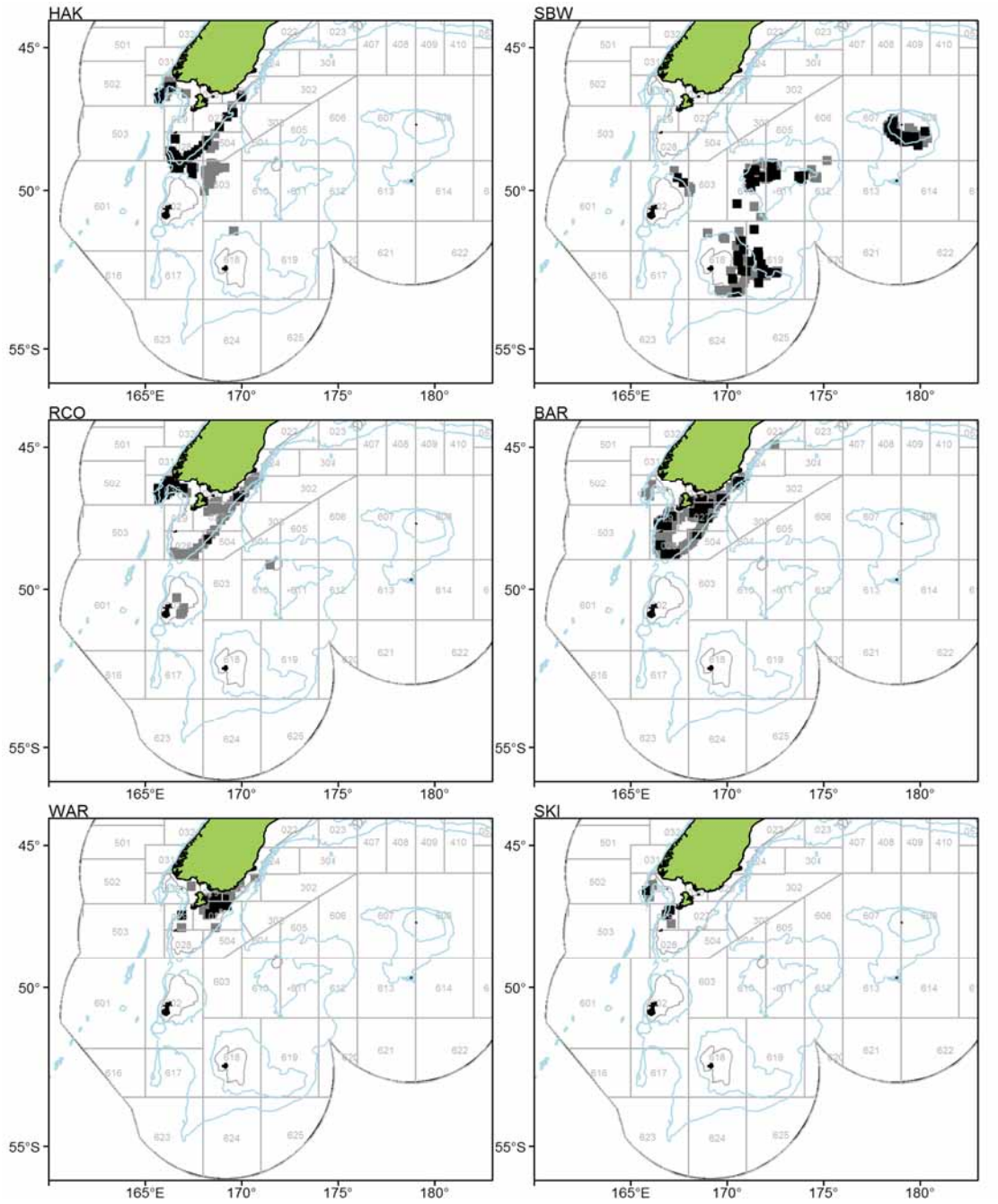


Figure C44: ctd. SUBA statistical areas and bathymetry showing the distribution of bottom trawls by target species in the merged processed data (grey) and bottom trawls by target species where lookdown dory was caught (black) for the main target species for all years combined. Target species are defined in Table 13.

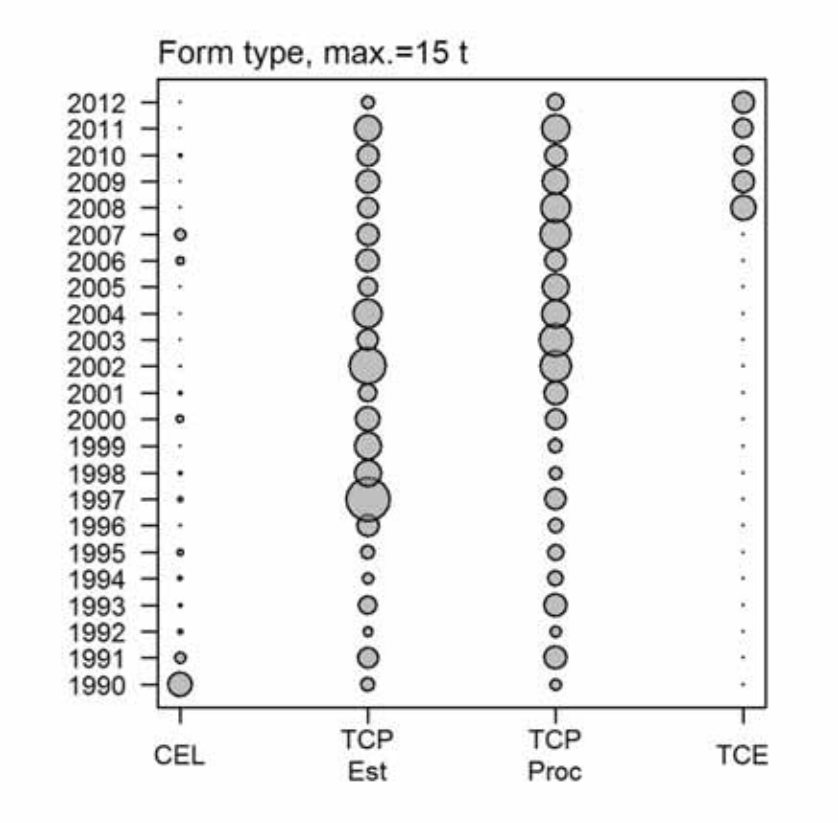


Figure C45a: Distribution of annual catch form type for ECNI estimated and merged daily processed data. TCP Est is estimated data from the Trawl, Catch, Effort, and Processing Return; TCP Proc is daily processed data from the Trawl, Catch, Effort, and Processing Return; TCE is Trawl, Catch, Effort Return. Circle size is proportional to catch; maximum circle size is indicated on each plot.

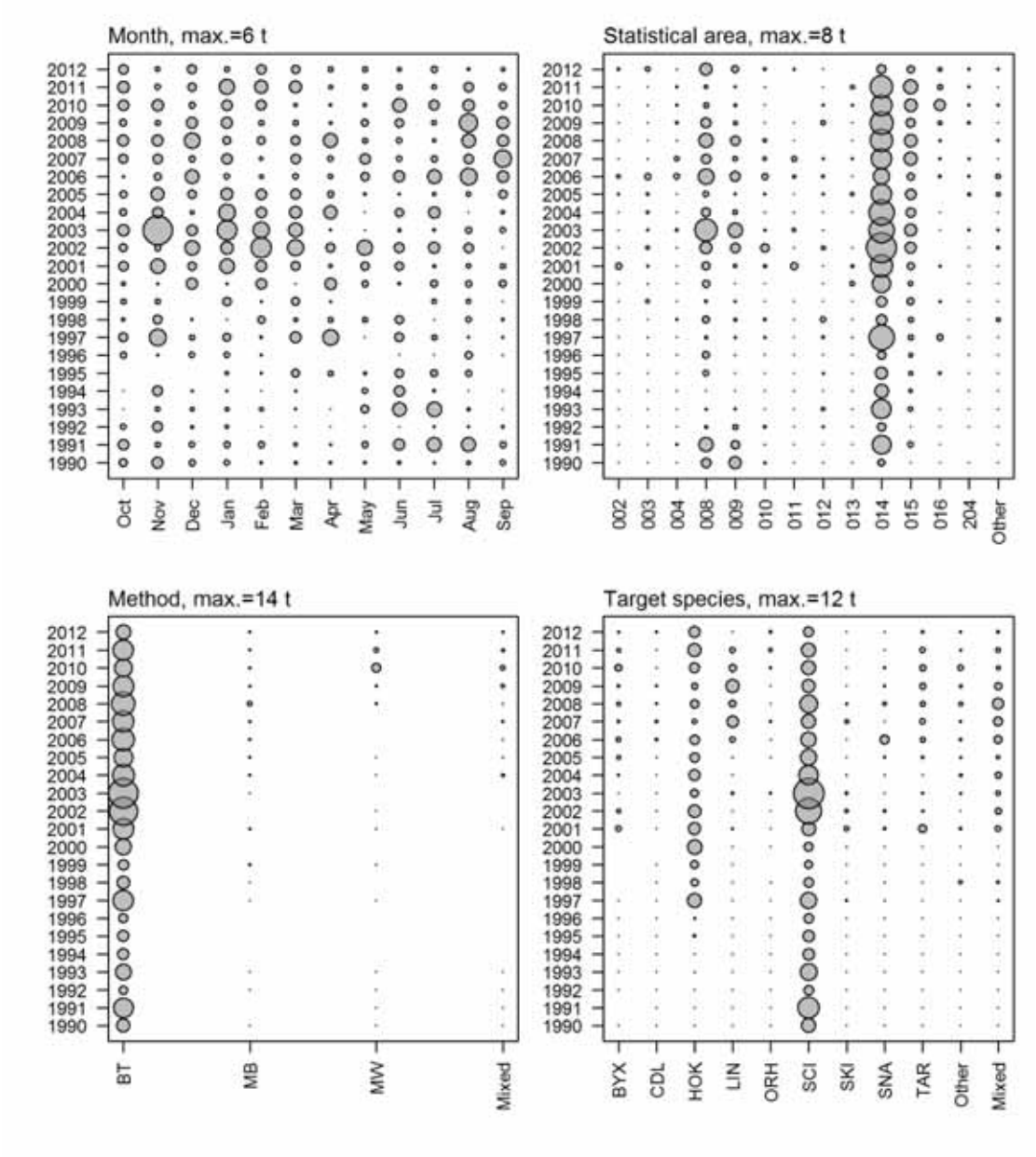


Figure C45b: Distribution of annual merged daily processed catch by month, statistical area, method, and target species for ECNI. Circle size is proportional to catch; maximum circle size is indicated on each plot. Statistical areas are shown in Figure 1. BT is bottom trawl; MB is midwater trawl within 5 m of the seabed; MW is midwater trawl; Mixed is a mix of bottom and midwater tows. Target species codes are defined in Table C13.

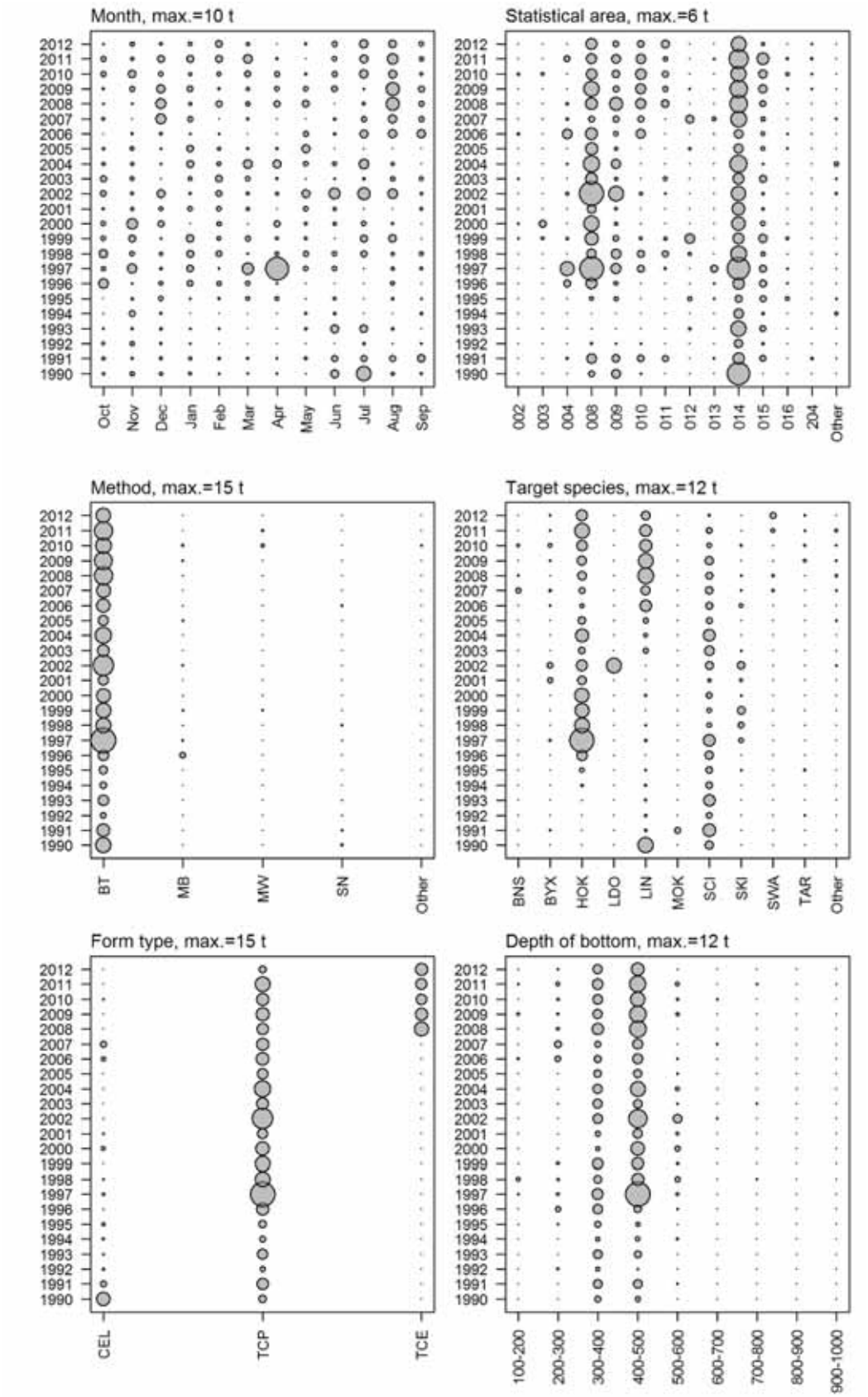


Figure C45c: Distribution of annual estimated TCEPR (TCP), TCER (TCE), and CELR (CEL) catch by month, statistical area, method, and target species for ECNI. Circle size is proportional to catch; maximum circle size is indicated on each plot. Statistical areas are shown in Figure 1. BT is bottom trawl; MB is midwater trawl within 5 m of the seabed; MW is midwater trawl; Mixed is a mix of bottom and midwater tows. Target species codes are defined in Table C13.

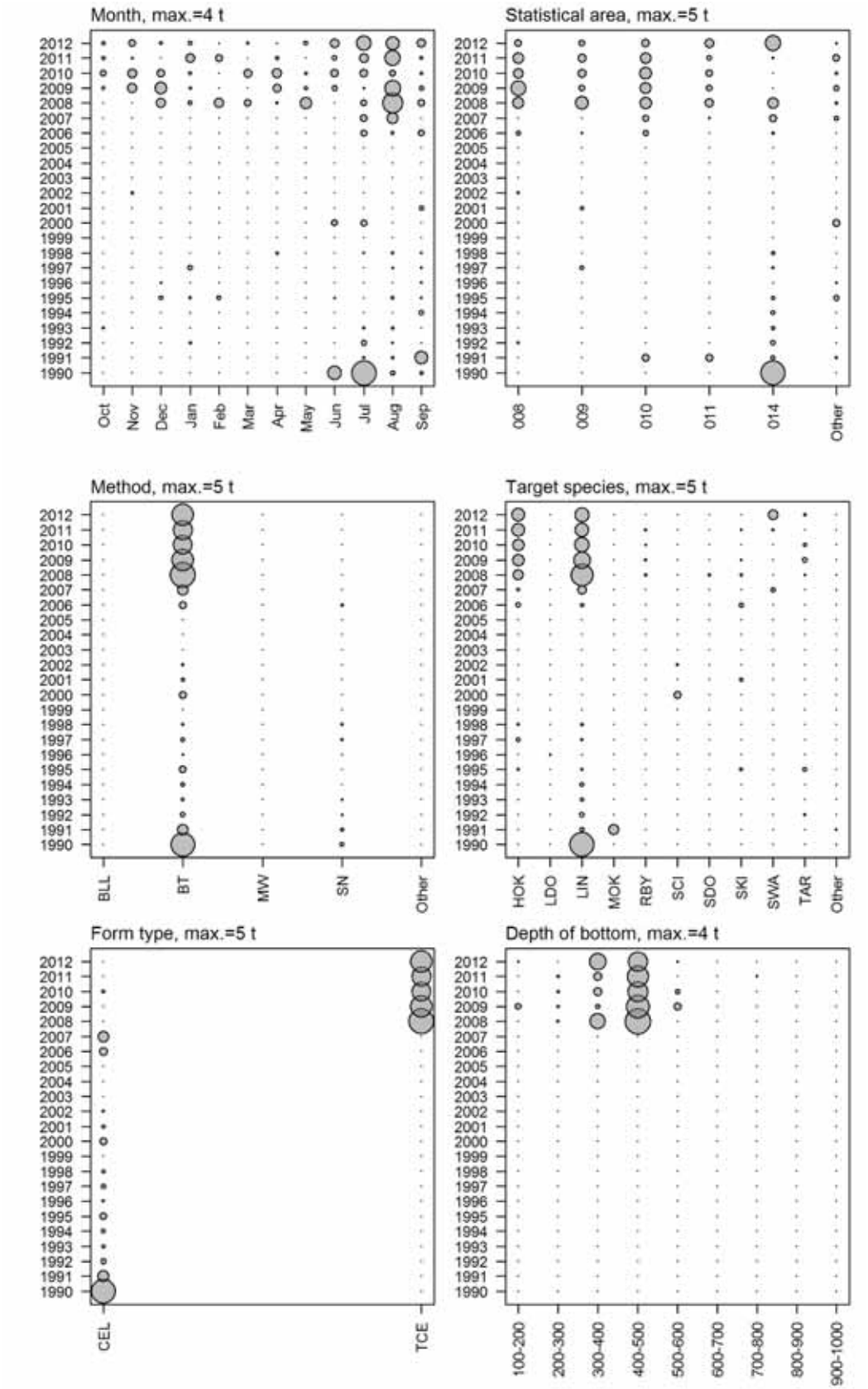


Figure C45d: Distribution of annual estimated CELR (CELR) and TCER (TCE) catch by month, statistical area, method, and target species for ECNI. Circle size is proportional to catch; maximum circle size is indicated on each plot. Statistical areas are shown in Figure 1. BT is bottom trawl; MB is midwater trawl within 5 m of the seabed; MW is midwater trawl; Mixed is a mix of bottom and midwater tows. Target species codes are defined in Table C13.

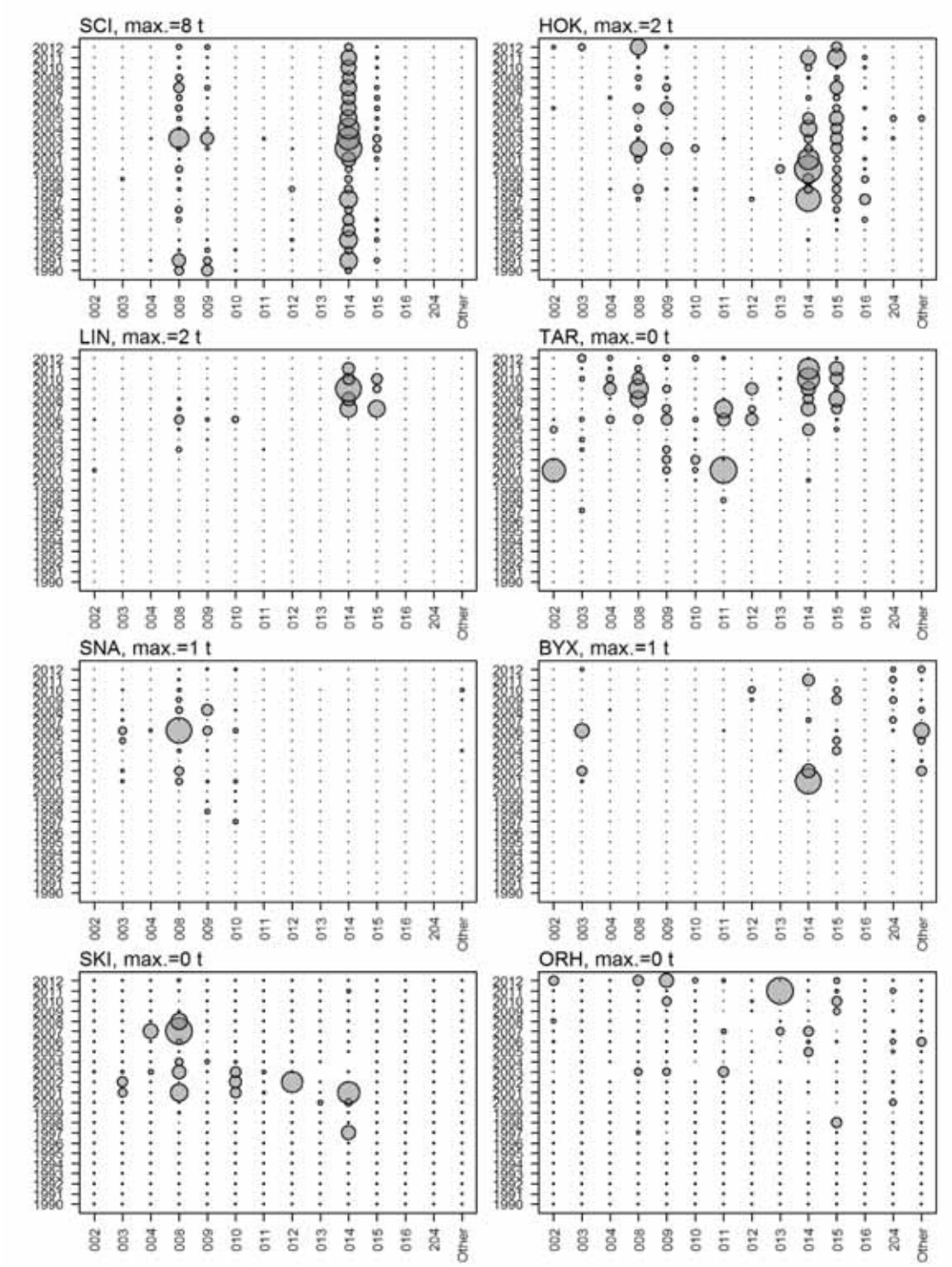


Figure C46: Distribution of lookdown dory annual catch (t) by month for ECNI merged daily processed data by main target species for all TCEPR bottom trawl tows. Circle size is proportional to catch; maximum circle size is indicated on the top left hand corner of each plot. Statistical areas are shown in Figure 1 and target species codes are defined in Table C13.

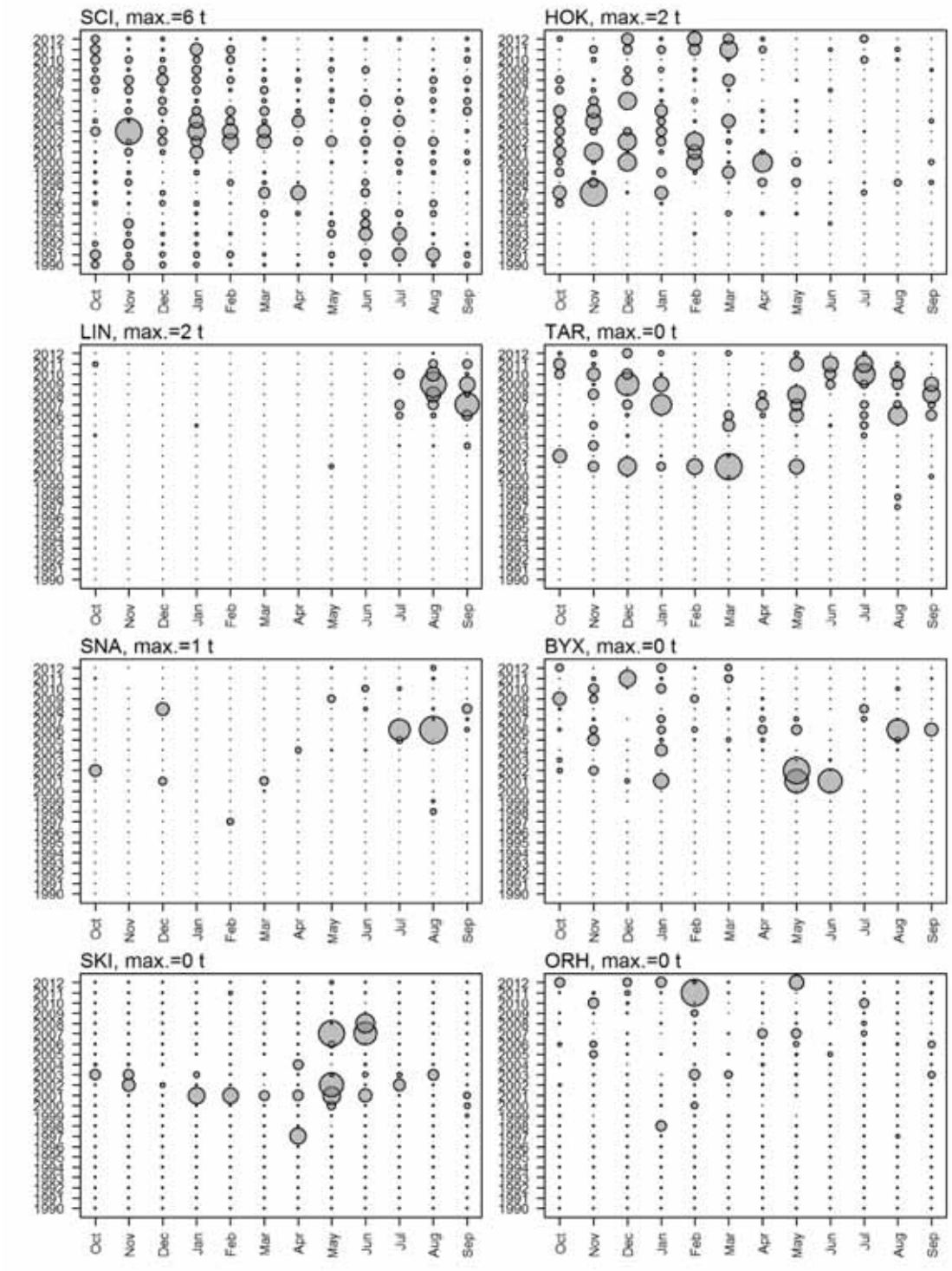


Figure C47: Distribution of lookdown dory annual catch (t) by month for ECNI merged data by main target species for all TCEPR bottom trawl tows. Circle size is proportional to catch; maximum circle size is indicated on the top left hand corner of each plot. Target species codes are defined in Table C13.

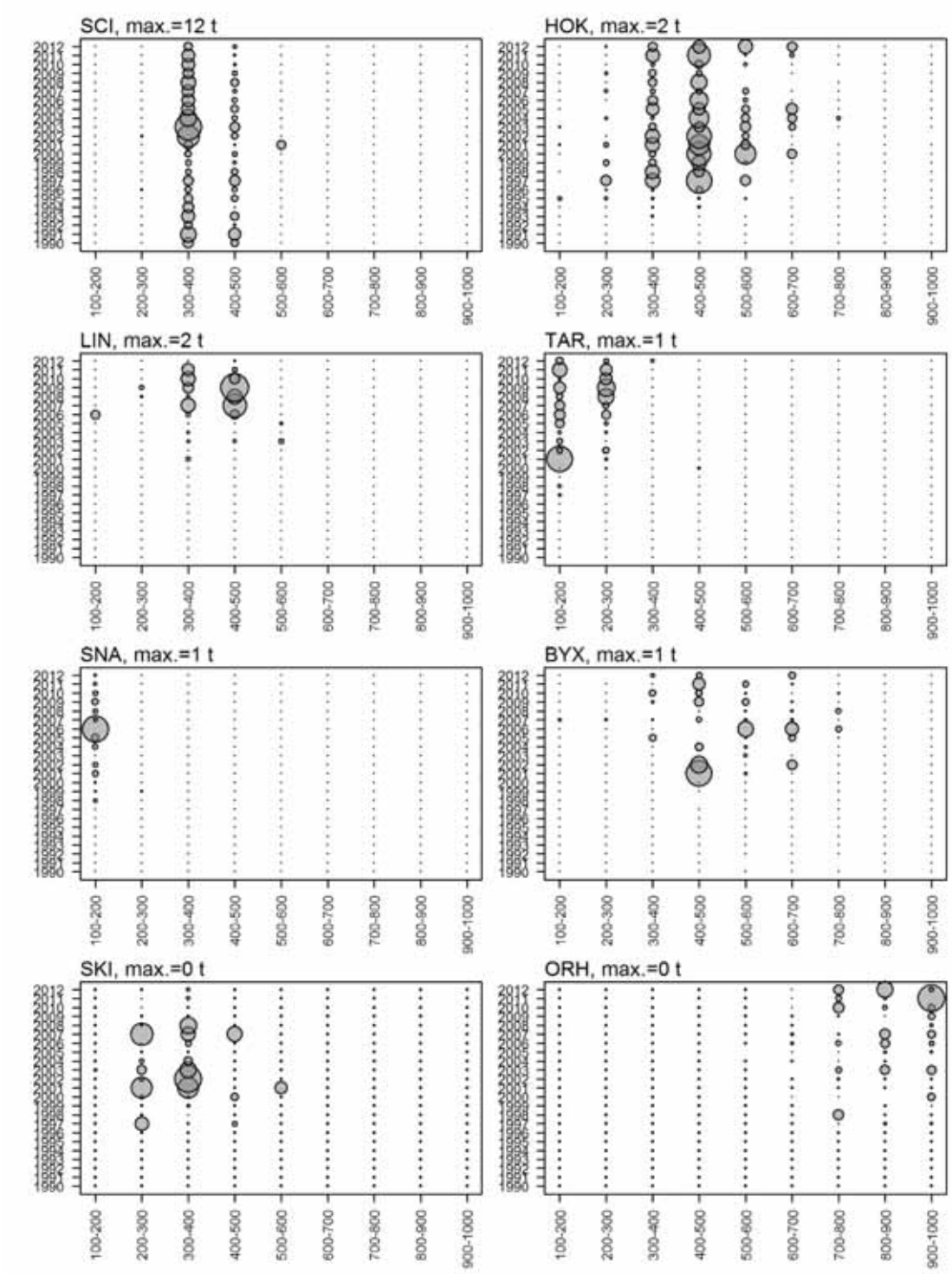


Figure C48: Distribution of lookdown dory annual catch (t) by mean depth for ECNI merged TCEPR daily processed data by main target species for all TCEPR bottom trawl tows. Circle size is proportional to catch; maximum circle size is indicated on the top left hand corner of each plot. Target species codes are defined in Table C13.

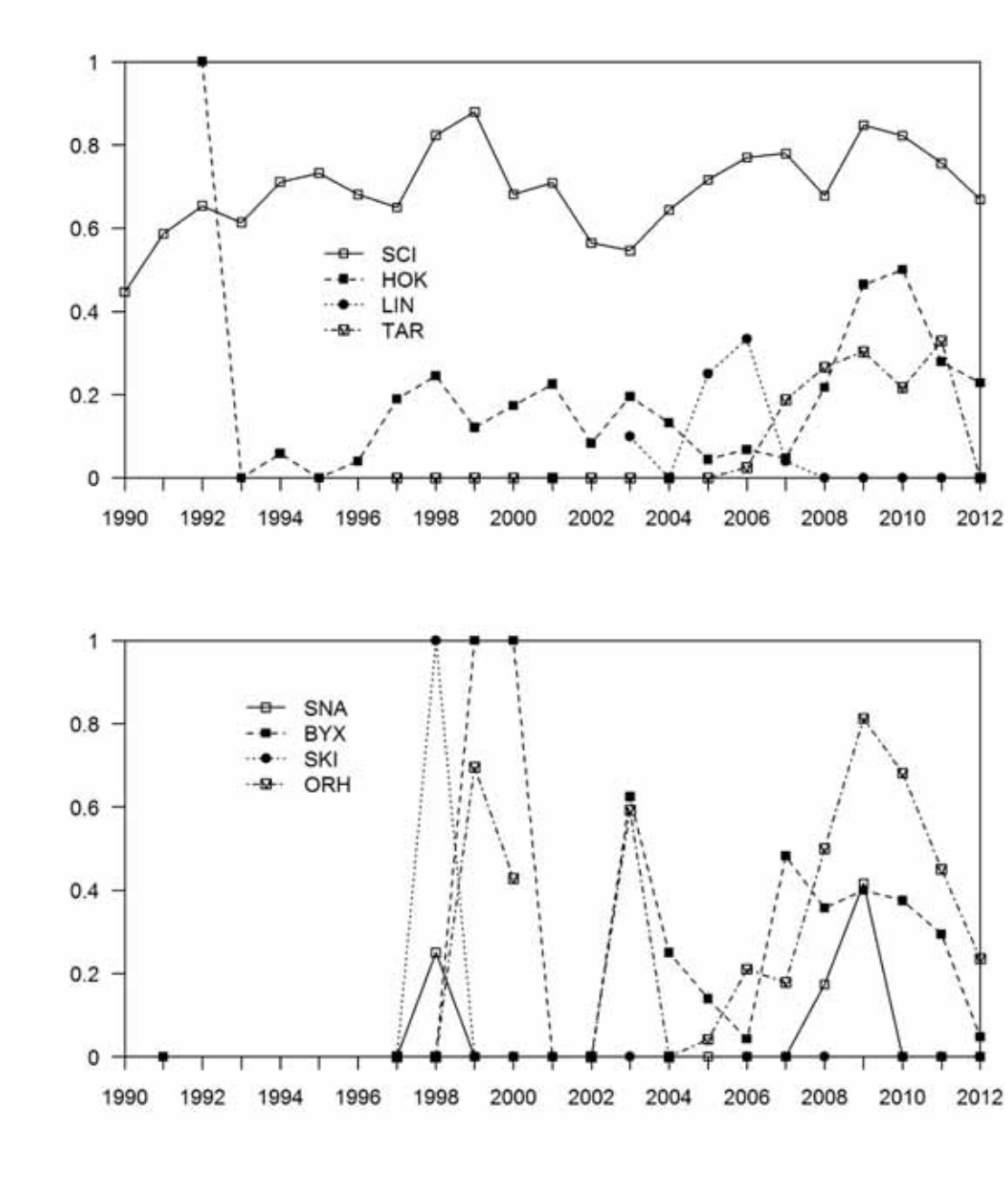


Figure C49: Proportion of zeros in merged daily processed data by main target species in the ECNI region for all TCEPR bottom trawl tows. Target species codes are defined in Table C13.

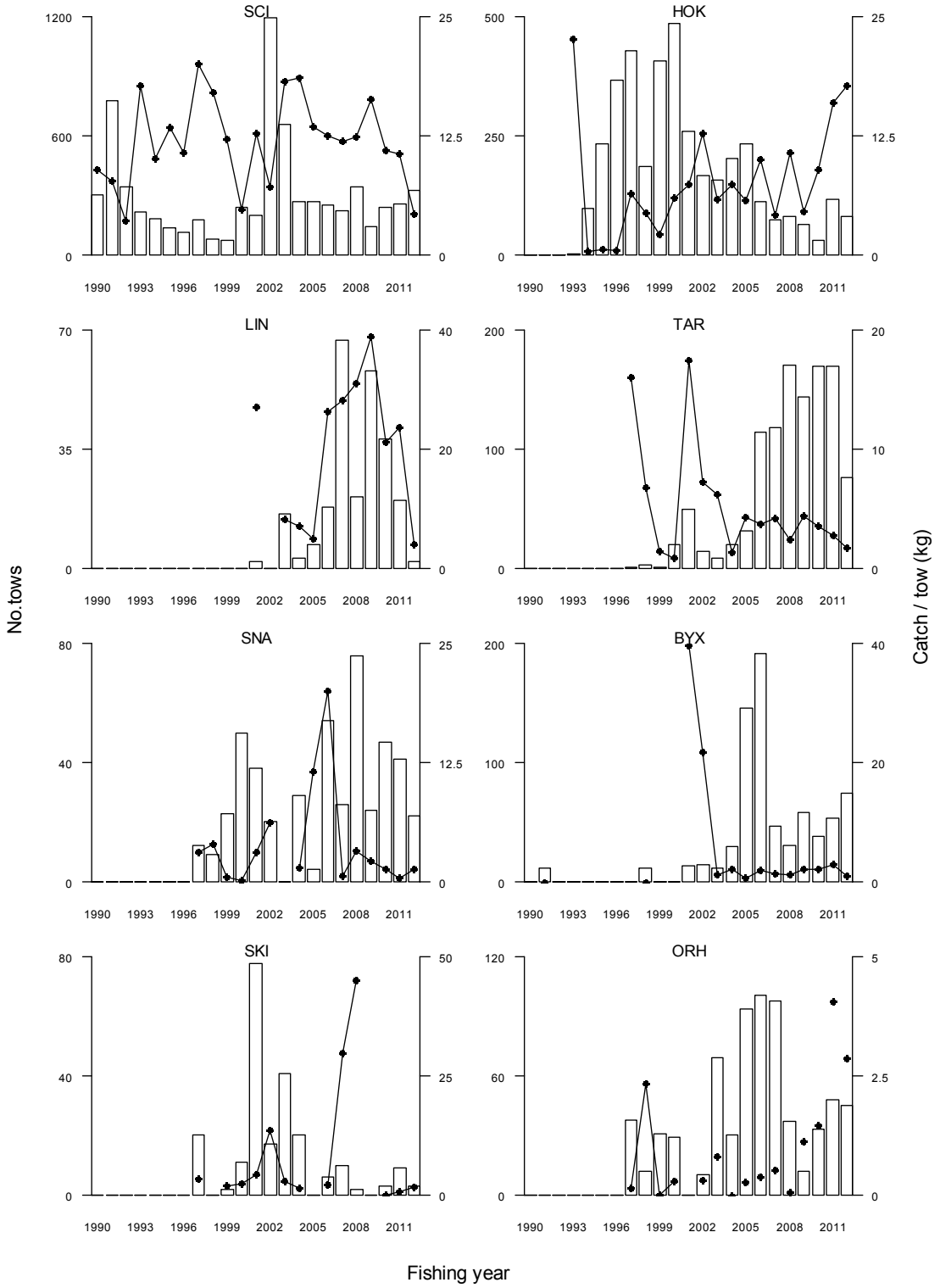


Figure C50: Unstandardised catch rate of LDO by main target species (kg/tow) and the number of tows for the ECNI region taken by bottom trawl gear. Target species codes are defined in Table C13.

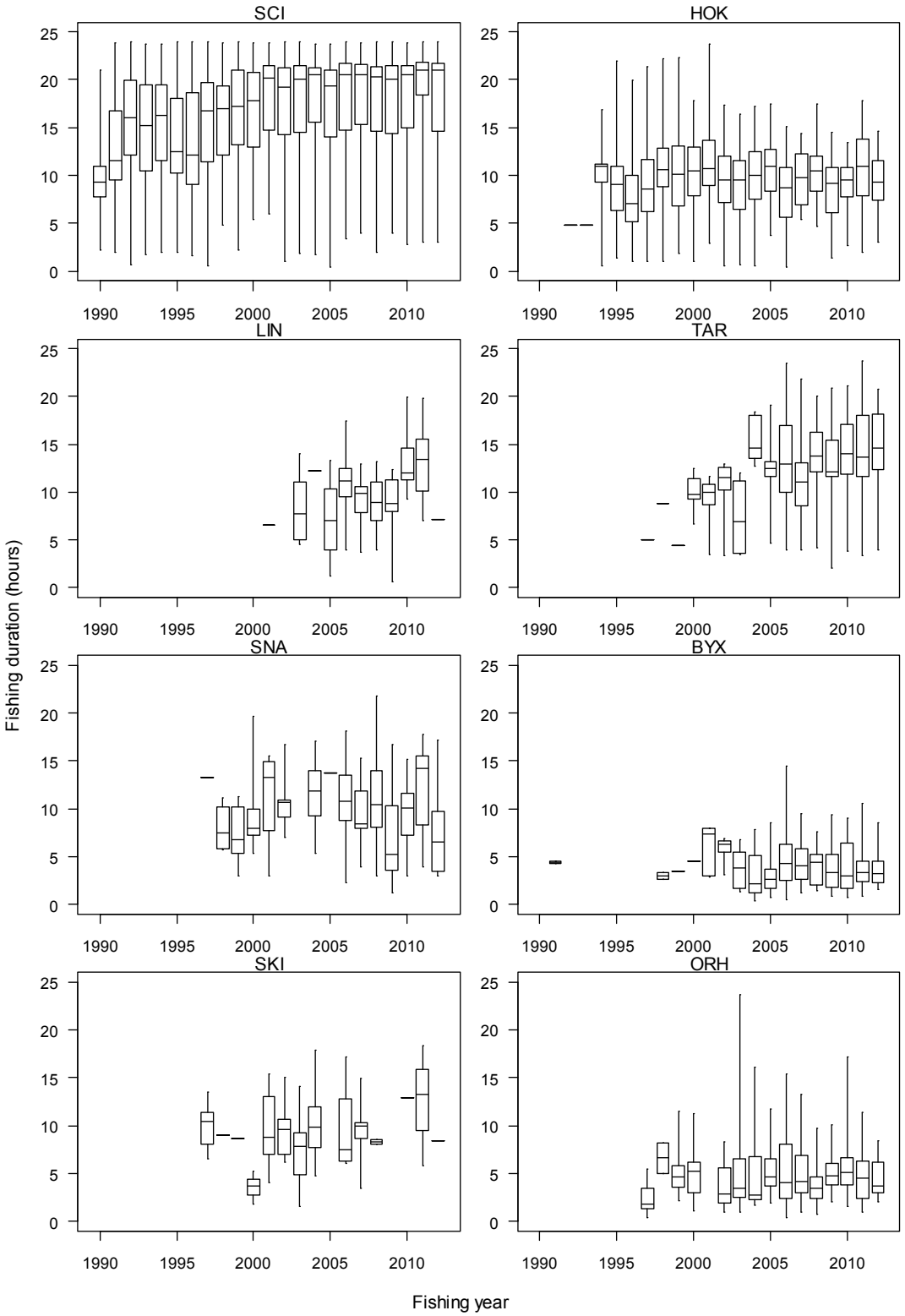


Figure C51: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) for summed daily tow durations (hours) reported by main target species of tows capturing lookdown dory in the ECNI region using bottom trawl gear. Target species codes are defined in Table C13.

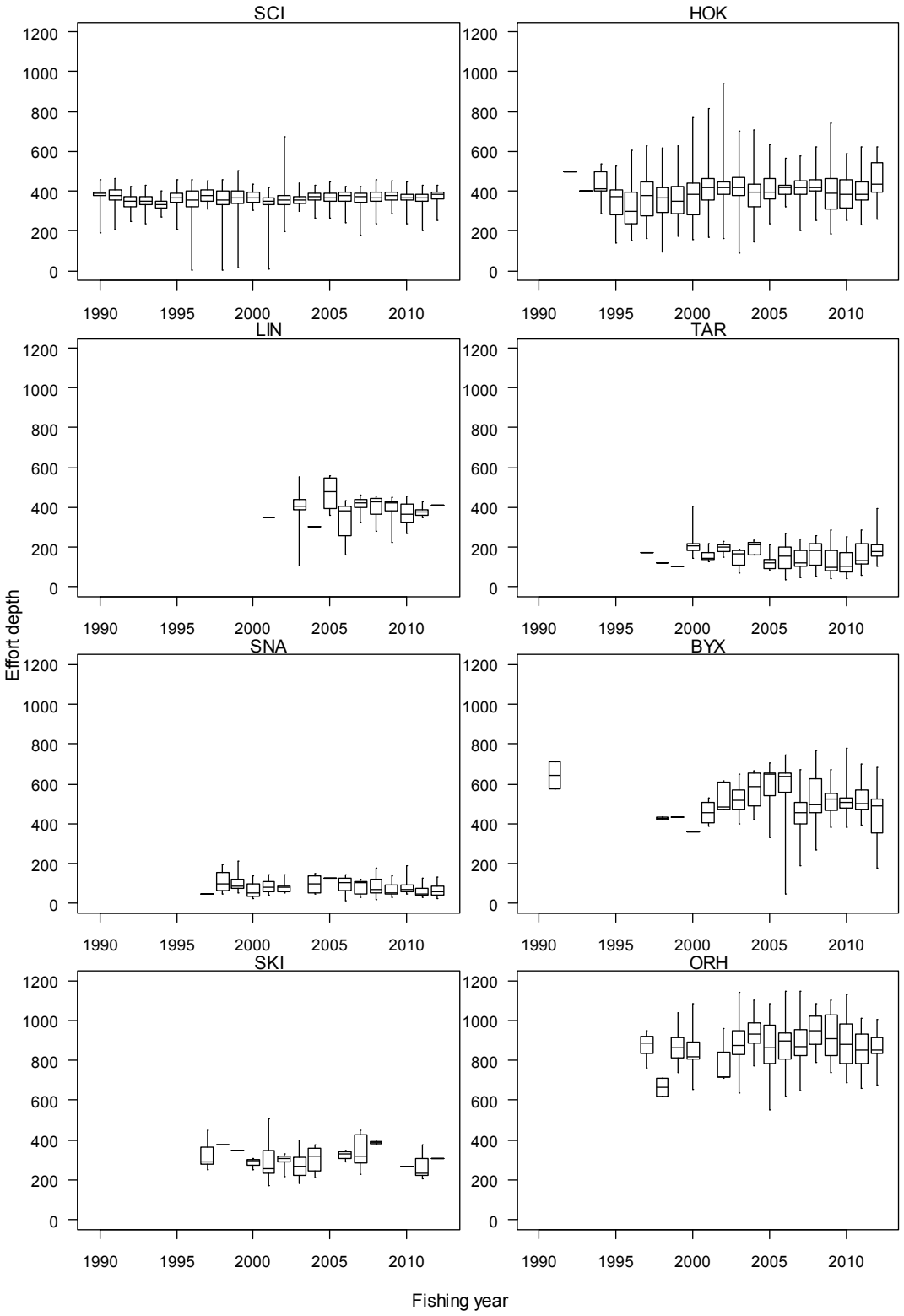


Figure C52: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) for depths (m) fished by main target species of tows capturing lookdown dory in the ECNI region using bottom trawling. Target species codes are defined in Table C13.

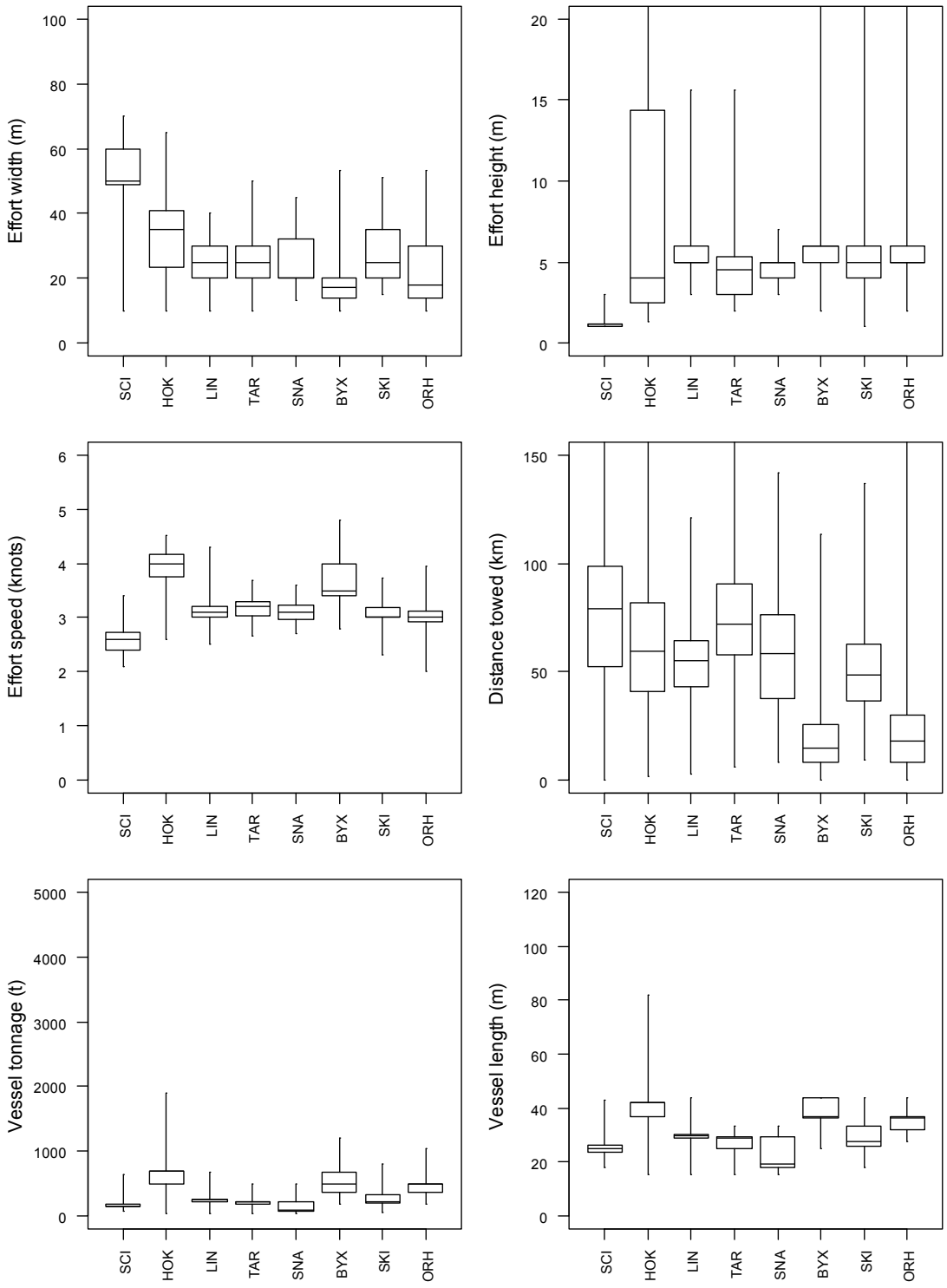


Figure C53: Median (horizontal line), inter-quartile ranges (box), and range (vertical lines) distribution of fishing effort variables and vessel characteristics for the ECNI area by main target species of tows catching lookdown dory using bottom trawl gear. Target species codes are defined in Table C13.

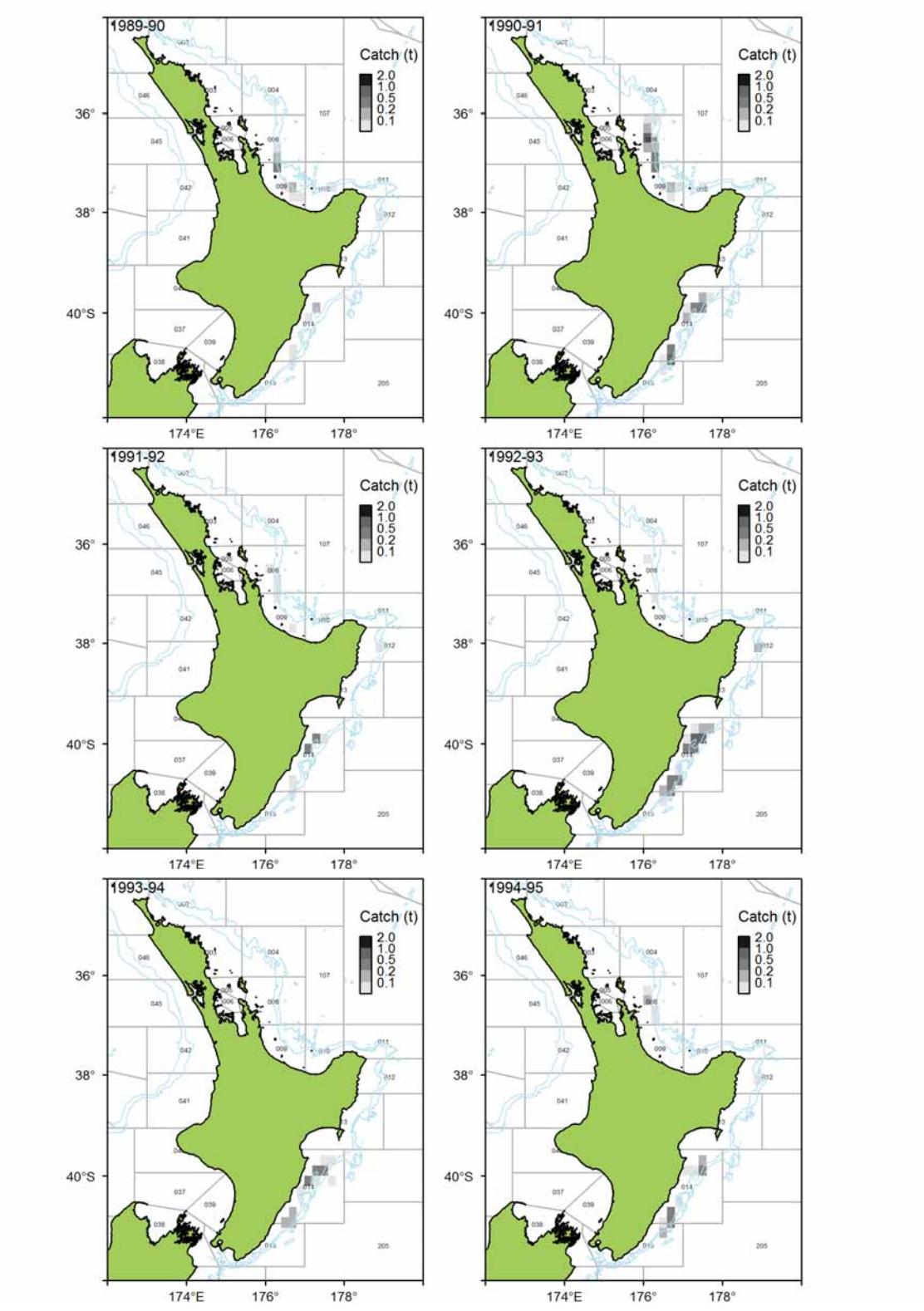


Figure C54: Distribution of lookdown dory catch taken by bottom trawl gear within the ECNI region aggregated into 0.2 degree spatial blocks for fishing years 1990–1995 for tows on the TCEPR form.

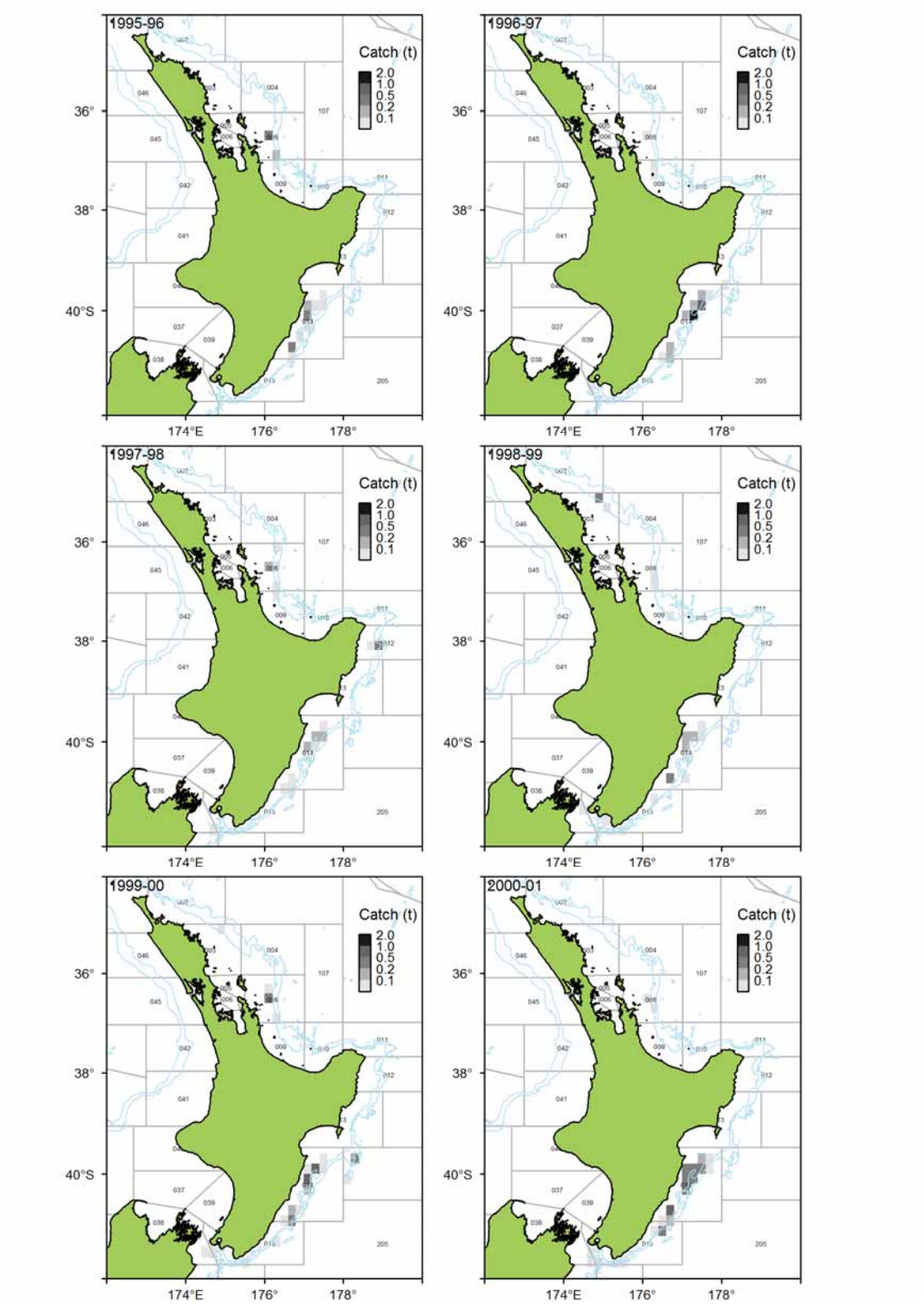


Figure 54: ctd: Distribution of lookdown dory catch taken by bottom trawl gear within the ECNI region aggregated into 0.2 degree spatial blocks for fishing years 1996–2001 for tows on the TCEPR form.

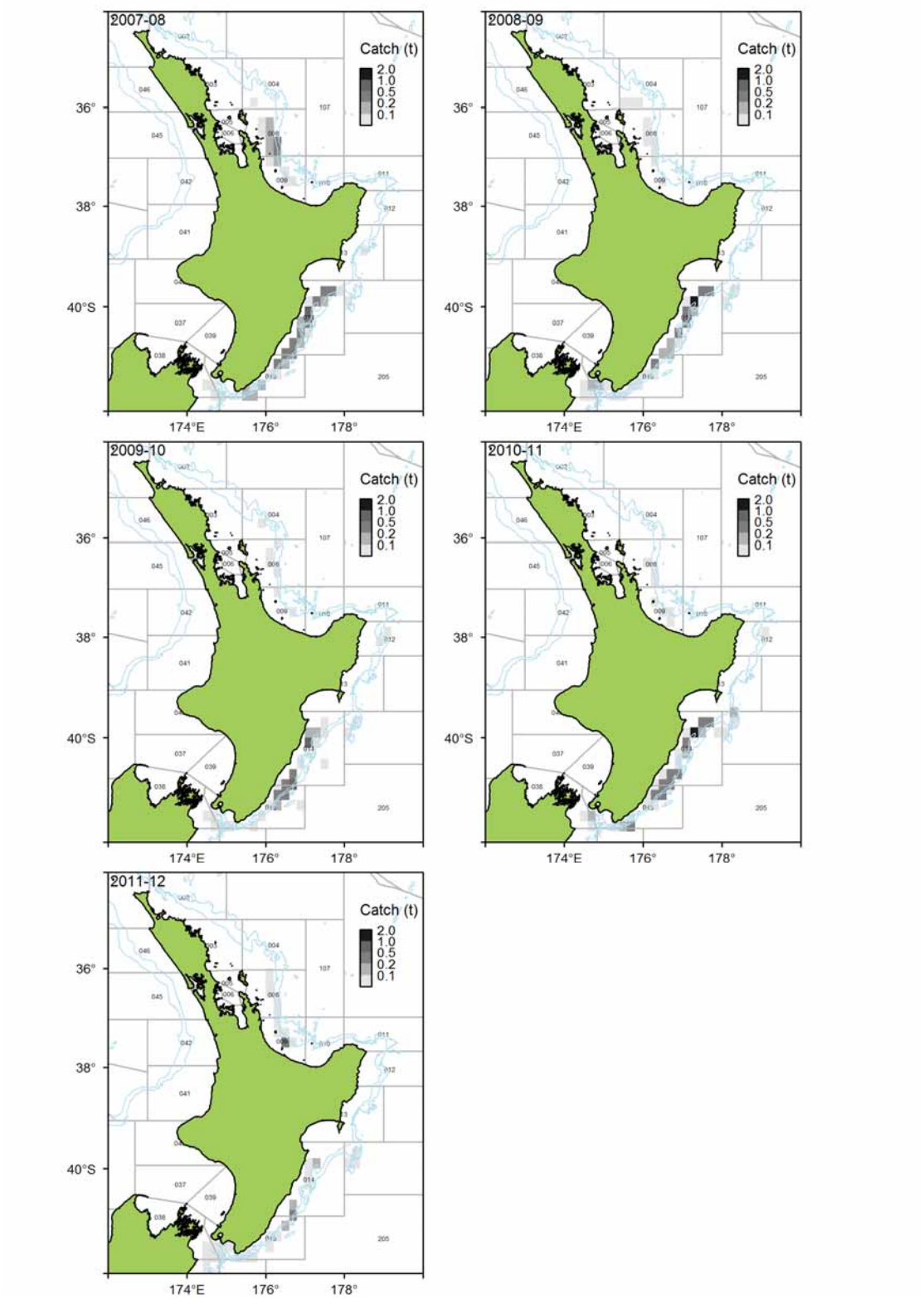


Figure C54: ctd: Distribution of lookdown dory catch taken by bottom trawl gear within the ECNI region aggregated into 0.2 degree spatial blocks for fishing years 2008–2012 for tows on the TCEPR form.

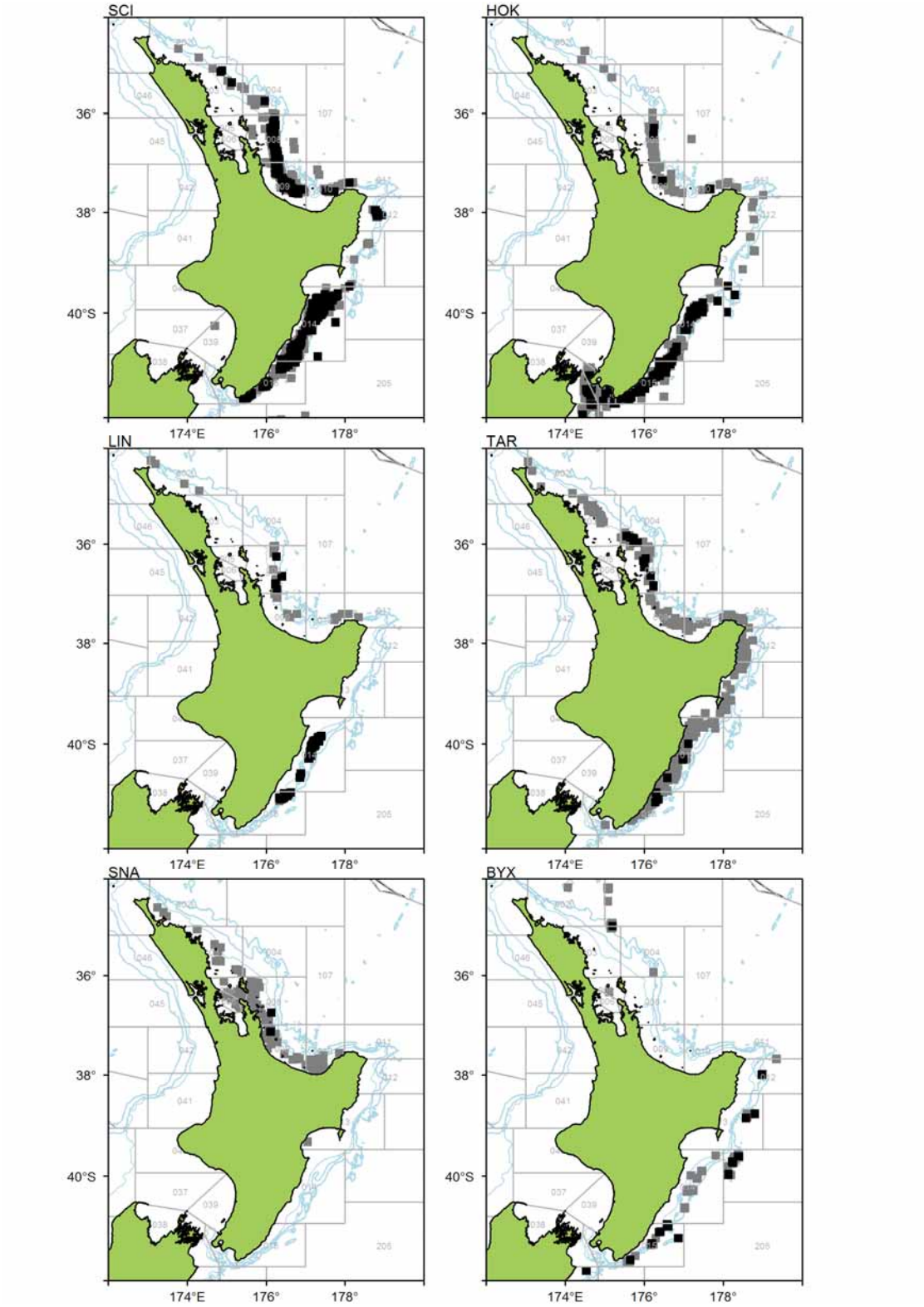


Figure C55: ECNI statistical areas and bathymetry showing the distribution of bottom trawls by target species in the merged processed data (grey) and bottom trawls by target species where lookdown dory was caught (black) for the main target species for all years combined. Target species are defined in Table 13.

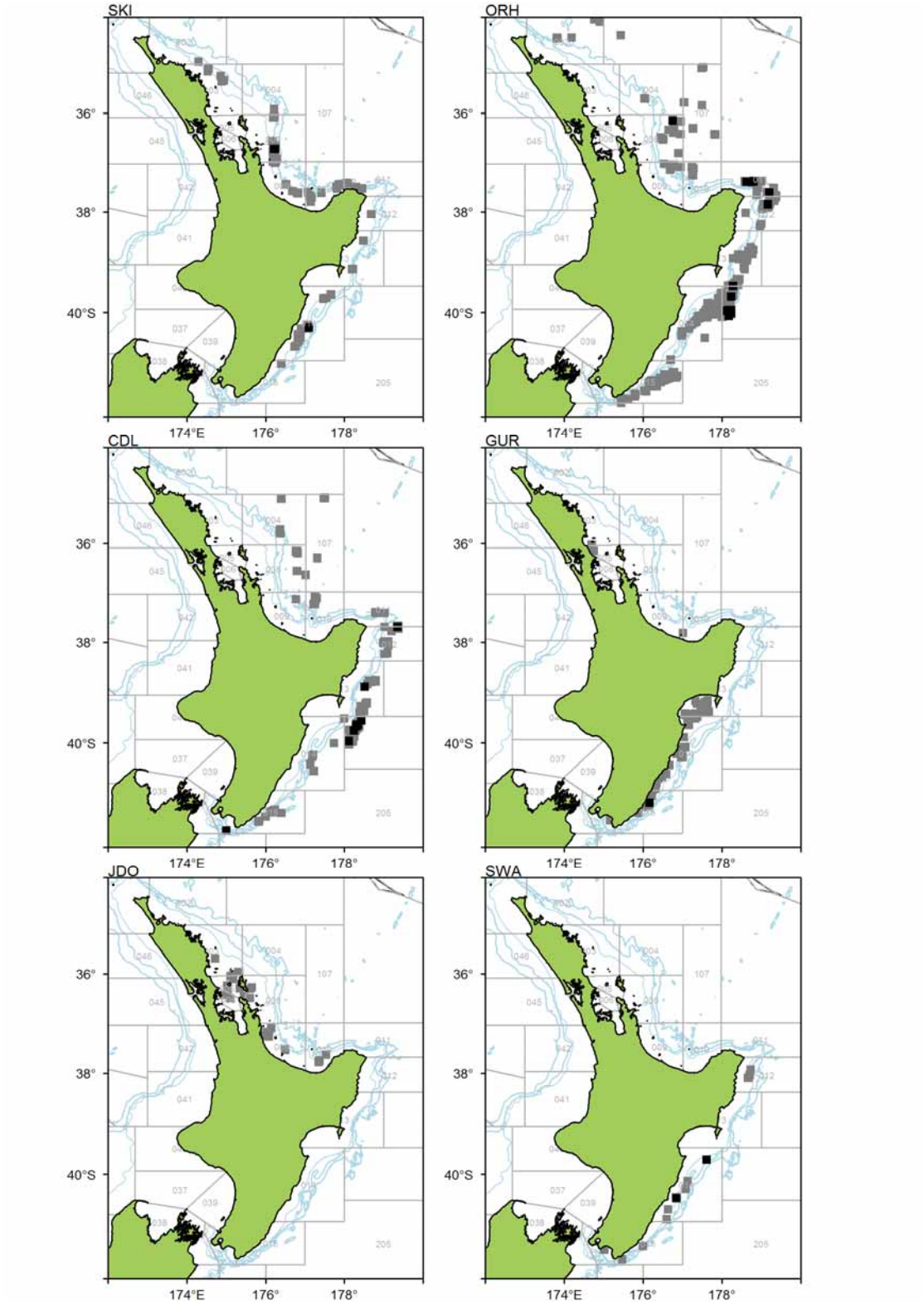


Figure C55: ctd. ECNI statistical areas and bathymetry showing the distribution of bottom trawls by target species in the merged processed data (grey) and bottom trawls by target species where lookdown dory was caught (black) for the main target species for all years combined. Target species are defined in Table 13.

APPENDIX D: CATCH-PER-UNIT-EFFORT ANALYSIS

Table D1: Description of variables and their type used in the CPUE analysis for the TCEPR daily processed data, and Observed 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) TCEPR daily processed data merged by vessel–date

Variable	Type	Description
Year	Categorical	Fishing year (Oct–Sep)
Vessel	Categorical	Unique (encrypted) vessel identification number
Statistical area	Categorical	Statistical area
Effort	Continuous	Number of tows for a given day
Tow duration	Continuous	Duration of all tows (hrs) on a given trip
Catch	Continuous	Estimated green weight of look down dory (t) caught on a given day
Target species	Categorical	Main target species on a given trip
Date	Continuous	Start date fish were processed
Month	Categorical	Month of the year
Fday	Continuous	Day of the year
Method	Categorical	Fishing method for a given day (BT is bottom trawl; MB is midwater trawl within 5 m of the seabed; MW is midwater trawl; Mixed is a mix of bottom and midwater tows)
Tow distance	Continuous	Distance of all tows on a given day
Distance2	Continuous	Distance (as speed*duration) of all tows on a given day
Headline height	Continuous	Median headline height (m) of the net on a given day
Bottom depth	Continuous	Median seabed depth (m) on a given day
Net depth	Continuous	Median net depth (m) for a tow
Speed	Continuous	Median vessel speed (knots) on a given day
Wingspread	Continuous	Median wingspread (m) on a given day
Vessel experience	Continuous	Number of years the vessel has been involved in the fishery
Twin trawl vessel	Categorical	T/F variable for a vessel that has used twin trawl
Twin day	Categorical	T/F variable for a vessel that has used twin trawl on a given day
Longitude	Continuous	Median longitude of the vessel on a given day
Latitude	Continuous	Median latitude of the vessel on a given day

(b) Observer data

Variable	Type	Description
Year	Categorical	Fishing year (Oct–Sep)
Vessel	Categorical	Unique (encrypted) vessel identification number
Statistical area	Categorical	Statistical area
Method	Categorical	Fishing method for a tow (BT is bottom trawl; MB is midwater trawl within 5 m of the seabed; MW is midwater trawl).
Tow duration	Continuous	Duration of tow (hrs)
Tow distance	Continuous	Distance of tow (kt)
Distance2	Continuous	Distance (as speed * duration) of tow (kt)
Headline height	Continuous	Headline height (m) of the net for a tow
Bottom depth	Continuous	Seabed depth (m) for a tow
Net depth	Continuous	Net depth (m) for a tow
Vessel experience	Continuous	Number of years the vessel has been involved in the fishery
Twin trawl vessel	Categorical	T/F variable for a vessel that has used a twin trawl
Number of nets	Categorical	Number of nets a vessel has used in a tow
Catch	Continuous	Observed catch of lookdown dory (t) caught from a tow
Longitude	Continuous	Longitude of the vessel for a tow
Latitude	Continuous	Latitude of the vessel for a tow
Target species	Categorical	Target species of tow
Month	Categorical	Month of the year
Fday	Continuous	Day of the year
Time start	Continuous	Start time of tow
Time mid	Continuous	Mid time of tow

Table D2: Definition of twin trawlers.

Fishing years	Data source	Twin trawl
1996–2007	Hurst (2009)	Twin trawl code 1:3
2008	No data	Vessel twin vessel 1996–2007 identified, so possible identification, but call these vessels twin trawlers
2009–2012	Primary_method recorded on TCEPR as effort_total_num ; fishing method; and effort_width eg 2MW100	Positive identification from effort_total_num as number of nets used

Table D3: CPUE data constraints for core datasets.

(a) CHAT: daily processed TCEPR BT data for target hoki

Data source	TCEPR daily processed data
Year range	1999–2012
Year definition	October–September
Statareas	≥ 50 tows: 019–023, 051, 052, 401–403, 407–410
Method	BT
Target species	HOK
Core vessel selection	80% of catch, ≥ 4 years vessel participation, ≥ 50 vessel-days per vessel-year
Catch	< 2 t
Other	200–800 m; longitude 172.2–185°; latitude 41.4–45°; 0.2–24 hours

(b) CHAT: Observed tow-by-tow data for target hoki

Data source	Observer data
Year range	1990–2012
Year definition	June–September
Statareas	018–023, 052, 401–403, 407–410
Method	BT
Target species	HOK
Core vessel selection	≥ 2 years vessel participation, ≥ 35 tows per vessel overall
Catch	< 1 t
Other	200–800 m; 0.2–15 hours

(c) WCSI: daily processed TCEPR BT data for target hoki or hake

Data source	TCEPR daily processed data
Year range	1994–2012
Year definition	June–September
Statareas	034, 035
Method	BT
Target species	HOK, HAK
Core vessel selection	80% of catch, ≥ 6 years vessel participation, all vessel-days per vessel-year
Catch	< 2 t
Other	200–800 m; 0.2–24 hours

(d) WCSI: Observed tow-by-tow data for target hoki or hake

Data source	Observer data
Year range	1990–2012
Year definition	June–September
Statareas	034, 035, 036
Method	BT, MW, MB
Target species	HOK, HAK
Core vessel selection	≥ 2 years vessel participation, ≥ 35 tows per vessel overall
Catch	< 1 t
Other	200–800 m; 0.2–15 hours; latitude 40–43°

(e) Sub-Antarctic: daily processed TCEPR BT data for target hoki or ling

Data source	TCEPR daily processed data
Year range	1997–2012
Year definition	October–September
Statareas	026–028 ,030, 504, 602, 603, 610, 618
Method	BT
Target species	HOK, LIN
Core vessel selection	80% of catch, ≥ 4 years vessel participation, all vessel-days per vessel-year
Catch	< 2 t
Other	200–800 m; longitude <172°; latitude > 46°; 0.2–24 hours

Table D4: Summary of CHAT data used in the analyses of CPUE for all vessels and for core vessels for each fishing year, where 1989–90 is 1990. Vessels, number of unique vessels fishing; Tows, number of tow records; Zeros, proportion of tows (estimated) or days (line) that caught zero catch; Catch, estimated; CPUE, unstandardised CPUE from the tow-by-tow data (estimated) or daily catch non-zero records (line); Days, number of vessel days fished.

CHAT: TCEPR daily processed BT catch for target hoki

	All vessels					Core vessels				
Fishing year	**No. vessels**	**Catch**	**Effort**	**Zeros**	**CPUE**	**No. vessels**	**Catch**	**Effort**	**Zeros**	**CPUE**
1998	45	358.7	1 844	0.19	0.19	10	264.5	1 253	0.14	0.21
1999	36	389.6	2 129	0.13	0.18	11	323.4	1 653	0.10	0.20
2000	29	372.7	1 849	0.10	0.20	12	349.4	1 668	0.09	0.21
2001	33	432.9	2 011	0.09	0.22	12	390.7	1 768	0.08	0.22
2002	25	430.5	1 715	0.07	0.25	12	396.5	1 524	0.06	0.26
2003	28	473.3	2 129	0.06	0.22	14	436.3	1 864	0.05	0.23
2004	26	277.6	1 647	0.08	0.17	10	240.4	1 434	0.08	0.17
2005	20	188.6	1 180	0.11	0.16	8	174.4	995	0.08	0.18
2006	16	223.5	1 202	0.08	0.19	8	212.5	1 028	0.08	0.21
2007	16	165.7	1 155	0.14	0.14	8	160.0	1 058	0.12	0.15
2008	22	121.9	1 052	0.13	0.12	7	109.5	860	0.12	0.13
2009	19	165.4	889	0.10	0.19	6	135.6	696	0.10	0.19
2010	20	175.1	1 006	0.12	0.17	6	148.8	840	0.09	0.18
2011	20	140.8	1 005	0.11	0.14	7	106.5	813	0.12	0.13
2012	20	180.5	1 057	0.08	0.17	7	149.4	900	0.08	0.17

Chatham Rise: Observer BT catch for target hoki

	All vessels					Core vessels				
Fishing year	**No. vessels**	**Catch**	**Effort**	**Zeros**	**CPUE**	**No. vessels**	**Catch**	**Effort**	**Zeros**	**CPUE**
1998	14	32.0	889	0.23	0.04	13	31.7	877	0.23	0.04
1999	14	59.0	902	0.19	0.07	10	45.7	796	0.20	0.06
2000	12	29.6	711	0.22	0.04	10	29.5	708	0.21	0.04
2001	12	40.6	546	0.33	0.07	10	40.2	540	0.32	0.07
2002	12	80.4	1 064	0.17	0.08	10	80.0	1 053	0.15	0.08
2003	10	13.8	236	0.21	0.06	10	13.8	235	0.20	0.06
2004	12	24.3	420	0.25	0.06	8	16.3	278	0.26	0.06
2005	10	51.4	665	0.16	0.08	9	51.2	659	0.16	0.08
2006	10	32.9	606	0.25	0.05	8	32.7	596	0.25	0.05
2007	10	28.2	537	0.23	0.05	8	26.6	528	0.22	0.05
2008	10	21.7	507	0.35	0.04	8	17.8	424	0.33	0.04
2009	13	25.2	503	0.33	0.05	10	10.7	228	0.39	0.05
2010	12	15.5	345	0.24	0.04	7	7.6	104	0.10	0.07
2011	13	33.3	827	0.23	0.04	9	23.7	583	0.16	0.04
2012	8	16.4	320	0.28	0.05	7	13.8	235	0.27	0.06

Table D4: continued.

WCSI: TCEPR daily processed BT catch for target hoki or hake

	All vessels					Core vessels				
Fishing year	**No. vessels**	**Catch**	**Effort**	**Zeros**	**CPUE**	**No. vessels**	**Catch**	**Effort**	**Zeros**	**CPUE**
1994	18	39.9	218	0.28	0.18	8	20.7	108	0.22	0.19
1995	17	36.4	186	0.18	0.20	8	25.5	107	0.14	0.24
1996	24	36.8	233	0.36	0.16	9	16.8	106	0.15	0.16
1997	28	40.3	222	0.27	0.18	16	30.3	155	0.15	0.20
1998	28	35.9	217	0.30	0.17	14	24.0	152	0.26	0.16
1999	27	32.0	243	0.29	0.13	20	29.8	212	0.26	0.14
2000	29	41.3	346	0.25	0.12	22	38.9	322	0.26	0.12
2001	34	61.1	476	0.23	0.13	22	57.3	434	0.19	0.13
2002	29	86.4	591	0.22	0.15	25	81.8	552	0.19	0.15
2003	35	94.6	743	0.22	0.13	25	79.6	634	0.22	0.13
2004	29	74.8	518	0.22	0.14	24	70.8	479	0.21	0.15
2005	26	49.2	357	0.38	0.14	20	42.3	320	0.32	0.13
2006	23	94.9	589	0.18	0.16	19	88.8	554	0.18	0.16
2007	20	65.6	371	0.21	0.18	17	63.8	359	0.20	0.18
2008	16	90.9	533	0.07	0.17	15	85.0	500	0.08	0.17
2009	16	75.3	397	0.11	0.19	15	74.5	389	0.11	0.19
2010	18	66.6	353	0.12	0.19	17	66.6	353	0.12	0.19
2011	18	86.7	448	0.19	0.19	17	86.7	448	0.19	0.19
2012	20	67.5	453	0.19	0.15	16	64.5	414	0.16	0.16

WCSI: Observer catch for target hoki or hake

	All vessels					Final vessels				
Fishing year	**No. vessels**	**Catch**	**Effort**	**Zeros**	**CPUE**	**No. vessels**	**Catch**	**Effort**	**Zeros**	**CPUE**
1990	14	20.8	658	0.57	0.03	5	10.4	346	0.33	0.03
1991	14	14.6	439	0.65	0.03	5	4.1	162	0.69	0.03
1992	12	11.4	259	0.70	0.04	7	6.1	91	0.65	0.07
1993	15	10.8	370	0.70	0.03	13	5.8	276	0.73	0.02
1994	15	12.6	354	0.78	0.04	10	7.7	252	0.76	0.03
1995	9	9.1	261	0.69	0.03	6	5.6	105	0.77	0.05
1996	15	5.8	238	0.78	0.02	10	4.7	216	0.73	0.02
1997	12	4.4	184	0.74	0.02	11	4.3	171	0.73	0.03
1998	17	8.7	234	0.74	0.04	14	7.9	223	0.73	0.04
1999	14	12.8	359	0.68	0.04	14	12.7	353	0.67	0.04
2000	17	11.0	393	0.66	0.03	16	10.4	382	0.66	0.03
2001	21	6.4	336	0.67	0.02	20	5.8	325	0.66	0.02
2002	16	42.3	716	0.46	0.06	15	41.3	680	0.45	0.06
2003	13	18.1	418	0.56	0.04	13	17.8	413	0.56	0.04
2004	16	20.3	654	0.53	0.03	14	16.9	578	0.52	0.03
2005	13	7.3	279	0.74	0.03	12	6.9	274	0.74	0.03
2006	15	31.8	561	0.50	0.06	15	30.3	539	0.51	0.06
2007	16	9.7	232	0.65	0.04	16	8.2	192	0.66	0.04
2008	14	16.5	422	0.40	0.04	13	8.2	257	0.49	0.03
2009	16	9.1	254	0.52	0.04	15	7.5	209	0.53	0.04
2010	15	12.4	340	0.46	0.04	14	6.7	203	0.51	0.03
2011	11	22.9	311	0.50	0.07	11	8.0	183	0.60	0.04
2012	16	13.9	395	0.59	0.04	14	9.0	300	0.58	0.03

Table D4: continued.

SUBA: TCEPR daily processed BT catch for target hoki or ling

	All vessels					Core vessels				
Fishing year	**No. vessels**	**Catch**	**Effort**	**Zeros**	**CPUE**	**No. vessels**	**Catch**	**Effort**	**Zeros**	**CPUE**
1997	29	17.1	194	0.78	0.09	17	13.7	138	0.70	0.10
1998	28	33.8	285	0.75	0.12	18	19.3	215	0.73	0.09
1999	27	15.9	217	0.74	0.07	21	15.3	196	0.73	0.08
2000	27	30.9	560	0.61	0.06	23	29.1	523	0.62	0.06
2001	30	37.9	618	0.58	0.06	24	35.9	587	0.57	0.06
2002	29	25.6	454	0.70	0.06	22	24.9	429	0.70	0.06
2003	34	32.0	532	0.57	0.06	27	31.3	523	0.56	0.06
2004	26	23.2	417	0.54	0.06	23	23.2	415	0.52	0.06
2005	24	17.6	286	0.54	0.06	23	17.6	285	0.53	0.06
2006	24	12.1	253	0.49	0.05	18	11.7	244	0.48	0.05
2007	19	14.3	330	0.53	0.04	17	14.3	330	0.52	0.04
2008	21	13.6	291	0.53	0.05	17	12.7	268	0.54	0.05
2009	18	10.7	241	0.47	0.04	16	9.7	214	0.49	0.05
2010	18	13.5	270	0.43	0.05	17	13.3	261	0.44	0.05
2011	18	12.5	241	0.47	0.05	15	11.9	220	0.48	0.05
2012	21	9.0	204	0.53	0.04	17	8.4	173	0.56	0.05

Table D5: Variables retained in order of decreasing explanatory value by each model and the corresponding total r^2 values.

CHAT: TCEPR daily processed BT catch for target hoki

Lognormal		Binomial	
Variable	**R-squared**	**Variable**	**R-squared**
Fishing year	2.79	Fishing year	1.26
Statistical area	16.28	Duration	7.58
Vessel	24.03	Statistical area	11.55
Month	27.12	Vessel	13.42
Depth of bottom	29.37	Month	14.90
Duration	30.83		

Chatham Rise: Observer BT catch for target hoki

Lognormal		Binomial	
Variable	**R-squared**	**Variable**	**R-squared**
Fishing year	7.50	Fishing year	2.20
Vessel	22.02	Vessel	6.87
Statistical area	27.08	Duration	9.29
Mid time of tow	29.66	Mid time of tow	11.73
Duration	33.01	Statistical area	13.52
Month	35.45	Depth of bottom	14.78
		Month	16.10

WCSI: TCEPR daily processed BT catch for target hoki or hake

Lognormal		Binomial	
Variable	**R-squared**	**Variable**	**R-squared**
Fishing year	3.05	Fishing year	2.35
Day of year	16.69	Depth of bottom	9.71
Vessel	24.34	Vessel	13.42
Depth of bottom	28.61	Day of year	16.72
Distance	29.83	Duration	19.12

WCSI: Observer catch for target hoki or hake

Lognormal		Binomial	
Variable	**R-squared**	**Variable**	**R-squared**
Year	6.23	Fishing year	4.01
Vessel	30.46	Depth of net	14.95
Headline	35.95	Vessel	22.38
Day of year	38.96	Headline	25.72
Depth of net	40.62	Day of year	27.88
Duration	42.03		
Mid time of tow	43.21		

SUBA: TCEPR daily processed BT catch for target hoki or ling

Lognormal		Binomial	
Variable	**R-squared**	**Variable**	**R-squared**
Fishing year	3.53	Fishing year	2.37
Vessel	12.29	Depth of bottom	8.66
Longitude	15.46	Vessel	11.80
Month	16.99	Longitude	13.77
Depth of bottom	18.06		

Table D6: Lognormal CPUE standardised indices, and binomial, and combined CPUE indices (with 95% confidence intervals).

CHAT: TCEPR daily processed BT catch for target hoki

	Lognormal		Binomial		Delta lognormal
Year	**Index**	**CI**	**Index**	**CI**	**Index**
1998	0.99	0.93–1.05	0.06	0.03–0.09	1.53
1999	0.75	0.71–0.79	0.05	0.02–0.08	0.99
2000	1.01	0.96–1.06	0.04	0.02–0.06	0.98
2001	1.15	1.09–1.21	0.04	0.02–0.06	1.16
2002	1.42	1.35–1.50	0.03	0.01–0.04	0.94
2003	1.34	1.27–1.40	0.02	0.01–0.03	0.70
2004	1.06	1.01–1.12	0.03	0.02–0.05	0.94
2005	0.92	0.86–0.98	0.05	0.02–0.07	1.07
2006	1.19	1.12–1.27	0.04	0.02–0.05	1.09
2007	0.88	0.83–0.94	0.05	0.02–0.07	1.04
2008	0.86	0.81–0.92	0.04	0.02–0.06	0.80
2009	1.09	1.01–1.17	0.04	0.02–0.06	1.06
2010	0.87	0.82–0.94	0.04	0.02–0.07	0.96
2011	0.80	0.74–0.85	0.05	0.03–0.08	1.11
2012	0.91	0.85–0.97	0.04	0.02–0.06	0.88

Chatham Rise: Observer BT catch for target hoki

	Lognormal		Binomial		Delta lognormal
Year	**Index**	**CI**	**Index**	**CI**	**Index**
1998	0.88	0.81–0.96	0.07	0.03–0.10	0.79
1999	1.00	0.91–1.10	0.09	0.05–0.13	1.21
2000	1.11	1.01–1.22	0.05	0.02–0.07	0.73
2001	1.12	1.00–1.25	0.18	0.10–0.25	2.71
2002	1.53	1.41–1.65	0.04	0.02–0.06	0.93
2003	1.12	0.98–1.29	0.04	0.02–0.07	0.65
2004	1.42	1.24–1.63	0.06	0.03–0.09	1.17
2005	1.15	1.04–1.26	0.06	0.03–0.09	0.98
2006	1.16	1.06–1.27	0.07	0.04–0.10	1.09
2007	0.96	0.87–1.06	0.07	0.04–0.10	0.89
2008	0.86	0.78–0.96	0.12	0.07–0.17	1.41
2009	0.85	0.74–0.98	0.12	0.07–0.17	1.41
2010	0.82	0.65–1.05	0.03	0.00–0.05	0.33
2011	0.64	0.58–0.71	0.03	0.02–0.05	0.30
2012	0.76	0.66–0.88	0.07	0.04–0.11	0.77

Table D6: continued.

WCSI: TCEPR daily processed BT catch for target hoki or hake

	Lognormal		Binomial		Delta lognormal
Year	Index	CI	Index	CI	Index
1994	1.56	1.29–1.89	0.10	0.05–0.15	1.82
1995	1.58	1.30–1.91	0.06	0.02–0.10	1.16
1996	0.49	0.41–0.59	0.10	0.04–0.16	0.60
1997	1.35	1.16–1.59	0.08	0.04–0.12	1.28
1998	0.82	0.70–0.97	0.20	0.12–0.28	1.91
1999	0.94	0.81–1.09	0.10	0.06–0.15	1.13
2000	0.79	0.71–0.89	0.11	0.07–0.16	1.06
2001	0.87	0.79–0.96	0.11	0.06–0.15	1.09
2002	0.94	0.86–1.03	0.07	0.04–0.10	0.79
2003	0.69	0.63–0.74	0.12	0.08–0.16	0.95
2004	1.04	0.94–1.14	0.11	0.07–0.15	1.35
2005	0.86	0.76–0.96	0.15	0.10–0.20	1.51
2006	1.00	0.92–1.09	0.09	0.05–0.12	1.03
2007	1.12	1.01–1.25	0.07	0.04–0.10	0.93
2008	1.12	1.02–1.24	0.03	0.02–0.04	0.39
2009	1.06	0.95–1.17	0.03	0.01–0.05	0.38
2010	1.25	1.12–1.39	0.04	0.02–0.06	0.65
2011	1.19	1.08–1.31	0.07	0.04–0.10	1.03
2012	1.02	0.92–1.12	0.05	0.03–0.07	0.62

WCSI: Observer catch for target hoki or hake

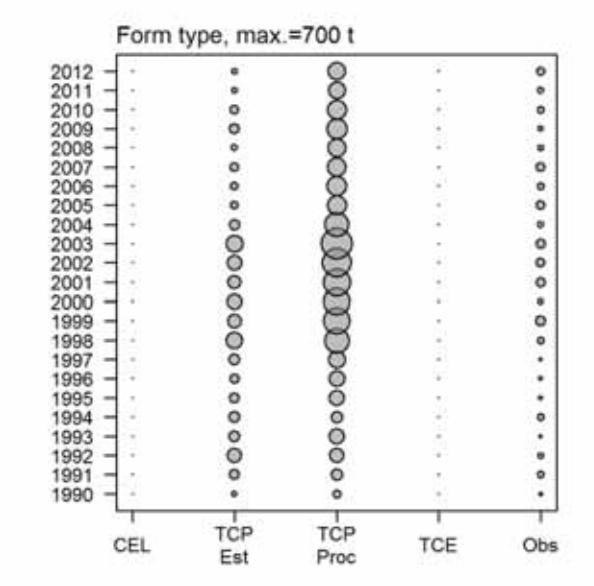
	Lognormal		Binomial		Delta lognormal
Year	Index	CI	Index	CI	Index
1990	0.86	0.71–1.04	0.84	0.75–0.93	0.94
1991	0.82	0.68–1.00	0.95	0.92–0.98	1.01
1992	0.91	0.71–1.15	0.91	0.85–0.96	1.07
1993	0.85	0.71–1.01	0.91	0.86–0.96	1.01
1994	0.81	0.68–0.97	0.86	0.79–0.94	0.91
1995	1.23	0.94–1.61	0.92	0.87–0.97	1.46
1996	0.99	0.82–1.19	0.87	0.79–0.94	1.11
1997	1.04	0.87–1.23	0.80	0.70–0.90	1.08
1998	1.02	0.88–1.19	0.87	0.80–0.94	1.15
1999	1.34	1.17–1.54	0.88	0.81–0.94	1.53
2000	1.01	0.89–1.14	0.75	0.64–0.86	0.98
2001	0.74	0.65–0.84	0.69	0.57–0.81	0.66
2002	1.33	1.20–1.47	0.61	0.48–0.75	1.05
2003	1.04	0.91–1.17	0.77	0.66–0.87	1.03
2004	1.24	1.11–1.38	0.53	0.39–0.68	0.86
2005	0.85	0.74–0.98	0.80	0.71–0.90	0.89
2006	1.16	1.04–1.30	0.63	0.49–0.77	0.95
2007	0.96	0.82–1.12	0.71	0.59–0.84	0.89
2008	1.10	0.95–1.27	0.68	0.55–0.81	0.97
2009	0.98	0.84–1.14	0.72	0.60–0.84	0.91
2010	1.04	0.89–1.21	0.69	0.56–0.82	0.93
2011	1.17	0.99–1.38	0.78	0.67–0.88	1.18
2012	0.83	0.71–0.96	0.69	0.56–0.82	0.75

Table D6: continued.

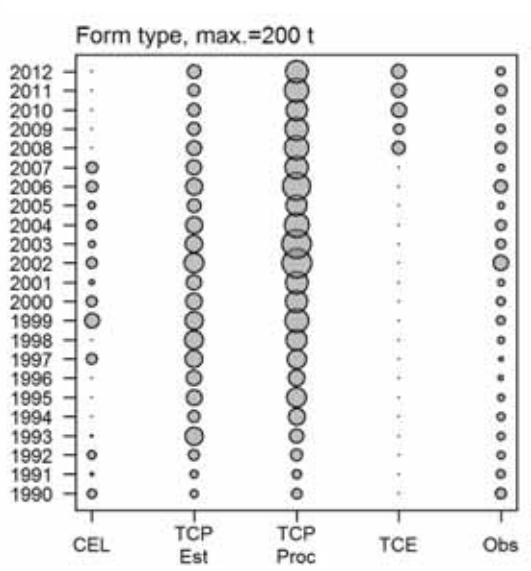
SUBA: TCEPR daily processed BT catch for target hoki or ling

	Lognormal		Binomial		Delta lognormal
Year	**Index**	**CI**	**Index**	**CI**	**Index**
1997	1.50	1.26–1.79	0.72	0.64–0.79	1.68
1998	1.39	1.20–1.60	0.76	0.69–0.82	1.65
1999	1.08	0.93–1.25	0.74	0.67–0.81	1.25
2000	0.88	0.80–0.96	0.65	0.57–0.72	0.89
2001	1.11	1.01–1.22	0.59	0.51–0.67	1.03
2002	1.07	0.97–1.18	0.68	0.60–0.75	1.14
2003	1.19	1.08–1.31	0.57	0.48–0.65	1.06
2004	1.05	0.94–1.16	0.57	0.49–0.66	0.95
2005	1.04	0.92–1.17	0.63	0.55–0.72	1.04
2006	0.92	0.81–1.04	0.61	0.53–0.70	0.89
2007	0.90	0.80–1.01	0.62	0.53–0.70	0.87
2008	0.96	0.85–1.08	0.65	0.57–0.73	0.98
2009	0.80	0.69–0.91	0.60	0.51–0.69	0.75
2010	0.95	0.84–1.08	0.52	0.42–0.61	0.77
2011	0.66	0.58–0.76	0.57	0.48–0.66	0.59
2012	0.84	0.72–0.97	0.61	0.52–0.71	0.81

(a) CHAT



(b) WCSI



(c) SUBA

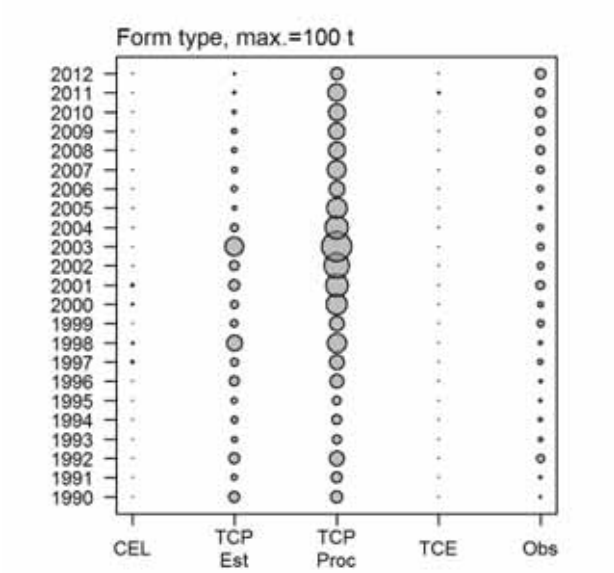


Figure D1: Distribution of annual catch by form type for estimated, merged daily processed data, and observer data. Circle size is proportional to catch; maximum circle size is indicated on each plot. TCP Est is Estimated data from the Trawl, Catch, Effort, and Processing Return; TCP Proc is daily processed data from the Trawl, Catch, Effort, and Processing Return; TCE is Trawl, Catch, Effort Return; Obs is observer data. Areas are shown in Figure 2.

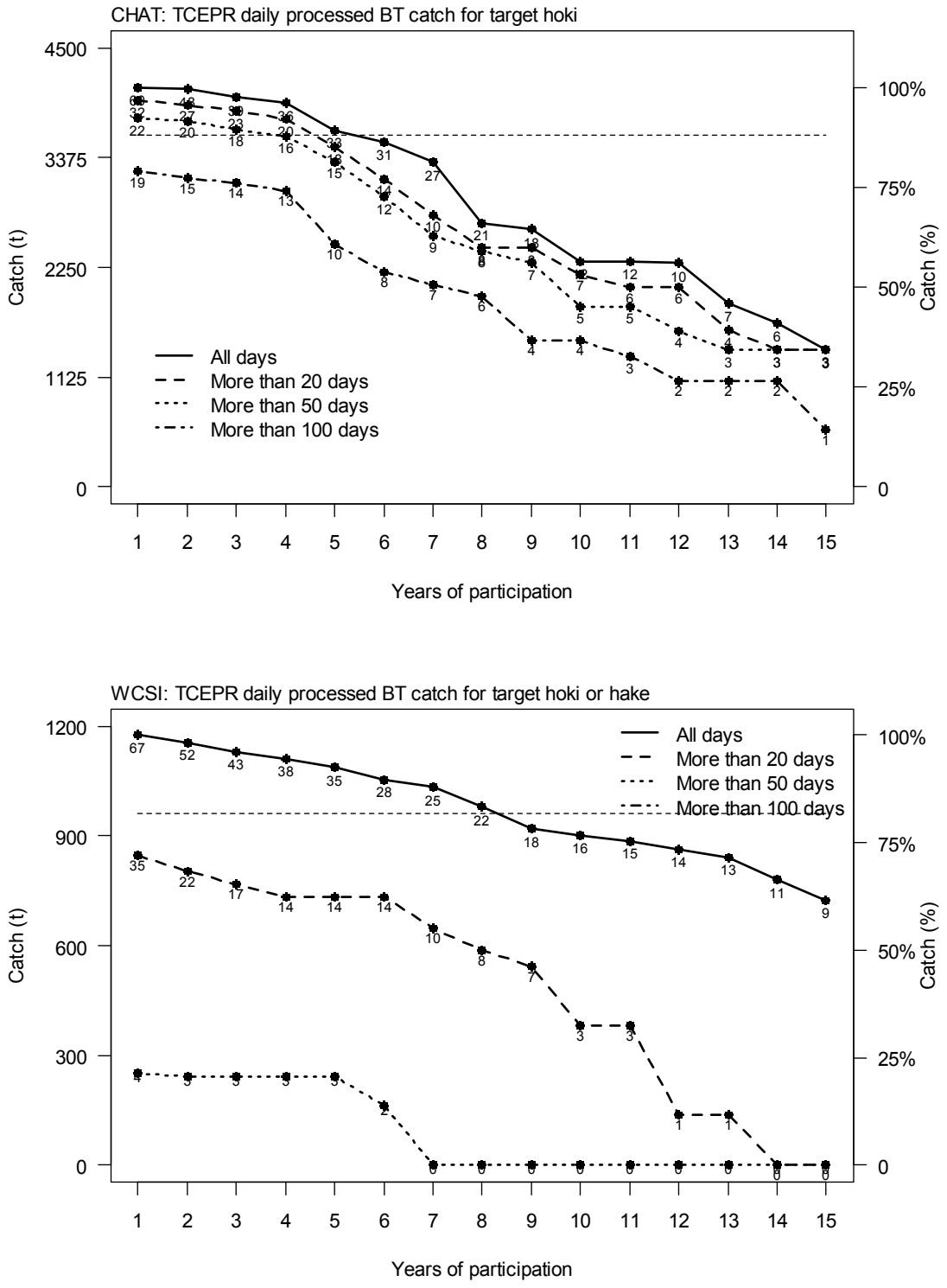


Figure D2: Relationship between years of vessel participation and total lookdown dory catch by area. The number under each circle indicates the number of vessels with the corresponding years of participation. Dotted horizontal line represents 80% of catch.

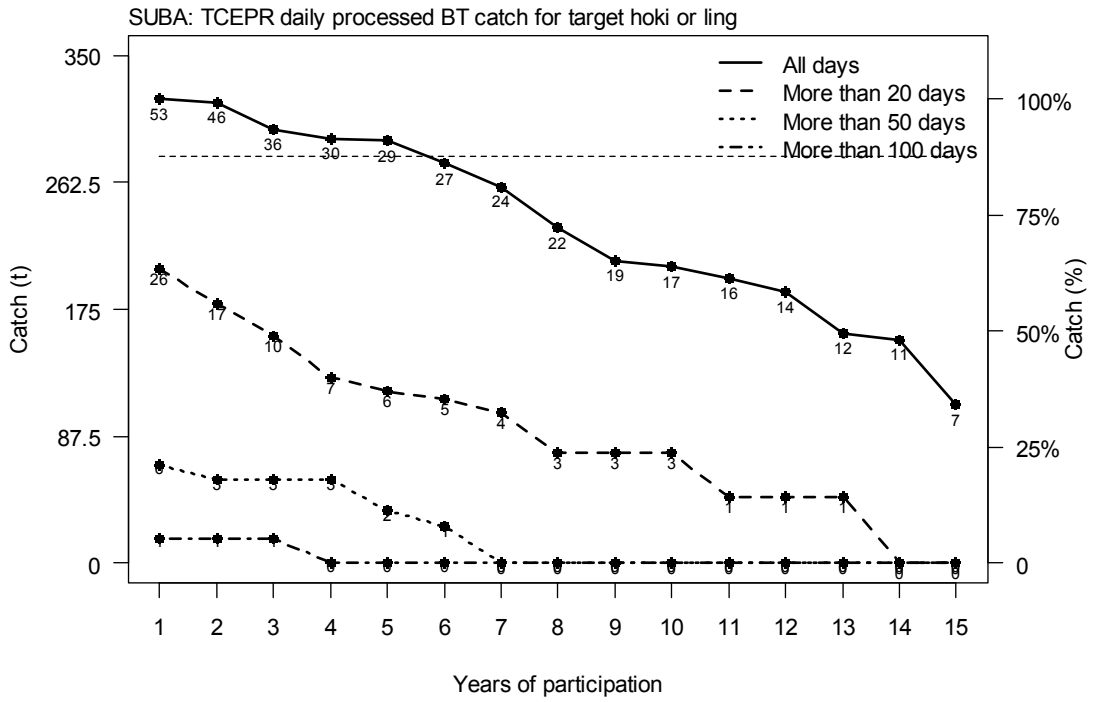


Figure D2: continued.

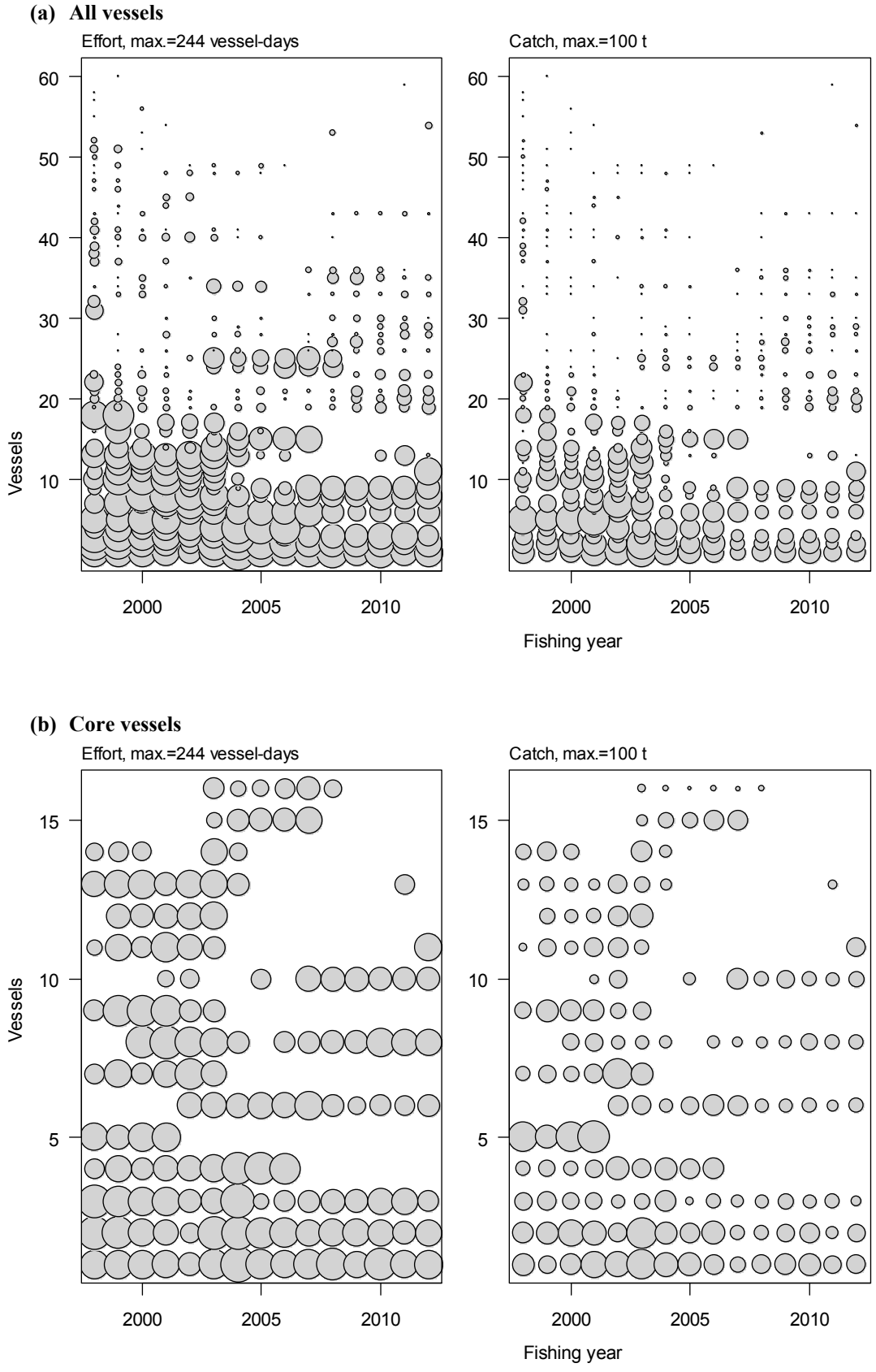


Figure D3: CHAT daily processed analysis. Summary of CHAT effort (number of vessel-days) and processed lookdown dory catch by fishing year 1997–98 (1998) to 2011–12 (2012) from BT target hoki all and core vessels. Symbol area is proportional to either number of vessel-days or annual catch, and maximum circle size is shown on the plot.

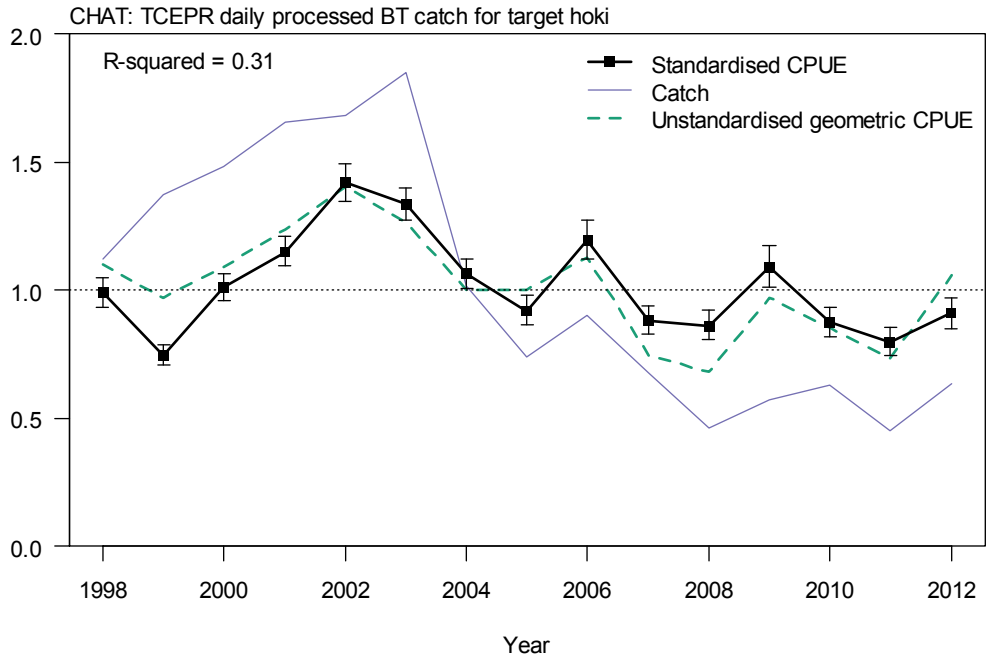


Figure D4: CHAT daily processed analysis. CHAT CPUE lognormal indices showing catches (scaled to same mean as indices), and lognormal standardised and un-standardised indices. Bars indicate 95% confidence intervals. Year defined as October–September.

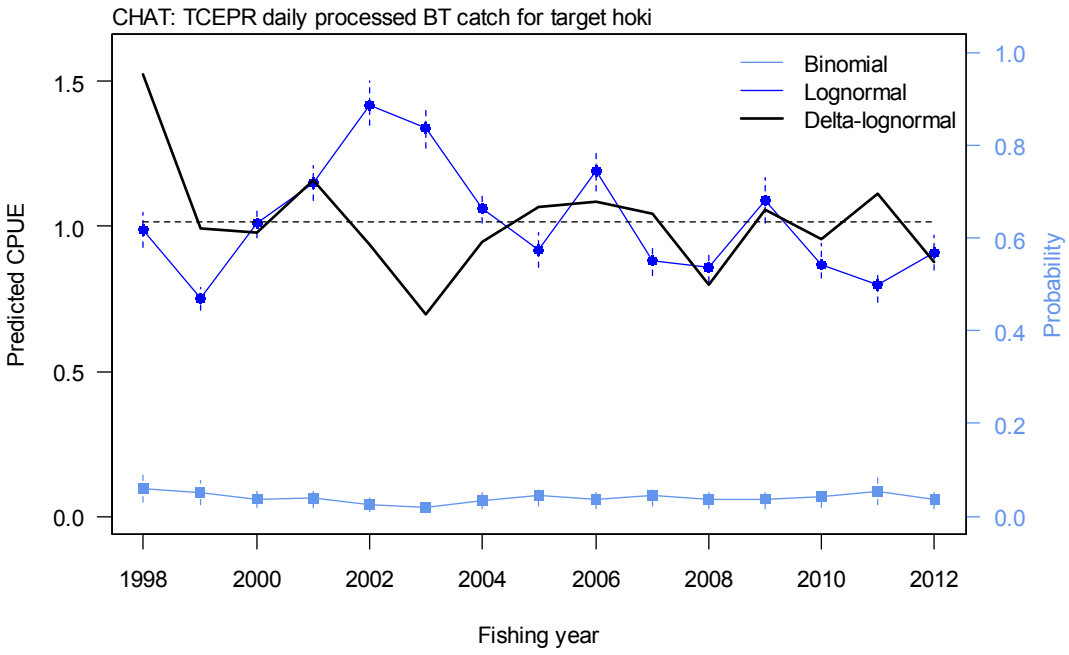


Figure D5: CHAT daily processed analysis. CHAT CPUE from the lognormal, binomial and combined BT target hoki model, 1998–2012. Bars indicate 95% confidence intervals. Year defined as October–September.

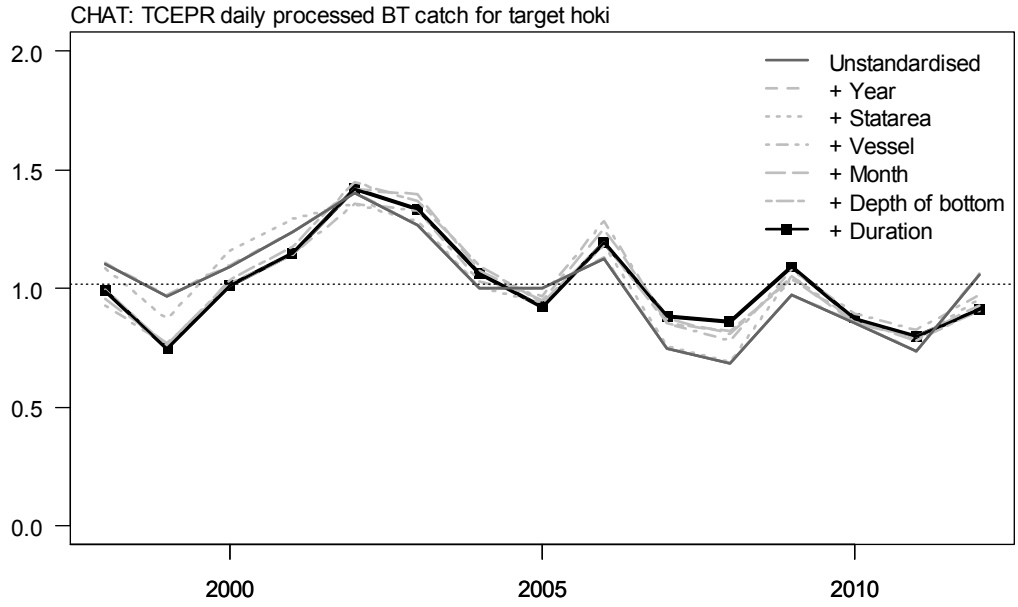


Figure D6: CHAT daily processed analysis. Addition of variables into the CHAT CPUE lognormal CPUE model for each fishery by fishing year. Year defined as October–September.

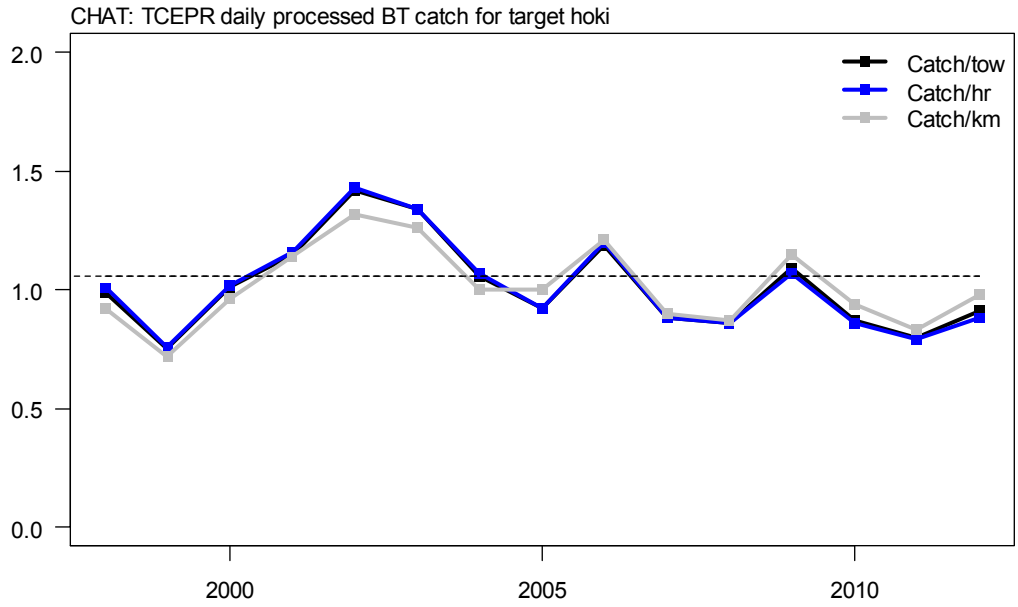


Figure D7: CHAT daily processed analysis. Comparison of CHAT daily processed indices for lookdown dory datasets by fishing year. Year defined as October–September.

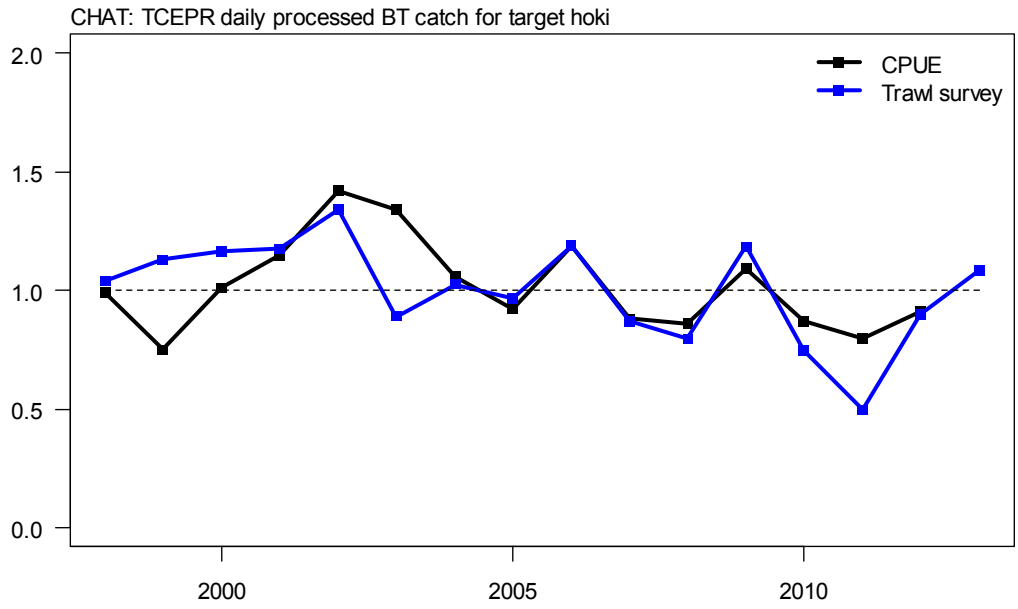


Figure D8: CHAT daily processed analysis. Comparison of CHAT TCEPR daily processed BT target hoki core indices with CHAT *Tangaroa* summer trawl survey series.

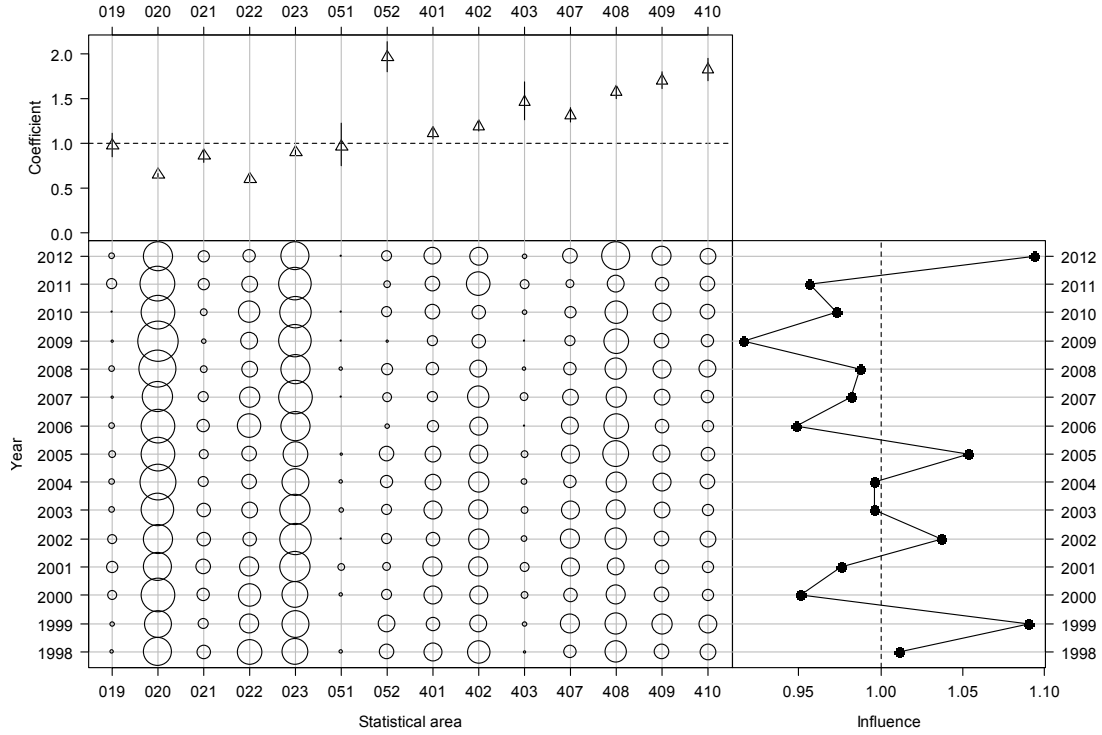


Figure D9a: CHAT daily processed analysis. Effect and influence of statistical area in the CHAT daily processed core BT target hoki vessel lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of variable (statistical area) by fishing year. Bottom right: influence of variable (statistical area) on unstandardised CPUE by fishing year.

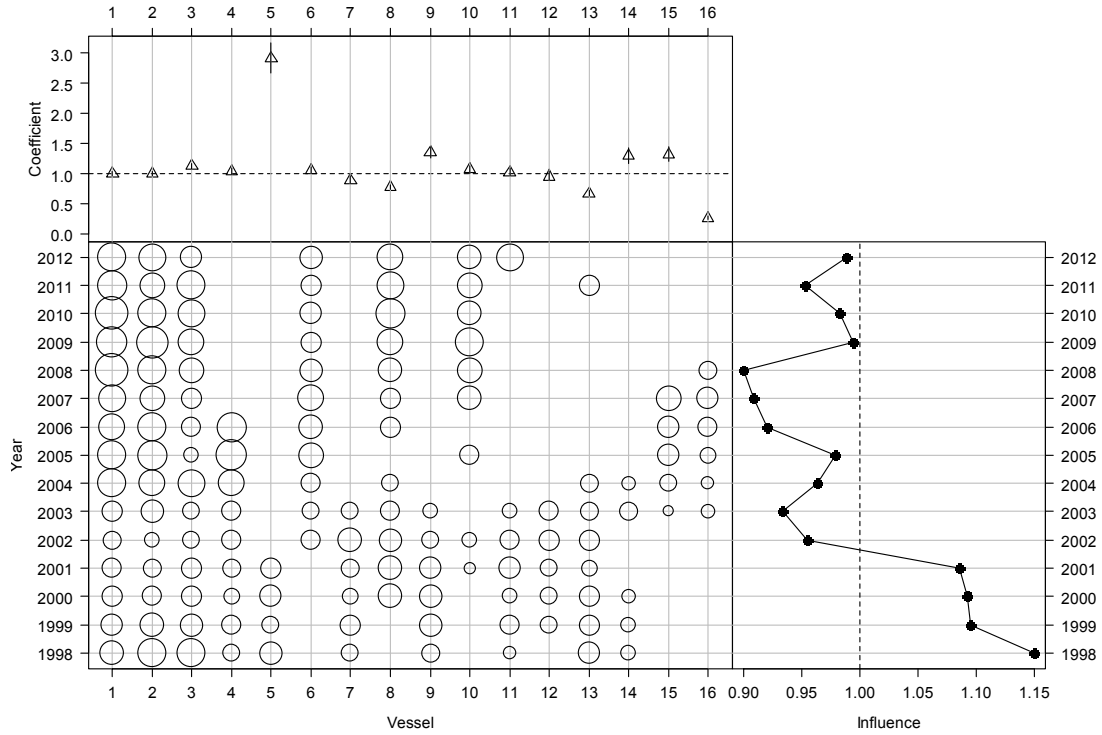


Figure D9b: CHAT daily processed analysis. Effect and influence of vessel in the CHAT daily processed core BT target hoki lognormal model. See caption (Figure D9a) for details.

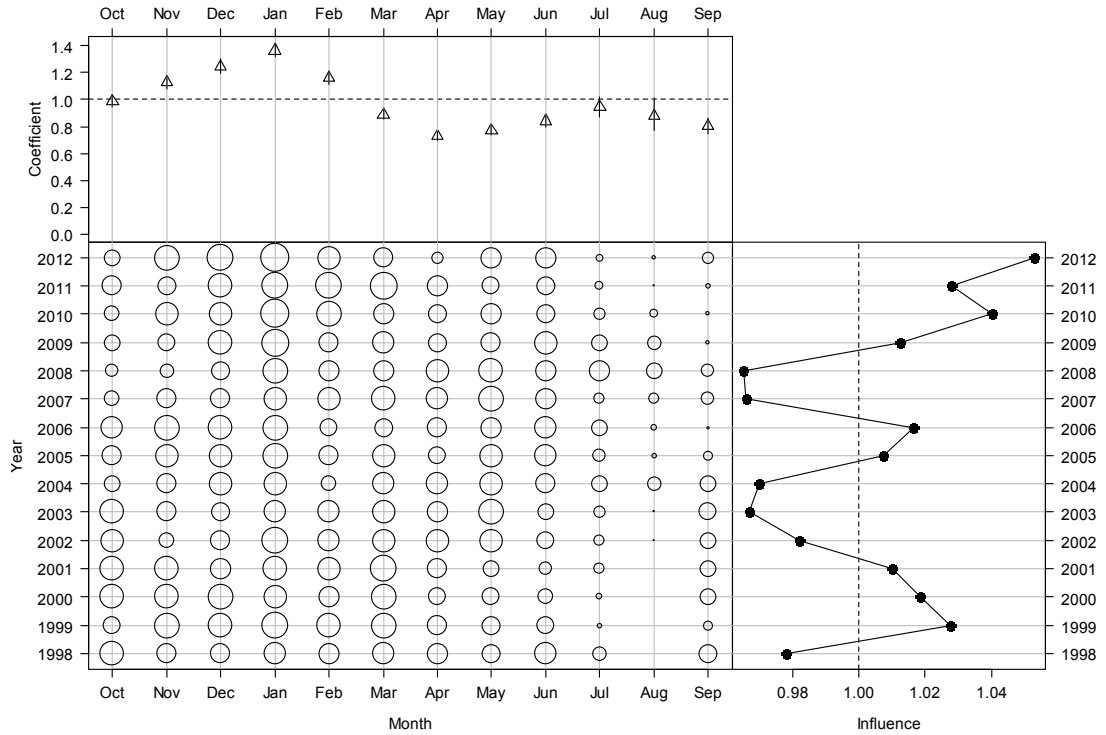


Figure D9c: CHAT daily processed analysis. Effect and influence of month in the CHAT daily processed BT target hoki core lognormal model. See caption (Figure D9a) for details.

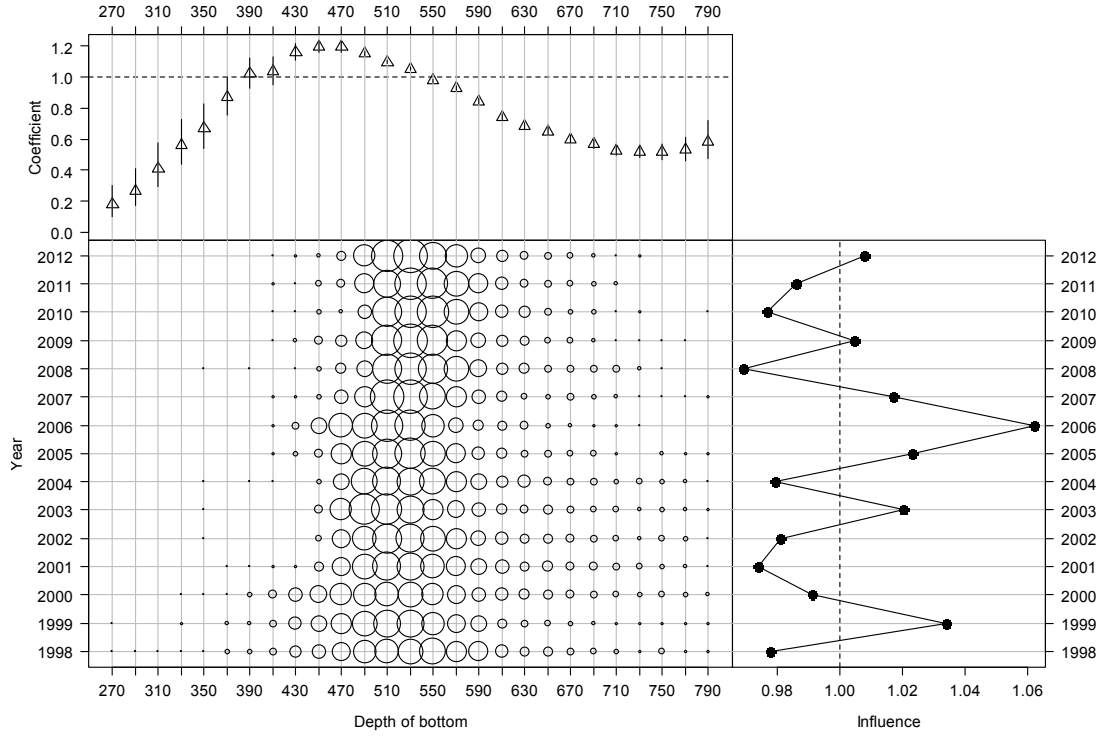


Figure D9d: CHAT daily processed analysis. Effect and influence of depth of bottom in the CHAT daily processed BT target hoki core lognormal model. See caption (Figure D9a) for details.

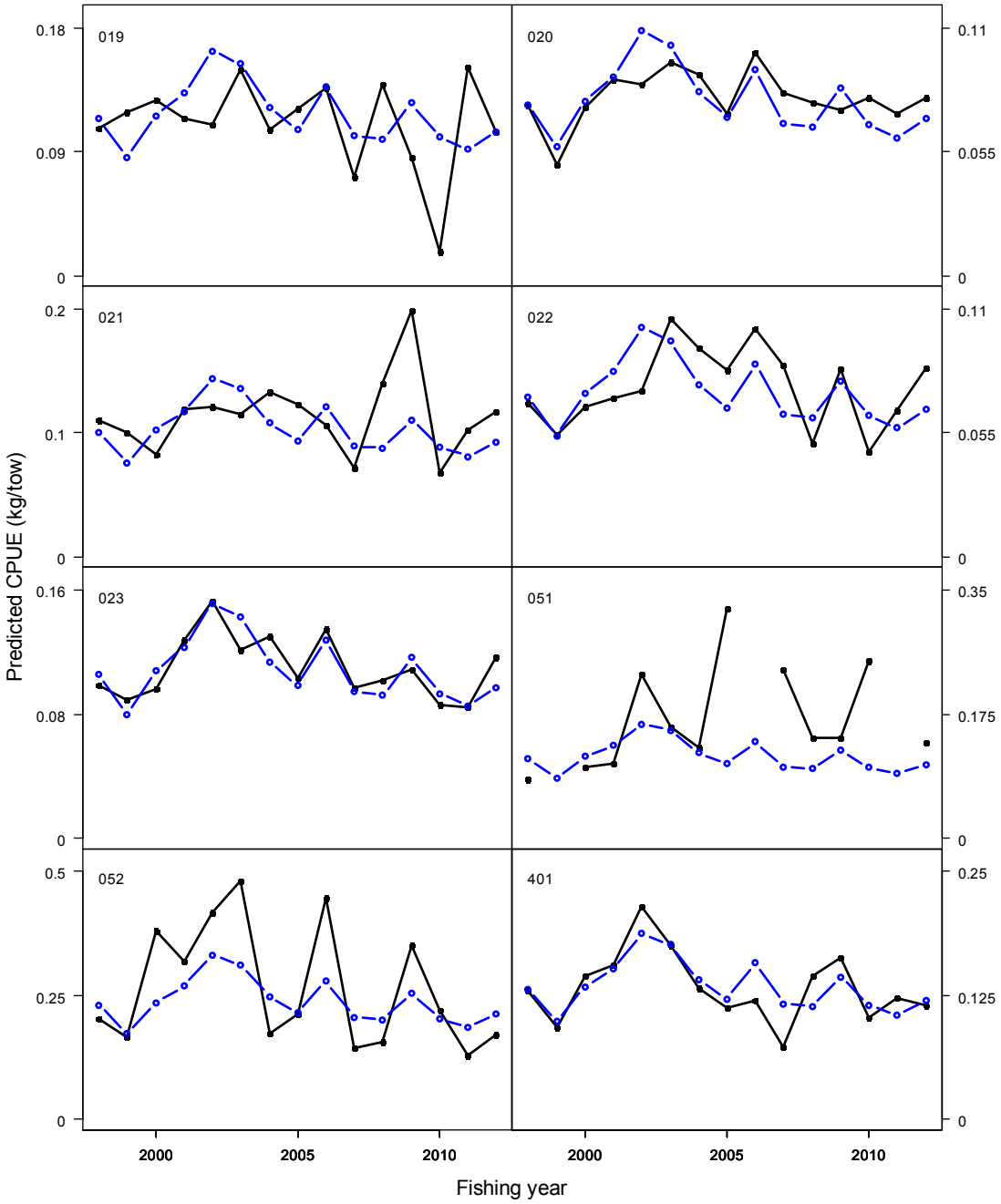


Figure D10: CHAT daily processed analysis. Predicted CPUE by statistical area for the CHAT daily processed BT target hoki core lognormal model showing model with year-statistical area interaction (black) and without year-statistical area interaction (blue).

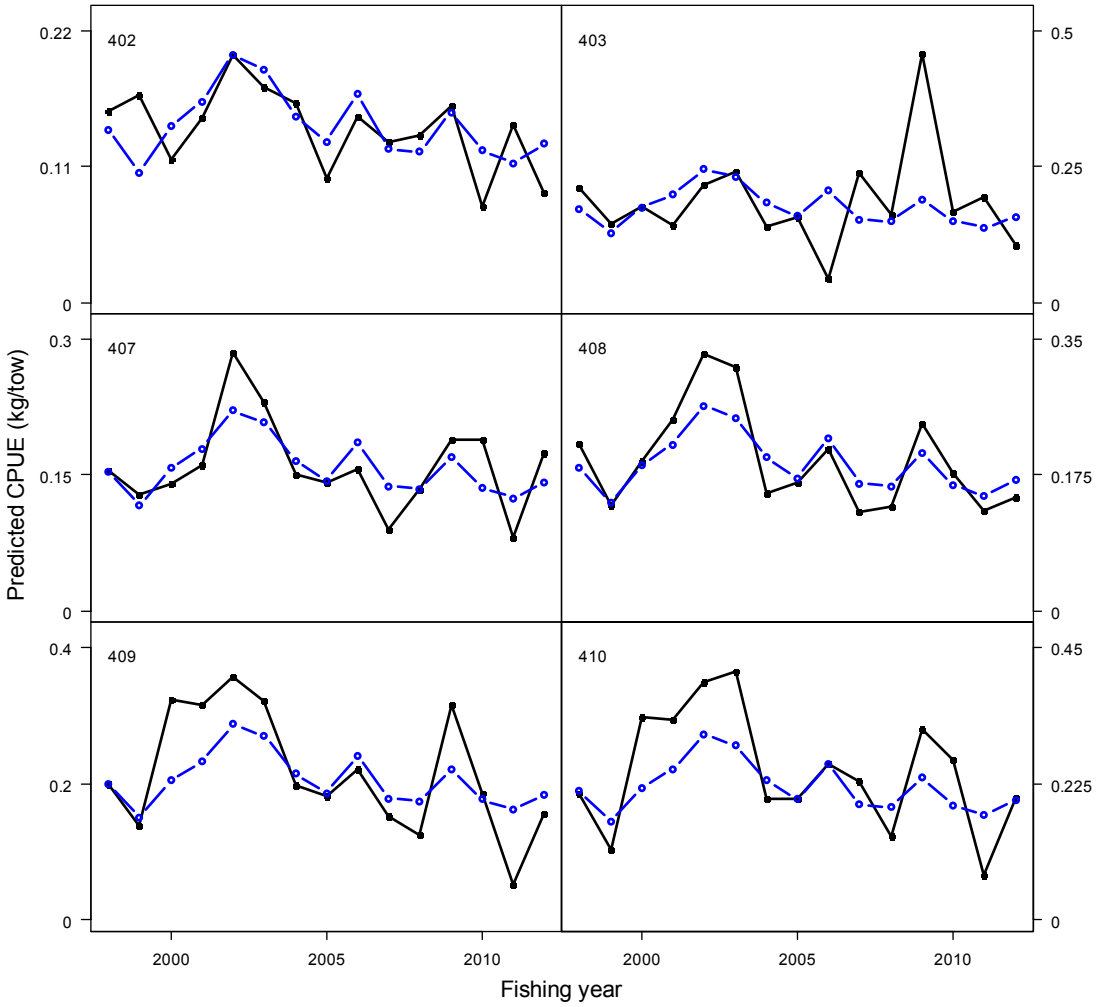


Figure D10 ctd.: CHAT daily processed analysis. CHAT Statistical area interactions continued.

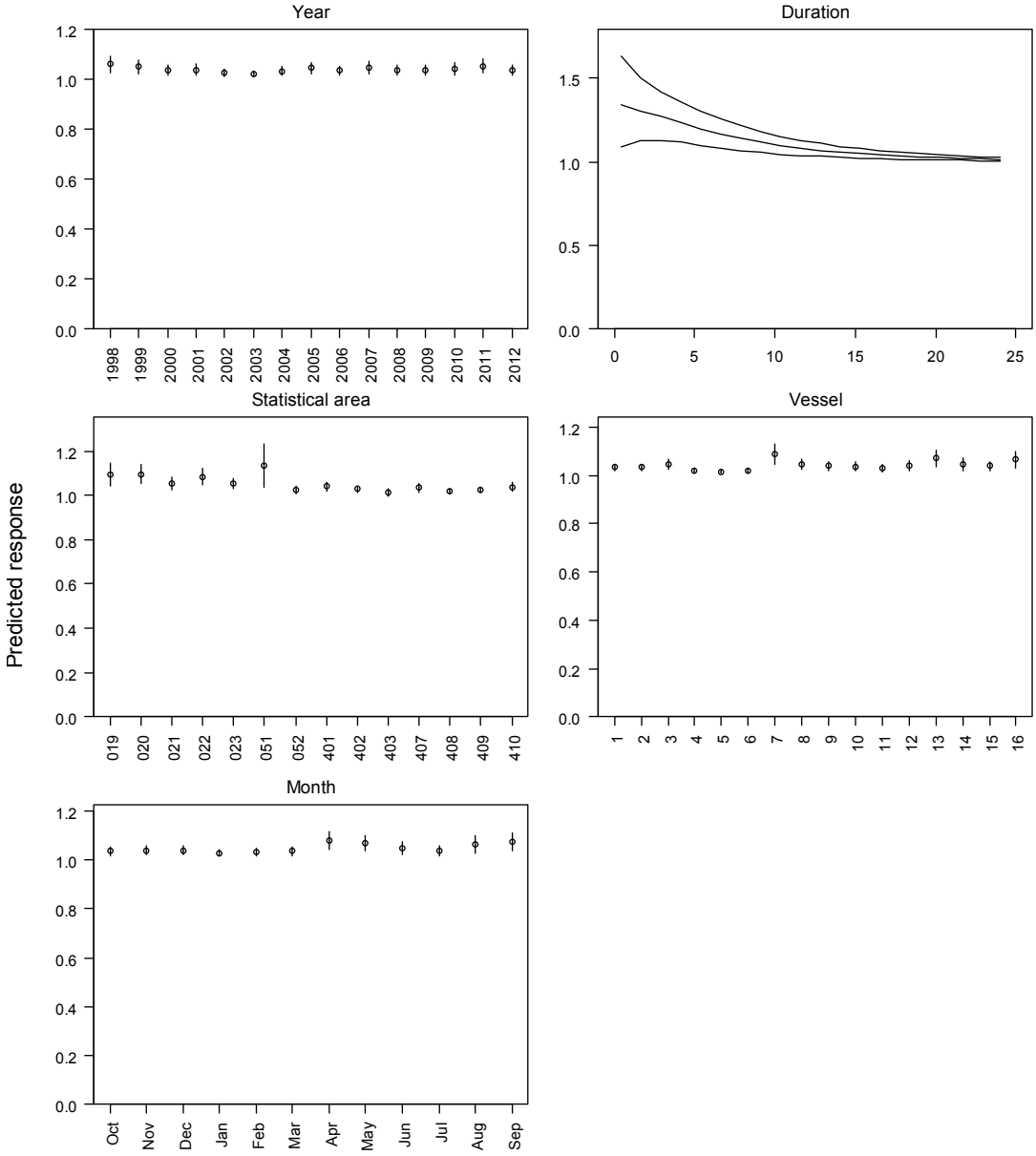


Figure D11: CHAT daily processed analysis. CHAT TCEPR daily processed BT catch for target hoki. Binomial effects of selected variables in the binomial model for the CHAT estimated catch for core BT target hoki vessels, 1998–2012. Bars indicate 95% confidence interval.

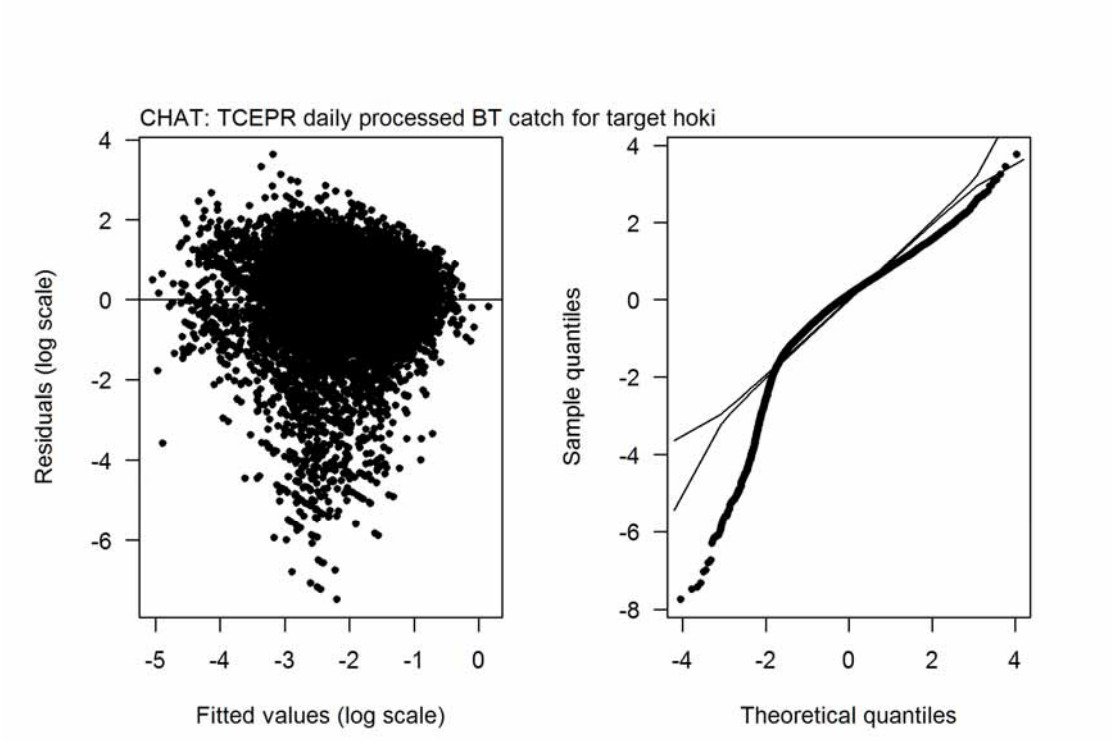


Figure D12a: CHAT daily processed analysis. CHAT daily processed BT target hoki core data for the lognormal model; distribution of the standardised residuals against fitted values (left) and quantile-quantile plot of the residuals (right).

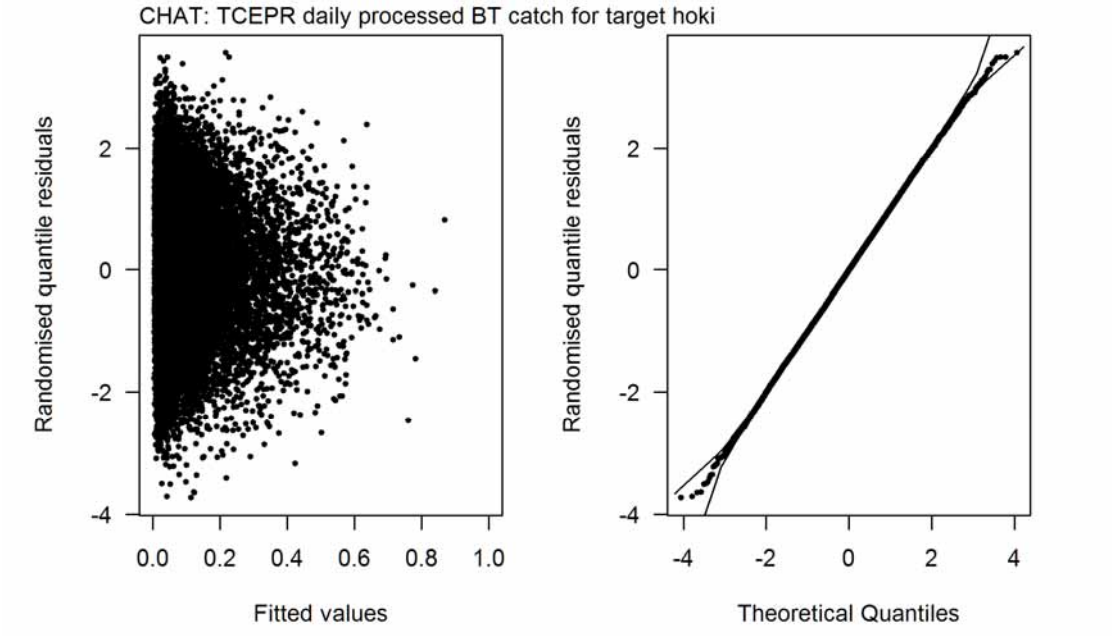
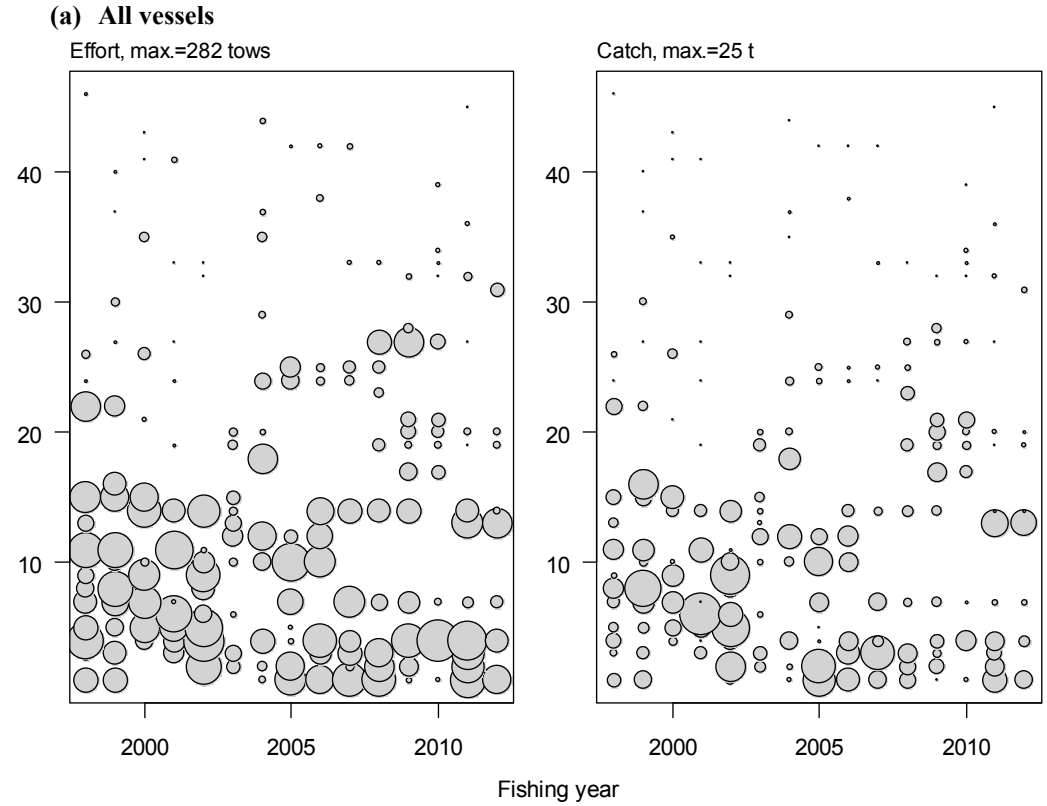


Figure D12b: CHAT daily processed analysis. CHAT daily processed BT target hoki core data for the binomial model; distribution of the randomised quantile residuals against fitted values (left) and quantile-quantile plot of the randomised quantile residuals (right).



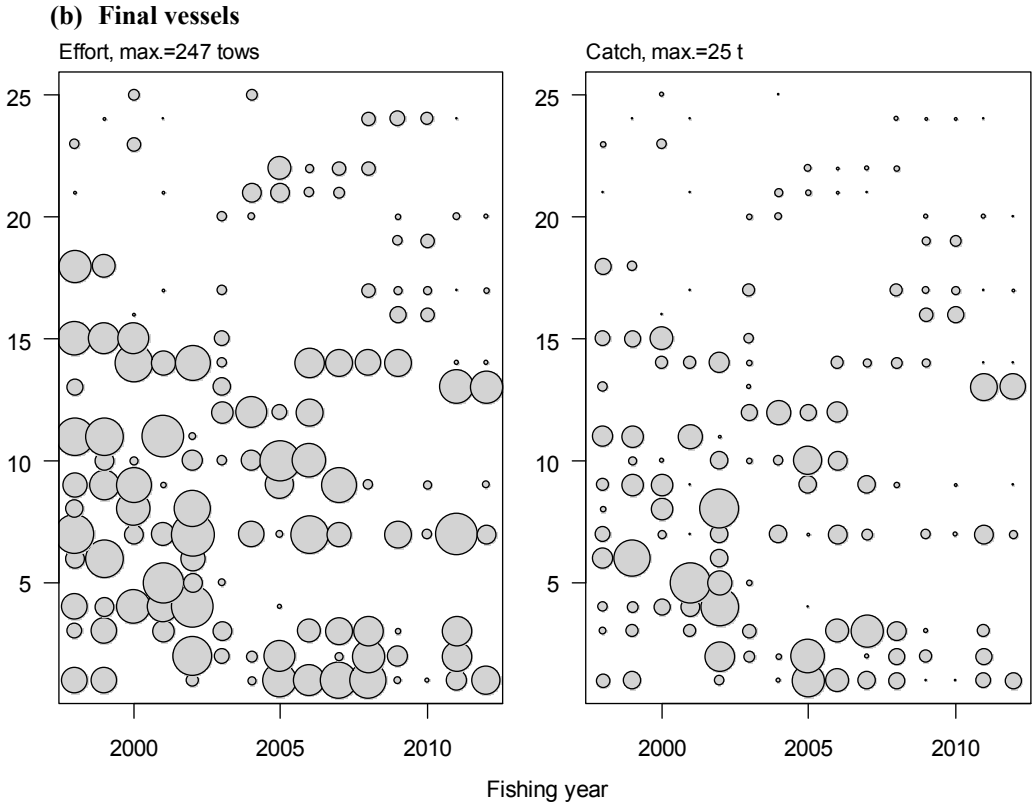


Figure D13: CHAT observer analysis. Summary of CHAT observed effort (number of tows) and estimated lookdown dory catch by fishing year 1997–98 (1998) to 2011–12 (2012) from BT target hoki all and final vessels. Symbol area is proportional to either number of vessel-days or annual catch, and maximum circle size is shown on the plot.

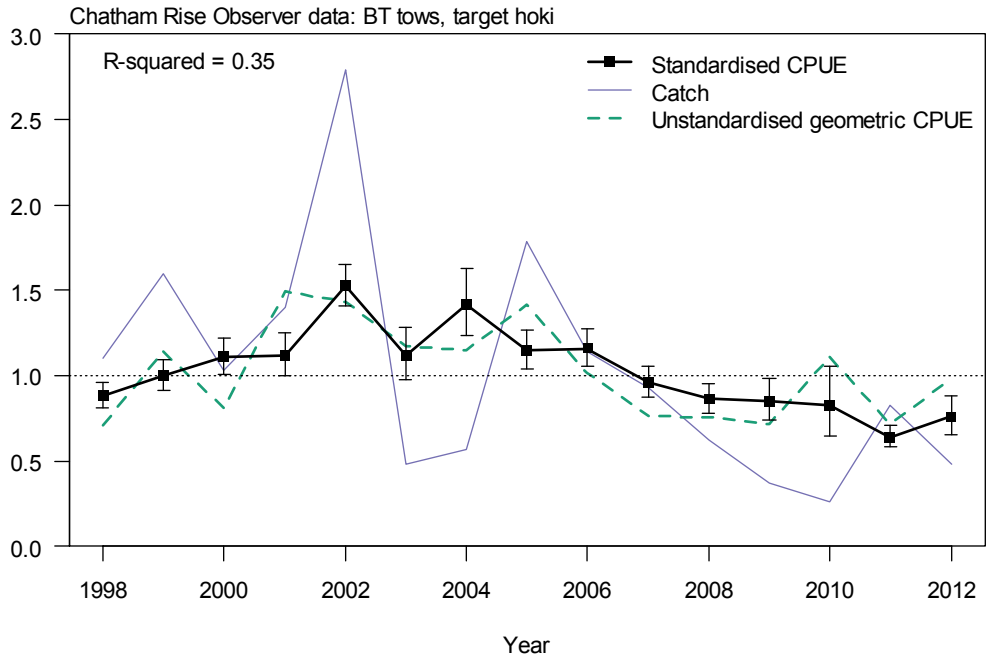


Figure D14: CHAT observer analysis. CHAT CPUE lognormal indices showing catches (scaled to same mean as indices), and lognormal standardised and un-standardised indices. Bars indicate 95% confidence intervals. Year defined as October–September.

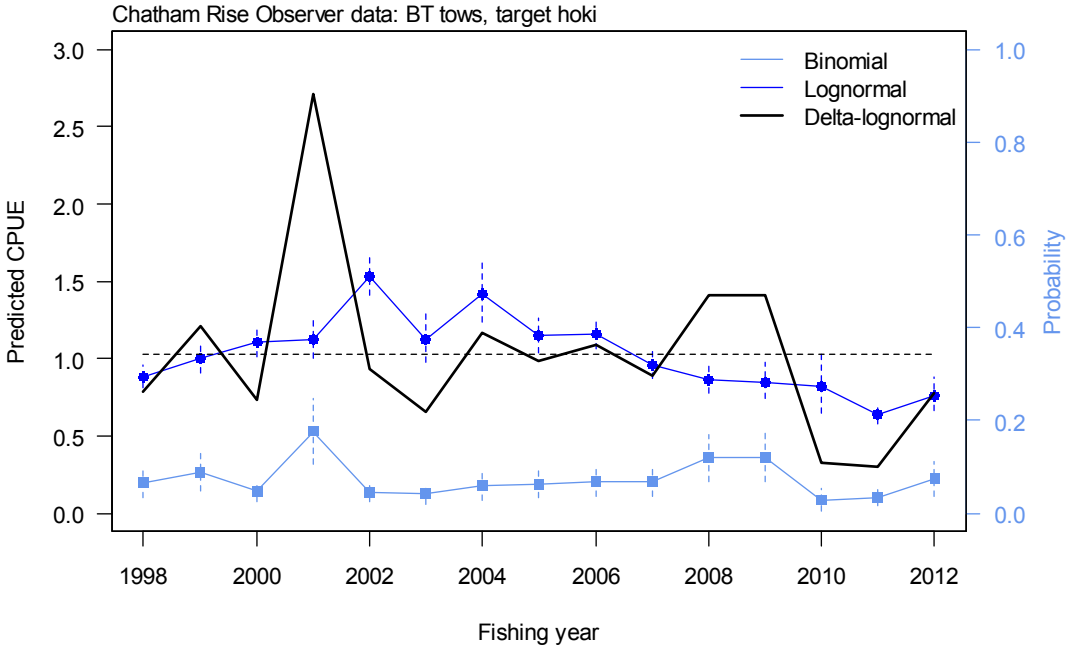


Figure D15: CHAT observer analysis. CHAT CPUE from the lognormal, binomial and combined BT target hoki model, 1998–2012. Bars indicate 95% confidence intervals. Year defined as October–September.

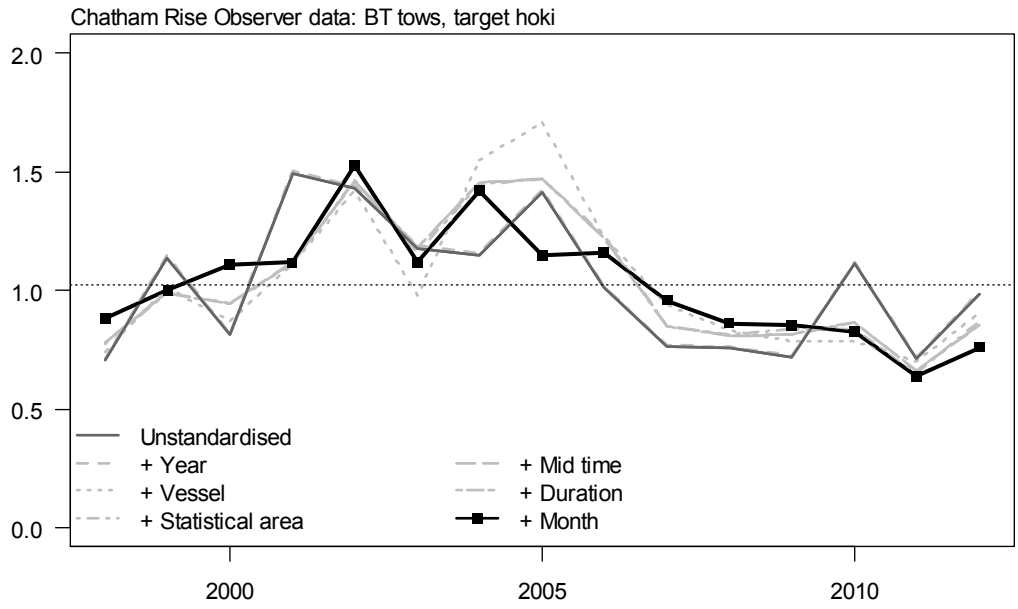


Figure D16: CHAT observer analysis. Addition of variables into the CHAT CPUE lognormal CPUE model by fishing year by fishing year 1997–98 (1998) to 2011–12 (2012). Year defined as October–September.

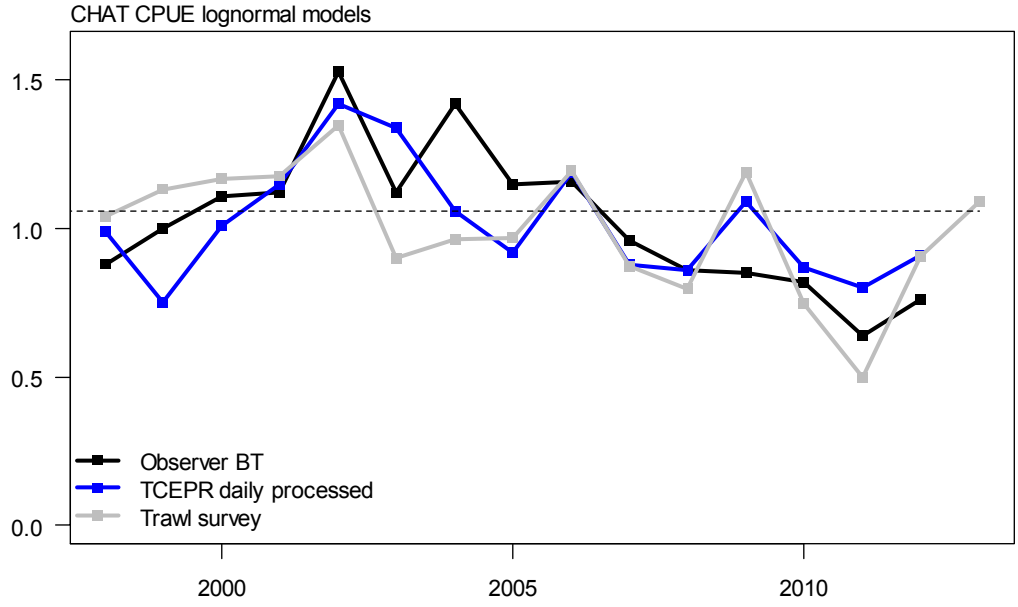


Figure D17: CHAT observer analysis. Comparison of CHAT TCEPR observer BT target hoki indices with CHAT *Tangaroa* summer trawl survey series by fishing year by fishing year for 1997–98 (1998) to 2011–12 (2012). Year defined as October–September.

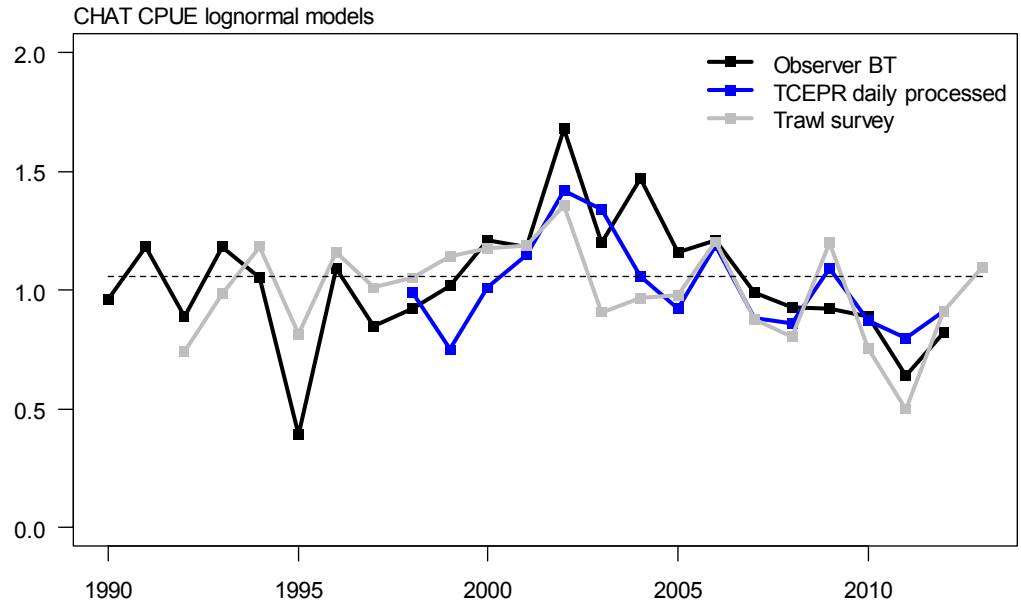


Figure D18: CHAT observer analysis. Comparison of CHAT TCEPR observer BT target hoki indices with CHAT *Tangaroa* summer trawl survey series by fishing year by fishing year for 1989–90 (1990) to 2011–12 (2012). Year defined as October–September.

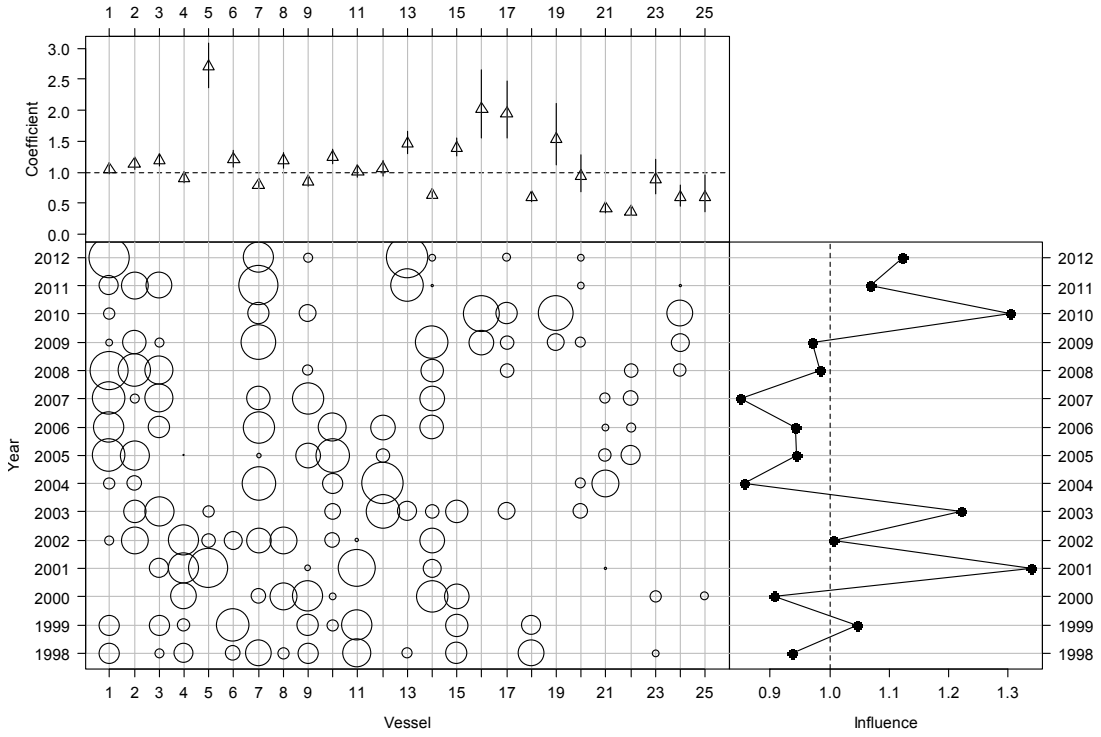


Figure D19a: CHAT observer analysis. Effect and influence of vessel in the CHAT observer BT target hoki vessel lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of variable (vessel) by fishing year. Bottom right: influence of variable (vessel) on unstandardised CPUE by fishing year.

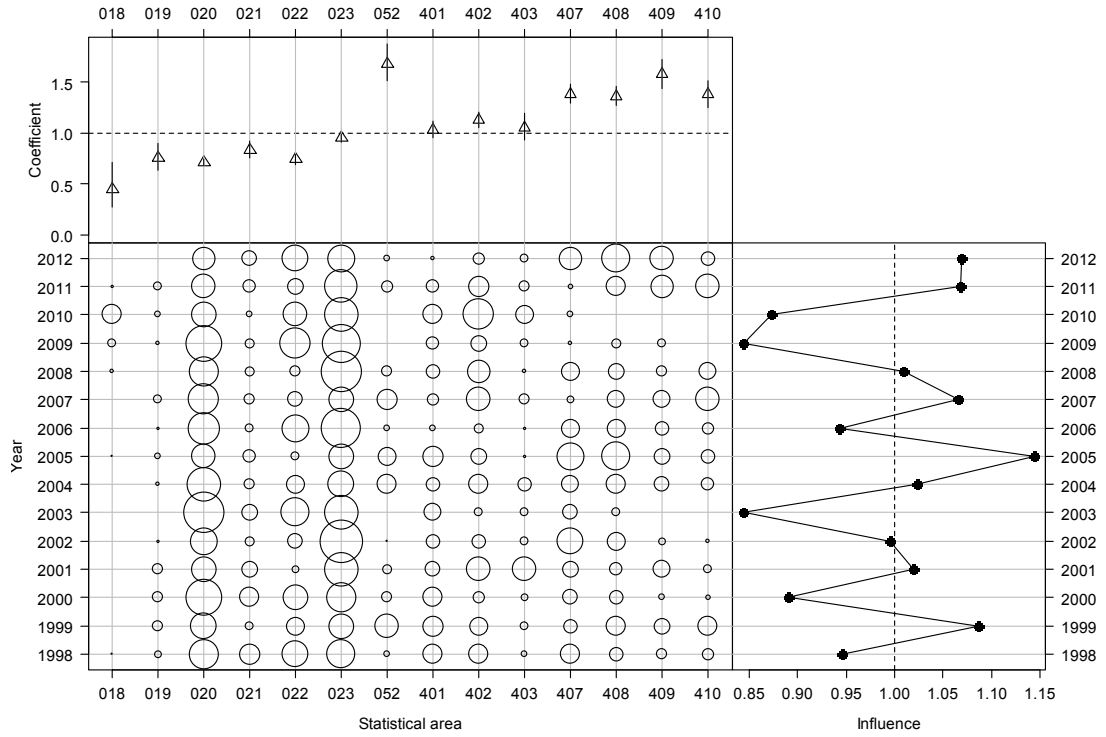


Figure D19b: CHAT observer analysis. Effect and influence of statistical area in the CHAT observer BT target hoki lognormal model. See caption (Figure D19a) for details.

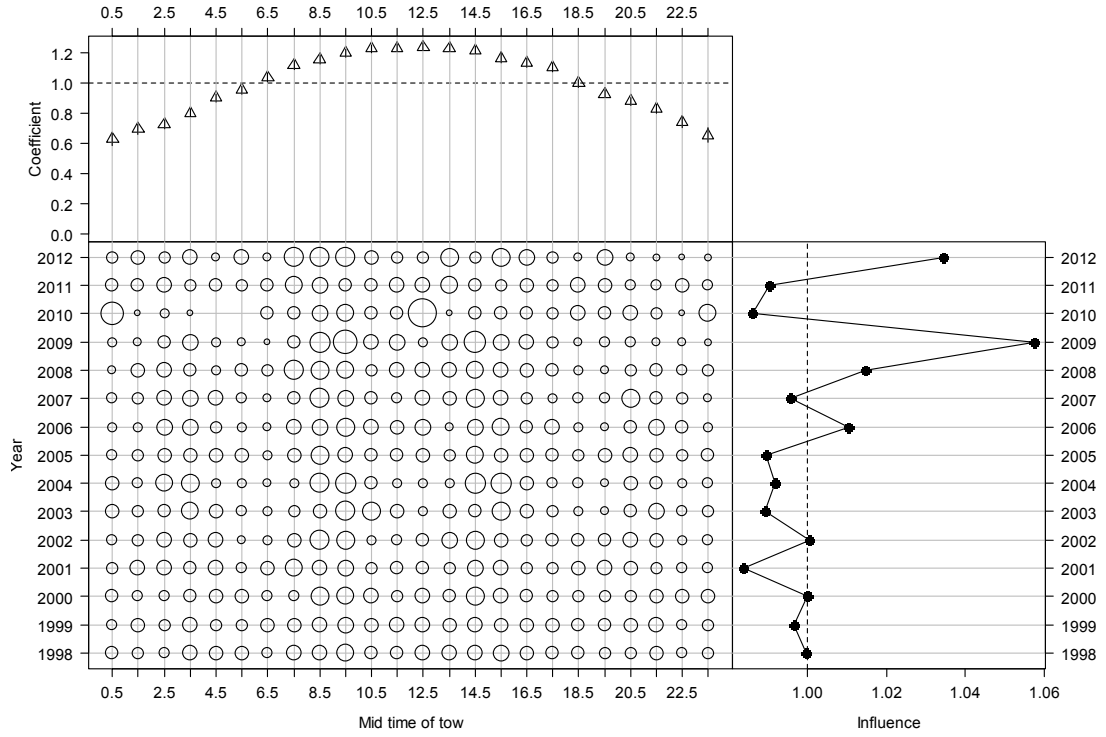


Figure D19c: CHAT observer analysis. Effect and influence of mid time of tow in the CHAT observer BT target hoki lognormal model. See caption (Figure D19a) for details.

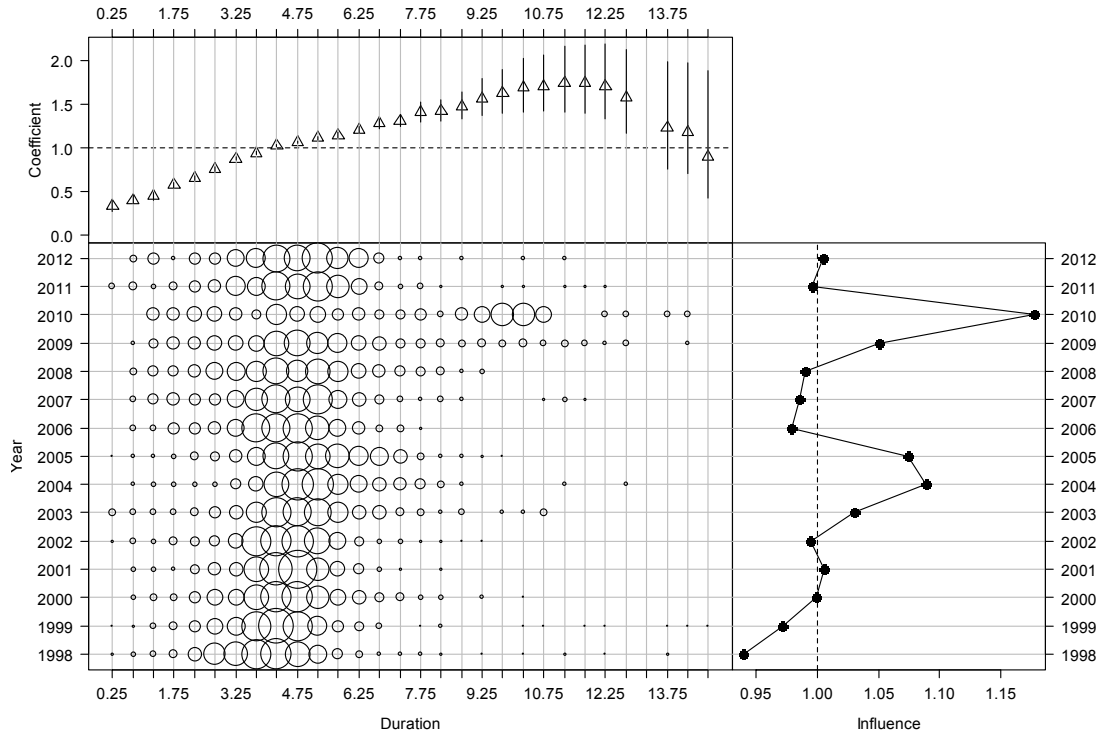


Figure D19d: CHAT observer analysis. Effect and influence of duration in the CHAT BT target hoki lognormal model. See caption (Figure D19a) for details.

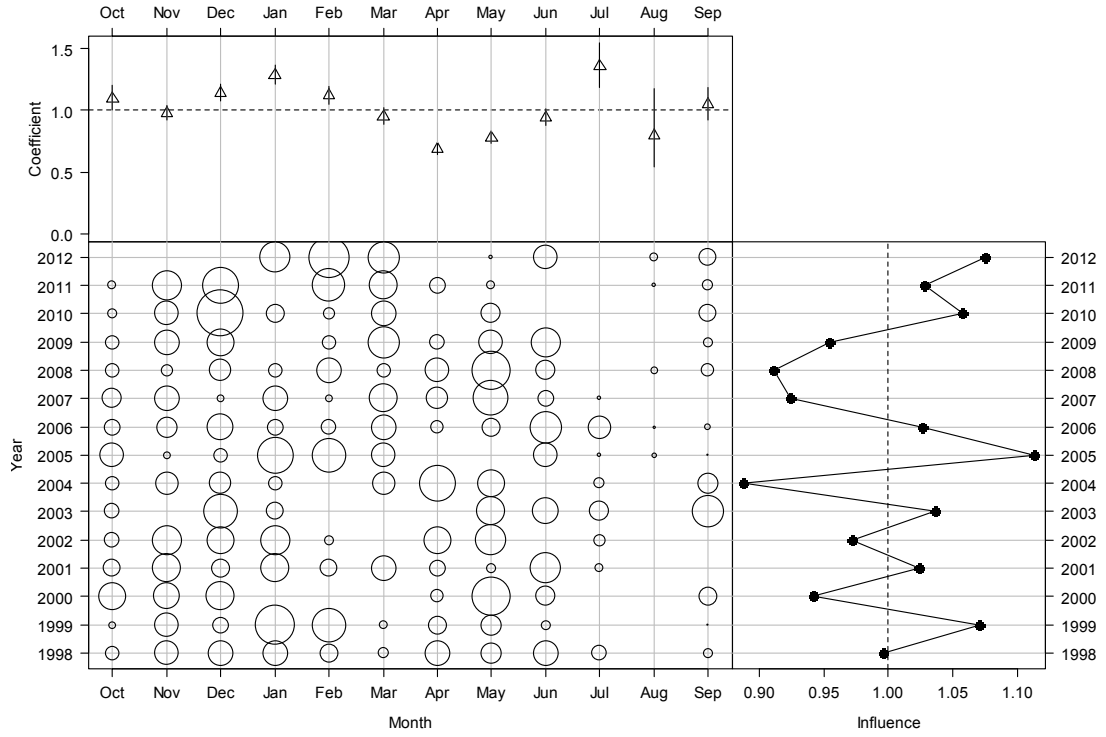


Figure D19e: CHAT observer analysis. Effect and influence of month in the CHAT BT target hoki lognormal model. See caption (Figure D19a) for details.

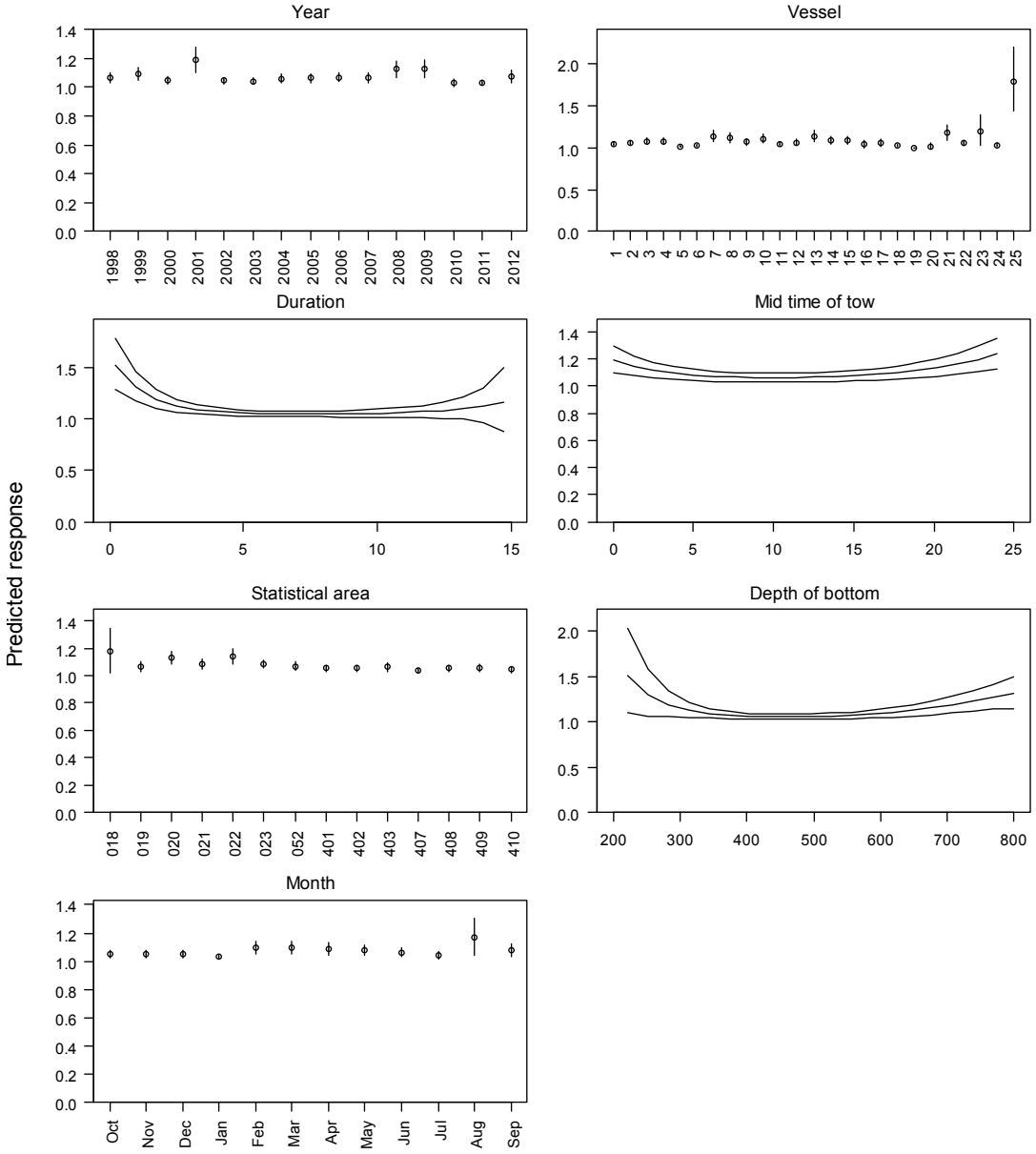


Figure D20: CHAT observer analysis. Binomial effects of selected variables in the binomial model for the CHAT estimated observer catch for core BT target hoki vessels, 1998–2012. Bars indicate 95% confidence interval.

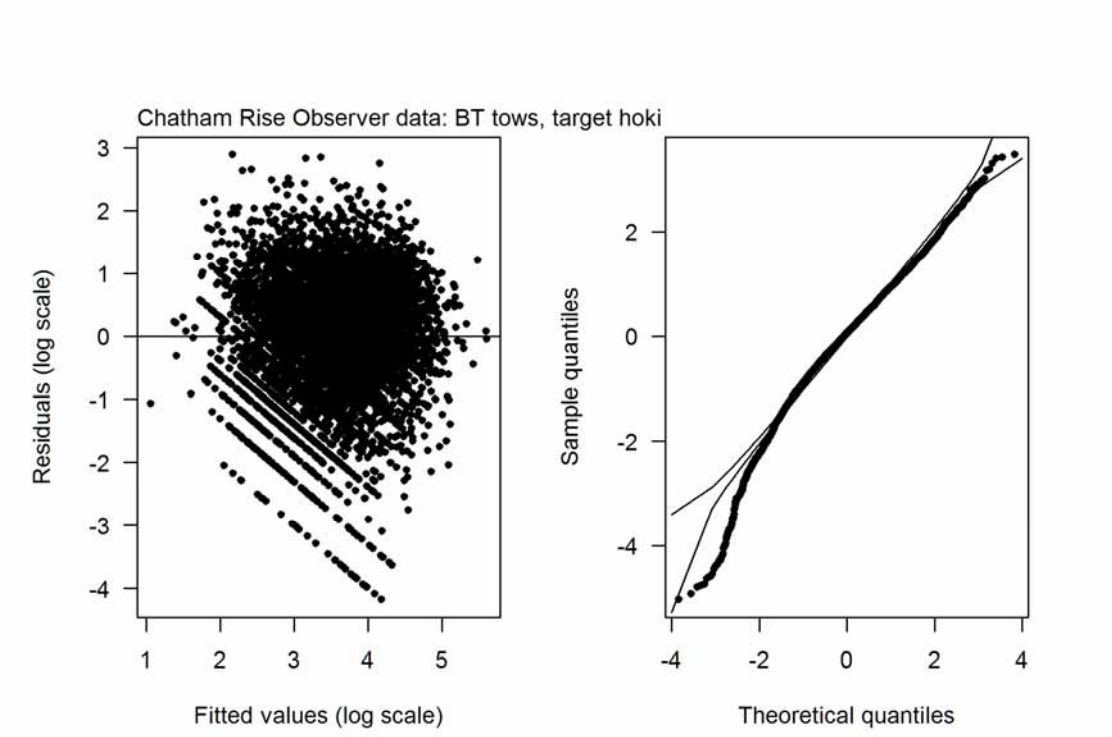


Figure D21a: CHAT observer analysis. CHAT observer BT target hoki core data for the lognormal model; distribution of the standardised residuals against fitted values (left) and quantile-quantile plot of the residuals (right).

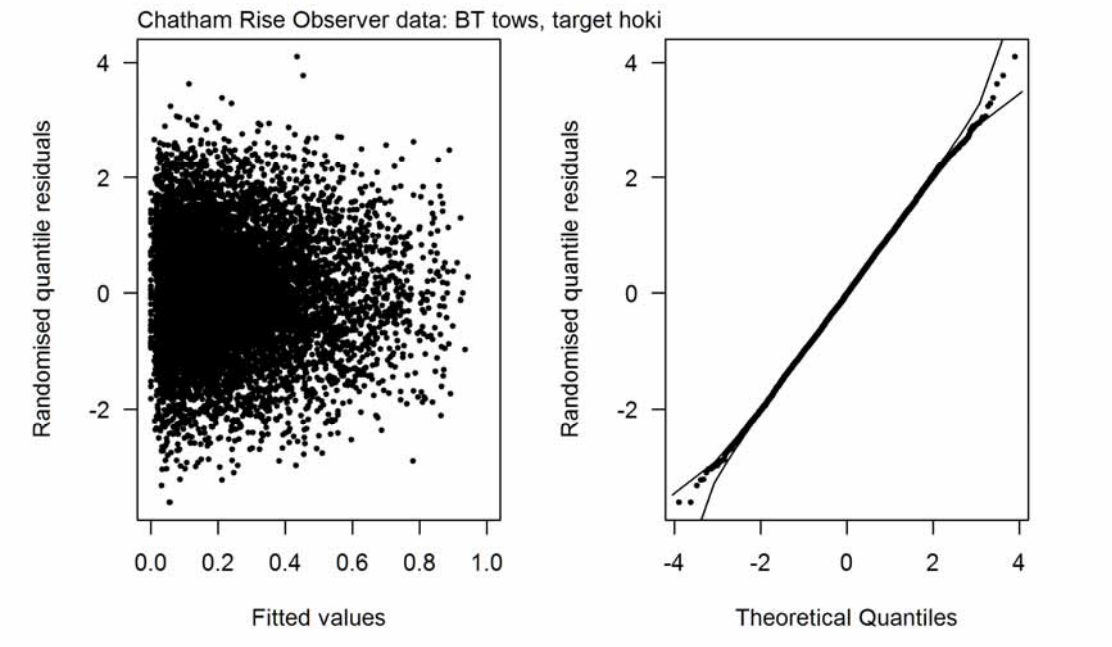


Figure D21b: CHAT observer analysis. CHAT observer BT target hoki core data for the binomial model; distribution of the randomised quantile residuals against fitted values (left) and quantile-quantile plot of the randomised quantile residuals (right).

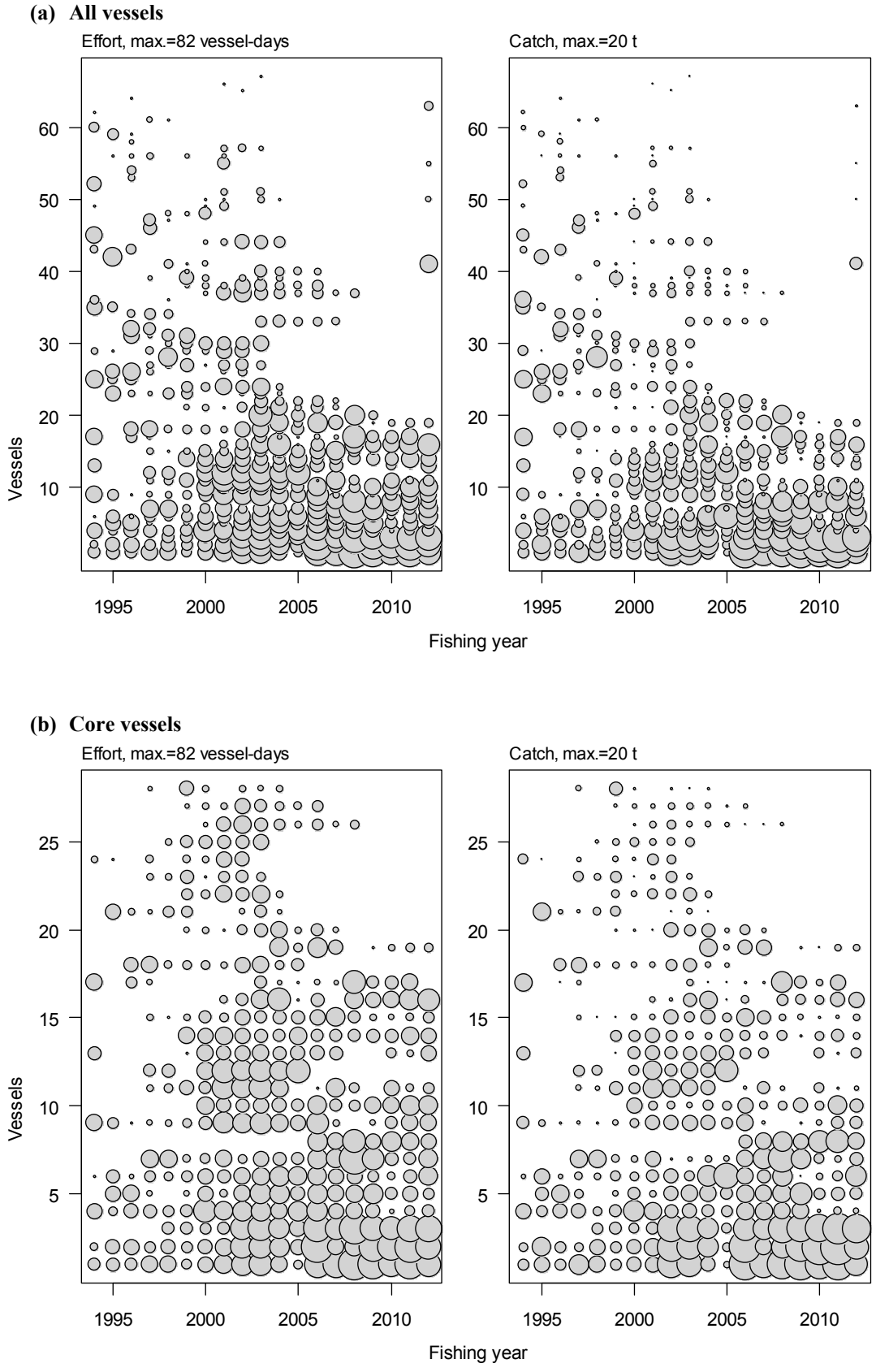


Figure D22: WCSI daily processed analysis. Summary of WCSI effort (number of vessel-days) and processed lookdown dory catch by fishing year 1993–94 (1994) to 2011–12 (2012) from BT hoki or hake all and core vessels. Symbol area is proportional to either number of vessel-days or annual catch, and maximum circle size is shown on the plot.

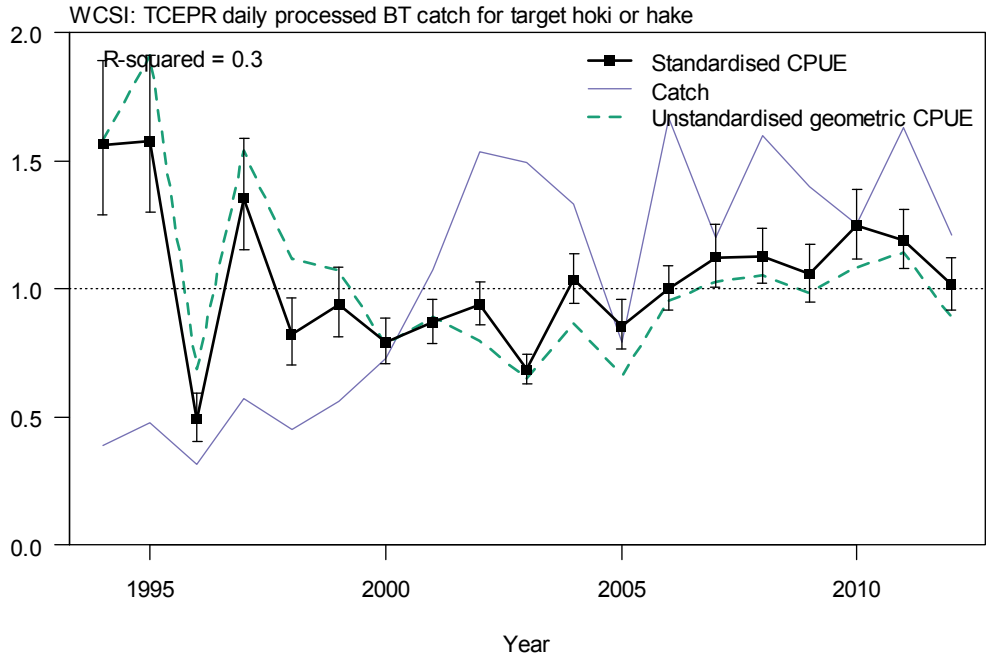


Figure D23: WCSI daily processed analysis. WCSI daily processed BT target hoki or hake daily processed CPUE lognormal indices showing catches (scaled to same mean as indices), and lognormal standardised and un-standardised indices. Bars indicate 95% confidence intervals. Year defined as June–September.

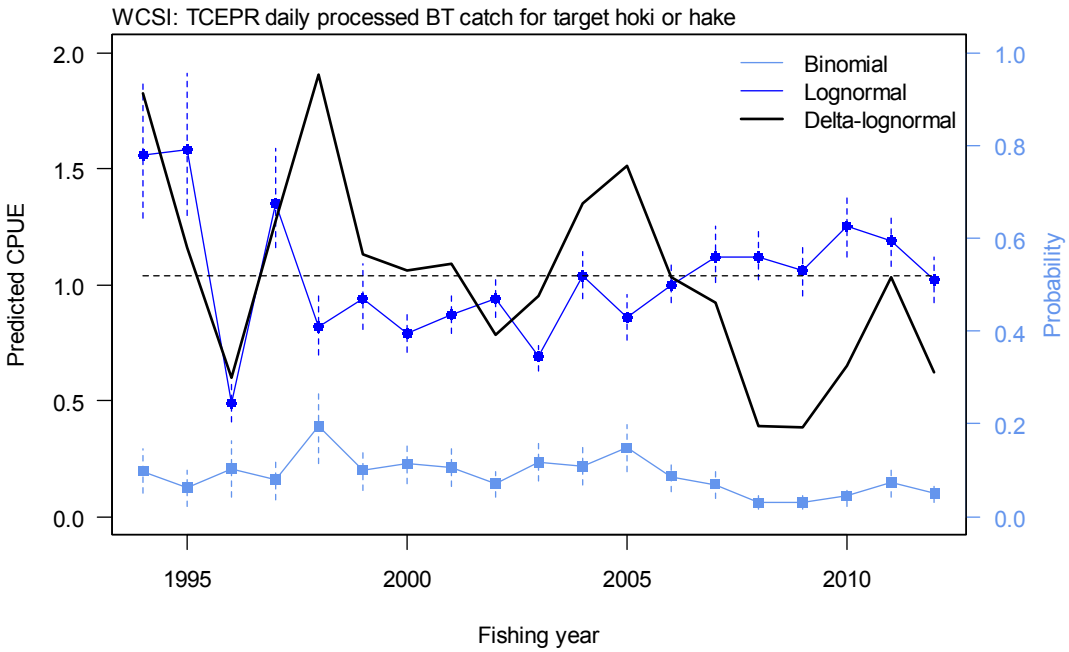


Figure D24: WCSI daily processed analysis. WCSI BT daily processed target hoki or hake CPUE from the lognormal, binomial and combined model, 1994–2012. Bars indicate 95% confidence intervals. Year defined as June–September.

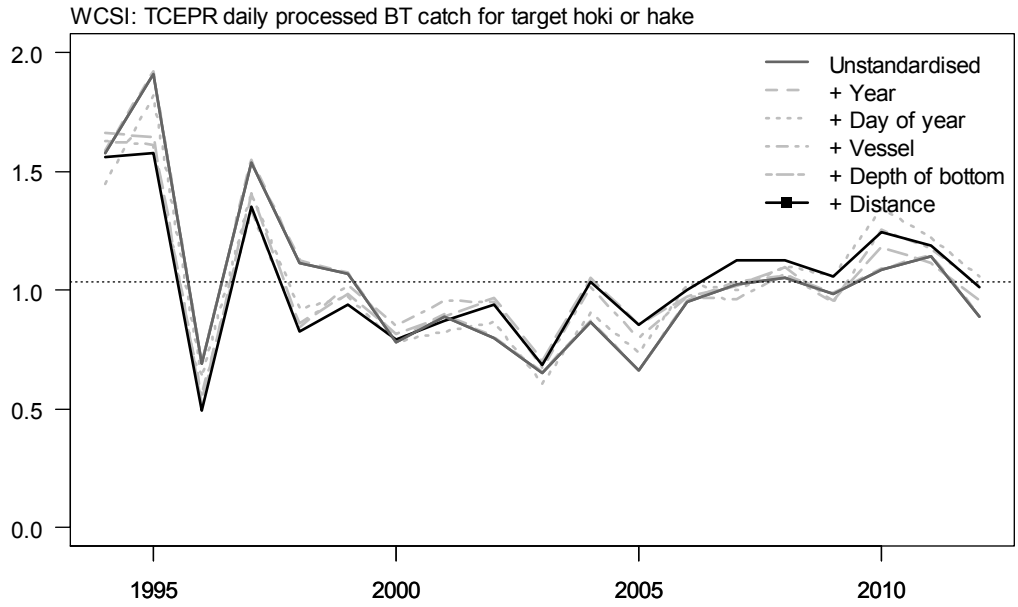


Figure D25: WCSI daily processed analysis. Addition of variables into the WCSI BT target hoki or hake daily processed CPUE lognormal CPUE model for each fishery by fishing year. Year defined as June–September.

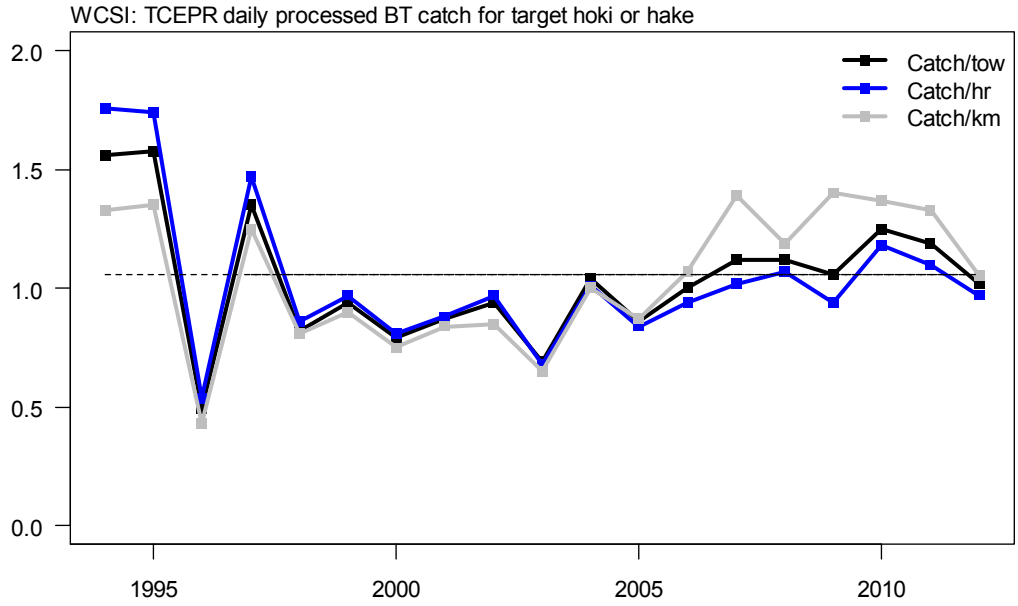


Figure D26: WCSI daily processed analysis. Comparison of WCSI BT daily processed target hoki or hake indices for lookdown dory datasets by fishing year. Year defined as June–September.

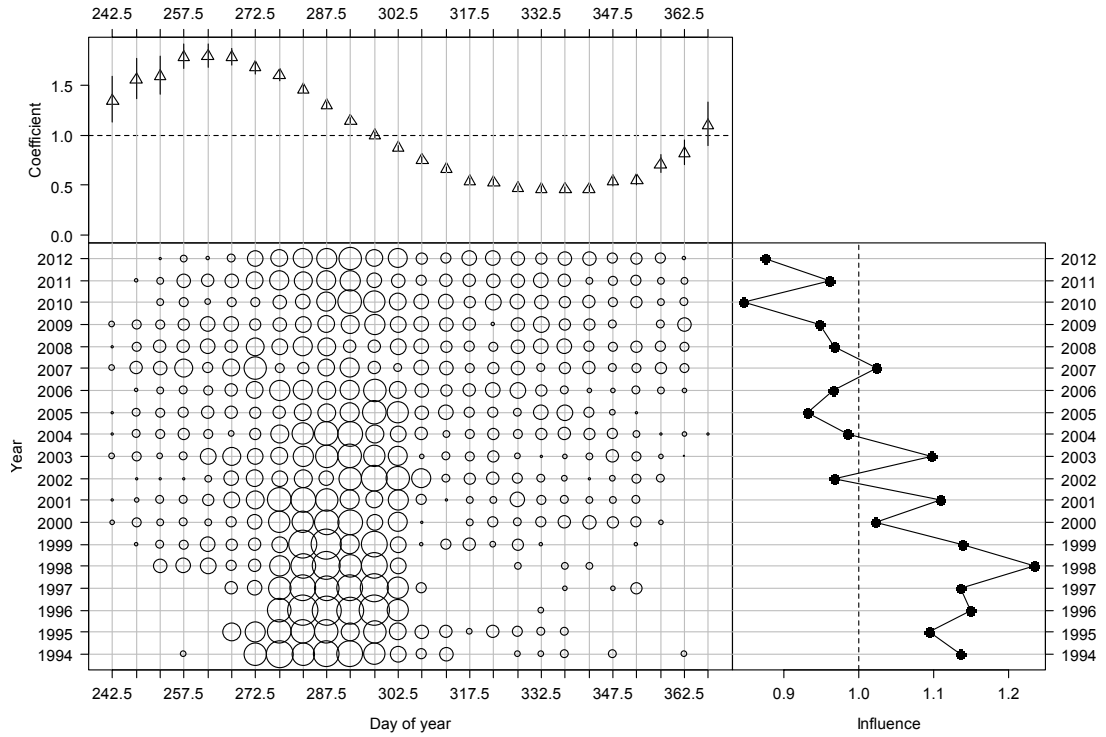


Figure D27a: WCSI daily processed analysis. Effect and influence of statistical area in the WCSI daily processed core BT target hoki or hake vessel lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of variable (day of year) by fishing year. Bottom right: influence of variable (day of year) on unstandardised CPUE by fishing year.

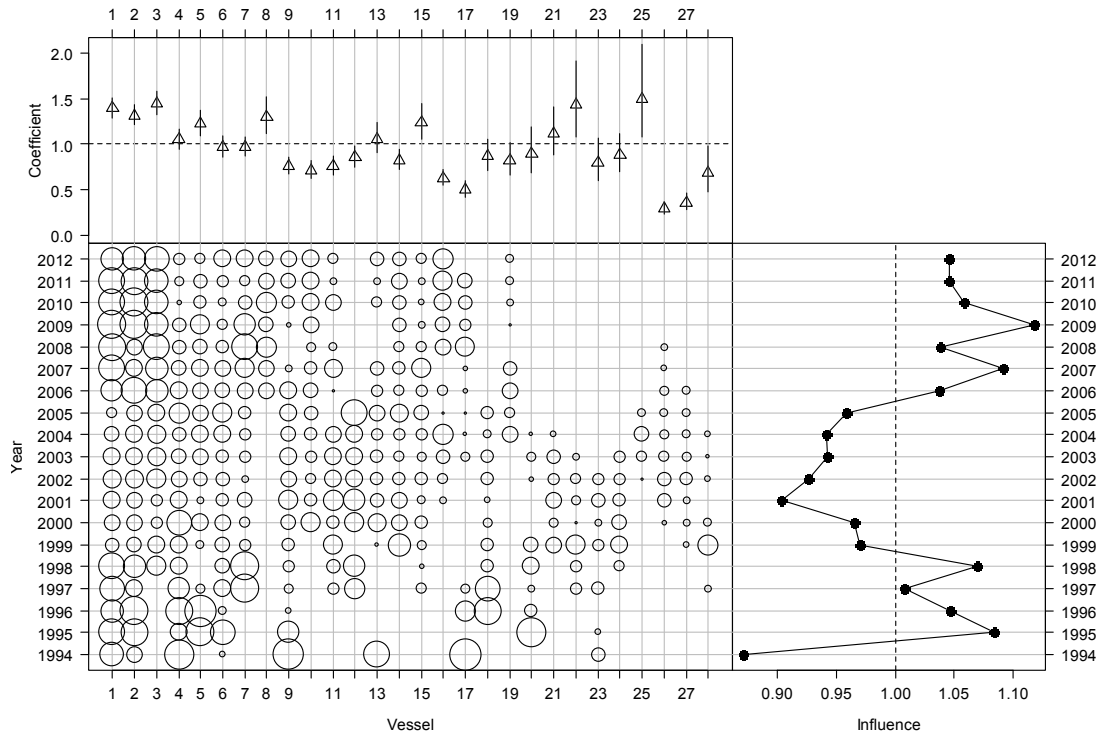


Figure D27b: WCSI daily processed analysis. Effect and influence of vessel in the WCSI daily processed core BT target hoki or hake lognormal model. See caption (Figure D27a) for details.

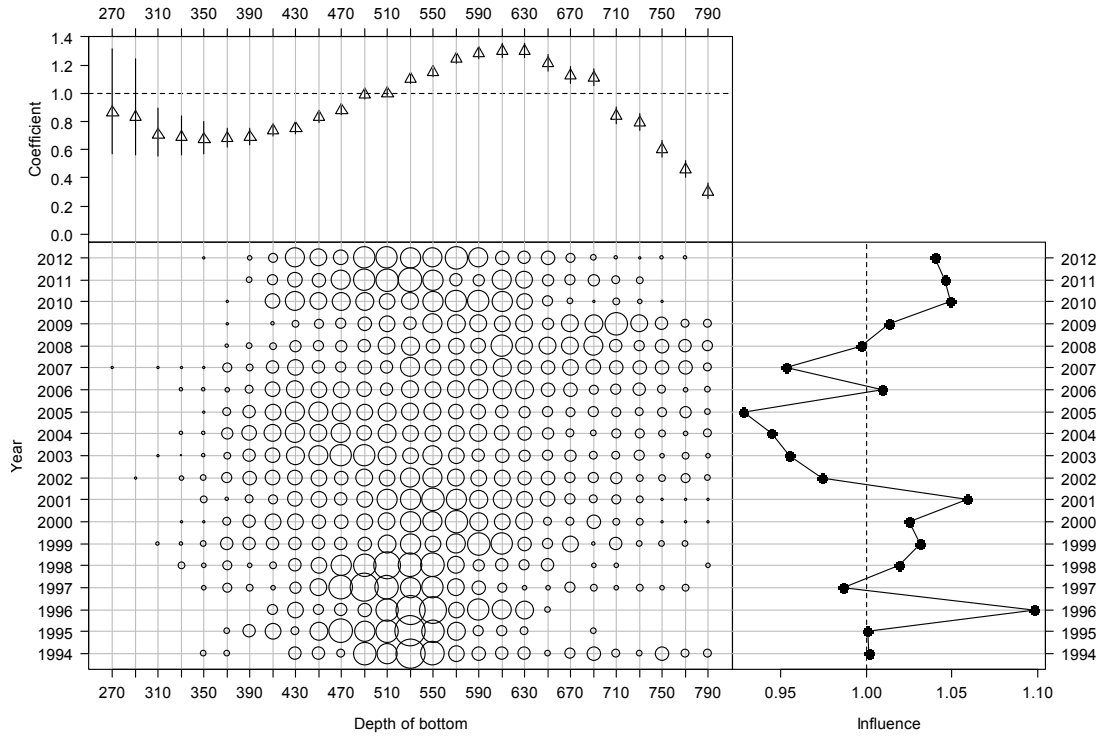


Figure D27c: WCSI daily processed analysis. Effect and influence of depth of bottom in the WCSI daily processed core BT target hoki or hake core lognormal model. See caption (Figure D27a) for details.

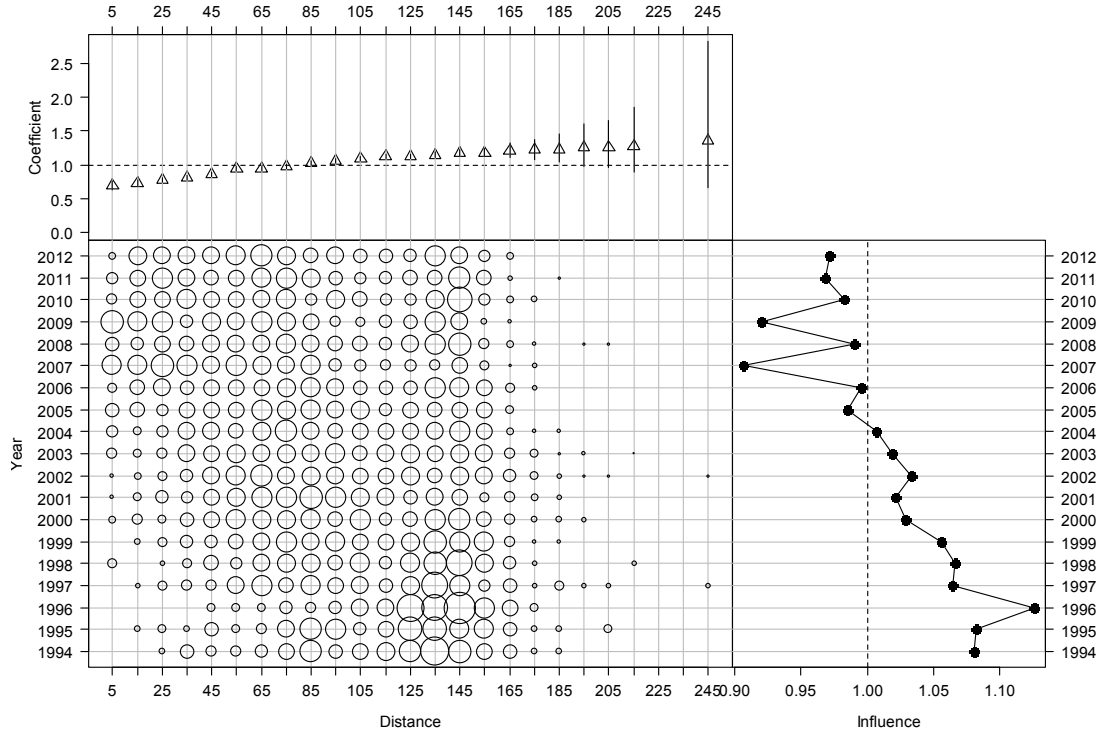


Figure D27d: WCSI daily processed analysis. Effect and influence of distance in the WCSI daily processed core BT target hoki or hake core Lognormal model. See caption (Figure D27a) for details.

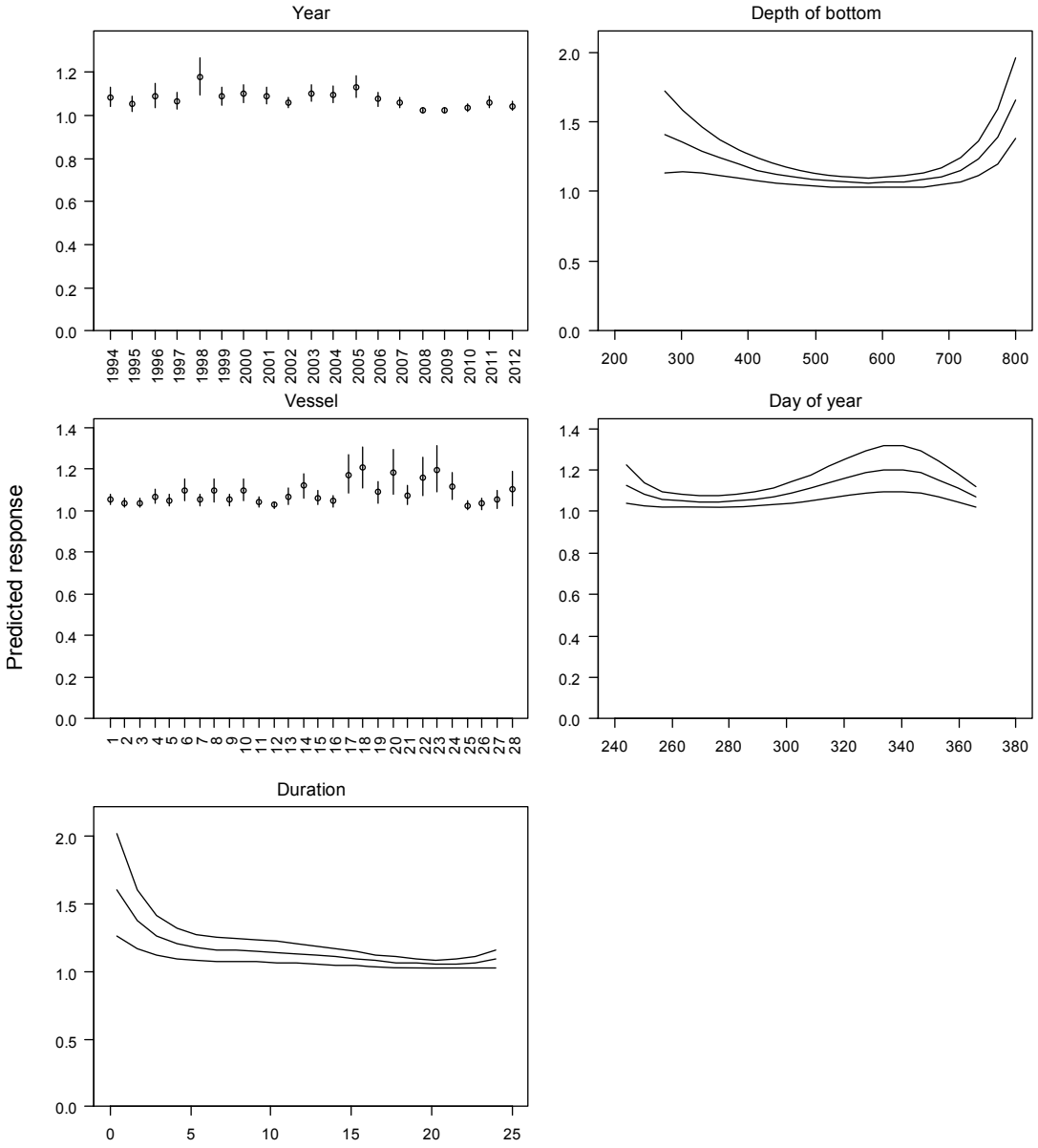


Figure D28: WCSI daily processed analysis. Binomial effects of selected variables in the binomial model for the WCSI daily processed catch for core BT target hoki or hake vessels, 1994–2012. Bars indicate 95% confidence interval.

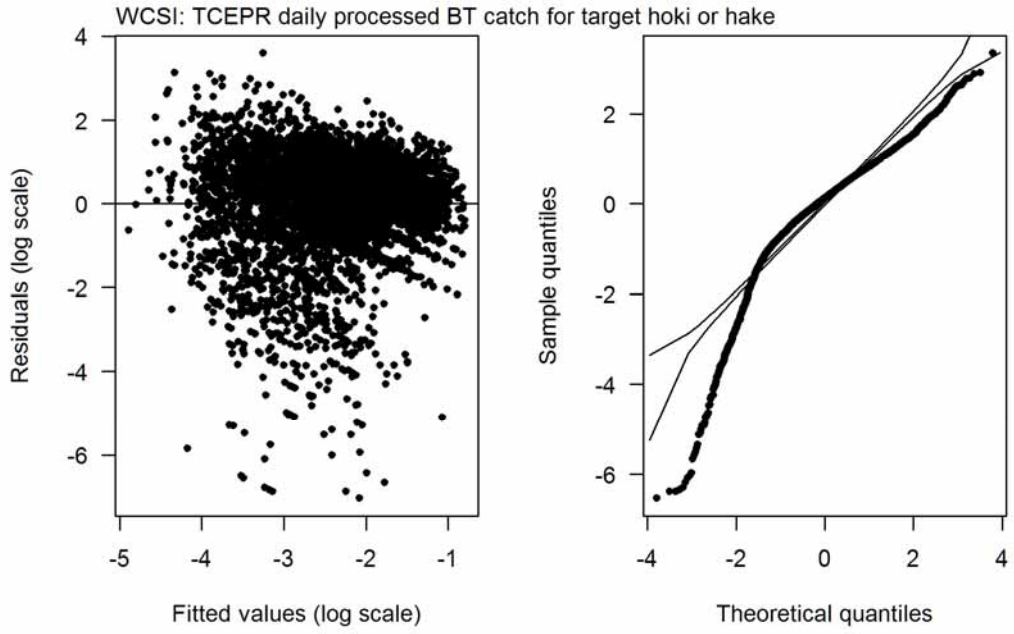


Figure D29a: WCSI daily processed analysis. WCSI daily processed data for the lognormal model; distribution of the standardised residuals against fitted values (left) and quantile-quantile plot of the residuals (right).

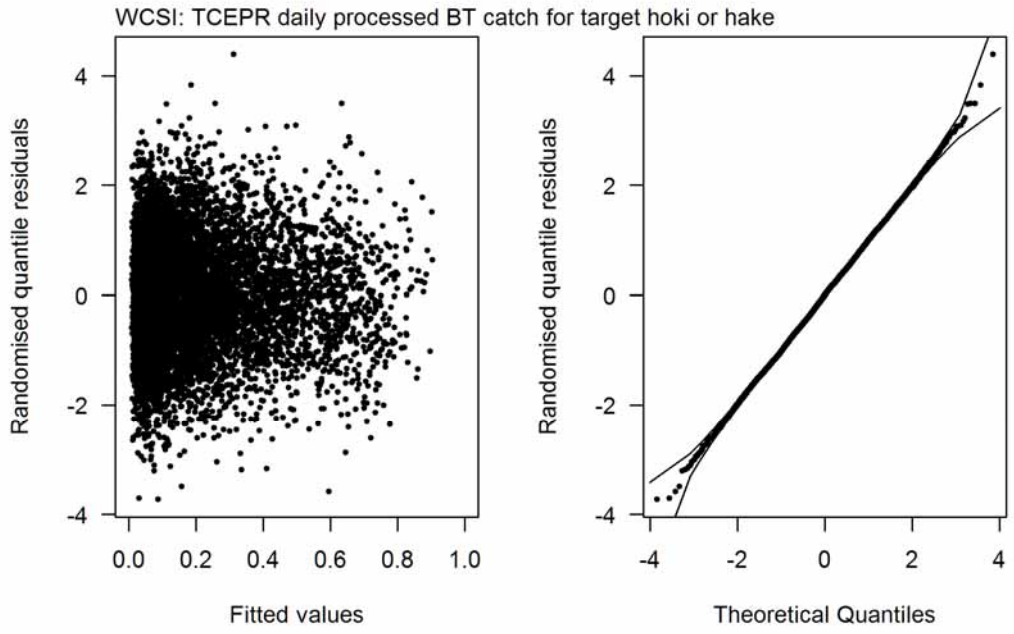


Figure D29b: WCSI daily processed analysis. WCSI daily processed data for the binomial model; distribution of the randomised quantile residuals against fitted values (left) and quantile-quantile plot of the randomised quantile residuals (right).

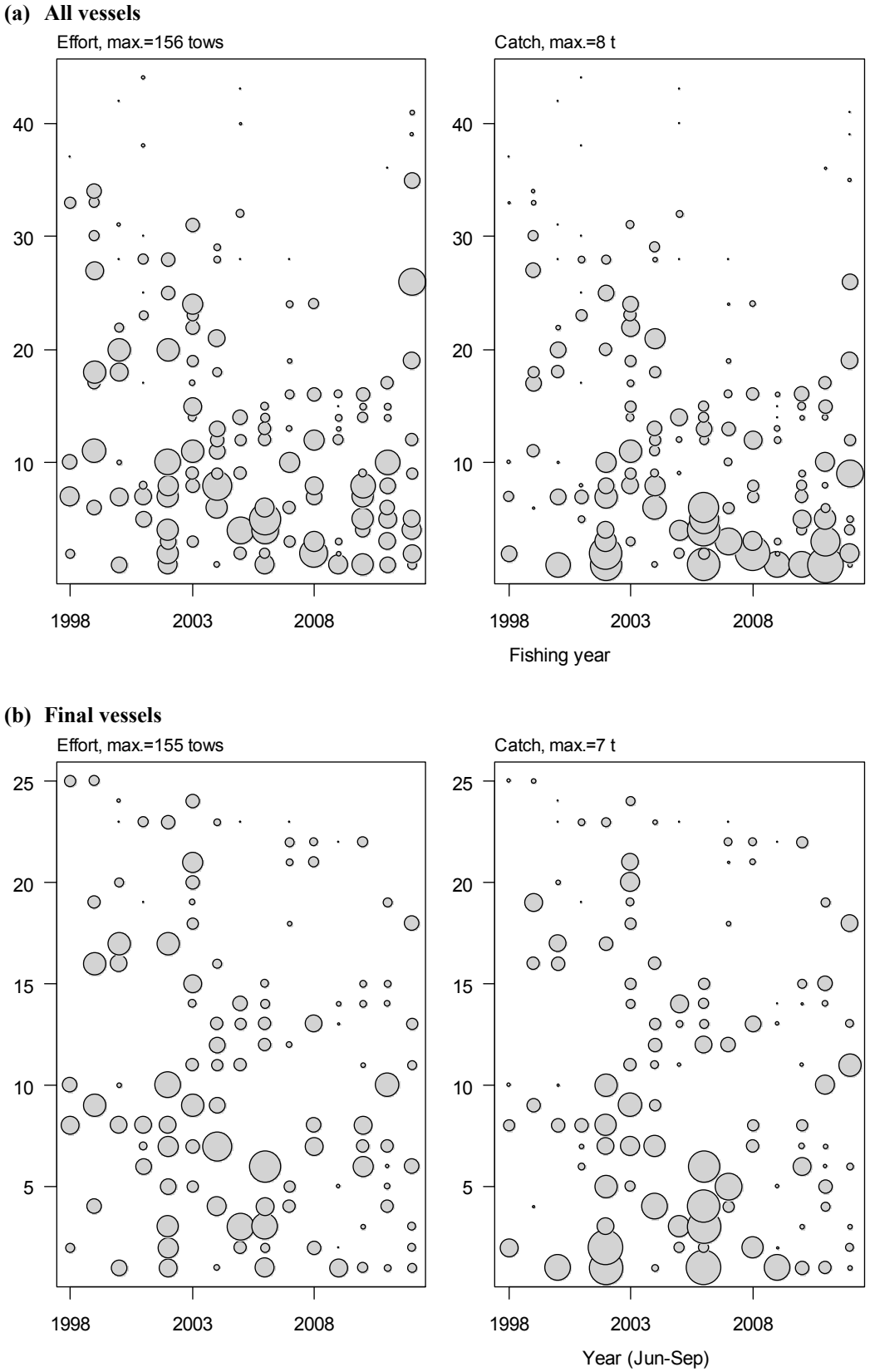


Figure D30: WCSI observer tow-by-tow analysis. Summary of WCSI observed effort (number of tows) and estimated lookdown dory catch by fishing year 1997–98 (1998) to 2011–12 (2012) from BT target hoki or hake all and core vessels. Symbol area is proportional to either number of vessel-days or annual catch, and maximum circle size is shown on the plot.

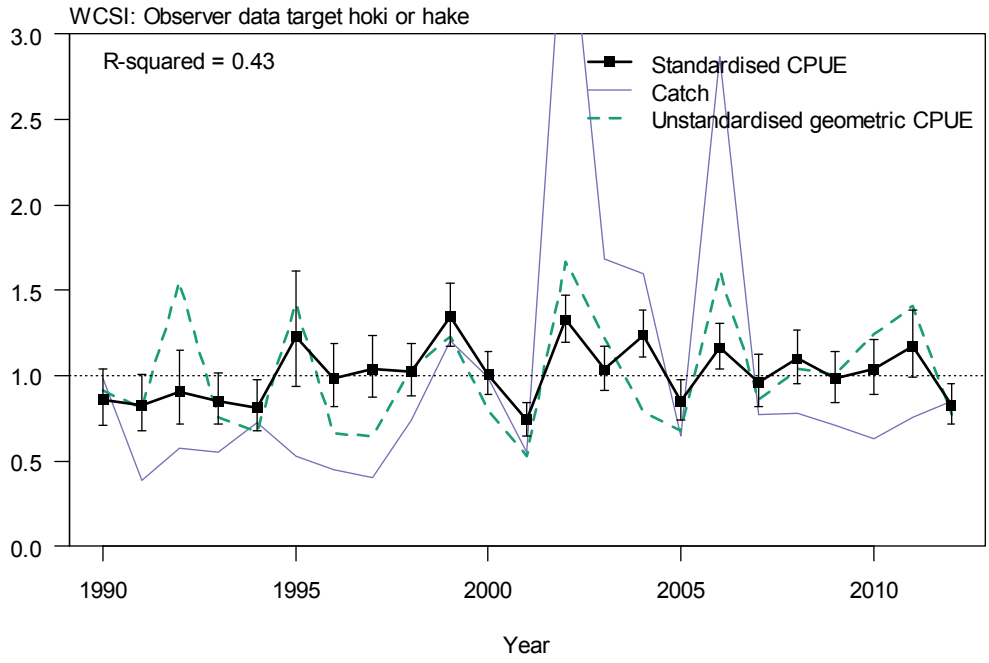


Figure D31: WCSI observer tow-by-tow analysis. WCSI observed target hoki or hake CPUE lognormal indices showing catches (scaled to same mean as indices), and lognormal standardised and un-standardised indices. Bars indicate 95% confidence intervals. Year defined as June–September.

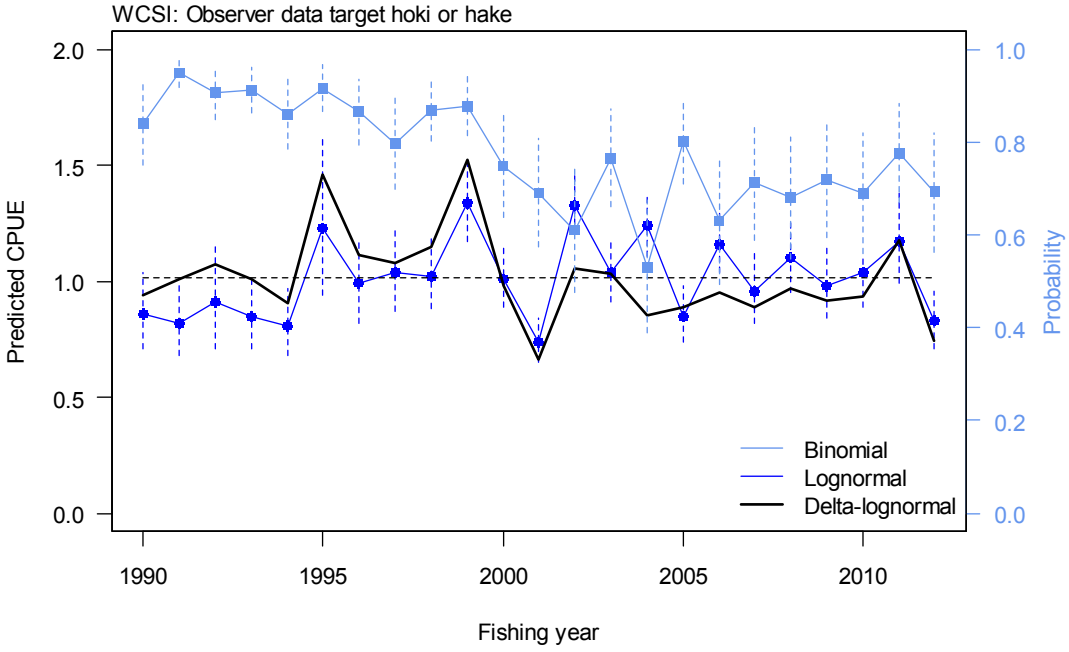


Figure D32: WCSI observer tow-by-tow analysis. WCSI observed CPUE from the lognormal, binomial and combined target hoki or hake model, 1998–2012. Bars indicate 95% confidence intervals. Year defined as June–September.

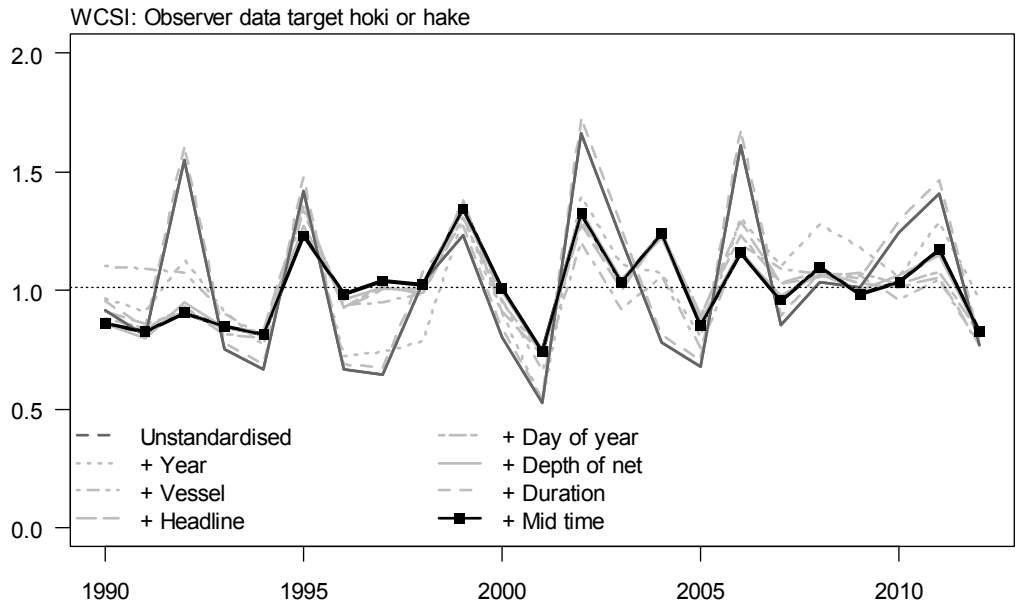
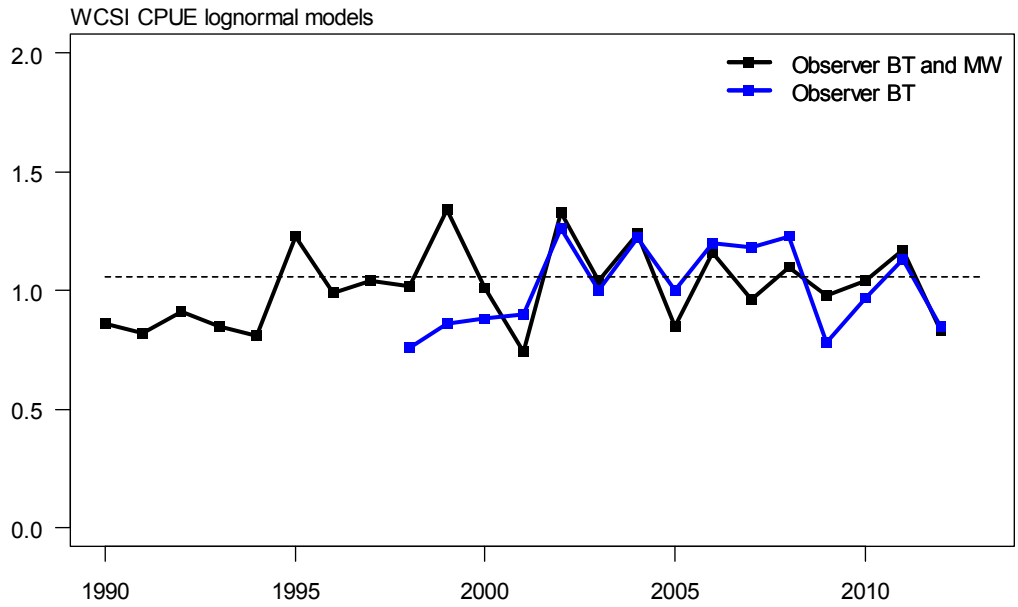


Figure D33: WCSI observer tow-by-tow analysis. Addition of variables into the WCSI observed target hoki or hake CPUE lognormal CPUE model for each fishery by fishing year. Year defined as June–September.



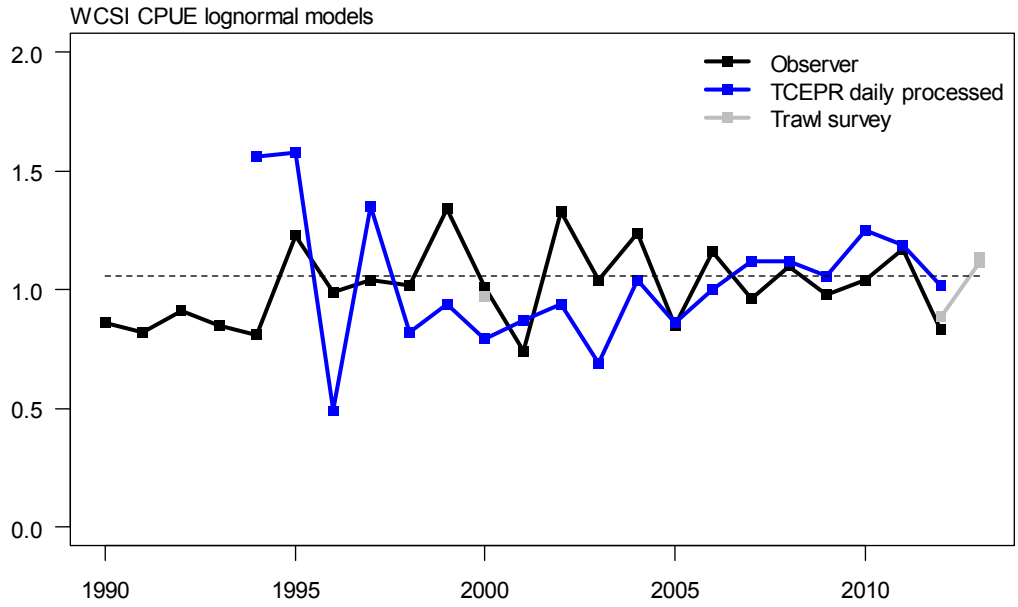


Figure D34: WCSI observer tow-by-tow analysis. Comparison of WCSI models.

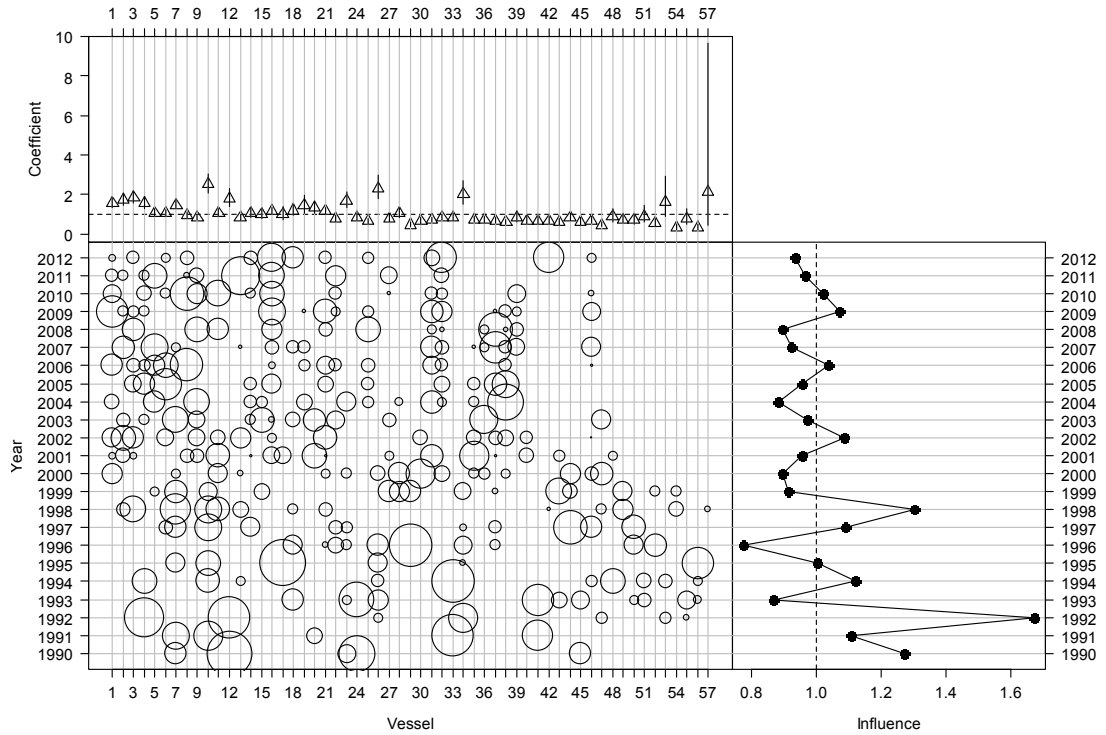


Figure D35a: WCSI observer tow-by-tow analysis. Effect and influence of vessel in the WCSI observed final catch for target hoki or hake vessel lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of variable (vessel) by fishing year. Bottom right: influence of variable (vessel) on unstandardised CPUE by fishing year. Year defined as June–September.

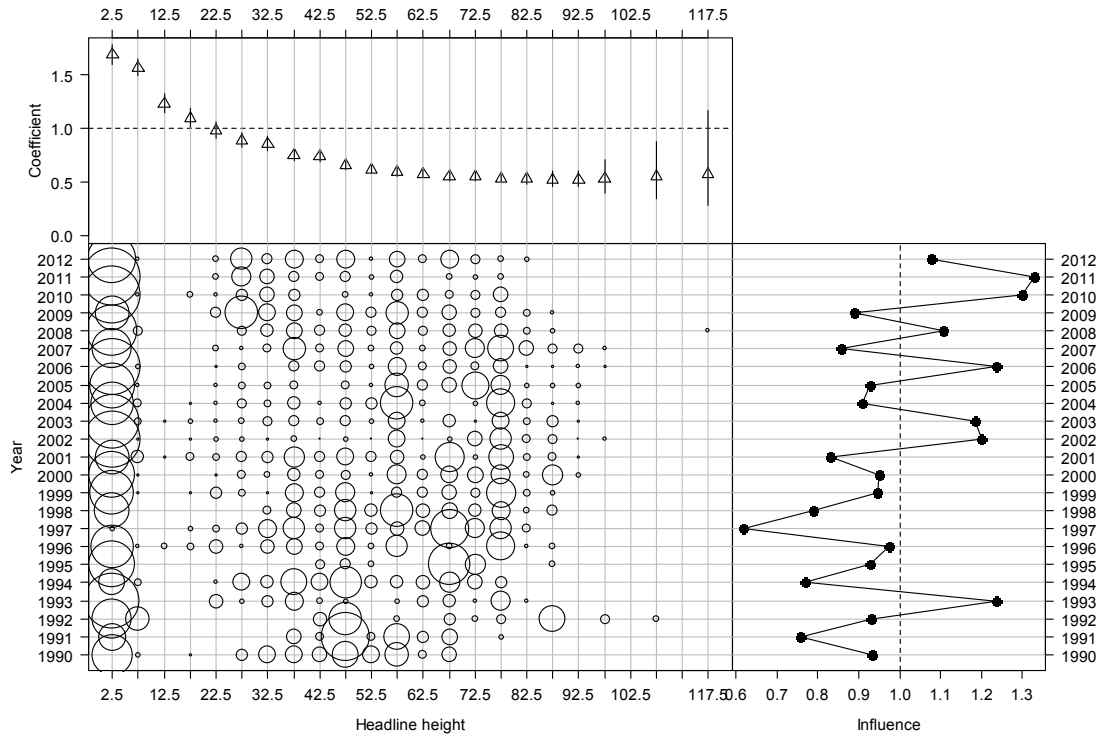


Figure D35b: WCSI observer tow-by-tow analysis. Effect and influence of headline height in the WCSI observed final catch for target hoki or hake lognormal model. See caption (Figure D35a) for details.

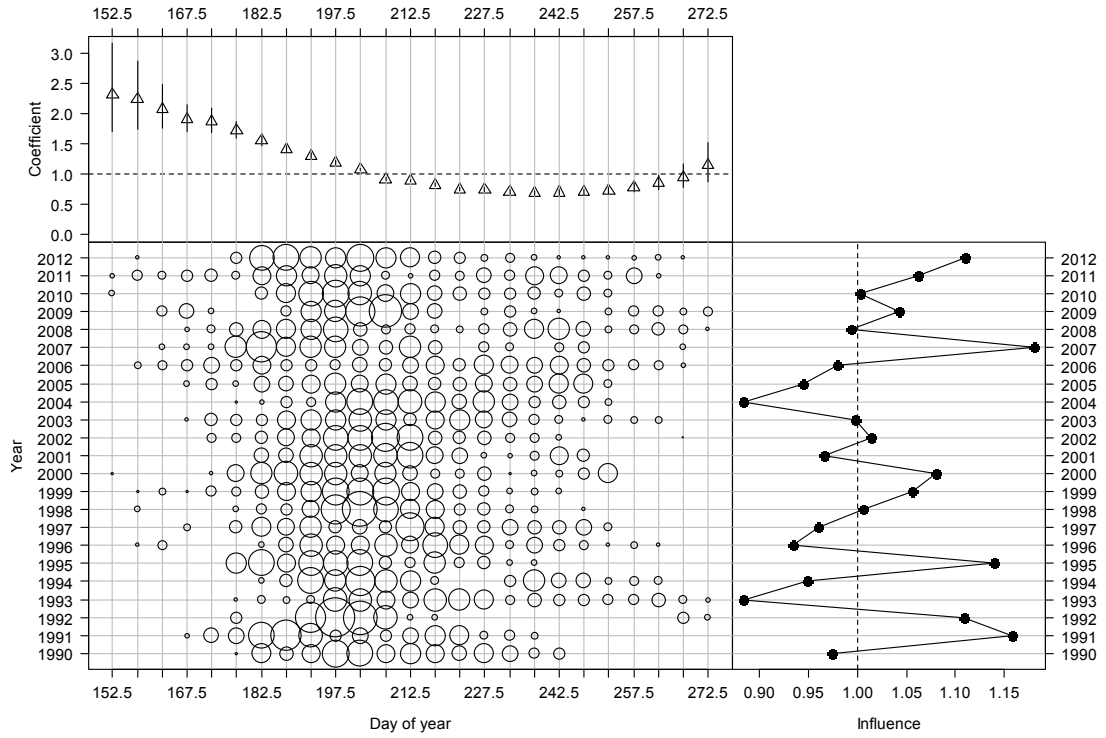


Figure D35c: WCSI observer tow-by-tow analysis. Effect and influence of day of year in the WCSI observed final catch for target hoki or hake lognormal model. See caption (Figure D35a) for details.

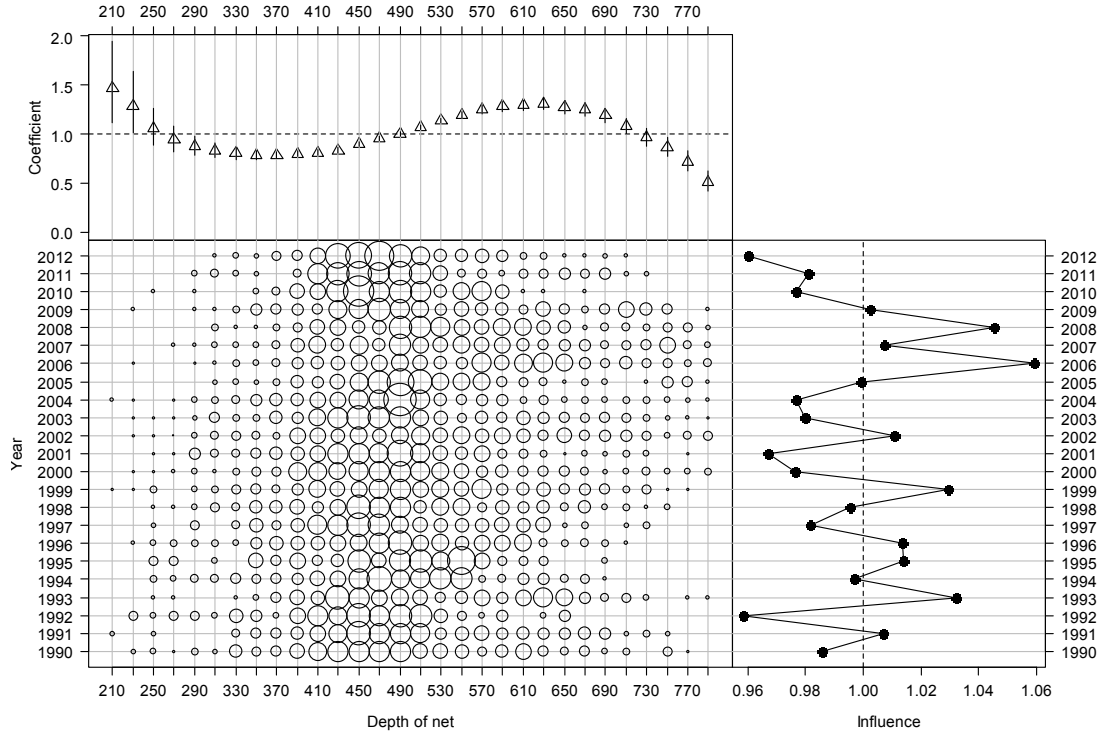


Figure D35d: WCSI observer tow-by-tow analysis. Effect and influence of depth of net (m) in the WCSI observed final catch for target hoki or hake Lognormal model. See caption (Figure D35a) for details.

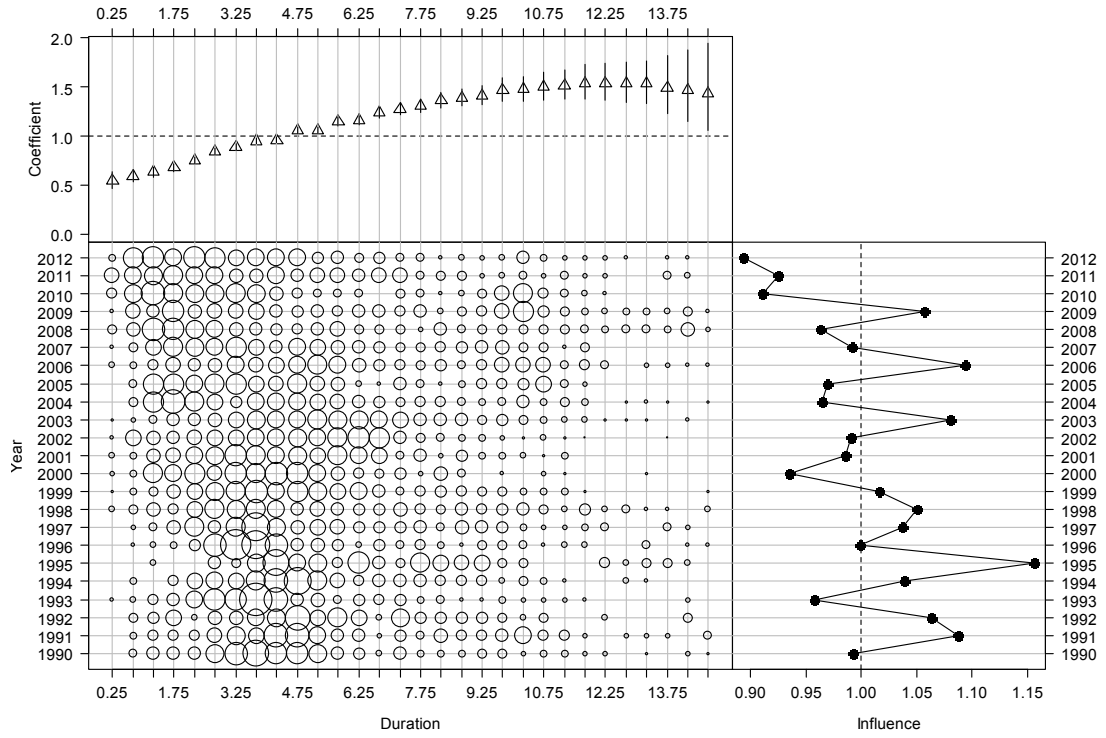


Figure D35e: WCSI observer tow-by-tow analysis. Effect and influence of fishing duration (hrs) in the WCSI observed final catch for target hoki or hake Lognormal model. See caption (Figure D35a) for details.

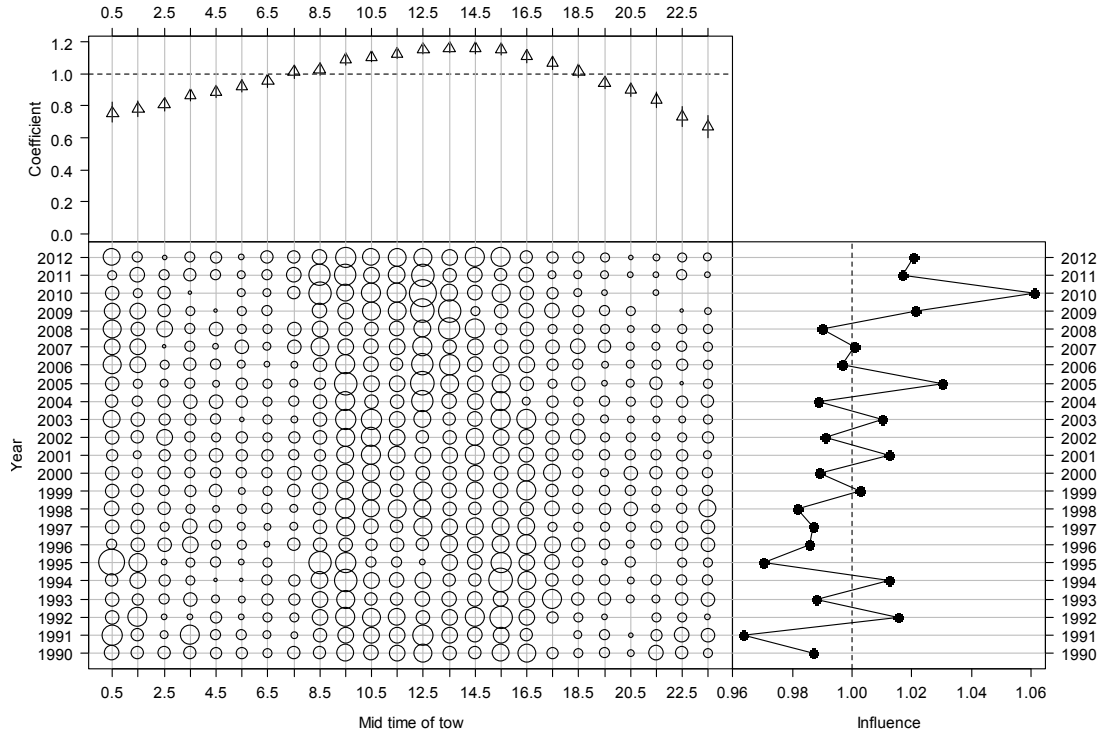


Figure D35f: WCSI observer tow-by-tow analysis. Effect and influence of mid time of tow in the WCSI observed final catch for target hoki or hake Lognormal model. See caption (Figure D35a) for details.

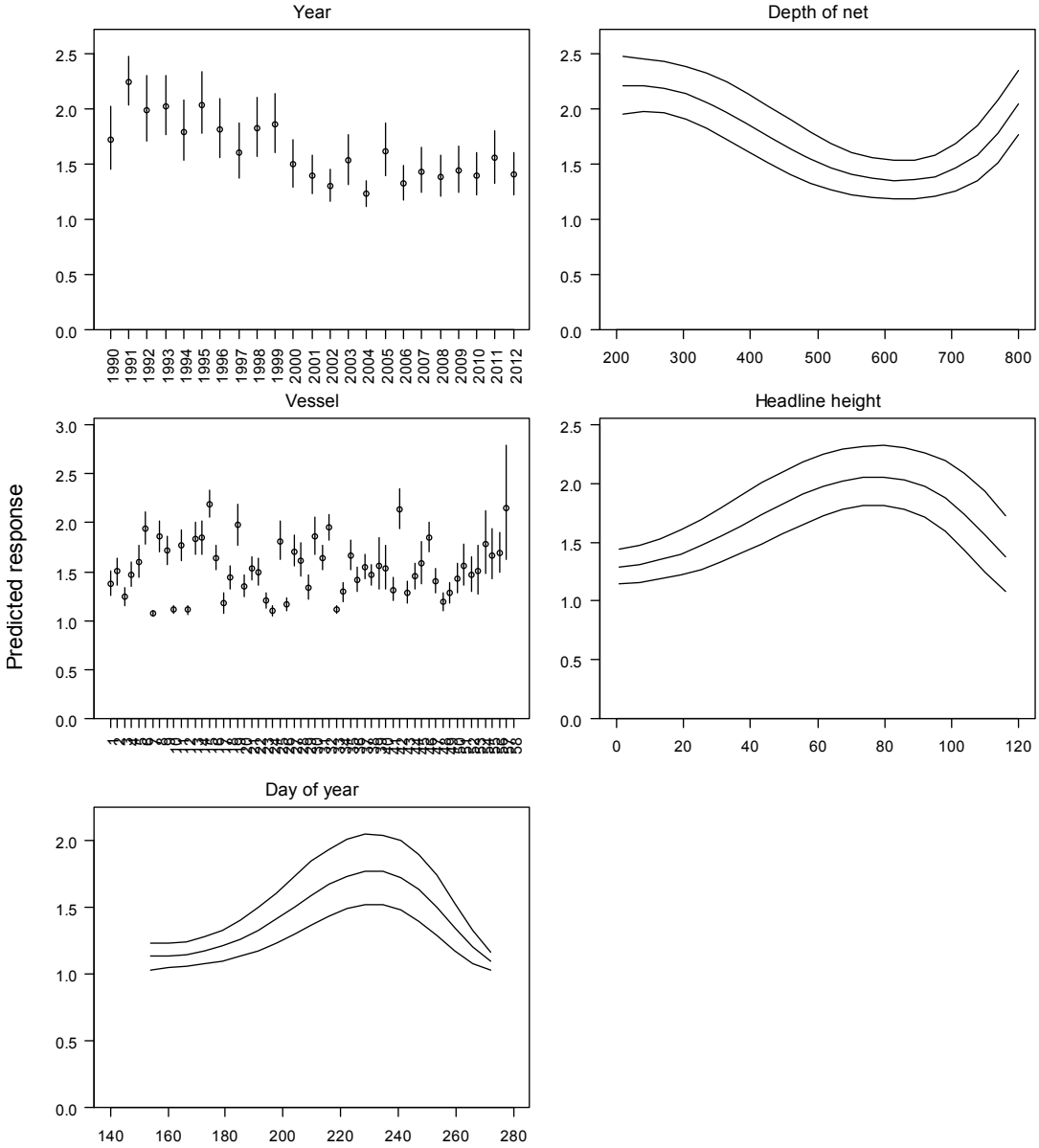


Figure D36: WCSI observer tow-by-tow analysis. Binomial effects of selected variables in the binomial model for the WCSI estimated observed catch for final target hoki or hake vessels, 1990–2012. Bars indicate 95% confidence interval. Year defined as June–September.

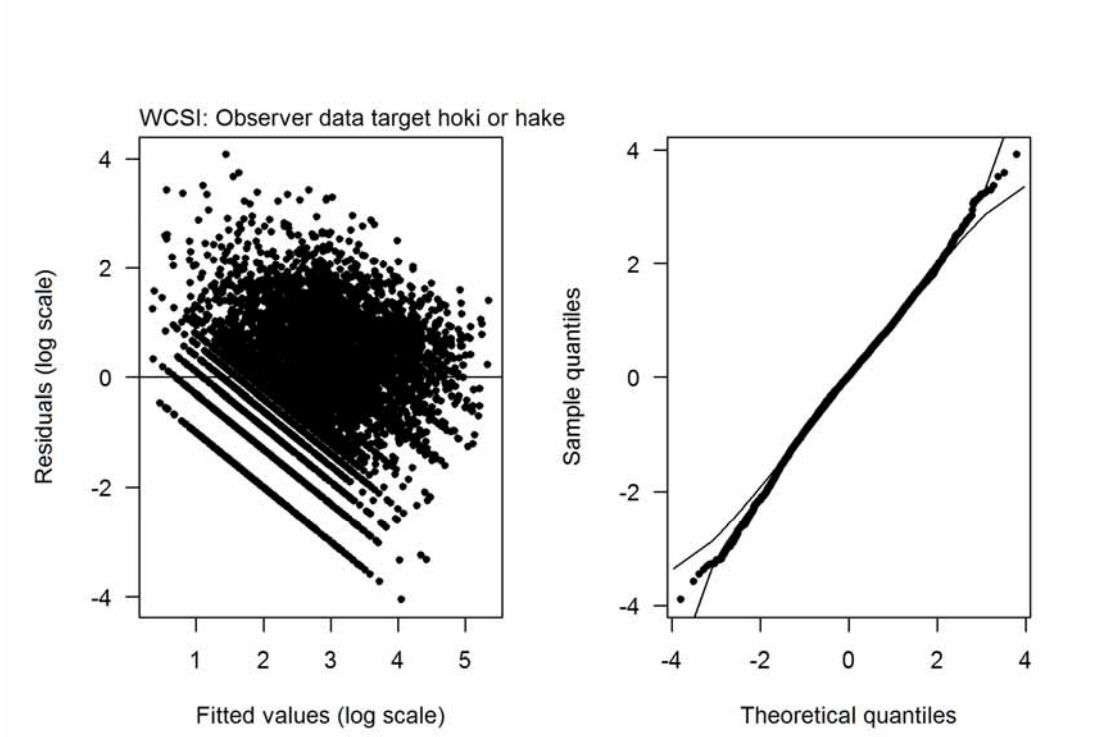


Figure D37a: WCSI observer tow-by-tow analysis. WCSI observed final catch for target hoki or hake data for the lognormal model; distribution of the standardised residuals against fitted values (left) and quantile-quantile plot of the residuals (right).

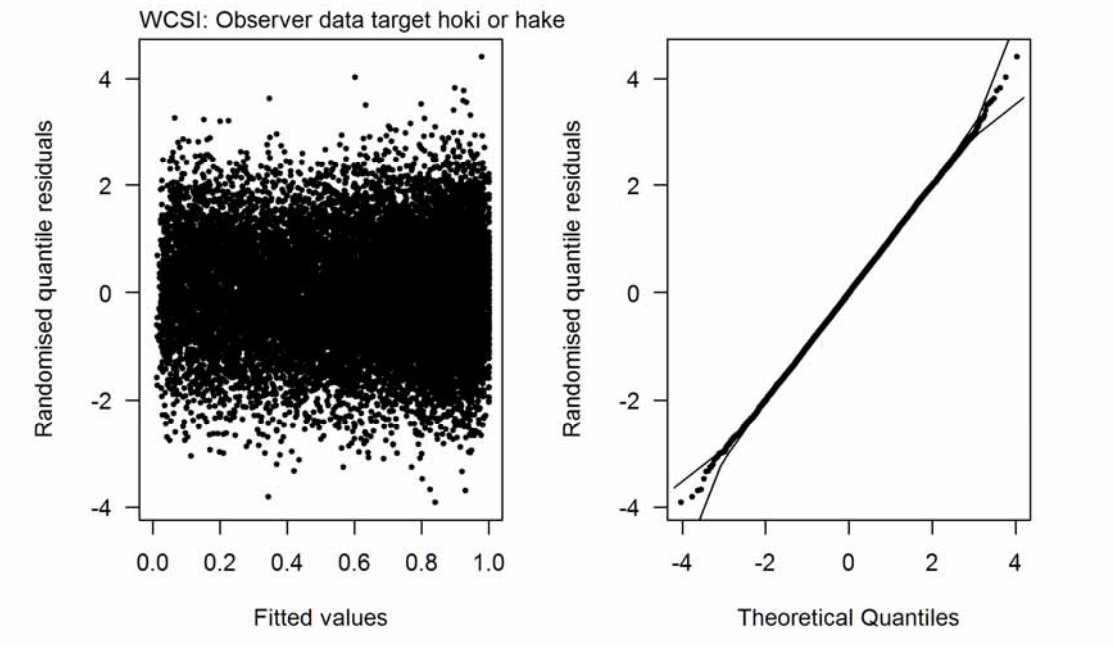


Figure D37b: WCSI observer tow-by-tow analysis. WCSI observed final catch for target hoki or hake for the binomial model; distribution of the randomised quantile residuals against fitted values (left) and quantile-quantile plot of the randomised quantile residuals (right).

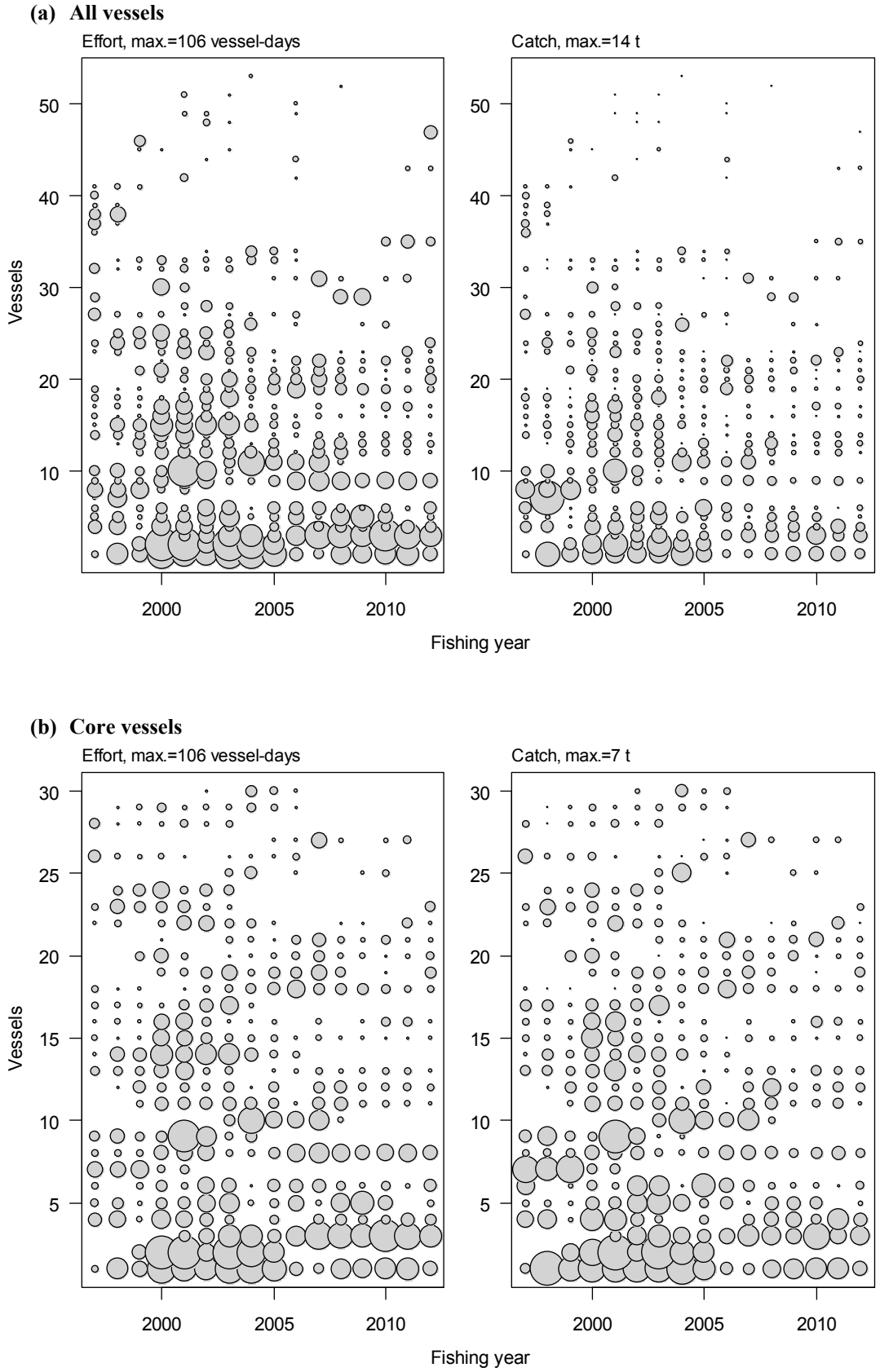


Figure D38: SUBA daily processed analysis. Summary of SUBA effort (number of vessel-days) and processed lookdown dory catch by fishing year 1996–97 (1997) to 2011–12 (2012) from BT target hoki or ling all and core vessels. Symbol area is proportional to either number of vessel-days or annual catch, and maximum circle size is shown on the plot.

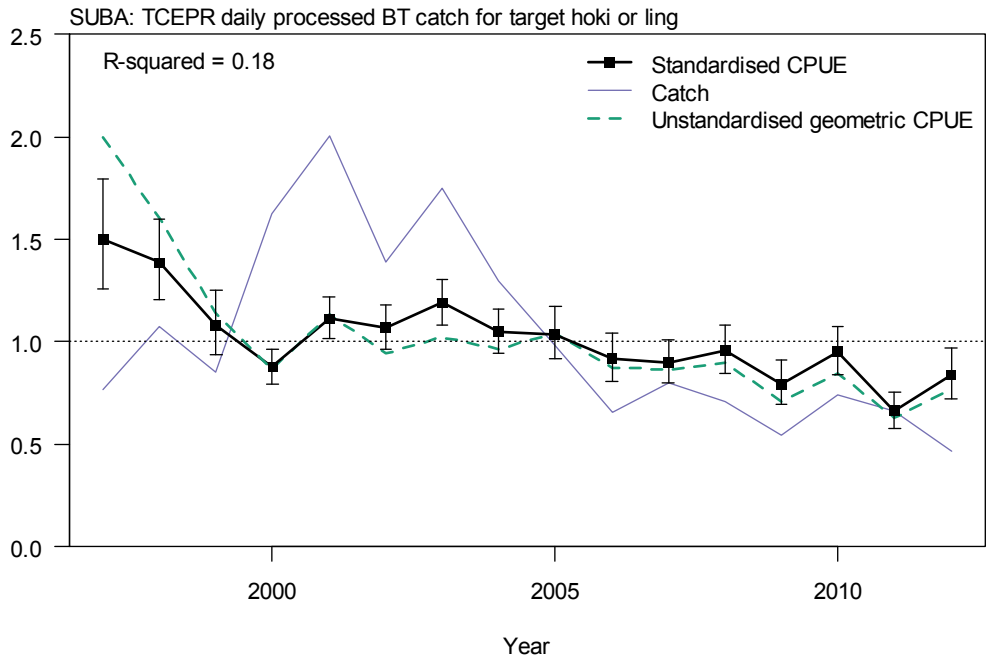


Figure D39: SUBA TCEPR daily processed BT target hoki or ling core CPUE lognormal indices showing catches (scaled to same mean as indices), and lognormal standardised and un-standardised indices. Bars indicate 95% confidence intervals. Year defined as October–September.

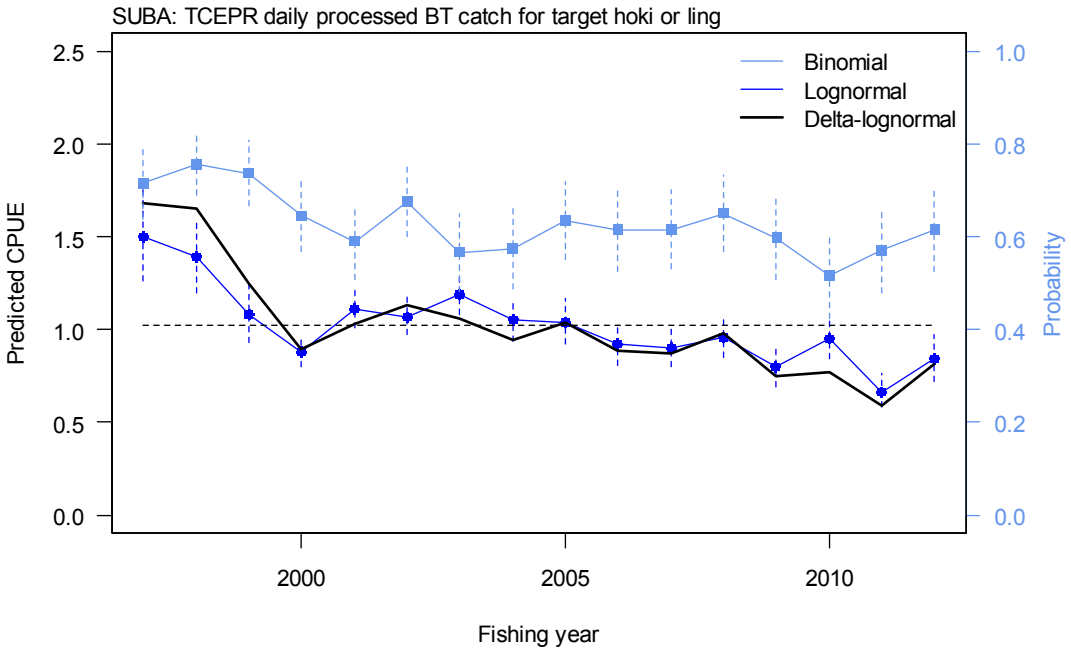


Figure D40: SUBA daily processed analysis. SUBA TCEPR daily processed BT target hoki or ling core CPUE from the lognormal, binomial and combined models, 1997–2012. Bars indicate 95% confidence intervals. Year defined as October–September.

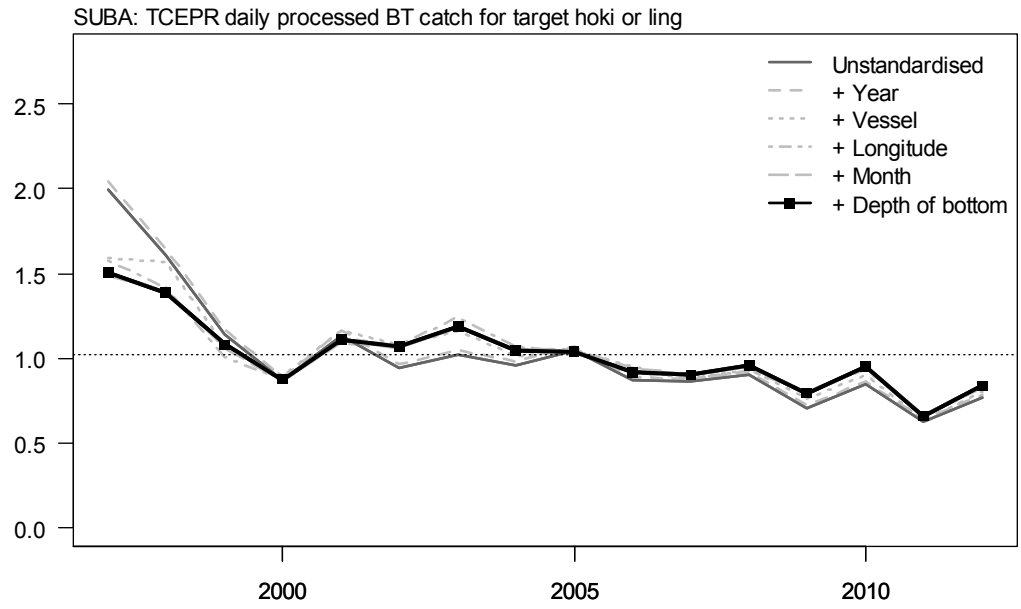


Figure D41: SUBA daily processed analysis. Addition of variables into the SUBA TCEPR daily processed BT target hoki or ling core CPUE lognormal CPUE model for each fishery by fishing year. Year defined as October–September.

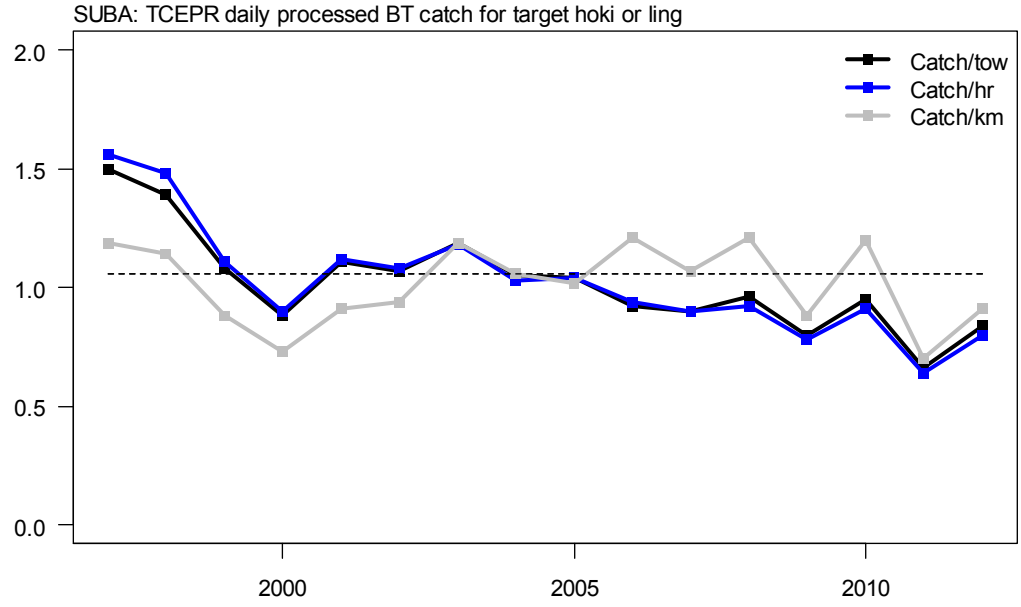


Figure D42: SUBA daily processed analysis. Comparison of SUBA TCEPR daily processed BT target hoki or ling core indices for lookdown dory datasets by fishing year. Year defined as October–September.

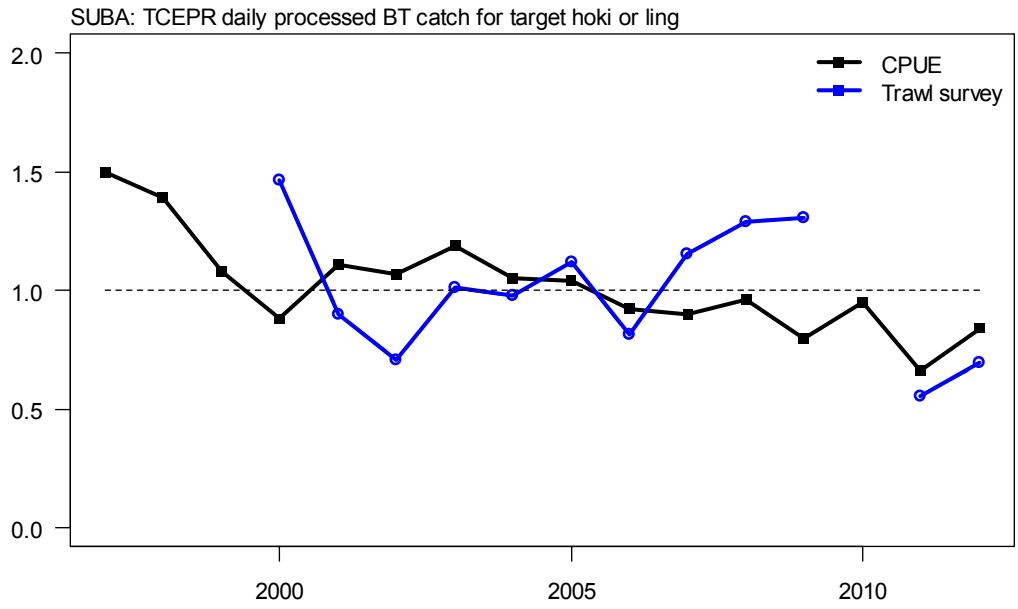


Figure D43: SUBA daily processed analysis. Comparison of SUBA TCEPR daily processed BT target hoki or ling core indices with SUBA *Tangaroa* summer trawl survey series.

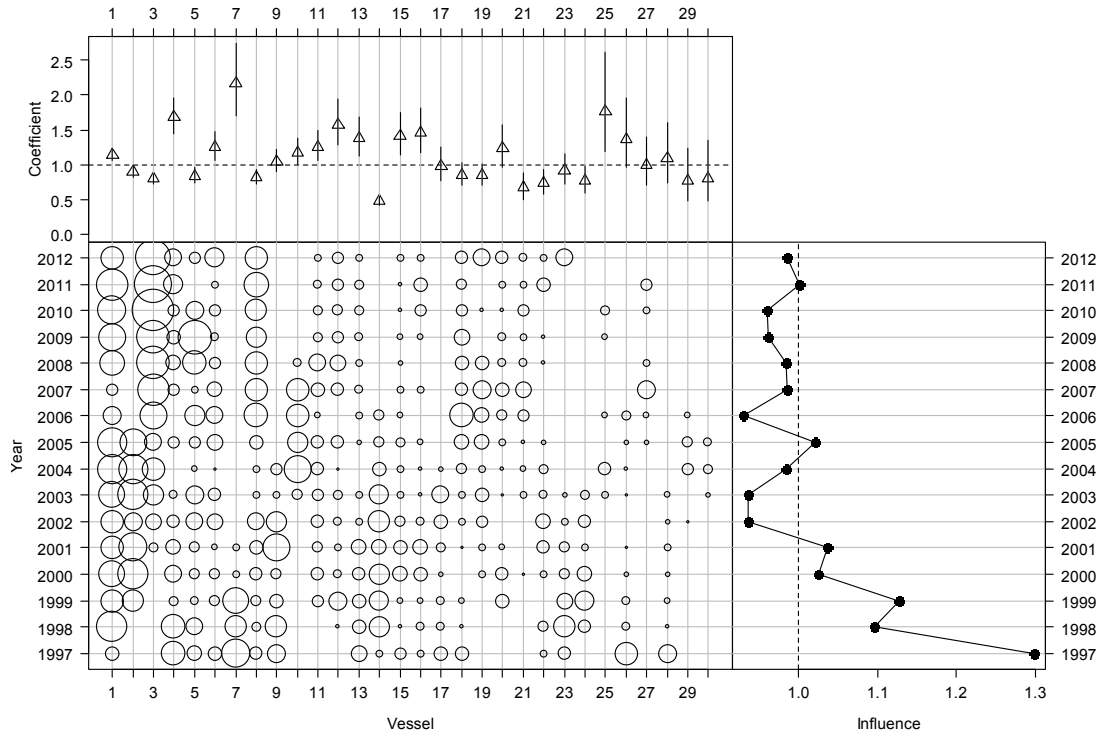


Figure D44a: SUBA daily processed analysis. Effect and influence of vessel in the SUBA TCEPR daily processed BT target hoki or ling core vessel lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of variable (vessel) by fishing year. Bottom right: influence of variable (vessel) on unstandardised CPUE by fishing year.

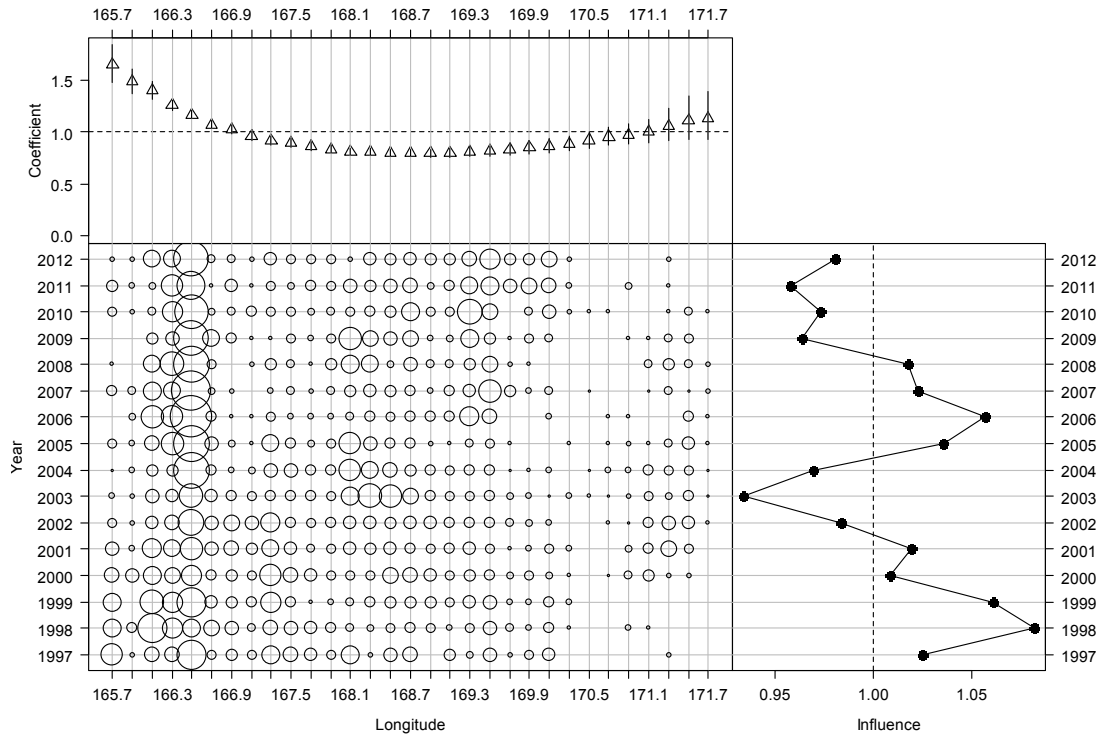


Figure D44b: SUBA daily processed analysis. Effect and influence of longitude in the SUBA TCEPR daily processed BT target hoki or ling core lognormal model. See caption (Figure D44a) for details.

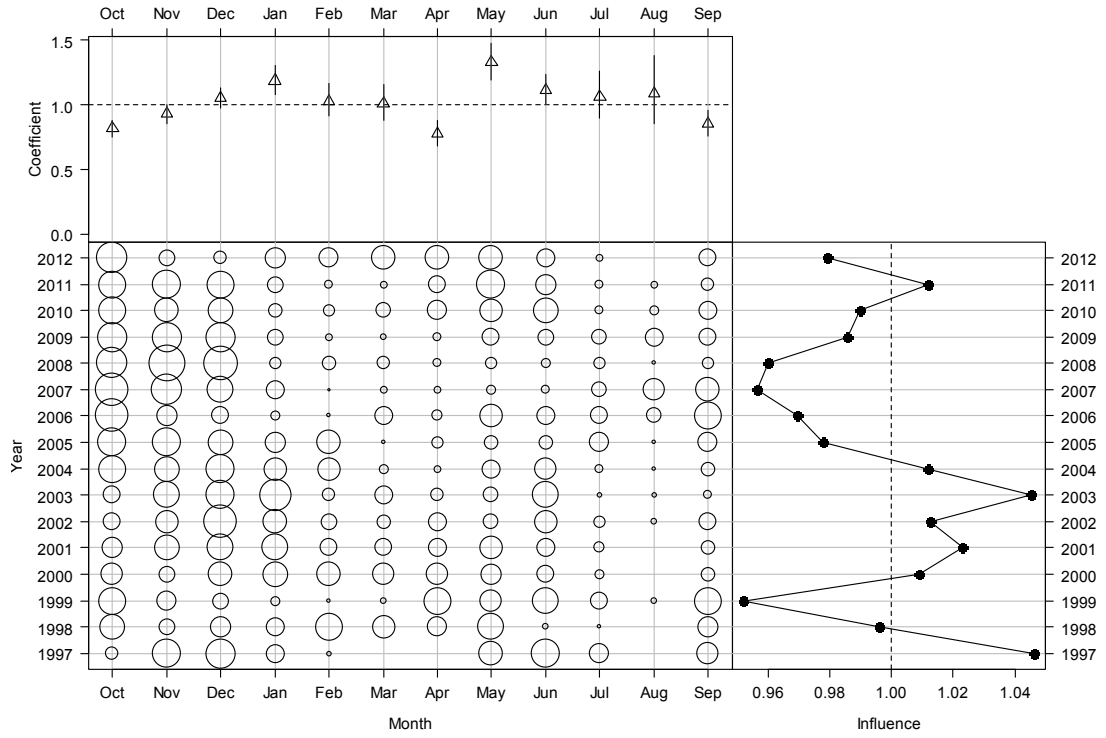


Figure D44c: SUBA daily processed analysis. Effect and influence of month in the SUBA TCEPR daily processed BT target hoki or ling core lognormal model. See caption (Figure D44a) for details.

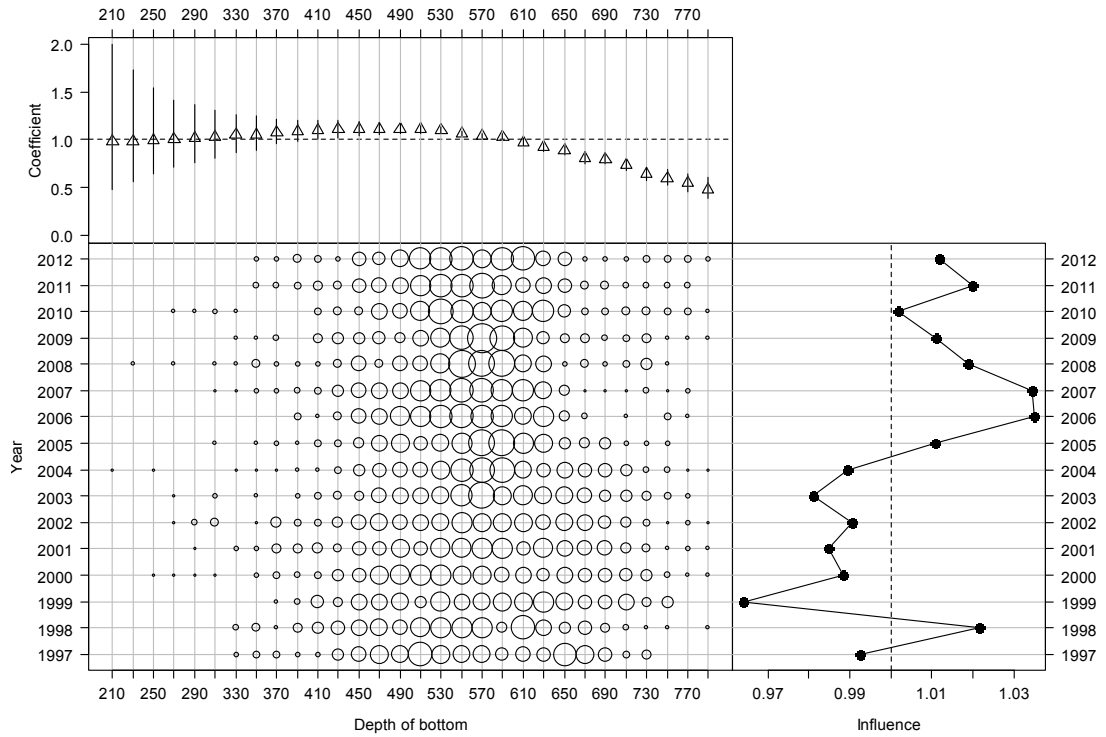


Figure D44d: SUBA daily processed analysis. Effect and influence of depth of bottom in the SUBA TCEPR daily processed BT target hoki or ling core Lognormal model. See caption (Figure D44a) for details.

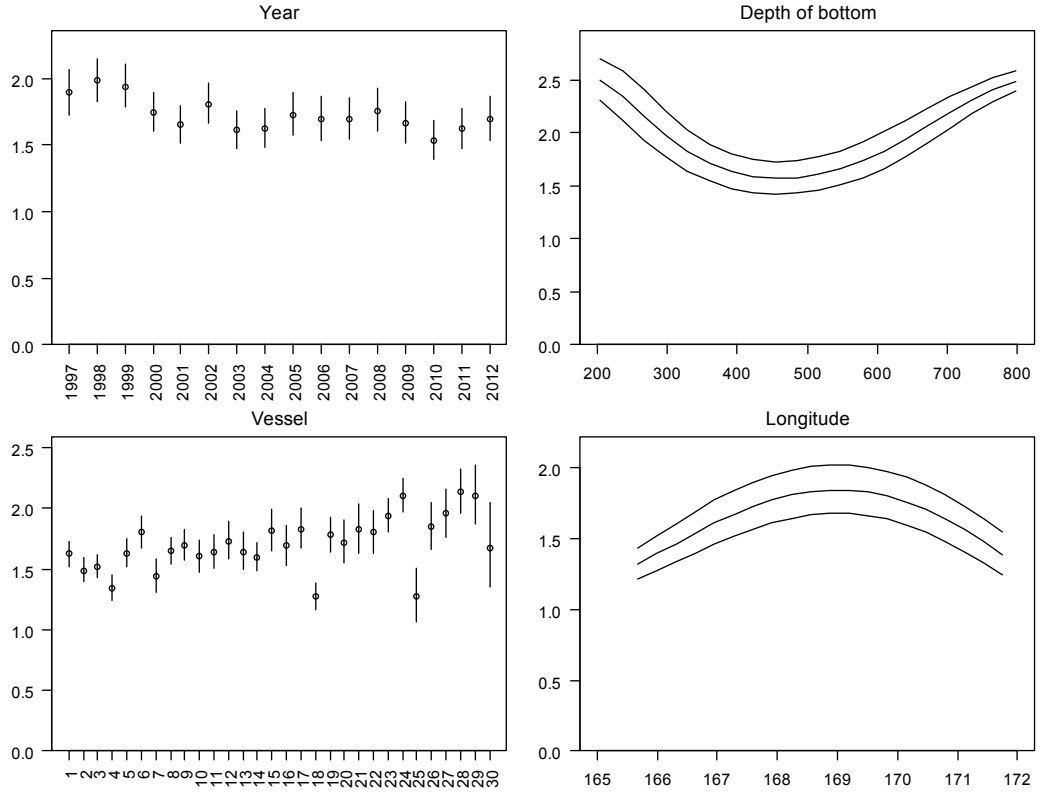


Figure D45: SUBA daily processed analysis. Binomial effects of selected variables in the binomial model for the SUBA TCEPR daily processed BT target hoki or ling core vessels, 1997–2012. Bars indicate 95% confidence interval.

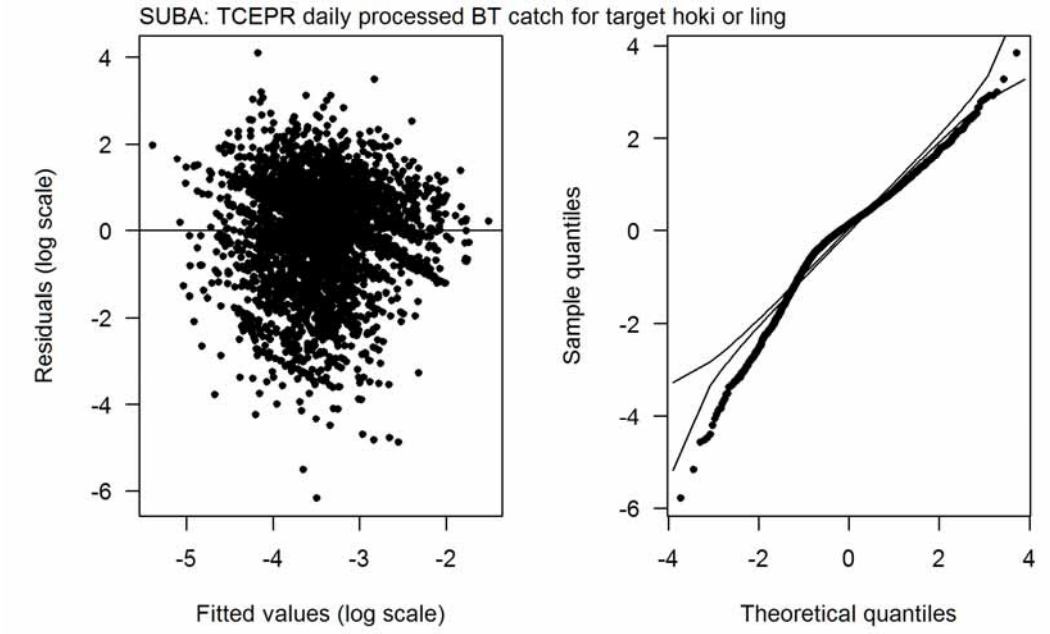


Figure D46a: SUBA daily processed analysis. SUBA TCEPR daily processed BT target hoki or ling core data for the lognormal model; distribution of the standardised residuals against fitted values (left) and quantile-quantile plot of the residuals (right).

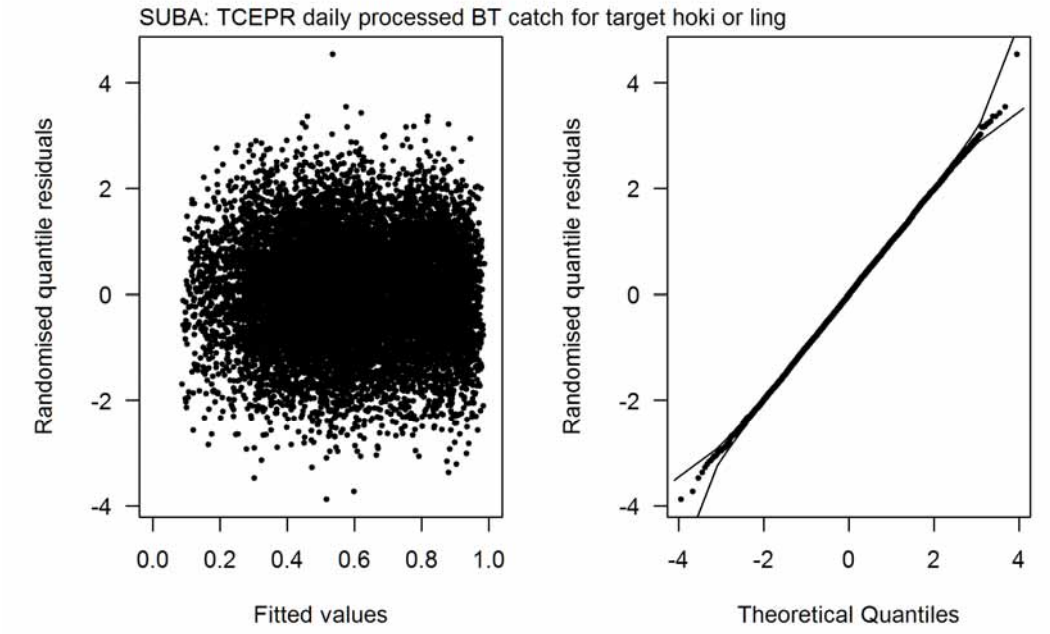


Figure D46b: SUBA daily processed analysis. SUBA TCEPR daily processed BT target hoki or ling core data for the binomial model; distribution of the randomised quantile residuals against fitted values (left) and quantile-quantile plot of the randomised quantile residuals (right).