Fishery characterisation and standardised CPUE analyses for lookdown dory, *Cyttus traversi* (Hutton, 1872) (Zeidae), 1989–90 to 2008–09

20 mm

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EXECUTIVE SUMMARY

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This report is the fifth in a series of middle depth fishery characterisations for species or stocks for which no robust stock assessment has been developed; the previous four being for silver warehou, *Seriolella punctata* (Parker & Fu, 2009), arrow squid, *Nototodarus gouldi* and *N. sloanii* (Hurst et al. in prep. b), barracouta, *Thyrsites atun,* (Hurst et al. in prep., a), and ribaldo, *Mora moro* (MacGibbon & Hurst, 2011). It follows the standardised reporting format used in those reports, with additional information and analyses where appropriate.

Reliable records of lookdown dory catches are available from the 1989–90 fishing year. The species entered the QMS on 1 October 2004 with a total TACC of 783 tonnes which has never been caught (although 813 tonnes was landed in the 2003–04 fishing year), and landings within LDO 1 have slightly exceeded the LDO 1 TACC in the 2006 and 2008 fishing years. Lookdown dory are almost entirely caught by bottom trawl with a smaller amount by midwater trawl. The four main areas in which lookdown dory are caught (in decreasing order of tonnage landed) are: the East Coast South Island/Chatham Rise ("ECSI/CHAT"), West Coast (mainly within the west coast of the South Island"), Southland/Sub Antarctic ("SUBA"), and East Coast North Island ("ECNI"). Lookdown dory is widespread around the New Zealand EEZ but is most abundant along the Chatham Rise where it is caught as bycatch in a variety of target fisheries but mainly in the hoki (*Macruronus novaezelandiae*) fishery. Most catch has been recorded on Trawl Catch Effort and Processing Return (TCEPR) forms on which only the top five species in any one haul are required to be recorded. As lookdown dory is caught in relatively small quantities compared with other species they do not often make the 'top five' in any one haul. Lookdown dory is therefore poorly represented in estimated catch figures and daily processed catch records had to be used for this study. There was no reported targeting of lookdown dory by vessels operating onboard factories.

Random trawl surveys of the Chatham Rise and SubAntarctic in summer have been ongoing since 1991. Carried out by R.V. *Tangaroa*, these time series provide relatively precise biomass indices of lookdown dory with coefficients of variation (c.v.) usually less than 10% and 25% for the Chatham Rise and SubAntarctic respectively. The Chatham Rise series is relatively flat while the Sub Antarctic showed a decline from 1991 to 2006, but an upturn to 2009. Both regions showed a slight decline in relative biomass in the mid-2000s but now appear to be increasing slightly. There are no random trawl survey biomass estimates for the WCSI or ECNI and the level of observer sampling from ECNI is low. Sampling in other key areas 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-or length-at-age series have been developed and otolith ageing has not been validated. A standardised CPUE analysis was attempted for the main fishery, ECSI/CHAT, but the R^2 values were low (25%).

1.   INTRODUCTION

Many of New Zealand's middle depth fisheries, other than gemfish, hoki, hake, ling, and southern blue whiting are not routinely monitored or assessed despite their moderate size and value. This project is designed to ensure that data available for monitoring important middle depth species are routinely summarised and assessed on a five-year rotating schedule as described in the Ministry of Fisheries medium–term research plan for Middle Depth species (Ministry of Fisheries 2008). The first species to be characterised was silver warehou for Quota Management Areas (QMA) SWA3 and SWA4 in early 2009 under project MID200703 (Parker & Fu 2009). The next two species were arrow squid (Hurst et al. 2010a) and barracouta (Hurst et al. 2010b) in late 2009 under project MID200801. The two species selected under the rotating schedule to be assessed in 2010 are ribaldo (*Mora moro*) and lookdown dory (*Cyttus traversi*, the subject of this report) under project MID200901.

There have been no previous characterisations of lookdown dory. 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 SubAntarctic annually by *Tangaroa* since 1991 (with a hiatus on the SubAntarctic from 1995 to 1999). Lookdown dory biomass is usually in the top 10 species for the Chatham Rise series (Ministry of Fisheries 2009). 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 SubAntarctic and biomass estimates have higher cvs than on the Chatham Rise.

This report summarises the analyses carried out for the Ministry of Fisheries under project MID200901, Objective 2: To characterise the New Zealand lookdown dory fisheries by analysis of commercial catch and effort data up to 2008–09 including:

- To carry out 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 otoliths

- To make recommendations on future data requirements (including recommendations for annual levels of Observer sampling) and methods for monitoring the stocks.

The report follows the standard format developed for the first report (Parker & Fu 2009), except where additional information and analyses have been included to meet the specific objectives of this project. The report contains sections of text and tables that can be transferred to the Ministry of Fisheries 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. In New Zealand it is most often caught on the Chatham Rise.

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.

Landings data are available from the 1989–90 fishing year after the introduction of the Catch Landing Return (CLR) forms (Ministry of Fisheries 2009). In most years CLR forms correspond well with records of annual landings from Licensed Fish Receiver Returns. Landings have increased from 127 t in 1989–90 to a high of 892 t in 2002–03. Estimated catch in the early 1990s was fairly well represented in the landed catch (around 60–70%) but has declined in recent years to around just 30%. Being a relatively minor bycatch species means that lookdown dory will often fail to make the top five species caught in a single trawl tow, but why the percentage of landed catch recorded in the estimated catch has declined so much compared to the past is unknown (Ministry of Fisheries 2009).

Catches by Fishstock are plotted in Figure 3. Catches in LDO 1 have slightly exceeded the TACC for that stock in the 2006 and 2008 fishing years (Table 2). Presumably most of this is due to it being unavoidable as bycatch in the WCSI hoki spawning fishery (FMA 7) as historical catches by FMA (Table 3) show minimal lookdown landed from FMAs 1, 2, 8 & 9 (the FMAs that comprise the rest of LDO 1). Catches in LDO 3 have never come close to reaching the TACC of 614 t. This is probably due to the reduction in the size of the hoki trawl fishery (in which most lookdown dory is caught as bycatch) which underwent several quota cuts from the 2002 fishing year (Ministry of Fisheries 2009).

While three administrative stocks exist, for the purpose of this report, LDO 1 & 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 ("ECSI/CHAT", most of FMA 3 and all of FMA 4), Southland/SubAntarctic ("Southland/SUBA", the lower part of FMA 3 just south of Dunedin and FMAs 5 & 6) and West Coast (FMAs 7–9).

Lookdown dory is usually caught by bottom trawl and to a lesser extent midwater trawl at depths of 200–800 m. It is usually caught as bycatch in a variety of target fisheries including hoki, hake, scampi, and ling. Of all target fisheries, the hoki fishery catches the majority of lookdown dory.

Table 1: Recreational and customary non–commercial allowances, TACCs and TACs, by Fishstock, for lookdown dory (Source: Ministry of Fisheries Lookdown Dory Plenary May 2009).

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 domestic landings (t) of lookdown dory by Fishstock and TACC from 2004–05 to 2007–08 (Source: Ministry of Fisheries Lookdown Dory Plenary May 2009).

Fishstock	LDO1		LDO3		LDO10		Total	
FMA	1,2,7,8&9		3,4,5&6		10			
	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	161	168	274	614	0	1	435	783

Table 3: Reported historic landings (rounded to nearest tonne) of lookdown dory by FMA and fishing year 1989–90 to 2003–04 (Source: Ministry of Fisheries Lookdown Dory Plenary May 2009).

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	1848	2698	255	202	1427	7	29	0	6608
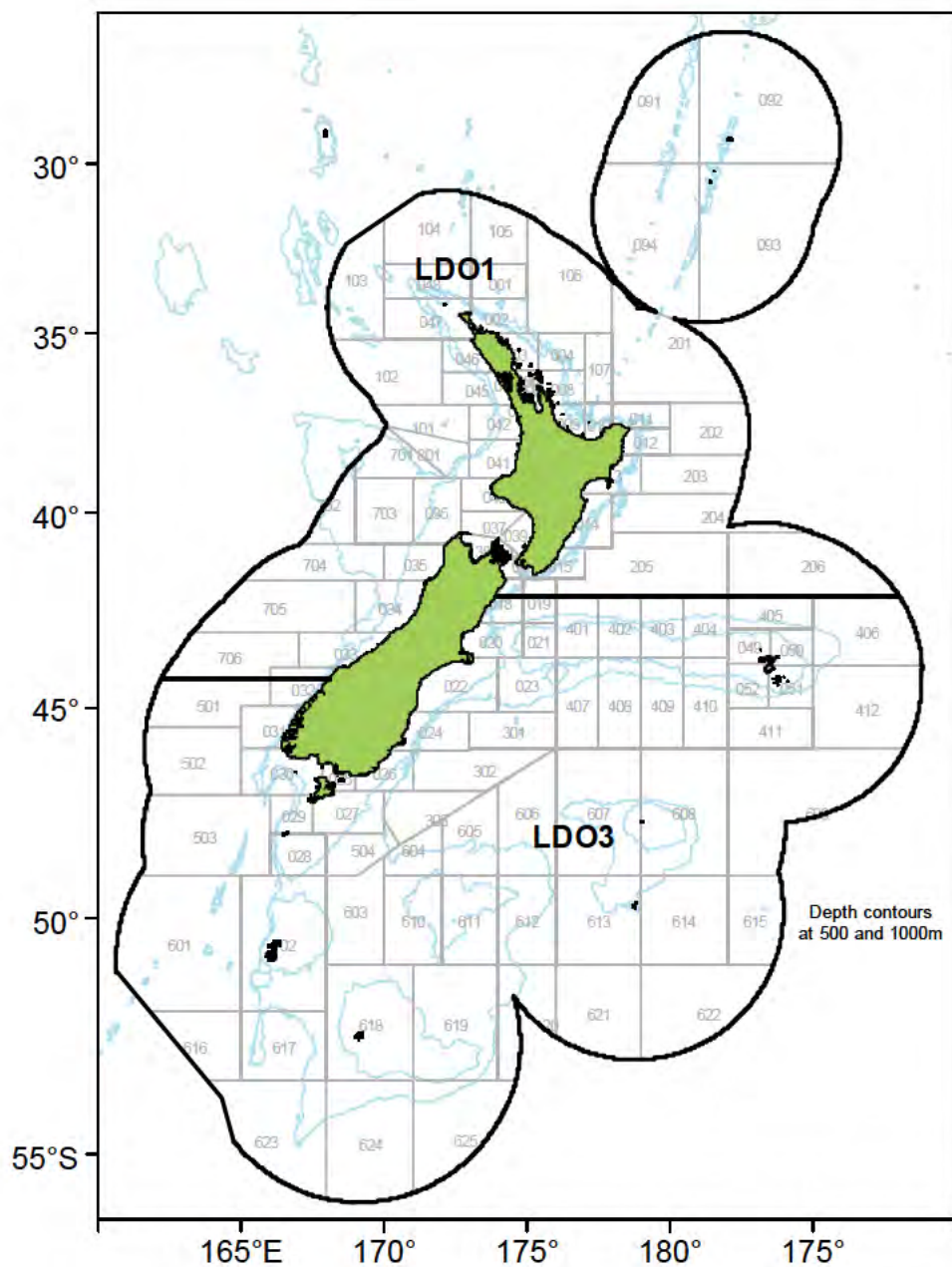
Figure 1: Map showing the administrative fishstock boundaries for LDO 1 and LDO 3, including statistical areas, and the 500 m and 1000 m depth contours.

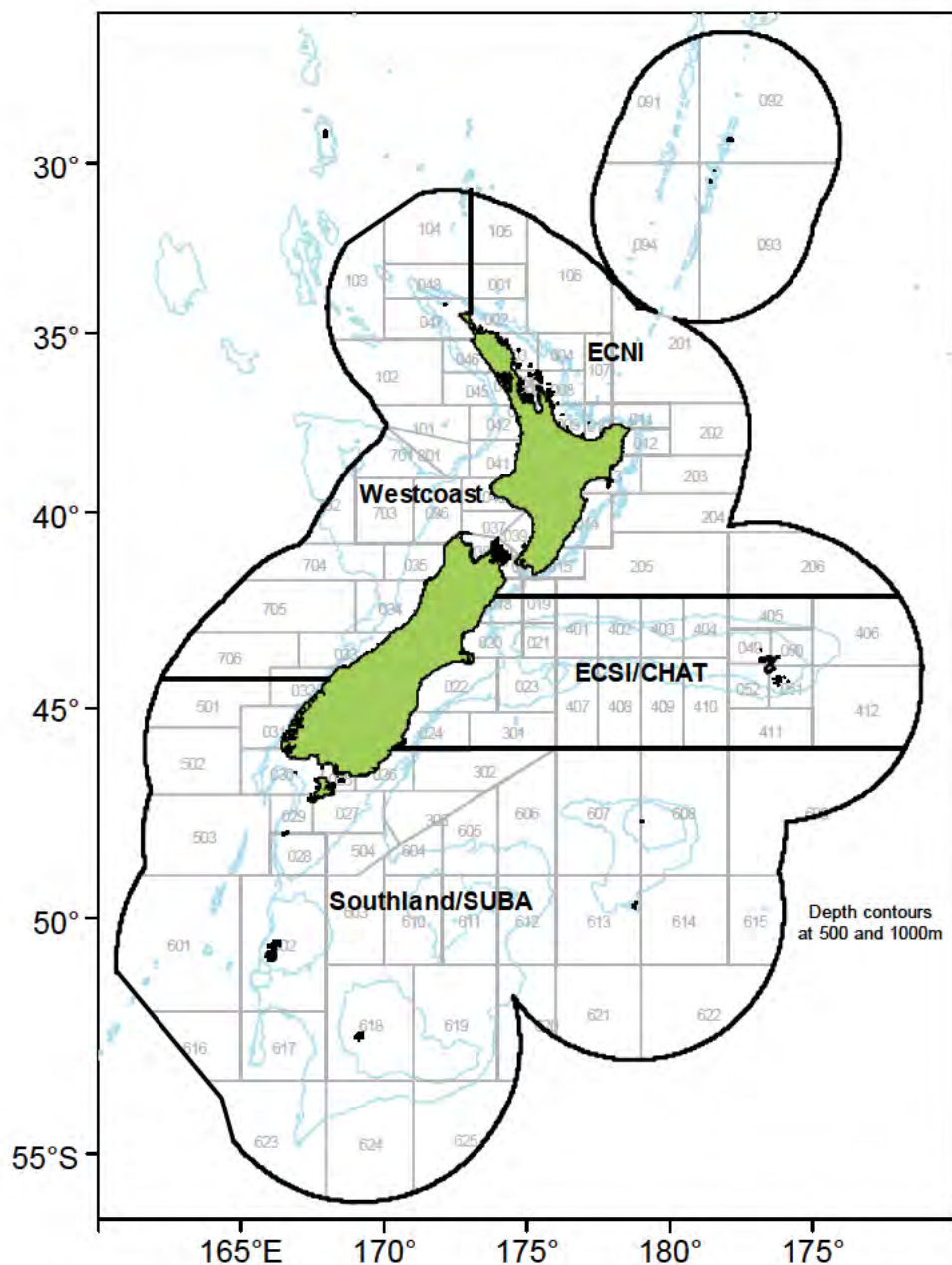**Figure 2: Map showing the areas used in this analysis, including statistical areas, and the 500 m and 1000 m depth contours. ECNI, east coast North Island; ECSI, east coast South Island (including the Chatham Rise); Westcoast; Southland (including the SubAntarctic). LDO 10 is not included as there is no catch in this area.**
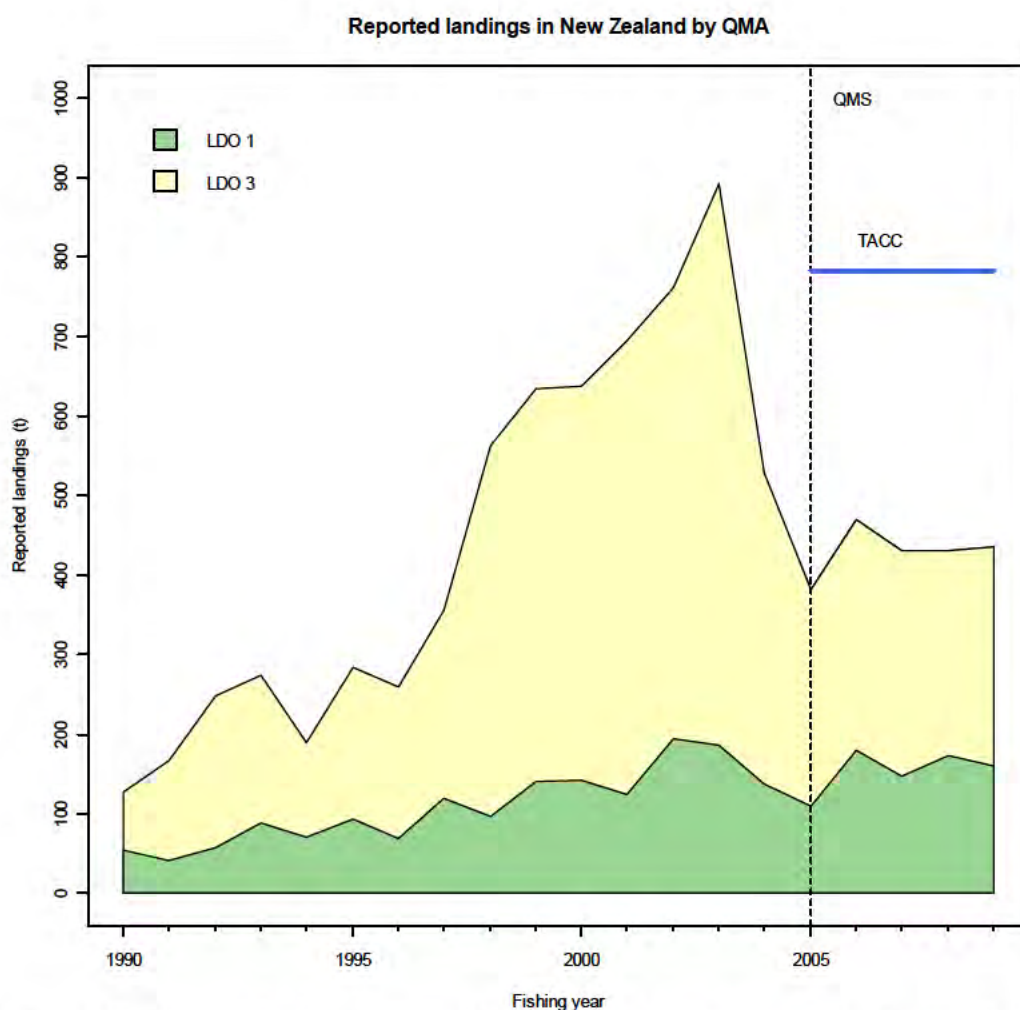
Figure 3: Total reported landings by QMA (shaded regions) and TACC from fishing years 1990 to 2008.

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 and effort in lookdown dory are described in Section 2.1. Codend minimum mesh-size regulations that currently apply to the trawl fisheries are 60 mm for SubAntarctic (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 on 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 are widely distributed throughout the New Zealand EEZ but 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 SubAntarctic trawl surveys but the distribution is much patchier and they are less abundant than on the Chatham Rise (O'Driscoll & Bagley 2001). Immature fish (less than 33 cm) have a similar geographical and depth distribution to adults (Hurst *et al*. 2000, O'Driscoll et al. 2003). Surveys using the same trawl gear show much higher abundance of immature fish on the Chatham Rise compared to the SubAntarctic (O'Driscoll et al., 2003). While adults are most common between 350 to 650 m they are found at a wide range of depths from 50 to 1200 m (Anderson et al. 1998). Juvenile fish of up to 12 cm are found in surface waters (May & Maxwell 1986) after which they metamorphose into the adult form and shift from a pelagic to a demersal habitat (James 1976).

The main prey of lookdown dory are natant decapod crustaceans, followed by euphausid, mysid, galatheid, and nephropsid crustaceans, and fish (Clark & King 1989). They are a less abundant member of a loosely associated group of 23 common species that comprise the upper slope assemblage of New Zealand's continental shelf (Francis *et al*. 2002). The most common species in this assemblage are hoki (*Macruronus novaezelandiae*), javelin fish (*Lepidorhychus denticulatus*), ling (*Genypterus blacodes*), pale ghost shark (*Hydrolagus bemisi*), sea perch (*Helicolenus percoides*), hake (*Merluccius australis*), and longnose spookfish (chimaerid). Commercially they are most often caught as bycatch in the hoki fishery, particularly on the Chatham Rise but also to a lesser extent in the SubAntarctic and WCSI. Other target fisheries that commonly catch lookdown dory include scampi (*Metanephrops challengeri*), hake, ling, barracouta (*Thyrsites atun*), orange roughy (*Hoplostethus atlanticus*), squid (*Nototodarus sloanii*), and silver warehou (*Seriolella punctata*).

Biomass trends and length frequencies for research survey series (at least four years) that cover appropriate depth ranges for lookdown dory are summarised in Appendix A. These are the summer Chatham Rise surveys, summer SubAntarctic surveys, and autumn SubAntarctic surveys on R.V. *Tangaroa*. The main conclusion from these data is that biomass on the Chatham Rise is consistently greater than on the SubAntarctic, by a factor between four and seven in many years. Female biomass in both regions is about double that of males in all years, with the exception of the 2001–03 in the summer SubAntarctic series.

The Ministry of Fisheries Observer sampling programme has collected length frequency, weight and gonad stage information from the ECSI region and WCSI. Data for these areas have been summarised by year and are presented in Appendix B. Scaled population length frequencies show that lookdown dory are more frequently caught in the ECSI region than on the West coast and in both regions females grow larger than males. This is consistent with findings from research trawl surveys.

3.2 Spawning

There are no known 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 (Clark & King 1989). 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. Observer collected gonad information summarised in this study (Appendix Figure B6) shows that most females are resting/immature or maturing throughout the year in the ECSI region. Ripe fish are most common in the summer months (consistent with the trawl survey records) and spent fish are more common in the winter than at other times of the year. Observer data collected from West coast comes mainly from the hoki spawning season (June–September) and shows mostly resting/immature and spent fish, but all stages are present. There is minimal data for the other areas ECNI and Southland, but evidence of some spawning activity in the Bay of Plenty and the Bounty Islands (Appendix Figure B7). 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 SubAntarctic Islands (Auckland Is., Campbell I. Bounty I) (O'Driscoll et al. 2003). These observations suggest the possibility of substocks within the LDO 1 & 3 Fishstock areas, although it is possible that in fact fish spawned in different location mix with one another and more data are needed to address this.

3.3 Stocks and spatial distribution

There has been no previous work on stock structure, recruitment, age or any other biological characteristics on which to base the boundaries of fish stocks. This study found some differences in size and abundance between the Chatham Rise and SubAntarctic 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. 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 zone counts, Tracey et al. found maximum ages of 38 and 25 years for males and females respectively. 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).

3.5 Growth curves

Von Bertalanffy growth parameters are presented in Table 4. Growth of females is faster than that of males. Hence females are significantly larger at age than males (Tracey et al. 2007). Females also attain larger maximum size than males. Initial growth of the species is rapid.

Table 4: Summary of von Bertalanffy growth parameters for Chatham Rise lookdown dory. Source : Tracey et al. 2007. NB : Ageing in this study used unvalidated methods.

Sex	N	L_∞	SE	95% CI	K	SE	95% CI	t_0	SE	95% CI
All	382	50.72	2.53	(45.75, 55.68)	0.058	0.007	(0.044, 0.073)	-3.53	0.67	(-4.84, -2.21)
Males	191	38.78	1.68	(35.49, 42.06)	0.074	0.011	(0.053, 0.095)	-4.28	0.87	(-5.97, -2.57)
Females	191	69.94	5.71	(58.75, 81.13)	0.039	0.006	(0.027, 0.051)	-3.90	0.72	(-5.31, -2.49)

3.6 Natural mortality

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 a variety of methods to give estimates but noted that their estimates of Z included unknown components of fishing mortality (F). Their estimate also assumes 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 estimate that M for lookdown dory is probably somewhere between 0.10 and 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. They were estimated as α=0.025 and β=2.96 for males, and α=0.022 and β=2.98 for females for the equation where weight (in grams) = αL^β and L is length in centimetres.

Table 5: Length-weight parameters for lookdown dory. Source : Tracey et al. 2007.

	α	β
Males	0.025	2.96
Females	0.022	2.98

3.8 Feeding and trophic status

Clark & King (1989) examined 187 stomachs of lookdown dory from three different coastal areas of the North Island and found that natant decapods were their main prey, concluding that lookdown dory forage close to the seabed. Blaber & Bulman (1987) examined 247 stomachs from eastern Tasmania and found that there macrourid and mesopelagic fishes comprised most of their prey and concluded that lookdown dory were benthopelagic omnivores. Foreman & Dunn (2010) recently completed the first study of the feeding ecology of lookdown dory on the Chatham Rise. They took stomachs sampled from three consecutive middle depth Chatham Rise trawl surveys on *Tangaroa* from December 2004–January 2005, December 2005–January 2006, and December 2006–January 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 TL), maturing males and females (26–39.5 cm TL benthopelagic omnivores) and an exclusively female group (mature females greater than 40 cm TL, 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 (Foreman & Dunn, 2010). None contained lookdown dory, suggesting that they are not common prey for other species on the Chatham Rise. However the Ministry of Fisheries (2009) report that lookdown dory are sometimes found in the

stomachs of large ling. Foreman & 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 among others.

4.   CURRENT AND ASSOCIATED RESEARCH PROGRAMMES

4.1   Ministry of Fisheries

Lookdown dory is one of 18 species included on a list to be characterised once every three years under the Ministry of Fisheries 'Deepwater 10-year Plan'. Research trawl surveys on *Tangaroa* on the Chatham Rise and SubAntarctic in summer are the only ongoing time series in which lookdown dory catches and length frequencies are regularly recorded (see Section 5). Note that the autumn SubAntarctic time series has been discontinued since 1998. Numbers of lookdown dory measured ranged from 2923–5610 on the Chatham Rise time series and from 99 – 300 on the summer SubAntarctic time series. Biomass estimates on the Chatham Rise time series range from 4797 – 8821 t, and 446–1017 t on the summer SubAntarctic time series. Precision is good on the Chatham Rise with cvs usually under 10%. Cvs are higher for the SubAntarctic but acceptable (11.3 – 35.1 %).

5.   FISHERY INDEPENDENT OBSERVATIONS

5.1   Research surveys

Biomass indices, length and age frequencies

Relevant trawl survey data are summarised in Table 6 and Appendix A. Note that years referred to in the research survey section are calendar years. Dates for surveys are also given in Table 6.

There have been no surveys designed specifically to estimate lookdown dory abundance. However the Chatham Rise and SubAntarctic *Tangaroa* random bottom trawl survey time series, started in 1991, cover the appropriate depth and provide relatively precise biomass indices (Chatham Rise cvs usually less than 10%, SubAntarctic cvs usually less than 25%). On the Chatham Rise, lookdown dory biomass is also often in the top ten species and the biomass trend is relatively flat (Table 6, Figure A1). On the SubAntarctic plateau, biomass declined through to a low period in 2002, but has subsequently increased (Table 6, Figure A2). SubAntarctic biomass is consistently lower than on the Chatham Rise by a factor between 4 and 7. There were only four autumn SubAntarctic surveys, in 1992, 1993, 1996 and 1998 (Table 6, Figure A3). Where there are comparable years with the summer series (1992 and 1993), 1992 shows similar biomass (summer = 1017 t, autumn = 1154 t) but 1993 has much higher biomass (summer = 796 t, autumn = 1955 t), although also has a much higher cv (44%). In both the SubAntarctic and Chatham Rise biomass estimates for females is about double that for males, except for the years 2001–03.

Length frequencies of Chatham Rise lookdown dory (Figure A4) suggest that recruitment is variable. 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 (TAN9106) and moving through until at least the sixth survey in the series (TAN9701). Another newly recruited year class in the seventh survey (TAN9801) can be tracked for around four years until the eleventh survey in the series (TAN0201). Other "strong" year classes, such as that seen in TAN9601, do not appear to track well is subsequent years. Generally, when a strongly recruiting year class is present, the male length frequencies are often bimodal and females show two or three modes. Length frequency plots show that females are usually more numerous than males with a mean ratio for the time series of 1.15 females to every male (range 0.98–1.52). Males do not grow as large as females, with few males growing larger than 40 cm.

Length frequencies from the summer SubAntarctic series (Figure A5) are less informative and no real tracking of cohorts is possible. Overall, scaled population numbers are much lower for both sexes here than on the Chatham Rise but females again are more numerous than males with a mean ratio for the time series of 1.8 females for every male (range 0.55–3.9). Females again appear to grow to a larger size than males but both sexes appear to grow to a larger size on the SubAntarctic than on the Chatham Rise which suggests the possibility that it may be a separate biological stock. Alternatively, lookdown dory may be less exploited in the SubAntarctic and able to grow to a larger size due to lower fishing pressure.

Length frequencies of the four autumn SubAntarctic series (Figure A6) also show that females are more numerous with a mean ratio for the time series of 1.82 females for every male (range 0.68–3.32). Females again appear to grow to a larger size than males.

Ageing has not been validated for lookdown dory. An attempt was made by Tracey et al. (2007) from 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.

Table 6: **Biomass indices (t) and coefficients of variation (cv) for lookdown dory from *Tangaroa* trawl surveys (Assumptions: areal availability, vertical availability and vulnerability = 1).**

Area	Vessel	Trip code	Date	Biomass (t)	% cv
Chatham Rise					
	Tangaroa	TAN9106	Dec 91–Feb 92	4797	5.6
		TAN9212	Dec 92–Feb 93	6439	5.2
		TAN9401	Jan 94	7664	7.2
		TAN9501	Jan 95–Feb 95	5270	6.5
		TAN9601	Dec 95–Jan 96	7540	8
		TAN9701	Jan 97–Jan 97	6568	7.6
		TAN9801	Jan 98–Jan 98	7019	6
		TAN9901	Jan 99–Jan 99	7417	8.2
		TAN0001	Dec 99–Jan 00	7655	7
		TAN0101	Dec 00–Jan 01	7713	6.5
		TAN0201	Dec 01–Jan 02	8821	11.1
		TAN0301	Dec 02–Jan 03	5853	7
		TAN0401	Dec 03–Jan 04	6304	8
		TAN0501	Dec 04–Jan 05	6351	9.3
		TAN0601	Dec 05–Jan 06	7818	8.5
		TAN0701	Dec 06–Jan 07	5714	7.7
		TAN0801	Dec 07–Jan 08	5230	9.3
		TAN0901	Dec 08–Jan 09	7789	8.7
SubAntarctic (summer)					
	Tangaroa	TAN9105	Nov–Dec 91	987	13.3
		TAN9211	Nov–Dec 92	1017	11.3
		TAN9310	Nov–Dec 93	796	13.5
		TAN0012	Nov–Dec 00	921	15.2
		TAN0118	Nov–Dec 01	566	19.7
		TAN0219	Nov–Dec 02	446	22.1
		TAN0317	Nov–Dec 03	636	23.7
		TAN0414	Nov–Dec 04	614	27.9
		TAN0515	Nov–Dec 05	703	19.1
		TAN0617	Nov–Dec 06	513	35.1
		TAN0714	Nov–Dec 07	725	20
		TAN0813	Nov–Dec 08	811	24.7
		TAN0911	Nov-Dec 09	820	25.1
SubAntarctic (autumn)					
	Tangaroa	TAN9204	Apr–May 92	1154	40
		TAN9304	May–Jun 93	1955	44.1
		TAN9605	Mar–Apr 96	1058	17.8
		TAN9805	Apr–May 98	529	32.6

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 contained in Appendix B (Tables B1–B4, Figures B1–7).

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 (Figure B1–2). 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. By area, sampling best represents catch distributions for ECSI region and WCSI. Southland and East Coast North Island are under-represented (Figure B1). By month, sampling best represents catch for WCSI; sampling for ECSI is sporadic (Figure B2).

A total of 220 and 493 pairs of otoliths have been taken from lookdown dory from LDO 1 and LDO 3, respectively, 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 (Section 3.5).

Length and age frequencies

Length frequencies are presented for ECSI and West coast in Figures B4 & B5, respectively. Sample sizes are small for the ECSI region and the plots are not informative with respect to tracking of cohorts through time. As for the *Tangaroa* surveys of the same area, male fish appear to be less numerous and smaller than female fish.

Sample sizes on the West coast are also small and there is no clear picture of any cohorts moving through the fishery. As in other regions females are usually more numerous and grow to a larger size than males. There are no time series of trawl survey length frequencies of lookdown dory from the West coast with which to make comparisons.

Female maturity

Observer collected data on female lookdown dory maturity have used a 5-stage gonad scale (immature/resting, maturing, ripe, running ripe, spent). Results are summarised in Table B4 and Figure B6 for ECSI and West coast fish. Data are available throughout the year for the ECSI region, with both immature/resting and maturing fish being present throughout the year. Where there are reasonable samples (more than 40 per month), ripe fish are present mainly from November–May, running ripe fish are only present in February and August, and spent fish are present from February–August, peaking in June. This suggests an extended spawning season from at least February–August.

West coast data are only available from June to November (excluding October), presumably as most of the data is collected at the same time as the hoki spawn season and slightly beyond. The proportion of immature/resting stage fish is lower, and spent fish is higher, than for the same period for the ECSI. Maturing, ripe and running ripe fish are present in all months indicating spawning occurs at least from June–November.

The location of spawning activity (ripe and running ripe fish) includes WCSI, north, west, and south Chatham Rise, and one record from the Bounty Islands and Bay of Plenty (Figure B7)

6.2   Catch and effort data sources

Catch and effort data and daily processed data were requested from the Ministry of Fisheries catch-effort database "warehou" as extracts 7700 and 7759 respectively. The data consist of all fishing and landing events associated with a set of fishing trips that reported a positive landing of lookdown dory in LDO 1 or 3 between 1 October 1989 and 30 September 2009. In this report, fishing year is labelled as the most recent year (*i.e.,* the 1998–1999 fishing year is referred to as 1999). The fields from the database tables requested are listed in Table C1.

The daily processed catch associated with the fishing events were reported on the Trawl Catch Effort and Processing Return (TCEPR) forms. Daily processed catch was used because the landed catch was so poorly represented in the estimated catch as lookdown dory is a minor bycatch species that does not often make up one of the top five species in a haul. The greenweight associated with landing events were reported on the associated Catch Landing Return (CLR). TCEPR forms record tow-by-tow data and for each day record the catch for all species processed that day. 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 etc). 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. Information on total harvest levels are provided via the QMR/MHR system, but only at the QMA resolution.

The extracted data are groomed and restratified to derive the datasets required for the characterisation and CPUE analyses using a variation of Starr's (2007) data processing method as implemented by Manning et al. (2004), with refinements by Blackwell et al. (2005), and Manning (2007) and further modified for this study to make use of daily processed catch data in place of estimated catch data. The procedure has been developed for monitoring bycatch species in the AMP, and is comprehensively described by Manning et al. (2004) and Starr (2007). The major steps as used in this study 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 'BT+MW').	
Fishing duration	Sum
Effort depth	Mean
Effort speed	Mean
Effort height	Mean
Effort width	Mean
Bottom depth	Mean
Effort num (defaults to one per tow for TCP data)	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 LDO1 and LDO3, the proportion landed for each is calculated and the LDO catch is multiplied accordingly to get LDO1 catch and LDO3 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 using the fish stock code and trip ID.

Step 4: The greenweight landings are then allocated to the effort data using total processed catch for each date/vessel key as a proportion of the total processed catch for the trip.

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 C1–47). 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, catch-effort landings (un-groomed), and TACCs for LDO 1 and 3 from 1990–2009 are shown in Figure C1. MHR and TACC were also presented earlier in Table 1. For both fish stocks, the ungroomed catch-effort landings are fairly close to the reported MHR landings, particularly in LDO 3 and in both stocks since the 2005 fishing year when the species entered the QMS. Reported MHR landings slightly overran the TACC in 2006 and 2008 in LDO 1.

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, and interim landing events, where catch is transferred or retained, and may therefore appear subsequently as a final landing event (SeaFIC 2007). Starr's procedure separates final and interim landings based on the landing destination code, and only landings with destination codes that indicate a final landing are retained (see Table 2 in Starr (2007)).

Table C2 summarises the number of landing events for the major destination codes in the dataset. The proportion of landing events recorded under "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 common for CLR forms from the 1990s to around the early 2000s. From then 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). For CELR forms "T" and "R" destination codes forms have never been used other than single "R" events in LDO 1 in 2006 and 2007 in LDO 3 in 2009. Apart from the few "R" destination codes just described the only destination code used for CELR forms is "L". It was unknown how the catches from "T" trips are recorded, as the transferred catches could be landed by foreign vessels to ports

outside New Zealand. Other interim landing events (retained as bait, in holding receptacles, or on board) were dropped (after Starr 2007, Parker & Fu 2011). The weight, number of records, and disposition 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 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 well with the retained landings for a number of fishing years, particularly from 1990 to 1997. This improves somewhat after interim destination codes start to be used less often and the majority of lookdown dory is landed in New Zealand. Total daily processed catch and retained landings from LDO 1 represent 65% and 64% respectively of total reported QMR/MHR landings for the study period (Table C4). A similar but less severe pattern is seen in LDO 3 with good agreement between retained landings and MHR landings from 1997 (Figure C2). Total daily processed catch and retained landings from LDO 3 represent 91% and 89% respectively of total reported QMR/MHR landings for the study period (Table C4)

The main processed state for lookdown dory in LDO 1 is "dressed" (includes "Dressed", "Headed and gutted", and "Trunked") with smaller amounts made into 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. Dressed is also the most common processed state in LDO 3 and again smaller amounts are made into fish meal or landed green. As in LDO 1, "Other" processed states are more common in the early 1990s but are a minority later on in the time period. 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 were allocated to the effort strata using the relationship between the statistical area for each effort stratum and the statistical areas contained within each fish stock. Difficulties arise with effort strata associated with statistical areas that straddle stock management area boundaries (e.g. statistical areas 018, 019, and 032 in the case of lookdown dory), as the proportion of catches to be allocated to each QMA cannot be determined. The usual treatment for a trip fishing in a straddling statistical area is to assume the catches of the straddling statistical area had been taken from a single fish stock if the trip had only reported to that stock, and to exclude all the fishing and landing events from that trip if it had reported to multiple fish stocks ("straddle" method). This may not be ideal if trips often straddle fishstock boundaries. Therefore statistical areas were allocated to LDO fish stocks based on the location of the centroid of each statistical area ("centroid" method). This resulted in a closer relationship between QMR/MHR landing, merged landings and processed catch for both areas. Details of the retained landings in unmerged and merged datasets and processed catches in the groomed and merged datasets, by QMA, 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.

Processed catch, QMR, retained, and merged landings and are plotted in Figure C5. In LDO 1 the retained landings are usually lower than the QMR landings, particularly during the early 1990s. There is a dramatic improvement in the match between retained landings and QMR landings from 1998 on. Processed catch matches merged landings closely throughout the period with and are consistently lower than the QMR landings with an improvement from 1998 on as was seen with retained landings. In LDO 3 retained and merged landings and the processed catch follow each other very closely throughout the time period. All three are below the QMR landings during the early 1990s but match QMR landings well thereafter.

The reporting rate, defined to be the greenweight calculated from annual processed catch for this study as a proportion the retained landings in the groomed and merged dataset, was also calculated (Figure C6). The TCEPR/CLR reporting rate is quite variable in LDO 1 until about 2000 and is fairly steady

afterwards. The reported rate is usually less than one. Why this is so is uncertain but could be due to misreporting of landing weights or perhaps incorrect reporting of processed states. For other years there is fair 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.

For trips that reported landing lookdown dory, only one trip in 1998 recorded no processed catch in LDO 1 (Table C6). No trips in LDO 3 reported no processed catch for a trip when lookdown dory was landed. Figure C7 also shows that on a trip by trip basis for each fishing year, the landed catch of lookdown dory is often higher than the recorded processed catch for LDO1. In LDO 3, the landed catch usually matches the processed catch well.

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 (ECSI/CHAT), SubAntarctic (Southland), West coast (almost exclusively WCSI), and east coast North Island (ECNI).

The highest catches, particularly since the mid-1990s have come from the ECSI/CHAT region (Table C7, Figure C10b). Within this region the most important statistical areas are 020 and 022 for the more inshore areas, with catches being fairly even across most of the Chatham Rise (Figures C8, C11b). Catches in Southland are highest in area 602 (Auckland Islands) and 028 (Snares Shelf) and 030 (Puysegur Trench) (Figures C9, C21b). For WCSI catches are almost entirely from statistical areas 034 and 035 (Figures C9, C31b) where much of the effort in the hoki winter spawning fishery is concentrated, with reported catches being steady since the mid-1990s. The pattern of increasing reported catches since the mid-1990s is seen across all four of the main fishing areas. Highest catches from the ECNI have consistently been from statistical area 014 (South Hawkes Bay) followed by 015 (Wairarapa Coast), with sporadic catches from 008 though only a fraction of the catches from 014 (Figure C41b).

Across all fisheries most vessels are of an unknown flag followed by New Zealand, Korea, and Panama. The reason for the prevalence of unrecorded nationalities is unknown. The majority of vessels are over 2,000 kilowatts in power, 1700 gross tonnes, and 55 metres in length. A minor amount of lookdown dory is taken by much smaller inshore vessels. Vessel characteristics have been fairly constant since the mid-1990s, with little data prior (Figure C9a–d).

Total estimated catch for each region from the groomed and merged dataset are shown in Table C7 (Figure C10b). All areas had little reporting of lookdown dory catches in the early 1990s but since the mid-1990s the ECSI/CHAT region has been dominant with catches regularly in excess of 300 t compared to Southland and WCSI which both usually report around 80–150 t. The ECNI catch is minor in comparison to the other areas with annual estimated catches ranging from just one to eight tonnes totalling 81 t for the entire period compared to 5099 546, and 1449 t for ECSI, WCSI, and Southland, respectively.

Across all areas bottom trawling is the dominant fishing method that catches lookdown dory (Figure C10c). In all areas a small amount is also taken by midwater-trawling. On some days vessels report an even number of bottom and midwater tows. Method for these days is reported at 'BT+MW' but accounts for only a very small proportion of the catch. While bottom longline vessels with onboard processing factories operate in New Zealand waters, their take of the lookdown catch is negligible and they do not use TCEPR forms. While a variety of other fishing methods report catching lookdown dory the catch is negligible and they do not report on TCEPR forms (which include daily processed catch information) and so cannot be included in this analysis.

Lookdown dory is taken as bycatch in a variety of target fisheries but hoki has always been the dominant fishery by far (Figure C10d). Hake has been steadily 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. The Ministry of Fisheries 2009 plenary for lookdown dory reports that there is a small amount of target fishing (presumably by bottom trawl) 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.

Across all fisheries there is no distinct season in which most lookdown dory catches are taken (Figure C10a). This is true of the four main regions with the exception of the West coast where nearly all of the catch is taken between June and October, and most within that period taken in June and August (Figure C31a). This coincides with the hoki and hake fisheries that operate on the WCSI.

7.2.1   East Coast South Island and Chatham Rise (ECSI/CHAT)

The ECSI/CHAT region contributes by far the greatest proportion of the country's lookdown dory catch for the study period (Table C7, Figure C10b). No clearly distinct season is apparent for the region, although it appears that catches may decrease slightly from June to September/October 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 C11a & C12c).

Statistical areas 020 and 023 are important on the east coast South Island whereas most statistical areas are important on the Chatham Rise (Table C9b, Figures C11b & C12a–b).

Almost all of the lookdown dory catch here is taken by bottom trawl (96% overall) and to a much lesser extent midwater trawl (3% overall). Days with even splits of both methods ('BT+MW') account for just 1% of the overall catch (Table C9c, Figure C10c).

Hoki is the key target species reported on the Chatham Rise with 87% of the lookdown dory catch. Other targets include barracouta, hake, ling, scampi, sea perch, squid, and silver warehou specie (Table C9d, Figure C10d).

Unstandardised catch rates (kg per tow) of lookdown dory are presented in Figure C13. For most target species the lookdown dory catch rate is fairly flat with occasional spikes in some years. In the hoki fishery the catch per tow has been flat since the mid-1990s with catches of around 60 kg per tow. Hake, the next most important fishery for lookdown dory catch is more variable with catches usually being around 30–50 kg per tow.

Daily fishing duration for bottom tows has remained constant for the hoki target fishery at around 10–18 hours for most days (Figure C14). Daily bottom tow duration for hake rose during the early 1990s and is now usually between 10 and 20 hours a day. Similar daily bottom tow durations are seen in the mixed, ling and scampi fisheries. Daily tow duration is slightly lower in silver and white warehou fisheries and the squid fishery.

Daily tow duration for midwater tows have remained very constant for hoki at around 10–15 hours (Figure C15). Daily midwater tow duration is slightly higher for hake, usually 10–20 hours per day. Tow duration is variable in other target fisheries using midwater gear and often these fisheries do not report catching lookdown dory by midwater trawl. The reason why hoki and hake consistently report catching lookdown dory in midwater trawl is that these fisheries often operate midwater trawls on or close to the seabed where lookdown dory are found.

Effort depth for bottom trawls has remained constant throughout the time period for hoki with most trawls being 400–600 m (Figure C16). Effort depth for hake is similar to hoki but with a slightly lower upper range. For the other less important target fisheries effort depths are similar, with most tows being between

400–600 m, with the exceptions of squid (mainly between 200–400 m. For midwater tows (Figure C17) there are few data except for hoki and hake which show similar depths to bottom trawl gear.

Bottom trawl gear width and vessel speed, tonnage, and length are shown in Figure C18. Effort width for hoki is mainly between 30 and 45 m but can be as wide as 90 m. Hake is similar. Scampi appears to use wider effort widths than other fisheries with most values between 50 and 60 m. The majority of other species have effort widths mostly between 20 and 45 m. Effort speed is similar for most target species with the majority of bottom tows being between 3.5 and 4.5 knots. Scampi tows for the ECSI/CHAT region are slower with most tows being less than 3 knots. A wide range of vessel tonnage is seen from around 100 tonnes up to 5000 t, with most 500 to 2500 t. The wide range of vessel tonnage is probably a result of including inshore ECSI and deeper Chatham Rise areas together. Vessel length is similar with lengths ranging from around 30–100 m for most species, with hoki target vessels being up to 120 m. The majority of vessels are between 50 and 70 m in length.

For midwater trawl (Figure C19), fishing effort variables are fairly similar to bottom trawl, although hoki vessels have a wider effort width (up to around 160 m). Vessel characteristics are similar too, most likely because vessels using midwater gear are the same ones using bottom trawl gear.

The location of lookdown dory catch by vessels reporting on TCEPR forms has not changed since 1990 (Figure C20). 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.

7.2.2   Southland and SubAntarctic (Southland)

The Southland and SubAntarctic region contributes much less of the lookdown dory catch than the ECSI/CHAT region (Table C7, Figure C9b). There does not appear to be a distinct season, with lookdown dory being caught in all months of the year but like on the Chatham Rise there does appear to be a slight decrease in August–September when vessels targeting hoki move to hoki spawning grounds (Table C10a, Figures C21a, C22d).

Most lookdown dory is caught in statistical area 602 (Auckland Islands), 028 (Snares Shelf) and area 030 (Puysegur Trench), although a number of areas contribute to the overall catch (Table C10b, Figures C21b, C22c).

As in other areas, the majority of the catch is taken by bottom trawl (90% overall) and a small amount by midwater trawl (9% overall) (Table C10c, Figure C21c). Days with even splits of bottom and midwater tows again make up only 1% of the overall catch for the study period.

Target species catching lookdown dory are similar to the ECSI/CHAT region, with hoki again being the dominant species though less so with 51% of the overall catch (Table C10d, Figure C21d). Hoki target accounted for as much as 90% of the lookdown dory catch in some years but has declined somewhat, particularly since 2002. This is quite likely due to the reductions in hoki quota from this time. Although lookdown dory bycatch is much smaller in other target fisheries, there is an increasing amount being taken in hake, ling, and white warehou fisheries in recent years.

Unstandardised catch rates (kg per tow) of lookdown dory are presented in Figure C23. Catch rates of lookdown dory are fairly stable in most fisheries since 1998 with white warehou showing an increase from this time. Catch rates are usually around 20–30 kg per tow. Data for some target fisheries such as squid, hake and southern blue whiting is patchy and variable.

Daily fishing duration for most bottom tows in the hoki fishery has remained constant throughout the time period , mainly between 10–18 hours (Figure C24). Daily tow duration in the ling target fishery is similar to that of hoki and shorter in the squid fishery at around 8–16 hours. Other less important target fisheries have more variable daily tow durations.

There is little lookdown dory caught in the Southland region by midwater trawl and for most target fisheries daily tow duration is patchy and data is absent in most years. The hoki and southern blue whiting fisheries report catching lookdown dory in midwater tows more often than any other fishery and show a lot of variation but the majority of daily tow duration falls between 5 and 15 hours (Figure C25).

Effort depth for bottom tows is similar in Southland as for many of the same target species in the ECSI/CHAT region with most tows being 400–600 m for most species and ranging from 200–800 m (Figure C26). Squid and silver warehou are shallower than the rest with the majority of bottom tows being around 200–400 m in depth.

For midwater tows hoki and southern blue whiting are the only species regularly targeted that catch lookdown dory throughout the time period (Figure C27) and effort depth is similar to bottom tows in most years.

For bottom tows, most target species have effort width values of between 30 and 50 m, but widths of up to 90 m are reported for scampi (Figure C28). Hake and white warehou has substantially lower effort width values overall with most being between around 10 and 30 m. Effort speed is around 4 knots for most species with scampi again having a slower speed for most tows at less than 3 knots. Vessels range from around 100 tonnes to almost 5000 tonnes with the majority being between 500 and 2500 tonnes. Vessel length for most species is around 50 to 70 m, with scampi vessels being noticeably smaller than others at between 20–40 m.

Effort widths are noticeably wider for all species taken by midwater tows (Figure C29) with most being between 50–100 m. Effort speeds for midwater tows are similar with most being 4–4.5 knots. Jack mackerel towing speed are noticeable faster than other target species at around 4.5–5.5 knots. Smaller vessels are not well represented in the midwater boxplots with nearly all vessels being more than 1500 tonnes in weight and more than 50 m in length. Presumably this is because smaller vessels generally lack the horsepower needed to tow large midwater trawls

The location of lookdown dory catch as reported on TCEPR forms has changed little for Southland (Figure C30). Most of the catch is taken around the Auckland Islands, Snares Shelf, and Puysegur Trench. In some years reasonable catches are taken along the top of the Pukaki Rise, the western side of the Bounty Plateau and around the Campbell Rise. Catch rates appear to increase over time but this is most likely better reporting of catches rather than an actual change in catch rate.

7.2.3   West coast

The total lookdown dory catch from the West Coast region is 1449 t for the study period (Table C7). Although this is less than one third of the catch from the ECSI/CHAT region this nonetheless makes it the second most important area by tonnage. The West coast is the only region to have a distinct season with nearly all of the catch being taken from June to October, mainly in July–August (Table C11a, Figures C31a, C32d). This period coincides with the hoki and hake spawning fisheries on the WCSI.

Statistical areas 034 and 035 dominate, with 034 being of slightly more importance than 035 (Table C11b, Figures C31b, C32c). Other statistical areas only contribute a minor proportion of the catch. The lookdown dory catch increased in both areas 034 and 035 from about 1998 and has remained fairly constant since then despite cuts in the hoki quota starting in the 2001-02 fishing year.

Bottom trawl is again the dominant fishing method, taking 76% of the catch, though midwater trawl is more important here than in any other region with 21% of the catch (Table C11c, Figure C31c). Often in the hoki target fishery midwater trawls are fished on or near the sea bed and this probably accounts for the greater importance of midwater trawling for the West Coast region.

The main target species that catch lookdown dory as bycatch are hoki (65%) and hake (23%), with jack mackerels, barracouta, ling and squid being of secondary importance (Table C11d, Figure C31d). Hoki

has been the dominant target species throughout the period with fairly consistent catches from 1999 until 2007. Catches in the hoki fishery decline slightly around 2007 at which point catches in the hake fishery increase. At this point hake becomes the dominant target fishery catching lookdown dory. Prior to this the reported catch of lookdown dory in the hake fishery was relatively minor compared with the catch in the hoki fishery.

Unstandardised catch rates for lookdown dory in various target fisheries are presented in Figure C33. Catch rates in the hoki fishery have been fairly constant since around 1997 with around 50–70 kg per tow. The catch of lookdown dory per tow in the hake fishery has been fairly variable through time but has been at around 100 kg per tow for the last few years. Catch rates in other target fisheries are also quite variable and data is often patchy.

Daily tow duration in the hoki target fishery is fairly constant through the study period at around 10–18 hours per day for bottom tows (Figure C34). The upper limit of tow duration in the hake fishery appears to have been fairly constant for most of the study period but it appears that there was a period during the mid-2000s when tow duration overall increased.

Daily tow duration for midwater tows in the hoki target fishery is fairly constant throughout the time period and is shorter than that of bottom tows, at around 10–17 hours. Data is sparse for jack mackerel before 1997 but since then it appears that daily tow duration is relatively constant at 5–12 hours. Daily tow duration for hake is similar to that of hoki at 10–18 hours a day but is slightly more variable through time.

Effort depth for bottom tows for important target species is presented in Figure C36. Effort depth 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. Most target hake fishing is slightly deeper than hoki at around 500–700 m, and usually ranging from about 400–800 m. Data is patchy and often quite variable for other target species.

For midwater tows effort depth is similar to bottom tows for both hoki and hake (Figure C37). Jack mackerel midwater tows are usually shallower with most tows being around 150–250 m in depth. Data for other target species catching lookdown dory is variable and patchy.

Hake and hoki effort widths for bottom trawls are similar to the Southland and ECSI regions with the majority of tows for most target species being around 35–45 m, with the greatest range seen in the hoki fishery with widths of more than 100 m (Figure C38). Effort speed is similar between target species, usually around 4 knots. Target species for the West coast region are much the same as for the Southland and ECSI 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 spawn 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 knots for most tows (Figure C39). 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 lookdown dory catch from the West Coast is almost entirely from the west coast of the South Island. For vessels reporting on the TCEPR forms the location of catches has not changed on the west coast of the South Island since 1990 (Figure C40) where fishing is located on the hoki and hake spawning grounds (statistical areas 034 & 035) mainly along the 500 m contour.

7.2.4 East Coast North Island (ECNI)

Of the four main areas identified in this study the ECNI contributes the least amount of the total catch with catches ranging from one to eight tonnes each year and just 81 tonnes total for the study period (Table C7, Figure C10b). No distinct season is apparent for lookdown dory catches for ECNI. Catches are spread across all months of the year throughout the study period (Table C12a, Figures C41a, C42d).

Statistical area 014 (South Hawkes) dominates with area 015 (Wairarapa Coast) being of secondary importance (Table C12b, Figure C41b). Other areas are of little importance.

As in other regions, bottom trawling is the most common method for ECNI with 98% of the catch for the study period (Table C12c, Figures C41c, C42a). Midwater trawling is much less common.
Scampi is the most common target fishery in which lookdown dory is caught followed by hoki and ling (Table C12d, Figure C41d). There is no targeted fishing of lookdown dory for the ECNI region for vessels reporting on TCEPR forms.

Unstandardised catch rates of lookdown dory are fairly constant through time in the scampi fishery at around 10–15 kg per tow (Figure C43). Catch rates are more variable in the hoki target fishery ranging from just a few kilos to around 35 kg per tow. Data is variable and patchy in other target fisheries.

Daily tow duration appears be fairly consistent in the scampi fishery, usually around 12–20 hours per day (Figure C44). Hoki daily tow duration appears to decrease in the late 1990s to early 2000s and is now usually around 8–12 hours per day. Tow duration data is patchy for other target species that reported catching lookdown dory.

Effort depth is very consistent for scampi during the study period with most tows being between 350 m to just over 400 m. Most lookdown dory caught in the hoki target fishery is caught at depths of between 350 and 500 m. Data for other target species is again very patchy.

Bottom trawl gear width and vessel speed, tonnage and length are shown in Figure C46. Effort width varies a lot between target fisheries catching lookdown dory. Vessels targeting hoki mainly report effort widths of around 35 to 45 m. Vessels targeting scampi (the main fishery catching lookdown dory for ECNI) report effort widths mainly between around 45 to 60 m. Effort speed is slightly slower to that seen in most fisheries in other areas with most species towing at 3–3.5 knots. Slower towing speeds are again seen in the scampi fishery with nearly all tows being less than 3 knots. Vessel size is smaller for the ECNI with most being less than 750 gross tonnes and less than 40 m in length.

Only around 2% of lookdown dory on the ECNI is caught by midwater trawl. With such sparse data information on midwater trawl caught lookdown dory is not discussed here.

There is little evidence of change in the location of lookdown dory catch for the region during the study period for bottom and trawl vessels reporting on TCEPR forms (Figure C47). The catch is mainly taken from statistical areas 014 and 015 on the lower east coast and smaller amounts from Cook Strait. A smaller amount is taken from statistical areas 008 and 009 (Coromandel and Bay of Plenty)

Summary

A summary of the characterisations by fishery area 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.

Catches increased through the early 1990s and have been fairly steady since the mid-1990s for the main target fishery of hoki, in the main three regions, ECSI, Southland, and West coast. For ECNI, scampi is the main target fishery catching lookdown dory. Lookdown dory bycatch in the hake fishery has increased on the West Coast since 2006 and has overtaken hoki in its importance. Other target fisheries are generally patchy and inconsistent in their lookdown dory catch. The dominant fishing method is by bottom trawl with small amounts taken by midwater trawl. Other fishing methods also catch lookdown dory but only in negligible amounts.

Fishing effort variables, target species and vessel characteristics are similar between the ECSI, Southland, and West coast regions. It is likely that vessels that catch lookdown dory are active in all

three areas at various times of the year. The West Coast is the only region with a distinct time of year in which lookdown dory is caught which is related to target fishing of hoki during the spawning season. There is no distinct season for the other regions though lookdown dory bycatch drop off slightly in ECSI and Southland regions during the winter months when many vessels move away to hoki spawning grounds.

On the basis of this characterisation the ECSI is the only region 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, MW; midwater trawl. Area definitions are given in Figure 2; species codes in Table C13.

Area	ECNI	ECSI/CHAT	Southland	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	East Coast South Island/Chatham Rise	Auckland Islands/ Snares Shelf	West coast South Island
Key statistical areas	014	020, 023	602, 028, 030	034, 035
Secondary statistical areas	015	022, 401–402, 407–411	027, 610	036
Season	Year round	Year round, slight decline June–October	Year round, slight decline June–October	June–October
Gear type	BT	BT	BT	BT
LDO processed catch as a % of groomed & unmerged landings	95%	103%	102%	102%
Target species				
Key target species	SCI	HOK	HOK	HOK, HAK
Secondary target species	HOK, LIN, BYX	HAK, LIN, SCI	LIN, SWA, SQU	JMA
Target LDO as a % of total catch	0 %	0 %	0 %	0 %
Target LDO catch trends	NA	NA	NA	NA
Target LDO catch rate trends	NA	NA	NA	NA

8.   CPUE ANALYSES

Table 8: Summary of CPUE analyses for ECSI fishery (see Appendix D1 for details, Table C13 for species codes).

Area	Stat areas used	Major target species	Months
ECSI	020, 021, 022, 023, 052, 401, 402, 403, 404, 407, 408, 409, 410	HOK	Oct–Sep (all months)

All tables and figures relating to CPUE analyses of the ECSI lookdown dory fishery are contained in Appendix D (Tables D1–9, Figures D1–10). Species codes are in Table C13.

The recent standardised CPUE analyses for silver warehou (Parker & Fu, 2009), arrow squid, (Hurst et al., 2010a), and ribaldo (MacGibbon & Hurst, 2011) considered only TCEPR (tow by tow) data because CELR data were minor. Utilising 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 lookdown dory are rarely recorded in the top five species on TCEPR forms, this study used daily processed catch. 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.

Only the ECSI region was considered for standardised CPUE analyses as it was the only region in which there is a reasonable level of lookdown dory catch (over 200 t per annum) for at least 10 years (1998–2009 fishing years). In comparison to the ECSI/CHAT region, the catch of lookdown dory is minor for the other three regions identified in this study (Southland/SUBA, West Coast, ECNI). Only one model was run as the data set used represented 84% of the total lookdown dory catch from the region for the period 1998–2009. The model uses entirely bottom trawl caught lookdown dory and is further subdivided by the combination of variables given above in Table 8.

Estimates of relative year effects in each CPUE model were obtained from a stepwise multiple regression method in which the data were modelled using a lognormal generalised linear model following Dunn (2002). A forward stepwise multiple–regression fitting algorithm (Chambers & Hastie 1991) implemented in the R statistical programming language (R Development Core Team 2008) was used to fit all models. The algorithm generates a final regression model iteratively and used the *fishing year* term as the initial or base model in all cases. The reduction in residual deviance relative to the null deviance, R^2, is calculated for each single term added to the base model. The term that results in the greatest reduction in residual deviance is added to the base model if this would result in an improvement in the residual deviance of more than 1%. The algorithm then repeats this process, updating the model, until no new terms can be added. A stopping rule of 1% change in residual deviance was used as this results in a relatively parsimonious model with moderate explanatory power (Parker & Fu 2009). Alternative stopping rules or error structures were not investigated. Note that while R^2 values are reported they do not necessarily assist in helping choose between the various models.

Variables offered to the model were fishing year, vessel key, statistical area, month, effort width and fishing duration (effort width and fishing duration were offered as 3rd order polynomials). The variable *fishing year* was forced to be in the model as the relative year effects calculated from the regression coefficients represent the change in CPUE over time. Year indices were standardised to the mean and were presented in canonical form (Francis 1999).

Vessel effects were incorporated into the CPUE standardisations to allow for possible differences in fishing power between vessels. A set of core vessels was defined based on vessels that had at least four consecutive years in the fishery and collectively reported about 90% of the catch.

The dependent variable was the log–transformed daily processed catch. Only days that reported processed lookdown dory catches were retained, with zeros excluded. A zero refers to a day without any recorded daily processed catch. Model fits were investigated using standard regression diagnostic plots. 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).

8.1 East Coast South Island Standardised CPUE Model

The number of records, proportion of zeros, catch, effort and unstandardised CPUE for model 1 are listed in Table D1. Standardised model results are shown in Table D2–D3 and Figure D3.

The model (hoki target, bottom trawl, October–September, 1998–2009) represents 84% of the total ECSI/CHAT lookdown dory catch for the 1998–2009 period. There are 15 core vessels involved with around half of those consistently catching small amounts of lookdown dory in most years included in the analysis, while a number of other vessels disappear from the data set during the early to mid-2000s (Figure D1). There are a few higher catching vessels involved, with 90% of the catch being taken by about 25% of the vessels (Figure D2). The standardised CPUE index follows the geometric and arithmetic indices closely, with slight peaks in 2002, 2003, and 2006 but is fairly flat throughout the time period (Figure D3a). Confidence intervals are small, probably due to the small yet consistent nature of lookdown dory catches. Standardised biomass indices from the Chatham Rise Survey series are overlaid with the CPUE indices in Figure D3b. The two indices appear to follow each other reasonably well in most years. R^2 for the model is reasonable at 25.18%. Aside from fishing year which is forced into the model, three of the available variables are retained as predictors: statistical area, vessel key, and fishing month. Highest catch rates are predicted in summer months (November to February) in statistical areas 052 and 407–410 (south-east Chatham Rise) (Figure D4). Model assumptions are reasonably satisfied (Figure D5) and the similarity of the CPUE index with the Chatham Rise Trawl Survey helps validate the model.

8.2 CPUE summary

Standardised CPUE of lookdown dory was only attempted for the ECSI region as other regions had low catches (less than 150 t per annum). Only one model was run as the composition of the data set used represented the majority (84%) of the ECSI/CHAT lookdown dory catch. The model appeared to track relative abundance of lookdown dory well and could be used to compliment the Chatham Rise Trawl Survey time series which is also believed to track relative abundance well.

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)

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. These data also suggest that ECSI/CHAT and the SubAntarctic might support separate stocks. The difference in maximum size distributions from trawl surveys of Chatham Rise and SubAntarctic, particularly for males, also suggests there may be stock differences between the two areas, or that fishing pressure is heavier on the Chatham Rise, preventing fish from growing as large as they do in the SubAntarctic.

Research trawl surveys of middle depth species on the Chatham Rise and SubAntarctic areas, since 1991, 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% and 25%, respectively). To date, biomass trends for Chatham Rise are relatively flat, biomass from SubAntarctic declined to a lower period from 2001–2006, but has since increased to an average level for the series. 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 SubAntarctic are too low. 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 stomachs from three consecutive 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 ontogeny.

12.2 Status of the stocks

Lookdown dory have been harvested commercially at relatively low levels for some time with the largest landed catch since the 1990 fishing year being 892 t in 2003. Reliable data from before 1990 are not available.

Estimates of lookdown dory biomass are not available for LDO 1 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 spawn season and increasingly in the hake fishery. It is unavoidable as bycatch in these fisheries and landed catches have exceeded the LDO 1 TACC slightly in the 2006 and 2008 fishing years. Standardised CPUE analyses were not attempted for the two main fishing areas that make up LDO 1 (East Coast North Island and West Coast) as catches were low. A planned new trawl survey off the WCSI may provide biomass indices as well as other vital information such as length frequencies and sex ratios

Length frequency plots from the Chatham Rise trawl survey time series indicate that it may be possible to track the six youngest year classes, although age validation would need to be done in order to know the actual ages of these cohorts.

Estimates of biomass in LDO 3 are available for the two main subareas, from Chatham Rise and SubAntarctic trawl surveys since 1991. Relative biomass indices on the Chatham Rise have remained relatively flat, estimates from the SubAntarctic declined from 1991–2007 but have since increased back up to average levels. The CPUE analysis of the factory trawlers targeting hoki on the Chatham Rise may compliment the trawl survey indices.

12.3 Observer Programme sampling

Lookdown dory sampling by observers would benefit from optimisation in key fishery areas. Observer data for this study was found to be minimal for the ECNI and Southland regions and not well representative of months for ECSI and WCSI.

If ageing by marginal zone counts of 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 and to the best of our knowledge no attempt to age them has been made. Collection of length frequency and gonad stage and information is also important for better determination of stock structure, as outlined above.

More optimised coverage may also allow more accurate recording of catch per tow that might allow an observer CPUE series to be developed, rather than using the daily processed data as in this study.

12.4 Future data needs and research requirements

Summer trawl surveys of the Chatham Rise and SubAntarctic provide reasonable biomass estimates for two of the four main fishing areas identified in this study. However there are still gaps in the data such as spawning seasons and biological characteristics of the catch in the commercial fishery. Biological information from trawl surveys and observer sampling is lacking in the other two regions identified in this study (West Coast, ECNI). These gaps could be filled in and other knowledge augmented, 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, particularly for the ECSI region where most lookdown dory is caught.
2. Improved coverage of all fishing 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 by this method can be established). Improved observer coverage could also potentially allow the development of an observer CPUE series.
3. 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.
4. Biomass estimates of lookdown dory on the WCSI. This is the second largest lookdown dory fishery after the ECSI/CHAT region but there are no biomass estimates for the fishery. The possibility of a combined hoki trawl and acoustic survey for the WCSI in 2011 could provide an opportunity for monitoring for the future.

13.   ACKNOWLEDGEMENTS

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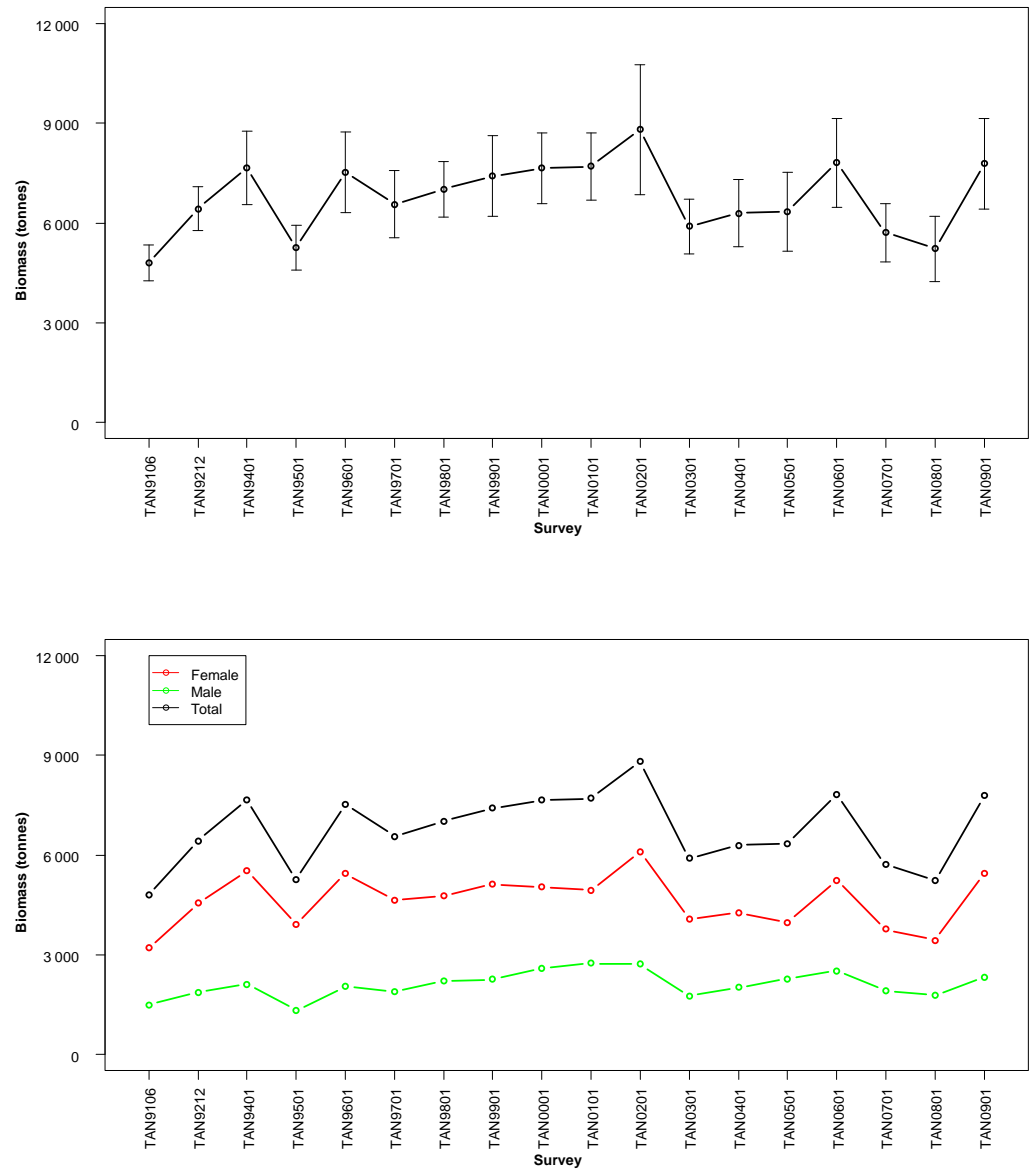
APPENDIX A: TRAWL SURVEY SUMMARIES

Figure A1. Doorspread biomass estimates, for all fish (± C.V., above) and by sex (below), from the Chatham Rise *Tangaroa* surveys from 1991 to 2009.
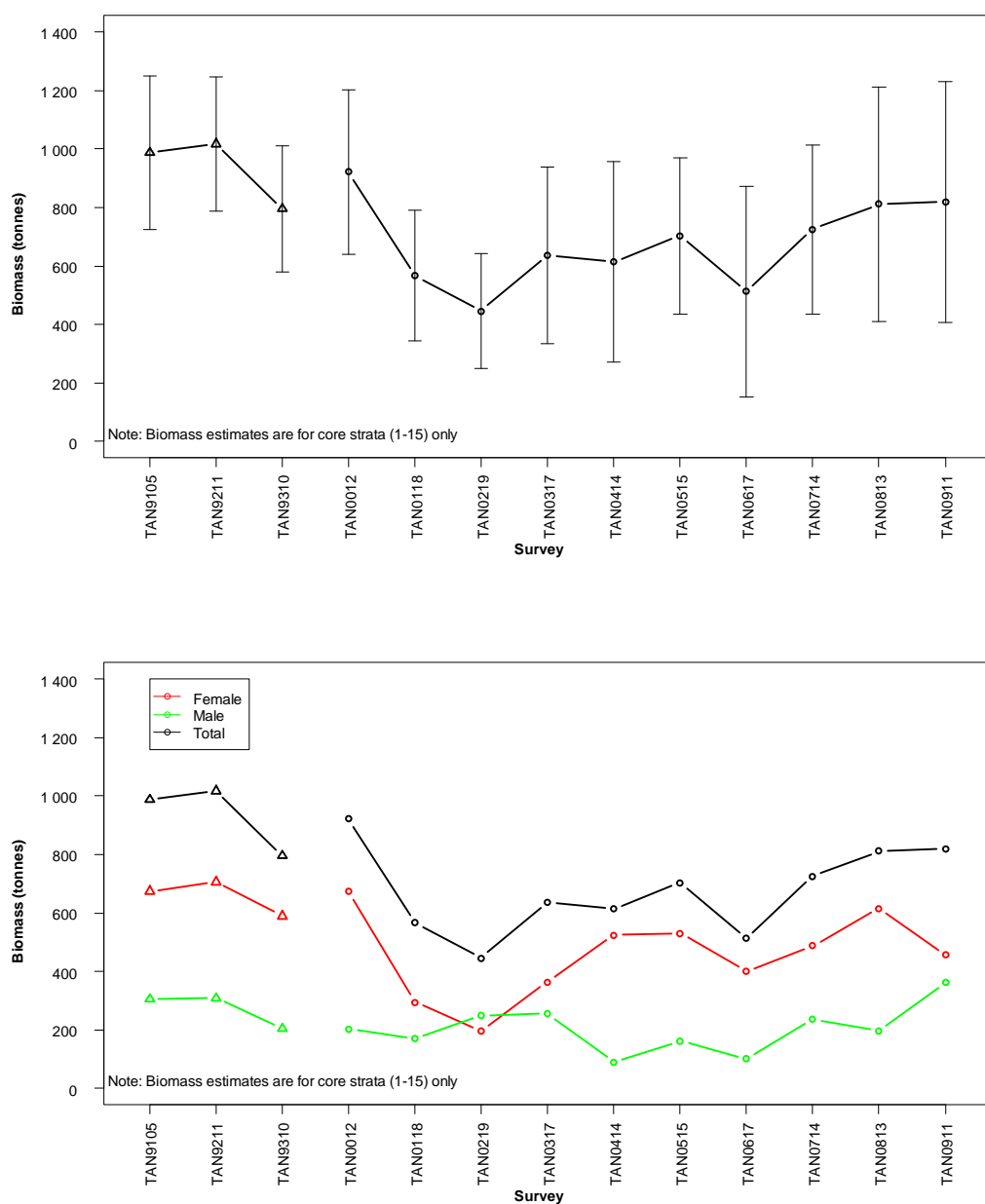
Figure A2. Doorspread biomass estimates, for all fish (± C.V., above) and by sex (below) from summer surveys of SubAntarctic by *Tangaroa* from 1991 to 2009. Triangles are surveys prior to the break in the time series (after 1993), circles are surveys from resumption of time series (from 2000 to present).
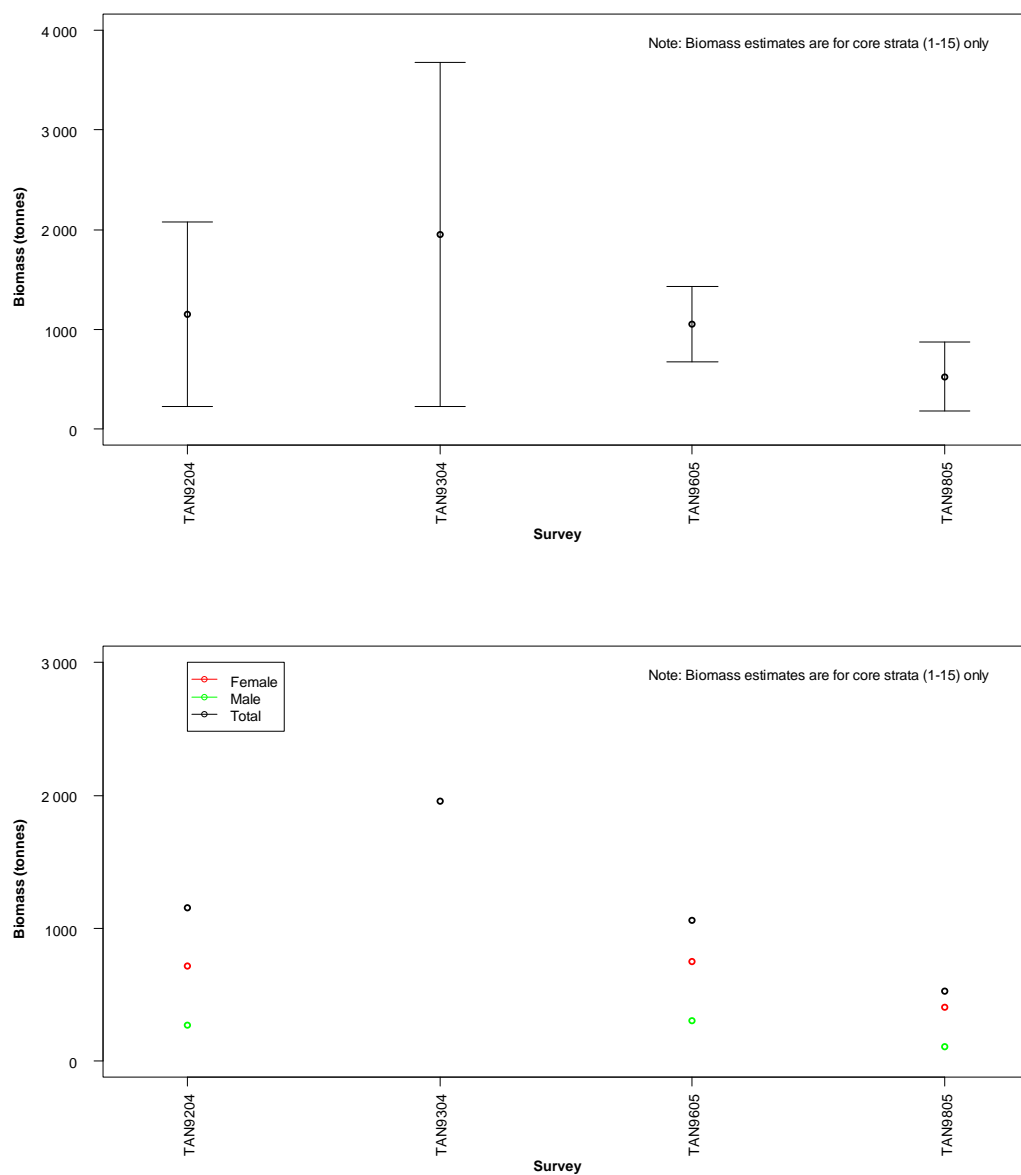
Figure A3. Doorspread biomass estimates, for all fish (± C.V., above) and by sex (below) from autumn surveys of SubAntarctic by *Tangaroa* from 1992 to 1993, 1996 and 1998. NB: Biomass by sex was not available for TAN9304.
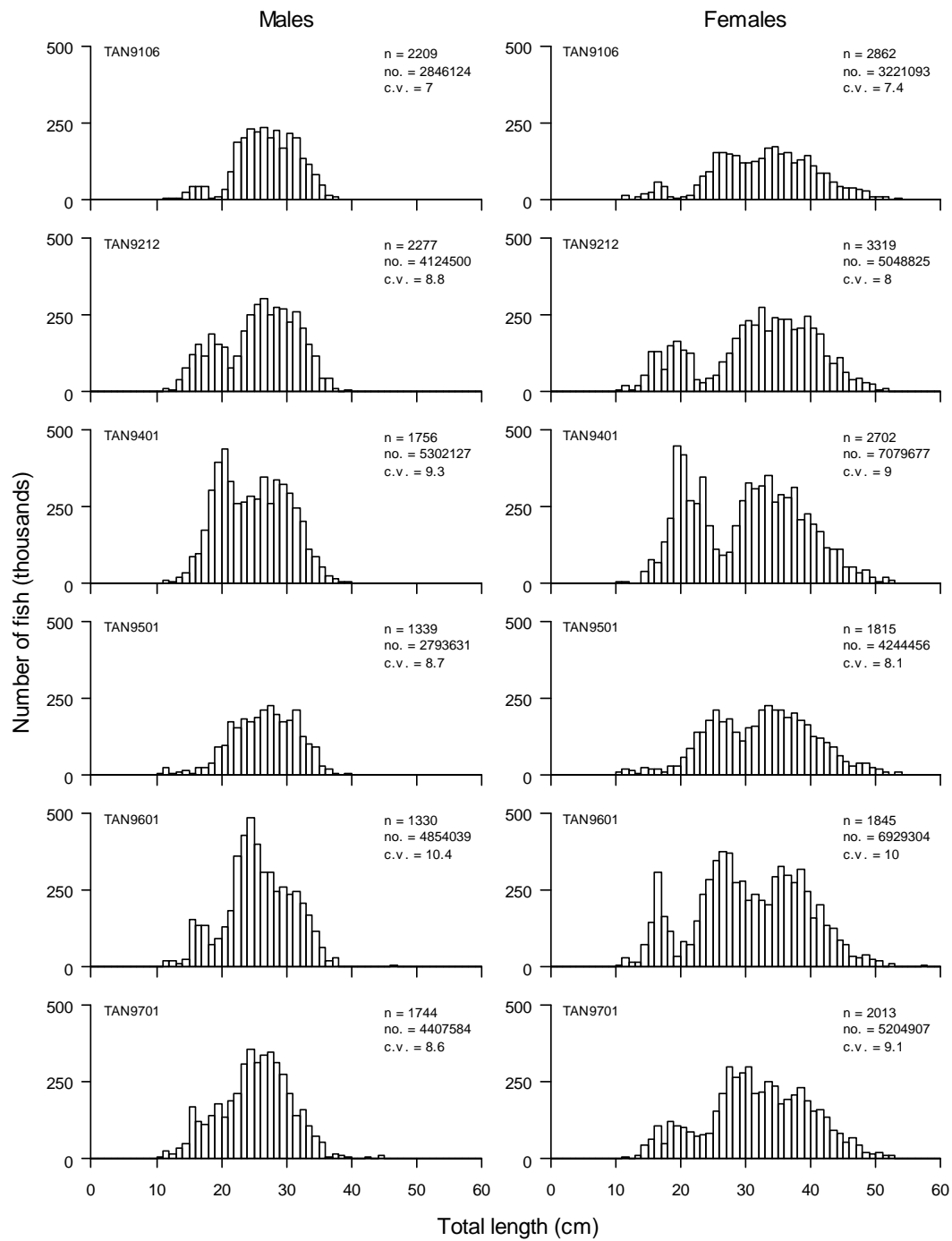
Figure A4: Length frequencies of lookdown dory from the Chatham Rise, from _Tangaroa_ (TAN) surveys, 1991–1997.
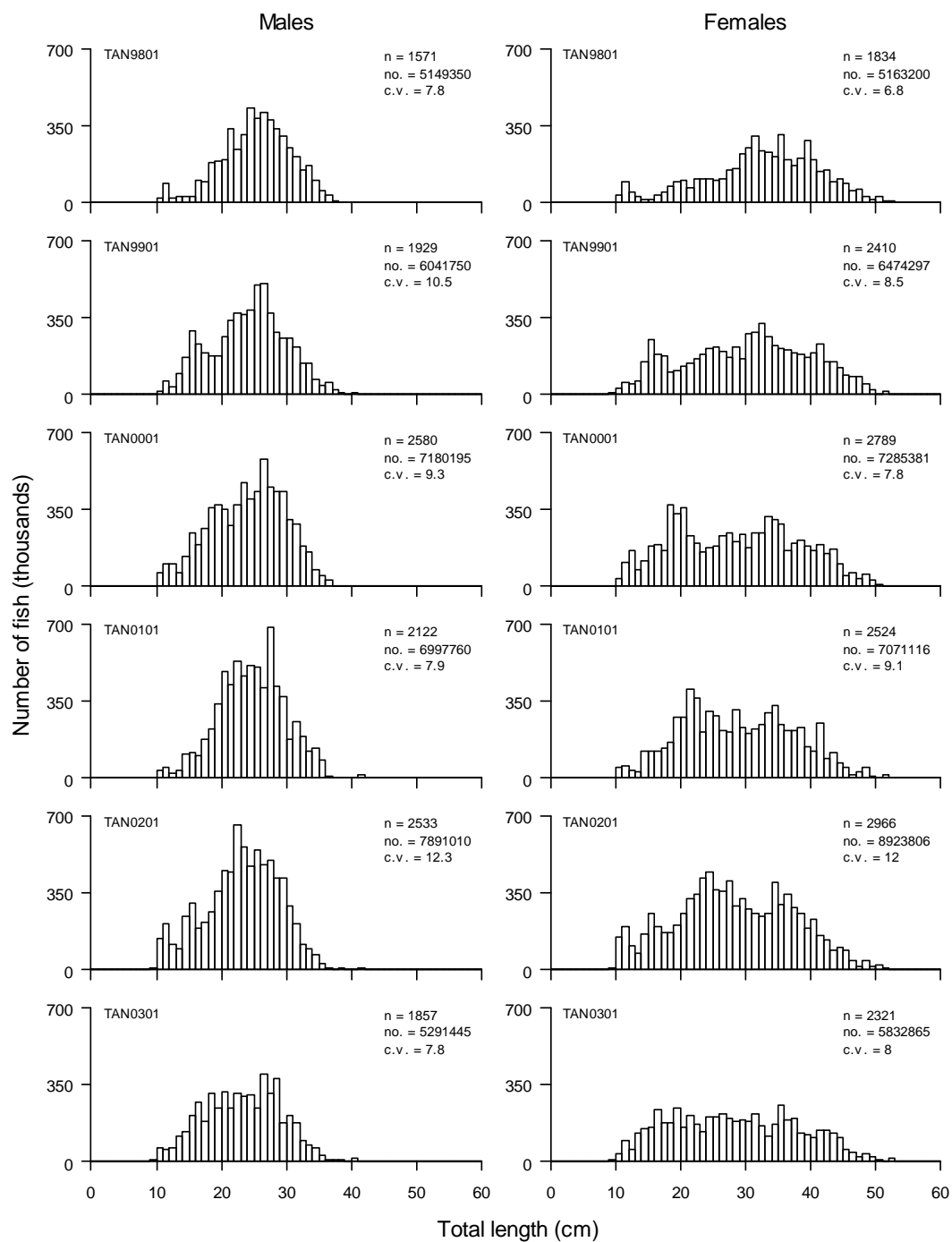
Figure A4 continued: Length frequencies of lookdown dory from the Chatham Rise, from *Tangaroa* (TAN) surveys, 1998–2003.
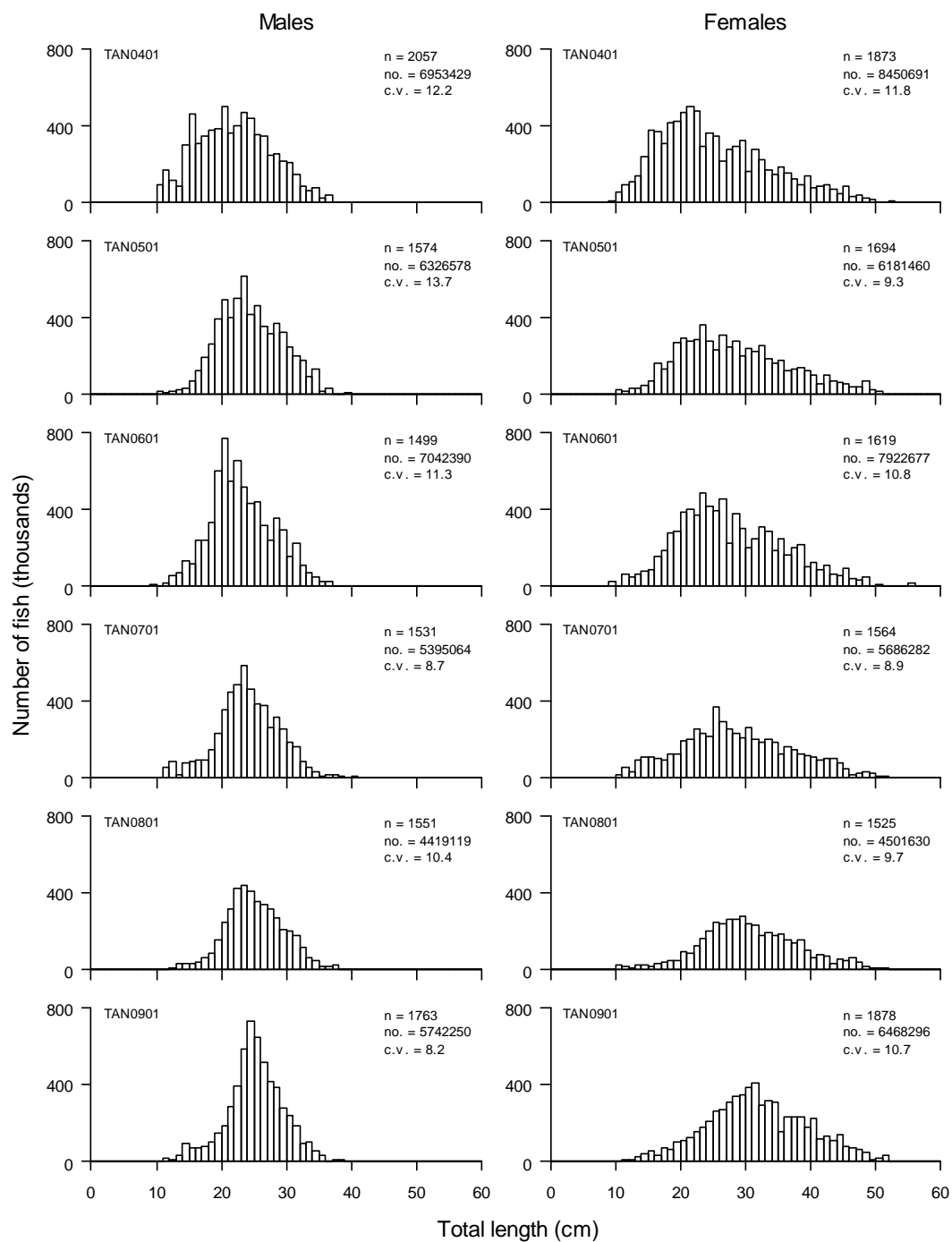
Figure A4 continued: Length frequencies of lookdown dory from the Chatham Rise, from *Tangaroa* (TAN) surveys, 2004–2009.
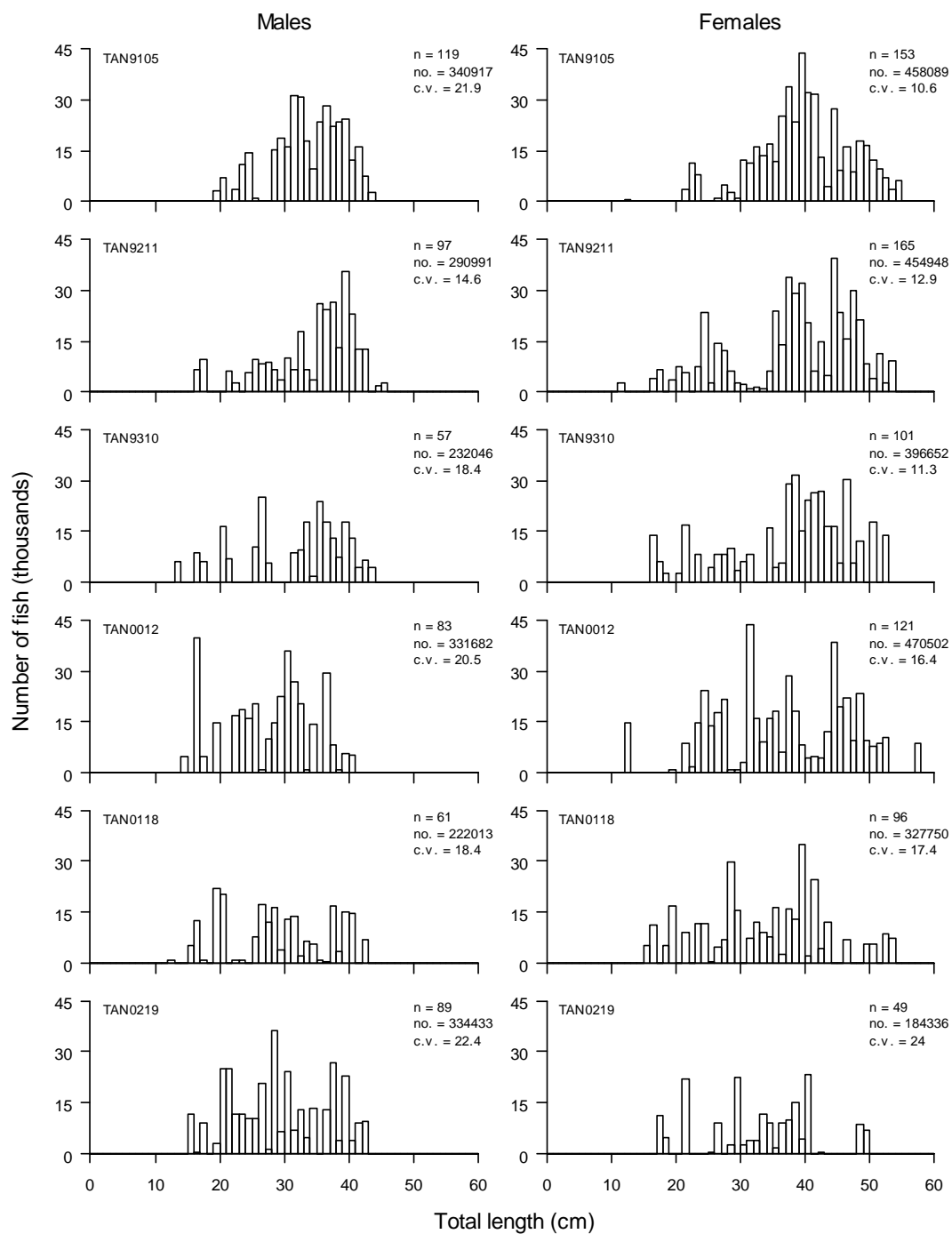
Figure A5. Length frequencies of lookdown dory from summer surveys of Southland by *Tangaroa* (TAN) surveys 1991–1993 and 2000–2002.
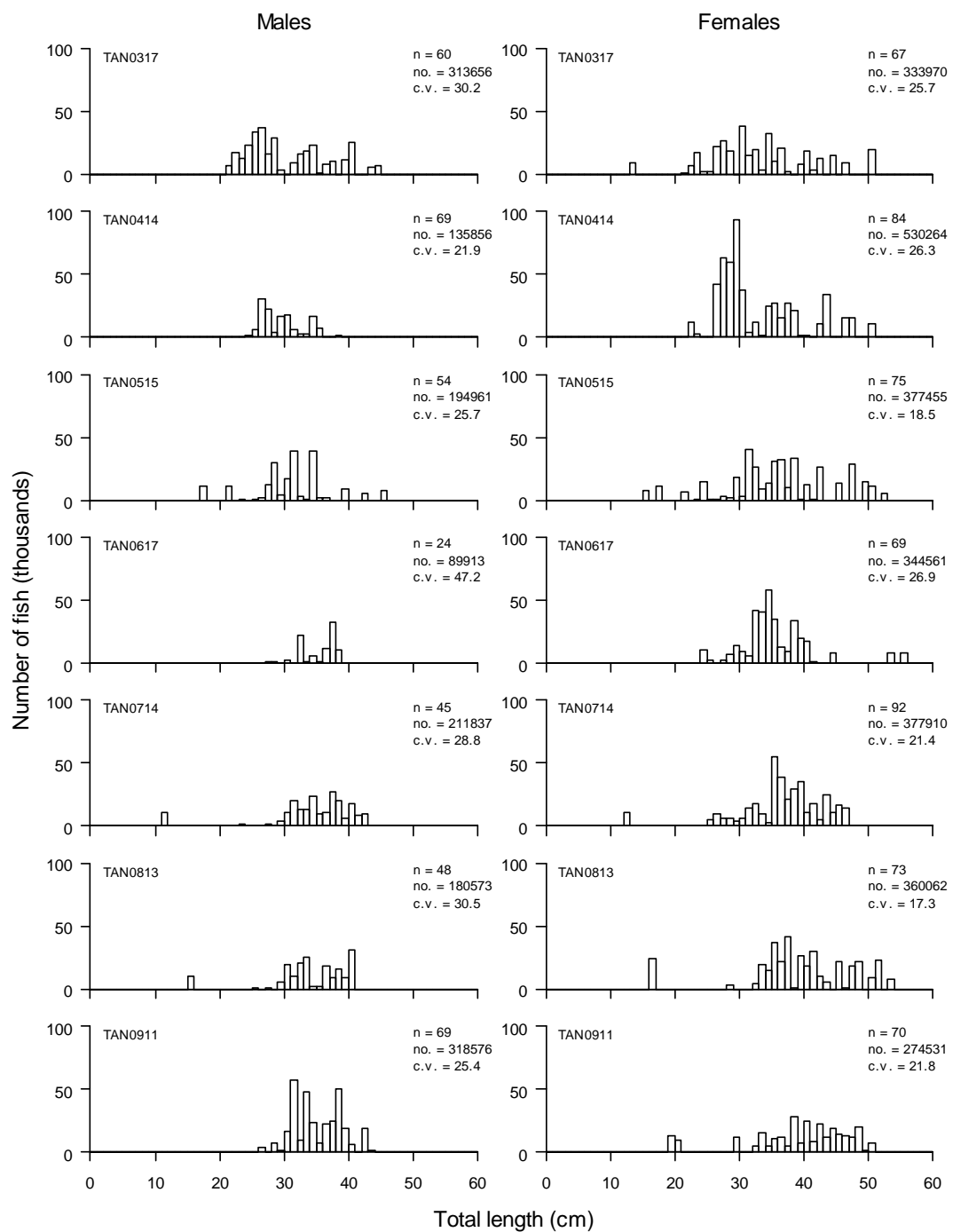
Figure A5 continued. Length frequencies of lookdown dory from summer surveys of Southland by *Tangaroa* **(TAN) surveys 2003–2009.**
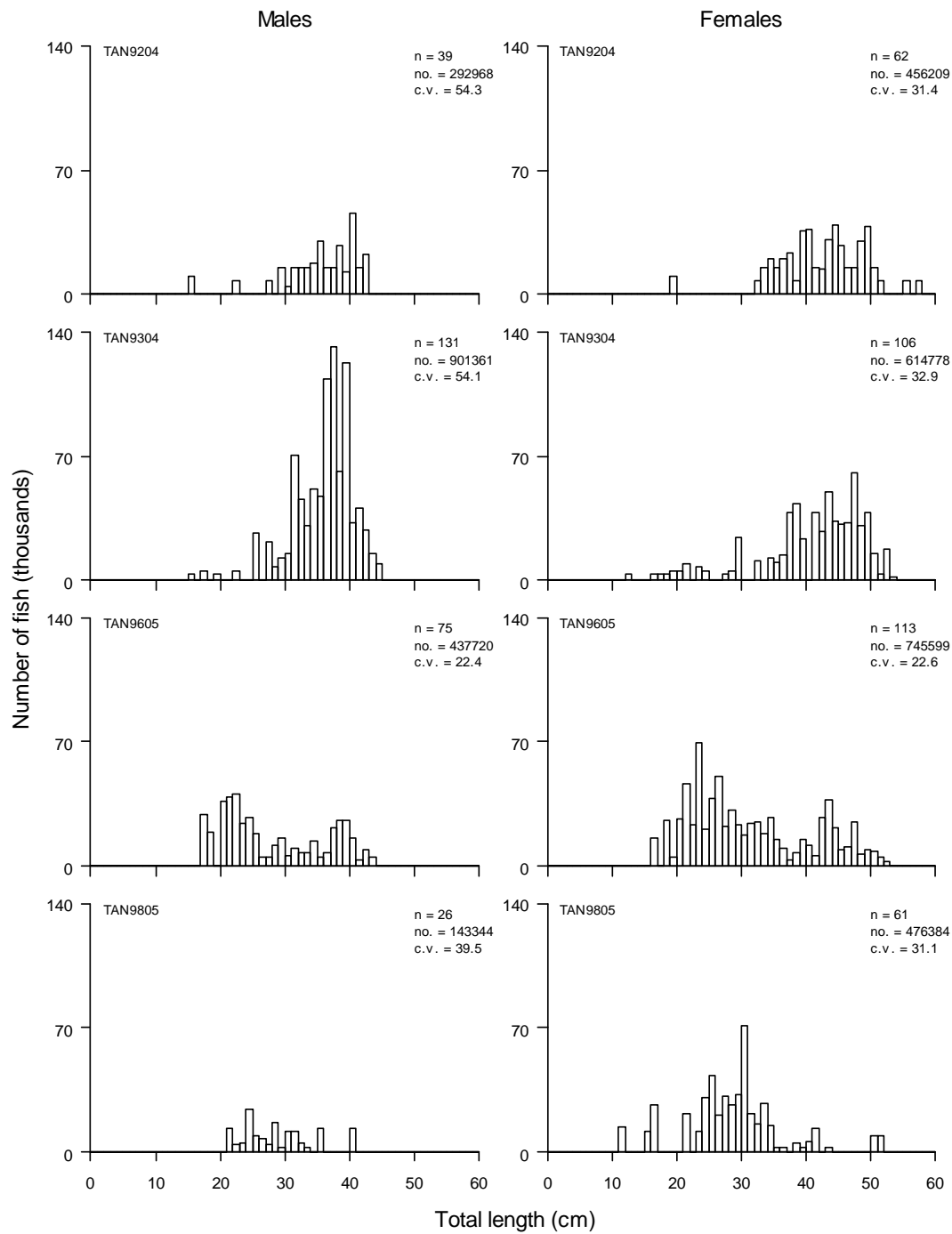
Figure A6. Length frequencies of lookdown dory from autumn surveys of Southland by _Tangaroa_ (TAN) surveys 1992–1993, 1996 and 1998.

APPENDIX B: OBSERVER DATA

Table B1: Total number of trawl tows sampled for length from each lookdown dory area by the observer programme, for fishing years 2001–02 to 2008–09. Note: Numbers of tows sampled are higher than values on the length frequency plots as this table includes tows where fewer than five fish have been sampled.

Year	ECNI	ECSI	Southland	West Coast	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
Total	7	131	14	73	225

Table B2: Number of tows by fishing year and month sampled for lookdown dory length from each area overall by the observer programme, for fishing years 2001–02 to 2008–09.

(a) ECNI

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2001–02	-	-	-	-	-	-	-	-	-	3	-	-
2002–03	-	-	-	-	-	-	-	-	-	-	-	-
2003–04	-	-	-	-	-	-	-	-	-	-	-	-
2004–05	-	-	-	-	-	-	-	-	-	-	-	-
2005–06	-	-	-	-	-	-	-	-	-	-	-	-
2006–07	-	-	-	-	-	-	-	-	-	-	-	-
2007–08	-	2	-	-	-	1	1	-	-	-	-	-
Total	-	2	-	-	-	1	1	-	-	3	-	-

(b) ECSI

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2002–03	-	2	2	-	-	-	-	-	-	-	-	-
2003–04	-	-	-	-	-	-	-	-	-	-	9	5
2004–05	1	-	1	5	16	21	-	-	-	-	-	-
2005–06	-	-	-	-	-	-	-	-	5	4	-	-
2006–07	2	5	2	9	5	4	1	7	2	-	-	-
2007–08	-	-	-	-	5	-	-	11	2	-	-	-
2008–09	-	-	5	-	-	-	-	-	-	-	-	-
Total	3	7	10	14	26	25	1	18	9	4	9	5

(c) West Coast

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2001–02	-	-	-	-	-	-	-	-	-	-	3	-
2002–03	-	-	-	-	-	-	-	-	-	-	-	-
2003–04	-	-	-	-	-	-	-	-	-	-	6	2
2004–05	-	5	-	-	-	-	-	-	-	7	2	1
2005–06	-	-	-	-	-	-	-	-	9	6	3	3
2006–07	-	-	-	-	-	-	-	-	-	4	2	3
2007–08	-	-	-	-	-	-	-	-	-	2	7	5
2008–09	-	-	-	-	-	-	-	-	-	3	-	-
Total	-	5	-	-	-	-	-	-	9	22	23	14

(c) Southland

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2001–02	-	-	-	-	-	-	-	-	-	-	3	-
2002–03	-	-	-	-	-	-	-	-	-	-	-	-
2003–04	-	-	-	-	-	-	-	-	-	-	6	2
2004–05	-	-	-	-	-	-	-	-	-	-	1	1
2005–06	-	1	2	-	-	-	-	-	-	-	2	-
2006–07	-	-	-	1	-	-	-	-	-	-	-	-
2007–08	-	4	-	1	-	-	-	-	-	-	-	-
2008–09	-	-	-	-	-	-	-	-	1	-	-	-
Total	-	5	2	2	-	-	-	-	1	-	3	1

Table B3: 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 2008–09. Note: Numbers measured differ from those on Figures B4 and B5 for some years as scaled length frequencies plots only include tows where more than five individual fish are measured.

Year	ECNI	ECSI	Southland	West Coast
2001–02	13	-	-	10
2002–03	-	50	-	-
2003–04	-	108	-	23
2004–05	-	261	3	124
2005–06	-	157	11	336
2006–07	-	517	7	89
2007–08	-	227	25	209
2008–09	-	44	10	60
Total	13	1364	56	851

Table B4: Number of female lookdown dory gonads staged by fishing year and month sampled from each area by the observer programme.

(a) ECNI

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

(b) ECSI

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2001–02	-	-	-	-	-	-	-	-	-	-	-	-
2002–03	-	22	10	-	-	-	-	-	-	-	-	-
2003–04	-	-	-	-	-	-	-	-	-	-	59	15
2004–05	2	-	1	49	29	81	-	-	-	-	-	-
2005–06	-	-	-	-	-	-	-	-	73	49	-	-
2006–07	11	39	24	112	13	35	2	20	8	-	-	-
2007–08	-	-	-	-	23	-	-	111	22	-	-	-
2008–09	-	-	23	-	-	-	-	-	-	-	-	-
Total	13	61	58	161	65	116	2	131	103	49	59	15

(c) West Coast

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

(d) Southland

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2001–02	-	-	-	-	-	-	-	-	-	-	-	-
2002–03	-	-	-	-	-	-	-	-	-	-	-	-
2003–04	-	-	-	-	-	-	-	-	-	-	-	-
2004–05	-	-	-	-	-	-	-	-	-	-	-	1
2005–06	-	3	2	-	-	-	-	-	-	-	2	-
2006–07	-	-	-	6	-	-	-	-	-	-	-	-
2007–08	-	5	-	13	-	-	-	-	-	-	-	-
2008–09	-	-	-	-	-	-	-	-	-	-	-	-
Total	-	8	2	19	-	-	-	-	-	-	2	1
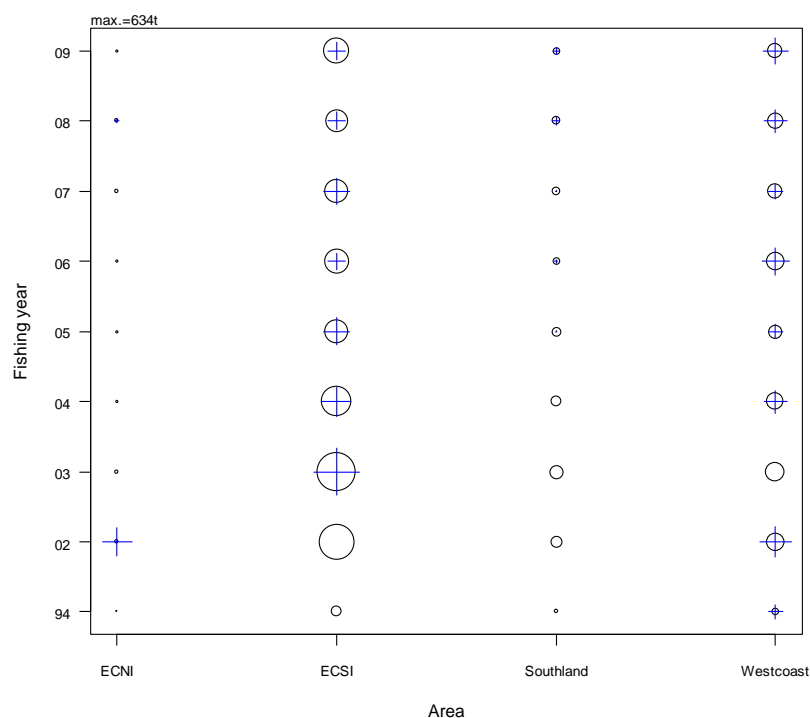
Figure B1: Representativeness of observer sampling of lookdown dory catch by fishing year and area. Circles show the proportion of target catch by area within a year; crosses show the proportion of observed target catch for the same cells. Representation is demonstrated by how closely the cross matches the circle diameter.
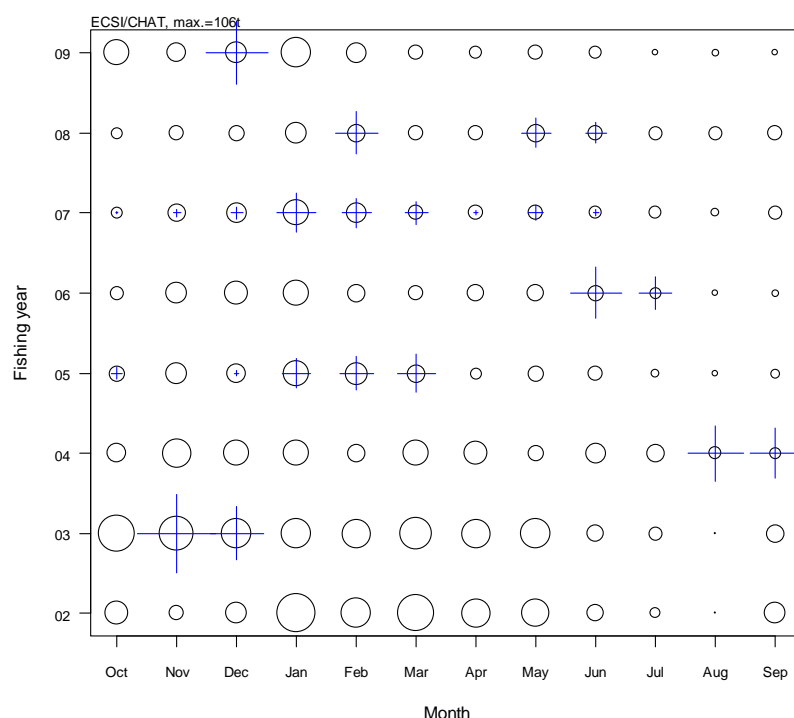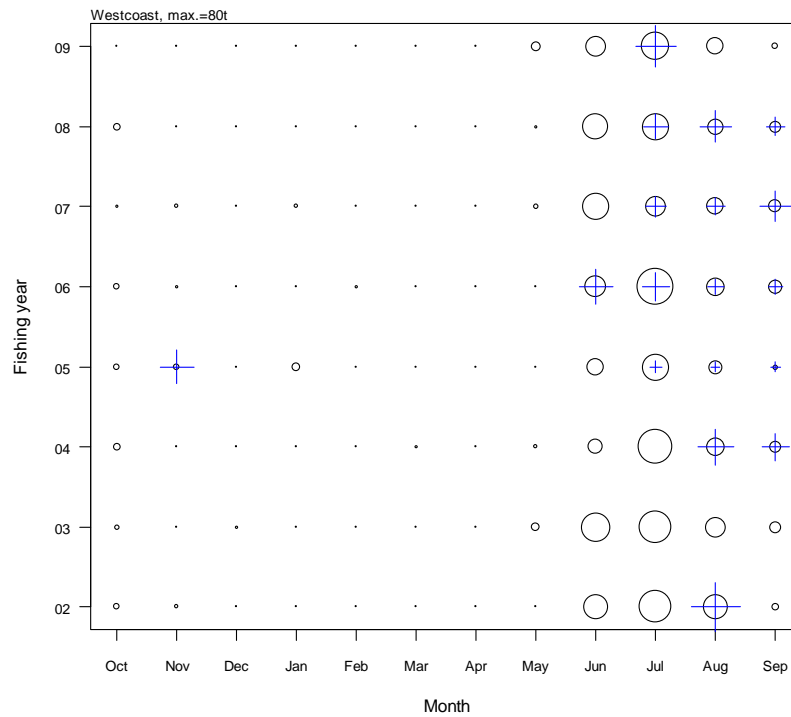

Figure B2: Representativeness of observer sampling of lookdown dory catch by fishing year and month (bottom panel) for the ECSI/CHAT region. Circles show the proportion of target catch by month within a year; crosses show the proportion of observed target catch for the same cells. Representation is demonstrated by how closely the cross matches the circle diameter.

Figure B3: Representativeness of observer sampling of lookdown dory catch by fishing year and month (bottom panel) for the West Coast. Circles show the proportion of target catch by month within a year; crosses show the proportion of observed target catch for the same cells. Representation is demonstrated by how closely the cross matches the circle diameter.
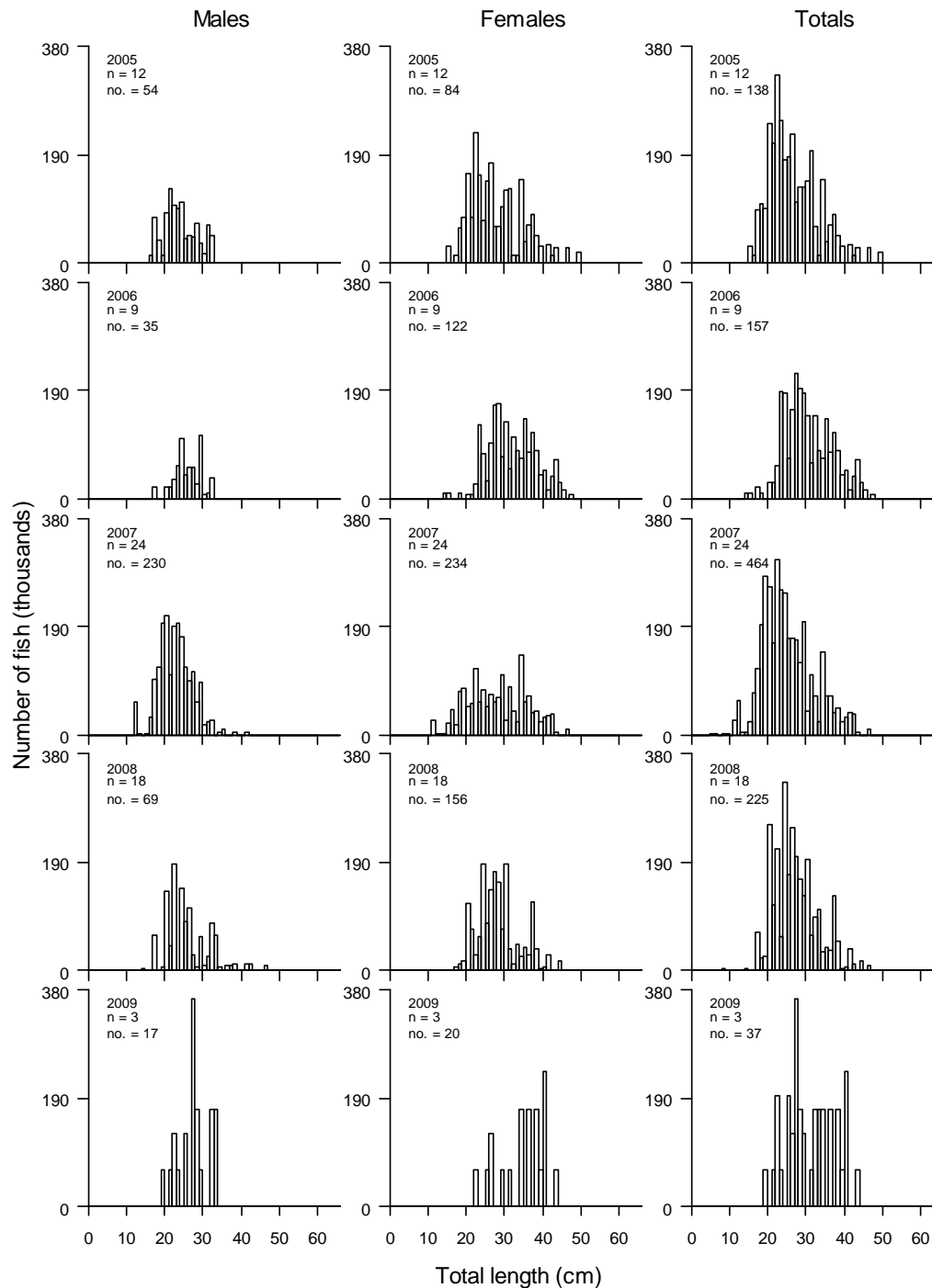
Figure B4: Scaled length frequency of lookdown dory taken in commercial catches from the ECSI/CHAT region by fishing year sampled by the Observer Programme. n, number of tows sampled with more than 5 individual LDO per tow; no., number of fish sampled. Note: tows sampled with fewer than 5 individual LDO were not included in scaled length frequency calculations.
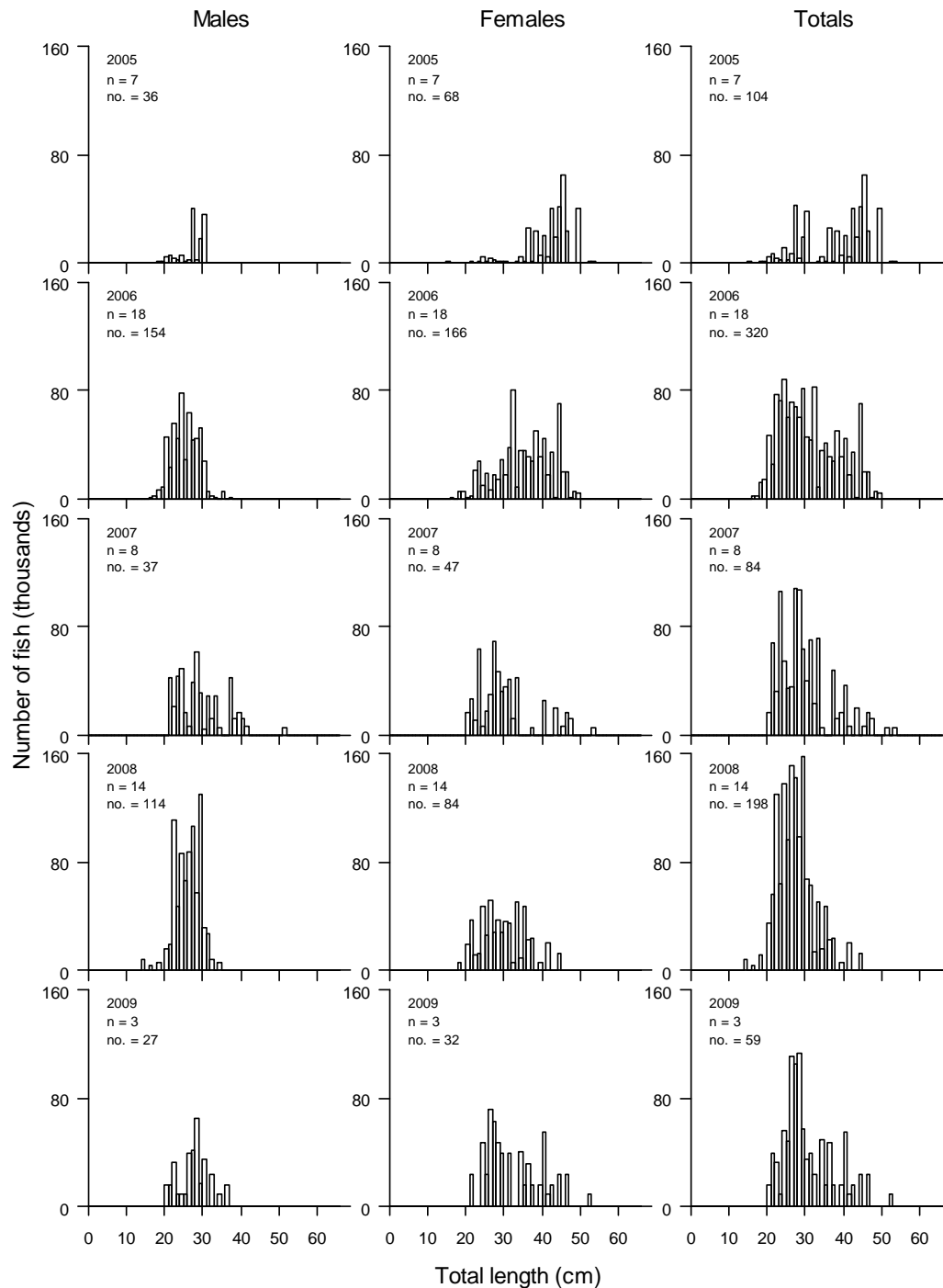
Figure B5: Scaled length frequency of lookdown dory taken in commercial catches from the West Coast region by fishing year sampled by the Observer Programme. n, number of tows sampled with more than 5 individual LDO per tow; no., number of fish sampled. Note: tows sampled with fewer than 5 individual LDO were not included in scaled length frequency calculations.
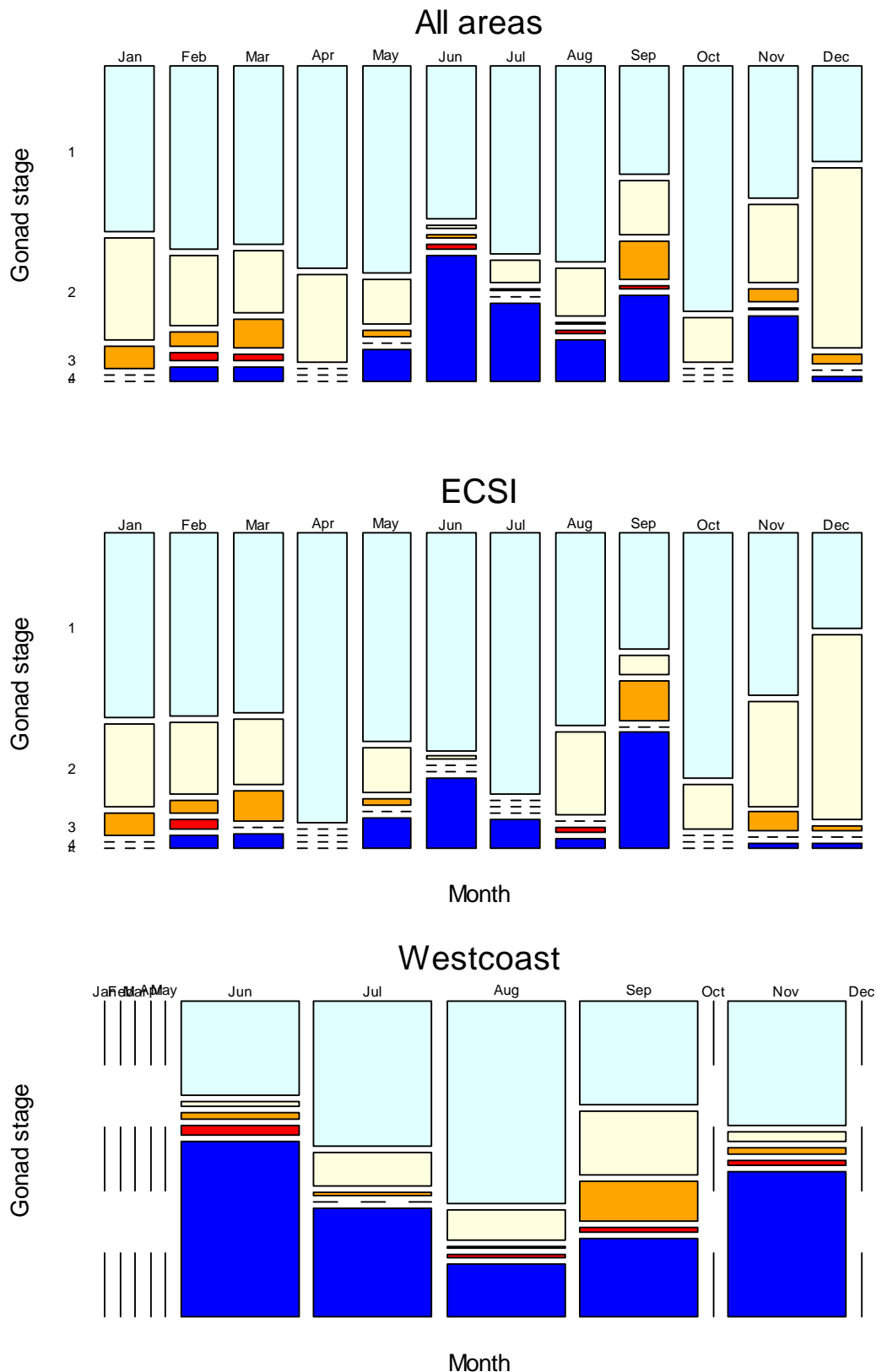
Figure B6: Gonad stages of female lookdown dory taken in commercial catches, by month and area, sampled by the Observer Programme. Stages are: light blue, resting/immature; light yellow, maturing; orange, ripe; red, running ripe; dark blue, spent.
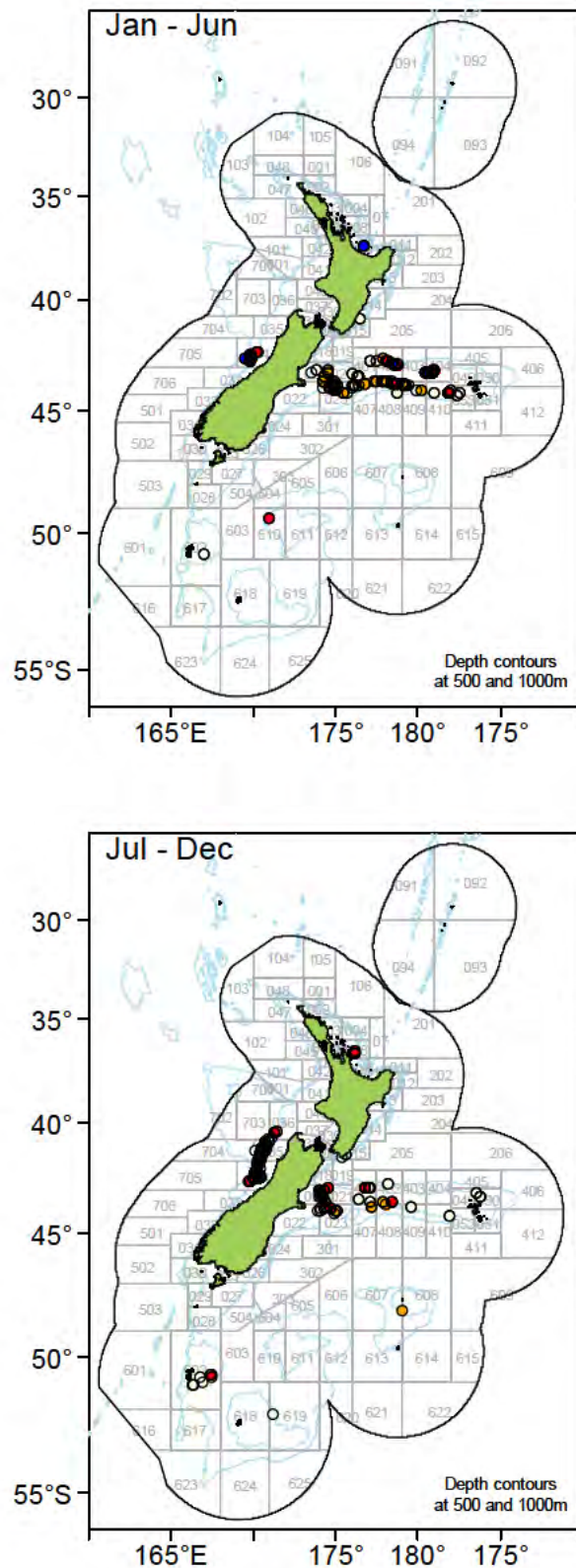
Figure B7: Location of female lookdown dory gonad stages sampled by the Observer Programme for the months of January to June (top plot) and July to December (bottom panel). Light blue = stage 1 (immature), light yellow = stage 2 (maturing), orange = stage 3 (ripe), red = stage 4 (running ripe) and dark blue = stage 5 (spent).

APPENDIX C: CHARACTERISATION

Table C1. List of tables and fields requested in the Ministry of Fisheries extract 7700 and 7759.

Fishing_events table

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

Landing_events table

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

Estimated subcatch table

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

Table C2: Number of landing events by major destination code and form type for LDO 1 and LDO 3 from 1990 to 2009. "L" refers to "landed to NZ"; "T" refers to "transferred to another vessel"; "R" refers to "retained on board".

LDO 1	CLR form			CELR form			Total
	L	T	R	L	T	R	
1990	35	19	51	30	-	-	148
1991	66	14	29	29	-	-	150
1992	45	19	26	35	-	-	132
1993	49	28	24	32	-	-	140
1994	56	27	31	18	-	-	148
1995	114	41	5	27	-	-	198
1996	159	31	6	10	-	-	218
1997	239	23	25	40	-	-	348
1998	315	15	17	29	-	-	403
1999	312	8	28	87	-	-	474
2000	316	3	24	83	-	-	481
2001	353	7	19	80	-	-	512
2002	391	5	15	78	-	-	570
2003	352	-	21	98	-	-	542
2004	295	1	11	73	-	-	449
2005	234	-	12	47	-	-	340
2006	233	-	22	66	-	1	377
2007	247	-	13	89	-	1	400
2008	371	-	13	-	-	-	433
2009	313	-	11	4	-	-	328
Total	4495	241	403	955	0	2	6791

LDO 3	CLR form			CELR form			Total
	L	T	R	L	T	R	
1990	50	52	12	1	-	-	115
1991	65	50	22	12	-	-	149
1992	120	81	33	24	-	-	258
1993	111	69	36	15	-	-	231
1994	128	44	39	7	-	-	218
1995	190	77	30	7	-	-	304
1996	231	86	33	3	-	-	353
1997	327	41	61	26	-	-	455
1998	384	15	46	44	-	-	489
1999	478	2	65	22	-	-	567
2000	578	-	55	50	-	-	683
2001	680	-	52	56	-	-	788
2002	592	-	68	27	-	-	687
2003	782	-	72	38	-	-	892
2004	604	5	83	25	-	-	717
2005	432	-	34	29	-	-	495
2006	337	-	37	28	-	-	402
2007	365	-	29	17	-	-	411
2008	332	-	37	-	-	-	369
2009	298	-	31	7	-	1	337
Total	7084	522	875	438	0	1	8920

Table C3: Destination codes, total landing weight, number of landings and if the records were kept or discarded for all LDO catch 1990–2009 for LDO 1 and 3.

Destination code	Greenweight (t)	No. records	Description	Action
LDO 1				
L	1948.502	5462	Landed in New Zealand to a Licensed Fish Receiver	Keep
T	333.163	241	Transferred to another vessel	Keep
D	79.778	209	Discarded	Keep
O	37.569	35	Conveyed outside New Zealand	Keep
E	14.845	459	Eaten	Keep
A	5.307	20	Accidental loss	Keep
S	3.888	2	Seized by the Crown	Keep
W	0.234	9	Sold at the wharf	Keep
F	0.016	2	Recreational catch	Keep
C	0.001	1	Disposed to the Crown	Drop
R	251.744	405	Retained on board	Drop
Q	0.403	2	Holding receptacle on land	Drop
B	0.113	1	Stored as bait	Drop
LDO 3				
L	5672.766	7658	Landed in New Zealand to a Licensed Fish Receiver	Keep
T	561.551	522	Transferred to another vessel	Keep
R	541.697	885	Retained on board	Drop
O	66.857	53	Conveyed outside New Zealand	Keep
E	21.883	919	Eaten	Keep
S	2.31	5	Seized by the Crown	Keep
A	2.088	18	Accidental loss	Keep
C	0.779	3	Disposed to the Crown	Keep
W	0.18	5	Sold at wharf	Keep
Invalid	0.018	4	Invalid destination type code recorded	Drop
D	111.165	453	Discarded	Keep

Table C4: Details of data corrections by imputation and invalid record removal during the grooming process for each QMA.

NB1: Under 'Imputations made', 'Records' refers to the number of records in the data set to which the variable being groomed is potentially applicable to; 'Before' refers to the number of records in the data set in which there were invalid values for the given variable *before* corrections by imputation were attempted; 'After' is the number of records that are still invalid *after* the corrections by imputation were attempted; 'Difference' refers to the number of invalid records that were satisfactorily corrected by imputation.; '% kept' is the percentage of 'Records' represented by 'Difference'.

NB2: Under 'Records removed', '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.

LDO 1

Imputations made	Records	Before	After	Difference	% kept
Invalid start date & time	201585	206	129	77	0.04
Invalid primary method	200703	101	0	101	0.05
Invalid target species	200703	81	0	81	0.04
Invalid stat area	200703	1995	0	1995	0.99
Invalid lat & long	187407	1507	123	1384	0.74
Invalid effort depth (TCEPR)	195715	1180	0	1180	0.60
Invalid bottom depth (TCEPR)	195715	2684	355	2329	1.19
Transpose bottom-effort depth	195715	8581	0	8581	4.38
Invalid BT effort number (TCEPR)	109912	38	0	38	0.03
Invalid BT effort width (TCEPR)	109912	4028	116	3912	3.56
Invalid BT effort height (TCEPR)	109912	3043	42	3001	2.73
Invalid BT effort speed (TCEPR)	109912	139	8	131	0.12
Invalid BT fishing duration (TCEPR)	109912	580	102	478	0.43
Invalid MW effort number (TCEPR)	77413	52	0	52	0.07
Invalid MW effort width (TCEPR)	77413	1389	10	1379	1.78
Invalid MW effort height (TCEPR)	77413	285	0	285	0.37
Invalid MW effort speed (TCEPR)	77413	206	0	206	0.27
Invalid MW fishing duration (TCEPR)	77413	473	2	471	0.61

	Effort				Landings		
Records removed	Records	Trips	Catch		Records	Trips	Catch
Original extract	202420	5425	1296		8542	5460	2676
Remove missing vessel keys	202420	5425	1296		8542	5460	2676
Remove unmatched trip numbers	202420	5425	1296		8494	5425	2663
Remove duplicate trip form	201585	5391	1293		8451	5391	2659
Remove invalid start date & time	200703	5381	1290		8421	5374	2656
Remove invalid primary method	200703	5381	1290		8421	5374	2656
Remove invalid target species	200703	5381	1290		8421	5374	2656
Remove invalid statistical area	195715	5306	1275		8288	5300	2624
Remove BPQRT destination type	176487	4987	1064		7245	4981	2054
Remove multiple state codes	176487	4987	1064		7244	4981	2054
Remove invalid green weight	176487	4987	1064		7244	4981	2054
Fix NA green weight	176487	4987	1064		7244	4981	2054
DQSS check	176487	4987	1064		7244	4981	2054
Merge effort and processed catch data	14053	1768	1549		2393	1740	1531

Table C4: continued.

NB1: Under 'Imputations made', 'Records' refers to the number of records in the data set to which the variable being groomed is potentially applicable to; 'Before' refers to the number of records in the data set in which there were invalid values for the given variable *before* corrections by imputation were attempted; 'After' is the number of records that are still invalid *after* the corrections by imputation were attempted; 'Difference' refers to the number of invalid records that were satisfactorily corrected by imputation.; '% kept' is the percentage of 'Records' represented by 'Difference'.

NB2: Under 'Records removed', '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.

LDO 3

Imputations made	Records	Before	After	Difference	% kept
Invalid start date & time	350848	293	141	152	0.04
Invalid primary method	350848	207	84	123	0.04
Invalid stat area	349669	3338	0	3338	0.95
Invalid lat & long	339899	3440	268	3172	0.93
Invalid effort depth (TCEPR)	341716	750	0	750	0.22
Invalid bottom depth (TCEPR)	341716	2840	612	2228	0.65
Transpose bottom-effort depth	341716	13926	0	13926	4.08
Invalid BT effort number (TCEPR)	297171	117	0	117	0.04
Invalid BT effort width (TCEPR)	297171	6510	10	6500	2.19
Invalid BT effort height (TCEPR)	297171	16465	27	16438	5.53
Invalid BT effort speed (TCEPR)	297171	4313	0	4313	1.45
Invalid BT fishing duration (TCEPR)	297171	2031	114	1917	0.65
Invalid MW effort number (TCEPR)	42723	25	0	25	0.06
Invalid MW effort width (TCEPR)	42723	1487	20	1467	3.43
Invalid MW effort height (TCEPR)	42723	397	0	397	0.93
Invalid MW effort speed (TCEPR)	42723	83	1	82	0.19
Invalid MW fishing duration (TCEPR)	42723	303	6	297	0.70

	Effort				Landings		
Records removed	Records	Trips	Catch		Records	Trips	Catch
Original extract	351214	4968	2096		11613	4998	6981
Remove missing vessel keys	351214	4968	2096		11613	4998	6981
Remove unmatched trip numbers	351214	4968	2096		11561	4968	6963
Remove duplicate trip form	350848	4944	2096		11536	4944	6962
Remove invalid start date & time	349753	4935	2088		11459	4908	6944
Remove invalid primary method	349669	4934	2088		11456	4907	6944
Remove invalid target species	349669	4934	2088		11456	4907	6944
Remove invalid statistical area	341716	4838	2052		11209	4811	6832
Remove BPQRT destination type	313052	4505	1729		9613	4478	5761
Remove multiple state codes	313052	4505	1729		9611	4478	5760
Remove invalid greenweight	313052	4505	1729		9611	4478	5760
Remove NA greenweight	313052	4505	1729		9611	4478	5760
DQSS check	313052	4505	1729		9611	4478	5760
Merge effort and processed catch data	39500	3065	5812		4821	3008	5652

Table C5: The reported MHR, annual retained landings in the groomed and unmerged dataset, and retained landings in the groomed and merged dataset, and estimated catches in the groomed and merged dataset for LDO 1 and LDO 3 from 1990 to 2009.

| | | | | LDO 1 | | | | | LDO 3 | |
| | | | | | Merged estimated | | | | | Merged estimated |
Year	MHR	Un-merged landings	Merged landings	Catch	% MHR	MHR	Un-merged landings	Merged landings	Catch	% MHR
1990	54	35	18	12	22	74	24	24	23	31
1991	41	26	12	12	29	126	35	31	28	22
1992	58	32	15	13	22	191	71	80	85	45
1993	88	26	11	7	8	187	58	34	42	22
1994	71	27	22	24	34	119	70	62	60	50
1995	93	21	18	28	30	191	141	145	149	78
1996	69	27	19	23	33	191	140	130	144	75
1997	119	87	45	47	39	236	217	207	197	83
1998	96	89	70	79	82	467	443	435	431	92
1999	141	153	101	101	72	494	453	448	467	95
2000	143	139	97	96	67	494	487	492	500	101
2001	124	118	95	99	80	570	554	542	531	93
2002	195	192	154	151	77	566	564	566	599	106
2003	186	187	156	162	87	706	697	683	719	102
2004	138	147	125	125	91	391	418	405	446	114
2005	110	116	91	90	82	272	262	257	286	105
2006	180	172	142	148	82	290	287	287	284	98
2007	147	144	108	108	73	284	271	270	270	95
2008	174	170	126	119	68	256	236	241	248	97
2009	161	146	105	104	65	274	317	307	301	110
Totals	2388	2054	1530	1549	65	2388	5745	5646	5810	91

Table C6: Total number of trips that reported landing lookdown dory, number of trips that reported landing lookdown dory with zero daily processed catch and proportion with zero daily processed catch, for TCEPR forms for LDO 1 and LDO 3 from 1990 to 2009.

LDO 1	TCEPR			LDO 3	TCEPR		
	Total	Zero	Proportion		Total	Zero	Proportion
1990	29	-	-		20	-	-
1991	41	-	-		27	-	-
1992	28	-	-		55	-	-
1993	24	-	-		37	-	-
1994	43	-	-		49	-	-
1995	43	-	-		87	-	-
1996	38	-	-		89	-	-
1997	72	-	-		140	-	-
1998	89	1	0.01		162	-	-
1999	110	-	-		190	-	-
2000	128	-	-		215	-	-
2001	139	-	-		233	-	-
2002	149	-	-		226	-	-
2003	156	-	-		271	-	-
2004	117	-	-		223	-	-
2005	109	-	-		226	-	-
2006	109	-	-		192	-	-
2007	118	-	-		220	-	-
2008	115	-	-		216	-	-
2009	110	-	-		184	-	-

Table C7: Total catch (t) for each region from groomed and merged data for fishing years 1990 – 2009.

Year	ECNI	ECSI/CHAT	Southland	West Coast	Total
1990	2	22	2	16	42
1991	6	27	4	6	43
1992	1	68	11	14	95
1993	4	30	3	7	44
1994	2	54	8	20	84
1995	2	141	5	16	163
1996	1	121	9	17	149
1997	4	187	20	42	252
1998	2	398	37	69	506
1999	1	427	21	100	549
2000	4	452	40	93	588
2001	4	492	50	91	638
2002	8	509	58	145	720
2003	7	602	81	149	839
2004	7	351	54	119	530
2005	5	226	31	86	348
2006	3	262	25	139	430
2007	6	240	31	102	378
2008	8	210	31	119	367
2009	6	281	26	99	411
Total	81	5099	546	1449	7175

Table C8: Total catch (t) by vessel nationality from groomed and merged data for fishing years 1990–2009.

Year	Unknown	NZ	Korea	Panama	Cyprus	Japan	Malta	Ukraine	Russian	Poland	Other	Total
1990	42	-	-	-	-	-	-	-	-	-	-	42
1991	43	-	-	-	-	-	-	-	-	-	-	43
1992	95	-	-	-	-	-	-	-	-	-	-	95
1993	44	-	-	-	-	-	-	-	-	-	-	44
1994	83	1	-	-	-	-	-	-	-	-	-	84
1995	151	11	1	-	-	-	-	-	-	-	-	163
1996	125	19	5	-	-	-	-	-	-	-	-	149
1997	165	70	13	4	-	-	-	-	-	1	-	252
1998	292	155	33	24	1	-	-	-	-	-	-	506
1999	265	205	27	26	23	-	2	-	-	-	-	549
2000	235	238	36	21	19	-	3	37	-	-	-	588
2001	241	272	41	34	19	25	3	1	-	-	-	638
2002	276	284	43	51	35	17	6	10	-	-	-	720
2003	286	350	65	38	46	32	20	2	-	-	-	839
2004	151	261	53	46	2	-	12	4	-	-	-	530
2005	96	175	26	45	-	-	5	1	-	-	-	348
2006	112	214	52	38	-	-	1-	1	2	-	-	430
2007	143	152	76	-	-	-	5	-	1	-	-	378
2008	159	112	89	-	-	-	6	1	-	-	-	367
2009	157	133	120	-	-	-	-	1	-	-	-	411
Total	3161	2652	681	327	145	74	72	59	3	1	-	7175

Table C9a: Proportion of lookdown dory catch reported each month from the ECSI/CHAT area for fishing years 1990–2009.

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1990	0.03	0.10	0.16	-	0.05	0.02	0.06	-	-	-	-	0.56	22
1991	0.24	-	0.19	0.07	0.03	0.01	-	-	0.03	0.01	0.10	0.31	27
1992	0.12	0.05	0.04	0.13	0.23	0.05	0.06	0.05	0.05	-	0.03	0.18	68
1993	0.04	0.05	0.12	0.27	0.24	0.15	0.01	0.03	0.01	-	0.04	0.03	30
1994	0.06	0.18	0.32	0.24	0.02	0.02	0.01	0.01	0.01	0.03	-	0.09	54
1995	0.19	0.12	0.10	0.08	0.07	0.12	0.05	0.12	0.02	0.02	0.01	0.10	141
1996	0.12	0.09	0.20	0.14	0.07	0.03	0.06	0.08	0.03	0.02	-	0.16	121
1997	0.16	0.13	0.08	0.11	0.07	0.13	0.08	0.07	0.04	0.04	-	0.09	187
1998	0.18	0.10	0.10	0.13	0.07	0.11	0.08	0.03	0.09	0.05	-	0.06	398
1999	0.07	0.18	0.11	0.18	0.13	0.10	0.06	0.06	0.06	0.02	-	0.04	427
2000	0.14	0.12	0.10	0.18	0.07	0.17	0.07	0.03	0.06	0.02	-	0.05	452
2001	0.11	0.12	0.08	0.15	0.10	0.18	0.08	0.04	0.08	0.02	-	0.05	492
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	602
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	351
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	226
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	262
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
Total	0.11	0.12	0.11	0.16	0.10	0.11	0.08	0.07	0.05	0.03	0.01	0.06	5 099

Table C9b: Proportion of lookdown dory catch reported for each statistical area from the ECSI/CHAT area for fishing years 1990–2009.

Year	020	021	022	023	052	401	402	403	404	407	408	409	410	Other	Total
1990	0.35	0.07	0.18	0.05	0.01	0.10	0.19	0.01	-	-	-	-	-	0.03	22
1991	0.29	0.20	0.07	0.13	-	0.10	0.04	0.01	0.10	-	-	-	-	0.05	27
1992	0.20	0.03	0.05	0.19	-	0.16	0.12	-	-	0.02	0.14	0.03	0.03	0.03	68
1993	0.07	0.06	0.04	0.03	0.02	0.11	0.11	-	0.03	0.04	0.15	0.07	0.26	0.03	30
1994	0.14	0.12	0.08	0.11	-	0.10	0.04	-	0.02	0.03	0.20	0.12	0.03	0.01	54
1995	0.09	0.08	0.05	0.05	0.06	0.10	0.06	0.03	0.05	0.02	0.18	0.05	0.09	0.09	141
1996	0.23	0.09	0.07	0.21	0.02	0.06	0.05	0.01	0.03	0.04	0.12	0.03	0.04	0.02	121
1997	0.21	0.06	0.10	0.15	0.02	0.08	0.07	0.01	0.05	0.03	0.08	0.05	0.07	0.02	187
1998	0.14	0.03	0.06	0.11	0.10	0.08	0.11	0.02	0.02	0.03	0.16	0.05	0.07	0.01	398
1999	0.12	0.03	0.05	0.12	0.10	0.06	0.11	0.01	0.02	0.07	0.11	0.11	0.07	0.01	427
2000	0.14	0.03	0.05	0.11	0.06	0.06	0.10	0.04	0.01	0.04	0.11	0.09	0.05	0.10	452
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	492
2002	0.10	0.02	0.05	0.15	0.06	0.05	0.07	0.01	0.02	0.10	0.15	0.08	0.11	0.02	509
2003	0.12	0.02	0.10	0.13	0.05	0.07	0.09	0.03	0.03	0.08	0.12	0.08	0.05	0.02	602
2004	0.19	0.02	0.03	0.13	0.06	0.06	0.09	0.05	0.02	0.03	0.12	0.08	0.08	0.03	351
2005	0.14	0.01	0.06	0.11	0.09	0.06	0.06	0.02	0.02	0.07	0.17	0.08	0.08	0.03	226
2006	0.16	0.03	0.11	0.16	0.02	0.04	0.07	-	0.01	0.06	0.18	0.06	0.07	0.01	262
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	0.02	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
Total	0.14	0.03	0.07	0.14	0.05	0.07	0.09	0.03	0.03	0.06	0.12	0.07	0.07	0.03	5 099

Table C9c: Proportion of lookdown dory catch reported by gear type from the ECSI/CHAT area for fishing years 1990–2009.

Year	BT	MW	BT+MW	Total
1990	1.00	-	-	22
1991	0.99	0.01	-	27
1992	0.91	0.09	-	68
1993	1.00	-	-	30
1994	0.86	0.13	0.01	54
1995	0.97	0.03	-	141
1996	0.97	0.03	-	121
1997	0.96	0.03	0.01	187
1998	0.97	0.03	-	398
1999	0.99	0.01	-	427
2000	0.91	0.09	-	452
2001	0.99	0.01	-	492
2002	0.95	0.05	-	509
2003	0.91	0.09	-	602
2004	0.99	0.01	-	351
2005	0.99	0.01	-	226
2006	1.00	-	-	262
2007	1.00	-	-	240
2008	1.00	-	-	210
2009	1.00	-	-	281
Total	0.96	0.03	<0.01	5 099

Table C9d: Proportion of lookdown dory catch reported by target species from the ECSI/CHAT area for fishing years 1990–2009.

Year	BAR	HAK	HOK	LIN	SCI	SPE	SQU	SWA	Mixed	Other	Total
1990	0.01	-	0.68	-	-	-	-	0.26	0.03	0.03	22
1991	0.03	0.06	0.34	0.44	-	-	0.01	0.02	0.07	0.03	27
1992	-	-	0.93	0.02	0.05	-	-	-	-	-	68
1993	-	0.03	0.77	0.01	0.15	-	-	0.05	-	-	30
1994	-	0.02	0.85	-	0.12	-	-	-	0.01	-	54
1995	-	0.02	0.91	-	0.03	-	0.01	0.01	0.01	0.02	141
1996	-	0.03	0.93	-	-	-	-	0.01	0.01	0.01	121
1997	-	0.05	0.93	0.01	-	-	0.01	-	0.01	0.01	187
1998	-	0.02	0.96	-	-	-	-	-	0.01	0.01	398
1999	-	0.03	0.96	-	-	-	-	-	0.01	0.01	427
2000	0.08	0.02	0.88	0.01	-	-	-	-	0.01	-	452
2001	-	0.03	0.95	-	-	-	-	-	0.01	-	492
2002	0.02	0.02	0.90	0.01	0.01	-	-	-	-	0.03	509
2003	0.04	0.03	0.85	-	0.01	0.03	0.03	-	0.01	-	602
2004	-	0.05	0.91	-	0.01	0.01	-	-	0.01	-	351
2005	-	0.03	0.91	-	0.04	-	-	0.01	0.01	-	226
2006	-	-	0.89	0.01	0.04	-	0.01	0.03	0.01	0.01	262
2007	-	0.10	0.72	0.06	0.05	0.02	0.02	0.01	0.02	0.01	240
2008	-	0.10	0.59	0.15	0.03	0.02	-	0.05	0.04	0.01	210
2009	-	0.12	0.60	0.07	0.02	-	-	0.11	0.07	-	281
Total	0.01	0.04	0.87	0.02	0.02	0.01	0.01	0.01	0.01	0.01	5 099

Table C10a: Proportion of lookdown dory catch reported each month from the Southland area for fishing years 1990–2009.

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1990	-	-	0.07	0.03	-	0.02	-	0.16	0.11	-	0.11	0.49	2
1991	-	0.38	-	-	-	-	0.03	0.05	0.10	-	0.02	0.42	4
1992	0.15	0.03	-	0.02	-	-	0.22	0.09	0.08	0.01	0.16	0.24	11
1993	0.10	0.05	0.19	-	0.03	0.04	0.24	0.23	0.13	-	-	-	3
1994	-	0.06	0.08	0.13	0.21	0.18	0.04	-	0.02	-	0.12	0.16	8
1995	0.21	0.15	0.06	0.25	0.09	0.05	0.02	0.06	0.01	0.01	-	0.10	5
1996	0.09	0.22	0.06	0.03	0.04	0.13	0.02	0.09	0.03	0.13	0.02	0.15	9
1997	0.07	0.08	0.12	0.17	0.09	0.03	0.02	0.04	0.17	0.06	0.02	0.12	20
1998	0.09	0.02	0.08	0.04	0.09	0.04	0.09	0.33	0.14	0.01	-	0.05	37
1999	0.12	0.10	0.08	0.06	0.01	0.04	0.11	0.11	0.21	0.03	0.01	0.13	21
2000	0.10	0.08	0.12	0.16	0.10	0.08	0.03	0.08	0.08	0.04	0.02	0.09	40
2001	0.11	0.12	0.14	0.14	0.05	0.09	0.08	0.15	0.07	0.02	-	0.04	50
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	0.14	0.13	0.10	0.09	-	0.03	0.04	0.08	0.07	0.04	0.13	31
2006	0.17	0.09	0.07	0.01	-	0.02	0.02	0.24	0.09	0.08	0.05	0.17	25
2007	0.14	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
Total	0.11	0.11	0.12	0.10	0.06	0.07	0.09	0.11	0.08	0.05	0.03	0.07	546

Table C10b: Proportion of catch reported for each statistical area from the Southland area for fishing years 1990–2009.

Year	026	027	028	029	030	504	602	603	610	618	Other	Total
1990	0.27	0.11	0.01	-	0.22	-	0.39	-	-	-	-	2
1991	0.05	0.43	0.03	-	0.41	0.01	0.05	0.02	-	0.02	-	4
1992	0.10	0.29	0.20	0.01	0.21	0.03	0.01	0.02	0.03	-	0.10	11
1993	0.41	0.38	0.02	-	0.05	0.08	0.04	0.02	-	-	-	3
1994	0.28	0.29	0.01	-	-	0.02	0.22	0.06	-	-	0.13	8
1995	0.09	0.25	0.08	-	0.24	0.03	0.28	0.04	-	-	-	5
1996	0.12	0.22	0.06	-	0.26	0.05	0.21	0.07	-	-	-	9
1997	0.06	0.12	0.16	-	0.18	0.05	0.38	0.03	-	-	0.01	20
1998	0.05	0.04	0.16	-	0.15	0.01	0.57	0.01	-	-	-	37
1999	0.05	0.09	0.08	-	0.23	0.03	0.49	0.01	0.01	-	0.01	21
2000	0.05	0.09	0.14	0.01	0.28	0.04	0.29	0.01	0.07	0.03	0.01	40
2001	0.08	0.07	0.12	-	0.25	0.01	0.31	0.03	0.11	0.02	0.01	50
2002	0.02	0.04	0.27	0.01	0.17	0.01	0.34	0.02	0.05	0.03	0.05	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	0.06	0.06	0.04	54
2005	0.02	0.03	0.21	-	0.34	0.01	0.20	0.05	0.06	0.02	0.06	31
2006	0.04	0.11	0.21	-	0.47	-	0.12	0.01	0.02	-	0.02	25
2007	0.08	0.20	0.26	0.02	0.21	0.01	0.11	0.03	0.05	-	0.03	31
2008	0.08	0.10	0.21	0.01	0.19	0.02	0.18	0.03	0.08	0.09	0.01	31
2009	0.11	0.14	0.28	-	0.23	0.02	0.13	0.02	0.03	-	0.03	26
Total	0.05	0.09	0.19	0.04	0.21	0.02	0.26	0.04	0.05	0.03	0.03	546

Table C10c: Proportion of lookdown dory catch reported by gear type from the Southland area for fishing years 1990–2009.

	BT	MW	BT+MW	Total
1990	1.00	-	-	2
1991	1.00	-	-	4
1992	0.78	0.22	-	11
1993	1.00	-	-	3
1994	0.96	0.03	0.01	8
1995	1.00	-	-	5
1996	0.99	-	-	9
1997	0.97	0.02	0.01	20
1998	1.00	-	-	37
1999	0.97	0.02	0.01	21
2000	0.98	0.01	0.01	40
2001	0.99	0.01	-	50
2002	0.89	0.10	0.02	58
2003	0.70	0.29	0.01	81
2004	0.78	0.21	-	54
2005	0.94	0.05	0.01	31
2006	0.98	0.02	0.01	25
2007	0.99	0.01	-	31
2008	0.97	0.02	0.01	31
2009	0.98	0.01	0.01	26
Total	0.90	0.09	0.01	546

Table C10d: Proportion of lookdown dory catch reported by target species from the Southland area for fishing years 1990–2009.

Year	HAK	HOK	LIN	Other	SBW	SCI	SQU	SWA	Mixed	WWA	Total
1990	0.05	0.21	0.39	0.12	-	-	0.02	0.05	0.10	0.05	2
1991	-	0.14	0.74	-	-	-	-	0.12	-	-	4
1992	-	0.67	0.06	-	0.09	-	0.19	-	-	-	11
1993	-	0.99	0.01	-	-	-	-	-	-	-	3
1994	-	0.69	-	-	0.10	0.15	-	0.04	0.03	-	8
1995	-	0.54	-	0.06	0.01	0.23	-	0.11	0.05	-	5
1996	-	0.84	-	0.02	-	0.10	-	0.03	0.01	-	9
1997	-	0.76	0.01	0.02	-	0.14	0.05	-	0.02	-	20
1998	-	0.90	0.01	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	0.05	0.01	21
2000	0.02	0.74	0.09	0.01	-	0.02	0.03	0.03	0.04	0.01	40
2001	0.02	0.73	0.08	0.01	-	0.01	0.05	0.04	0.05	0.02	50
2002	0.03	0.49	0.04	0.04	0.04	0.05	0.05	0.06	0.04	0.15	58
2003	0.02	0.44	0.03	-	0.01	0.06	0.31	0.01	0.07	0.05	81
2004	0.03	0.37	0.09	-	0.02	0.06	0.24	0.01	0.06	0.11	54
2005	0.03	0.46	0.17	0.02	-	0.01	0.03	0.01	0.07	0.19	31
2006	0.01	0.19	0.28	-	0.01	0.02	0.08	0.09	0.10	0.23	25
2007	0.05	0.26	0.22	0.02	-	0.02	0.08	0.08	0.13	0.13	31
2008	0.09	0.13	0.31	0.01	0.09	0.02	0.02	0.10	0.08	0.14	31
2009	0.14	0.19	0.24	-	0.03	0.01	0.05	0.09	0.08	0.16	26
Total	0.03	0.51	0.11	0.01	0.02	0.04	0.10	0.04	0.06	0.08	546

Table C11a: Proportion of lookdown dory catch reported each month from the West Coast area for fishing years 1990–2009.

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1990	-	-	-	-	0.01	-	-	-	0.12	0.37	0.40	0.09	16
1991	-	-	-	-	-	-	-	-	0.02	0.75	0.22	-	6
1992	-	-	-	-	-	-	-	-	-	0.48	0.21	0.31	14
1993	0.01	-	-	-	0.01	0.05	-	-	0.20	0.57	0.04	0.13	7
1994	0.01	-	-	-	-	-	-	-	0.24	0.46	0.16	0.12	20
1995	-	-	-	-	0.01	-	-	-	0.23	0.40	0.19	0.17	16
1996	0.03	-	-	-	-	-	-	-	0.14	0.61	0.11	0.11	17
1997	-	-	-	-	-	-	-	0.01	0.19	0.57	0.14	0.10	42
1998	-	0.02	-	-	-	-	-	-	0.25	0.53	0.17	0.02	69
1999	0.02	0.04	-	-	-	-	-	0.02	0.22	0.41	0.21	0.06	100
2000	0.13	-	-	-	-	-	-	0.02	0.21	0.43	0.09	0.11	93
2001	0.05	-	-	-	-	-	-	0.04	0.27	0.50	0.10	0.05	91
2002	0.02	0.01	-	-	-	-	-	-	0.27	0.43	0.24	0.04	145
2003	0.01	-	0.01	-	-	-	-	0.03	0.36	0.40	0.14	0.05	149
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	-	-	-	-	-	-	0.16	0.57	0.15	0.09	139
2007	-	0.01	-	0.02	-	-	-	0.02	0.42	0.26	0.18	0.10	102
2008	0.02	-	-	-	-	-	-	0.01	0.36	0.39	0.13	0.08	119
2009	-	-	-	-	-	-	-	0.06	0.26	0.47	0.17	0.03	99
Total	0.02	0.01	<0.01	<0.01	<0.01	<0.01	-	0.01	0.25	0.46	0.16	0.07	1 449

Table C11b: Proportion of lookdown dory catch reported for each statistical area from the West Coast area for fishing years 1990–2009.

Year	033	034	035	036	040	703	Other	Total
1990	-	0.76	0.23	-	-	-	0.01	16
1991	-	0.62	0.35	-	-	0.03	-	6
1992	-	0.60	0.38	0.02	-	-	-	14
1993	-	0.44	0.49	0.03	-	-	0.04	7
1994	-	0.59	0.39	-	-	0.01	0.01	20
1995	0.06	0.64	0.25	0.05	-	-	-	16
1996	-	0.71	0.28	-	-	0.01	-	17
1997	0.01	0.59	0.34	0.05	-	0.01	-	42
1998	-	0.64	0.35	0.01	-	-	-	69
1999	-	0.70	0.27	0.02	-	0.01	-	100
2000	-	0.60	0.39	0.01	-	-	-	93
2001	0.01	0.65	0.33	0.01	-	-	-	91
2002	-	0.49	0.43	0.05	-	0.01	0.01	145
2003	-	0.57	0.31	0.10	0.01	0.01	0.01	149
2004	0.01	0.62	0.31	0.02	0.02	-	0.02	119
2005	-	0.64	0.27	0.03	-	0.01	0.05	86
2006	-	0.66	0.27	0.05	-	-	0.02	139
2007	0.01	0.65	0.34	-	-	-	-	102
2008	-	0.72	0.26	0.01	0.01	0.01	-	119
2009	-	0.82	0.18	-	-	-	-	99
Total	<0.01	0.64	0.31	0.03	<0.01	<0.01	0.01	1 449

Table C11c: Proportion of lookdown dory catch reported by gear type from the West Coast area for fishing years 1990–2009.

Year	BT	MW	BT+MW	Total
1990	0.31	0.65	0.04	16
1991	0.48	0.46	0.06	6
1992	0.71	0.26	0.03	14
1993	0.92	0.07	0.01	7
1994	0.56	0.37	0.07	20
1995	0.49	0.50	0.01	16
1996	0.69	0.26	0.05	17
1997	0.68	0.28	0.04	42
1998	0.58	0.36	0.07	69
1999	0.44	0.53	0.03	100
2000	0.54	0.44	0.02	93
2001	0.79	0.18	0.02	91
2002	0.74	0.24	0.02	145
2003	0.82	0.15	0.03	149
2004	0.76	0.21	0.03	119
2005	0.87	0.10	0.03	86
2006	0.87	0.11	0.02	139
2007	0.91	0.07	0.02	102
2008	0.98	0.02	-	119
2009	0.95	0.05	-	99
Total	0.76	0.21	0.03	1 449

Table C11d: Proportion of lookdown dory catch reported by target species from the West Coast area for fishing years 1990–2009.

Total	BAR	HAK	HOK	JMA	LIN	Other	SQU	SWA	TAR	Mixed	Total
1990	0.02	-	0.97	-	-	-	-	-	-	0.01	16
1991	-	-	0.94	0.03	-	-	-	-	-	0.03	6
1992	-	0.24	0.74	-	-	-	-	-	-	0.02	14
1993	0.01	-	0.92	0.04	-	0.03	-	-	-	-	7
1994	0.01	0.29	0.69	-	-	0.01	-	-	-	-	20
1995	0.04	0.16	0.71	-	0.02	0.02	-	-	0.01	0.03	16
1996	-	0.14	0.86	-	-	-	-	-	-	-	17
1997	0.01	0.03	0.90	0.01	-	-	-	-	-	0.05	42
1998	-	0.04	0.85	0.09	-	-	-	-	-	0.02	69
1999	0.01	0.06	0.87	0.04	-	0.01	-	-	-	0.01	100
2000	-	0.07	0.79	0.11	-	-	-	0.01	-	0.01	93
2001	-	0.04	0.90	0.01	-	-	-	0.02	-	0.03	91
2002	-	0.06	0.85	0.06	-	-	-	0.02	-	0.02	145
2003	-	0.10	0.82	0.03	-	0.01	0.02	-	-	0.04	149
2004	-	0.11	0.78	0.04	-	-	0.01	0.01	-	0.05	119
2005	-	0.18	0.61	-	-	0.01	0.04	-	0.05	0.11	86
2006	-	0.44	0.44	0.02	-	-	-	-	-	0.10	139
2007	-	0.40	0.37	0.01	0.02	0.01	-	0.02	-	0.16	102
2008	-	0.66	0.22	0.01	-	-	-	0.01	-	0.10	119
2009	-	0.73	0.14	-	-	0.01	-	0.01	-	0.10	99
Total	<0.01	0.23	0.65	0.03	<0.01	<0.01	<0.01	0.01	<0.01	0.06	1 449

Table C12a: Proportion of lookdown dory catch reported each month from the ECNI area for fishing years 1990–2009.

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1990	0.12	0.25	0.14	0.11	0.03	0.04	0.03	0.02	0.06	0.02	0.06	0.12	2
1991	0.12	0.04	0.04	0.05	0.05	0.02	0.01	0.05	0.15	0.23	0.22	0.03	6
1992	0.22	0.50	0.08	0.10	-	-	-	-	-	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	-	0.39	0.02	0.01	-	0.02	-	0.15	0.37	0.03	-	-	2
1995	-	-	-	0.06	0.01	0.20	0.09	0.04	0.27	0.18	0.16	-	2
1996	0.15	0.07	0.23	0.19	0.02	-	-	-	-	-	0.33	0.02	1
1997	0.06	0.02	0.05	-	-	0.24	0.45	-	0.15	0.01	-	0.01	4
1998	0.07	0.33	0.01	-	0.17	0.07	0.11	0.01	0.18	-	0.01	0.04	2
1999	0.12	0.17	-	0.22	-	0.10	-	-	-	0.20	0.16	0.02	1
2000	0.02	0.02	0.22	0.01	0.20	-	0.26	0.08	0.02	0.08	0.03	0.06	4
2001	0.08	0.29	0.06	0.30	0.14	-	-	-	0.03	0.02	0.03	0.04	4
2002	0.01	0.02	0.15	0.09	0.21	0.16	0.04	0.08	0.07	0.09	0.07	-	8
2003	0.04	0.04	0.09	0.32	0.27	0.21	-	-	0.01	-	-	0.03	7
2004	0.04	0.12	0.02	0.27	0.10	0.09	0.16	-	0.08	0.13	-	-	7
2005	0.08	0.20	0.10	0.20	0.14	0.10	0.03	0.01	-	0.01	0.02	0.10	5
2006	-	0.04	0.13	0.06	-	0.05	0.03	0.06	0.24	0.12	0.07	0.19	3
2007	0.08	0.11	0.04	0.10	0.02	0.11	0.02	0.03	0.01	0.05	0.10	0.34	6
2008	0.10	0.09	0.13	0.06	0.06	0.08	0.18	0.02	0.03	-	0.16	0.09	8
2009	0.06	0.03	0.08	0.12	0.04	0.04	0.02	0.05	0.08	0.02	0.35	0.14	6
Total	0.06	0.10	0.09	0.13	0.10	0.09	0.08	0.04	0.09	0.08	0.09	0.07	81

Table C12b: Proportion of lookdown dory catch reported for each statistical area from the ECNI area for fishing years 1990–2009.

Year	008	009	012	014	015	016	Other	Total
1990	0.29	0.47	0.01	0.21	-	-	0.02	2
1991	0.30	0.11	-	0.52	0.06	-	0.01	6
1992	0.12	0.11	0.03	0.64	-	-	0.10	1
1993	0.02	0.01	0.04	0.87	0.07	-	-	4
1994	-	-	-	0.92	0.06	-	0.01	2
1995	0.16	-	0.04	0.73	0.08	-	-	2
1996	0.40	0.02	-	0.58	-	-	-	1
1997	0.01	0.01	-	0.94	0.01	0.04	0.01	4
1998	0.24	0.01	0.17	0.55	0.01	-	0.01	2
1999	0.09	0.02	-	0.63	0.10	0.02	0.15	1
2000	0.10	-	-	0.78	0.03	0.02	0.08	4
2001	0.01	-	-	0.88	0.09	0.01	-	4
2002	0.05	0.05	0.01	0.75	0.12	-	0.02	8
2003	0.03	-	-	0.75	0.18	-	0.03	7
2004	0.02	0.02	-	0.83	0.12	0.01	-	7
2005	0.06	0.01	0.01	0.67	0.18	-	0.07	5
2006	0.20	-	-	0.69	0.10	0.01	-	3
2007	0.07	0.01	-	0.61	0.28	0.01	0.01	6
2008	0.19	0.04	-	0.57	0.19	0.01	-	8
2009	0.08	0.01	-	0.74	0.12	0.03	0.02	6
Total	0.10	0.04	0.01	0.71	0.12	0.01	0.02	81

Table C12c: Proportion of lookdown dory catch reported by gear type from the ECNI area for fishing years 1990–2009.

Year	BT	MW	BT+MW	Total
1990	1.00	-	-	2
1991	1.00	-	-	6
1992	1.00	-	-	1
1993	1.00	-	-	4
1994	1.00	-	-	2
1995	1.00	-	-	2
1996	1.00	-	-	1
1997	1.00	-	-	4
1998	0.99	0.01	-	2
1999	1.00	-	-	1
2000	0.98	-	0.02	4
2001	0.98	0.01	0.01	4
2002	1.00	-	-	8
2003	0.99	0.01	-	7
2004	0.95	0.03	0.02	7
2005	0.96	0.04	-	5
2006	0.97	0.03	-	3
2007	0.96	0.03	0.01	6
2008	0.94	0.06	-	8
2009	0.93	0.04	0.03	6
Total	0.98	0.02	<0.01	81

Table C12d: Proportion of lookdown dory catch reported by target species from the ECNI area for fishing years 1990–2009.

Year	BYX	HOK	LIN	Other	SCI	Mixed	Total
1990	-	-	-	-	1.00	-	2
1991	-	-	-	-	1.00	-	6
1992	-	-	-	-	1.00	-	1
1993	-	0.01	-	-	0.99	-	4
1994	-	-	-	-	1.00	-	2
1995	-	-	-	-	1.00	-	2
1996	-	-	-	-	1.00	-	1
1997	-	0.04	-	-	0.96	-	4
1998	-	0.27	-	-	0.71	0.01	2
1999	-	0.11	-	-	0.88	0.01	1
2000	-	0.74	-	0.01	0.25	-	4
2001	-	0.39	-	-	0.61	-	4
2002	-	0.15	-	-	0.85	-	8
2003	-	0.12	0.01	0.01	0.84	0.01	7
2004	-	0.23	-	0.01	0.74	0.02	7
2005	0.04	0.25	0.01	0.01	0.67	0.02	5
2006	-	0.04	0.07	-	0.89	-	3
2007	0.01	0.06	0.33	0.02	0.47	0.09	6
2008	0.04	0.09	0.08	0.08	0.55	0.17	8
2009	0.02	0.07	0.37	0.01	0.40	0.13	6
Total	0.01	0.14	0.06	0.01	0.74	0.04	81

Table C13: Species codes used in the report.

Code	Common name	Scientific name
BAR	Barracouta	*Thyrsites atun*
BYX	Alfonsino	*Beryx splendens, B. decadactylus*
ELE	Elephant fish	*Callorhinchus milii*
EMA	Blue mackerel	*Scomber australasicus*
FLA	Flatfish	*Rhombosolea leporina, R. plebeia, R. plebeia, R. plebeia, Peltotretis flavilatus, Peltorhamphus novaezeelandiae, Colistium guntheri, C. nudipinnis*
FRO	Frostfish	*Lepidopus caudatus*
GUR	Red gurnard	*Chelidonichthyes kumu*
HAK	Hake	*Merluccius australis*
HOK	Hoki	*Macruronus novaezelandiae*
JDO	John dory	*Zues faber*
JMA	Jack mackerels	*Trachurus declivis, T. novaezelandiae, T. symmetricus murphyi*
KAH	Kahawai	*Arripis trutta, A. xylabion*
LIN	Ling	*Genypterus blacodes*
LDO	Lookdown dory	*Cyttus traversi*
ORH	Orange roughy	*Hoplostethus atlanticus*
RCO	Red cod	*Pseudophycis bachus*
SCI	Scampi	*Metanephrops challengeri*
SFL	Sand flounder	*Rhombosolea plebeia*
SKI	Gemfish	*Rexea solandri*
SNA	Snapper	*Pagrus auratus*
SPD	Spiny dogfish	*Squalus acanthias*
SPE	Sea perch	*Helicolenus percoides*
SQU	Arrow squid	*Nototodarus gouldi, N. sloanni*
SQX	Squid	Unidentified squid
SSO	Smooth oreo	*Pseudocyttus maculatus*
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*
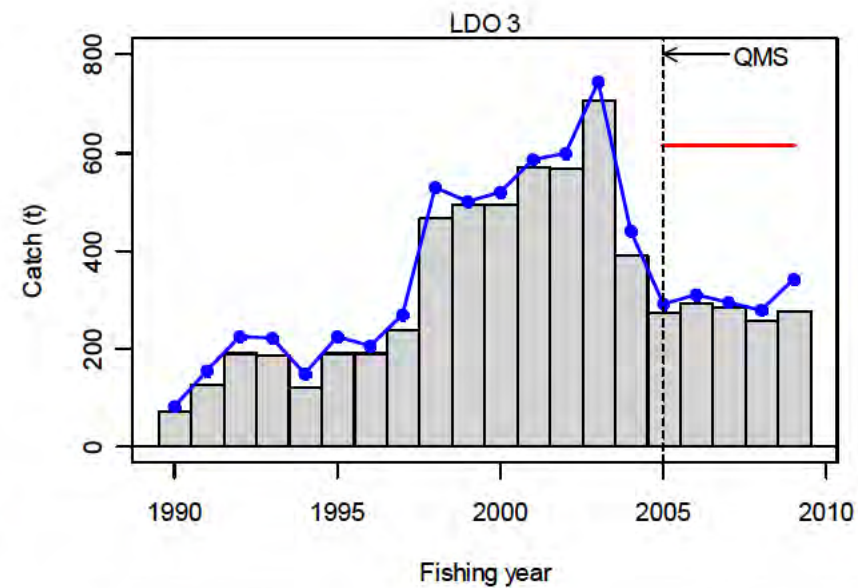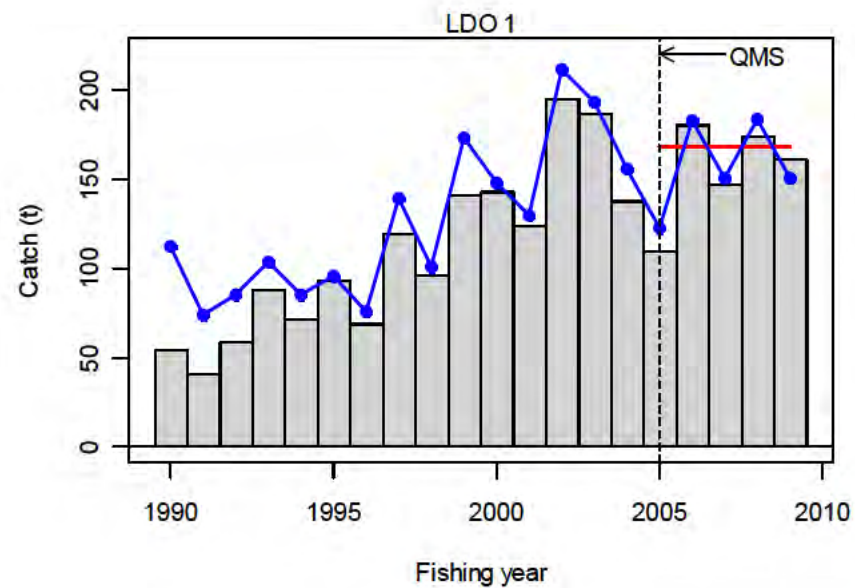
Figure C1: The QMR/MHR landings (gray bars), un-groomed catch effort landings (dotted blue line), and TACC (red line) for LDO 1, and 3 from the 1990 to 2009 fishing year.
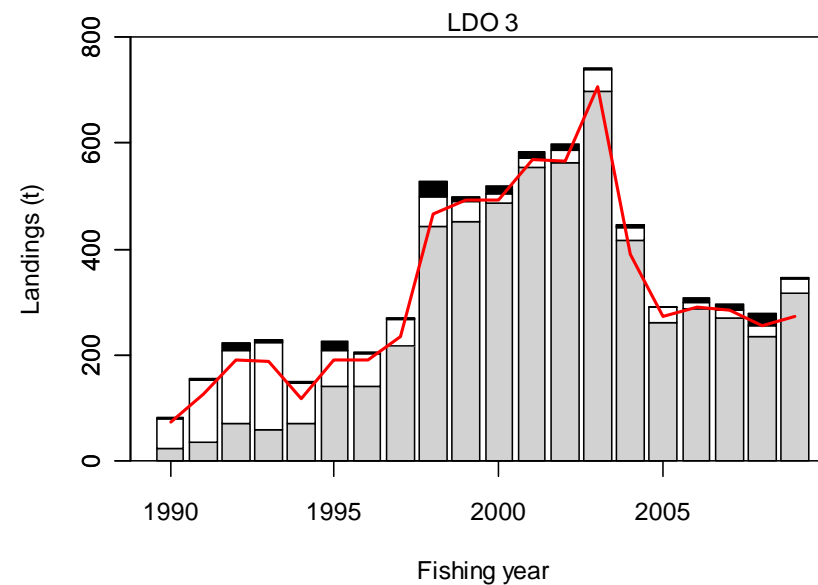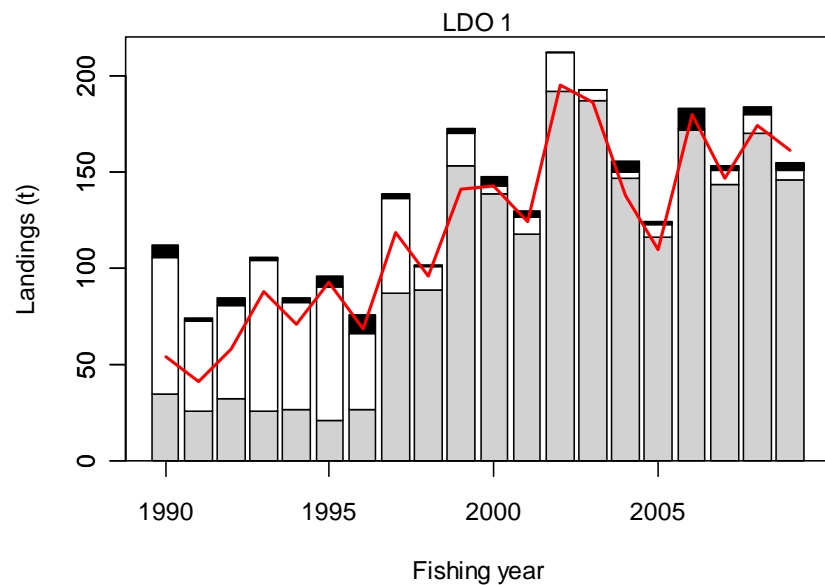
Figure C2:The retained landings (gray bars), interim landings (white bars), and landings dropped during data grooming (black bars), and MHR landings (red line) for LDO 1, and 3 from the 1990 to 2009 fishing year.
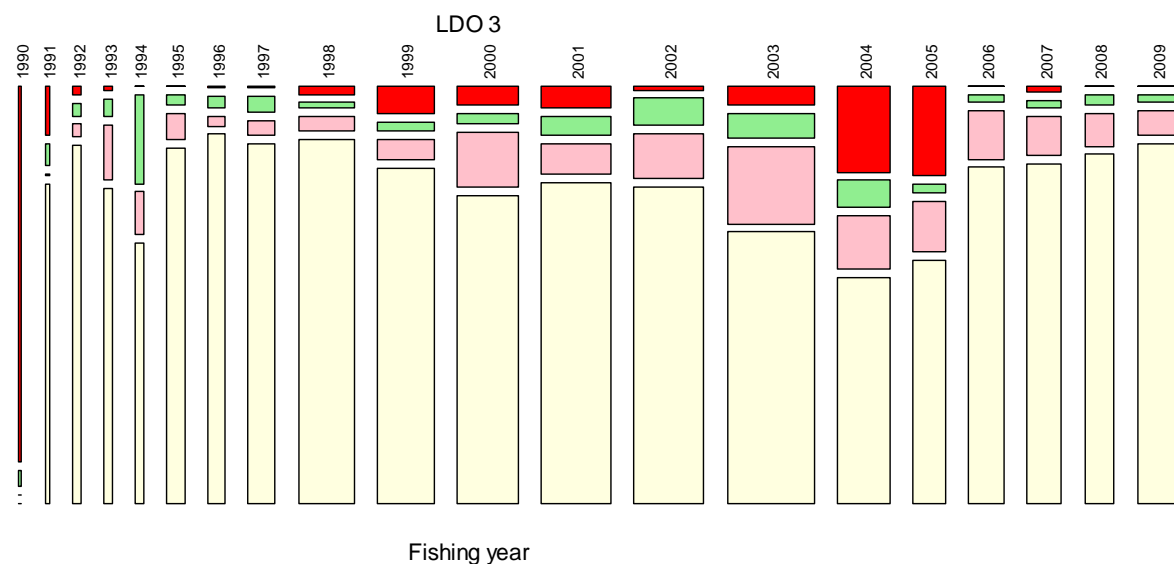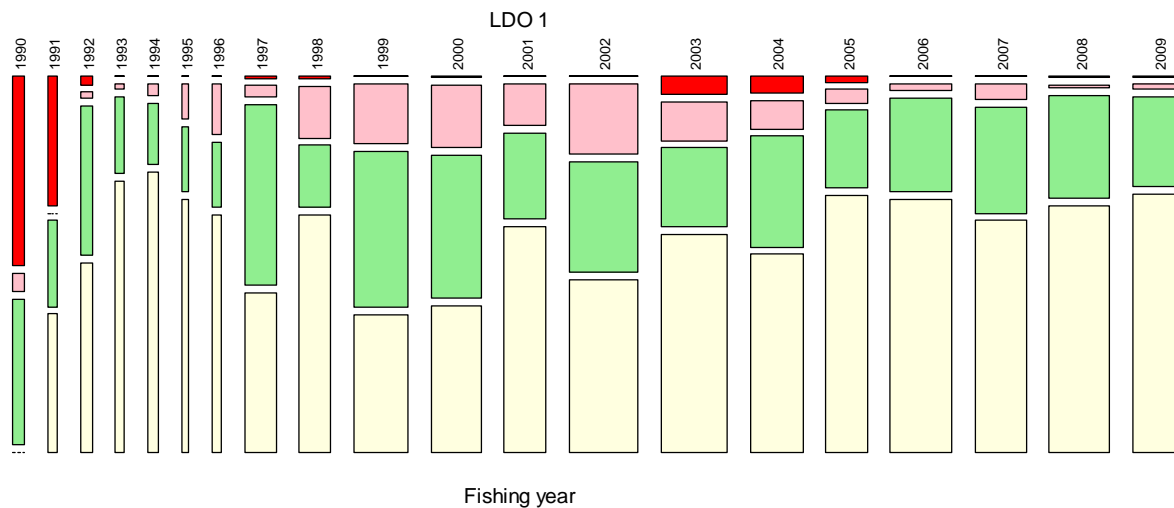
Figure C3: The proportion of retained landings (greenweight) by processed state for LDO 1, and 3 from the 1990 to 2009 fishing year in the groomed and unmerged dataset. Red = "Other"; pink = "Mealed"; light yellow = "Dressed" and also includes "Headed, gutted, and tailed"; light green = "Green".
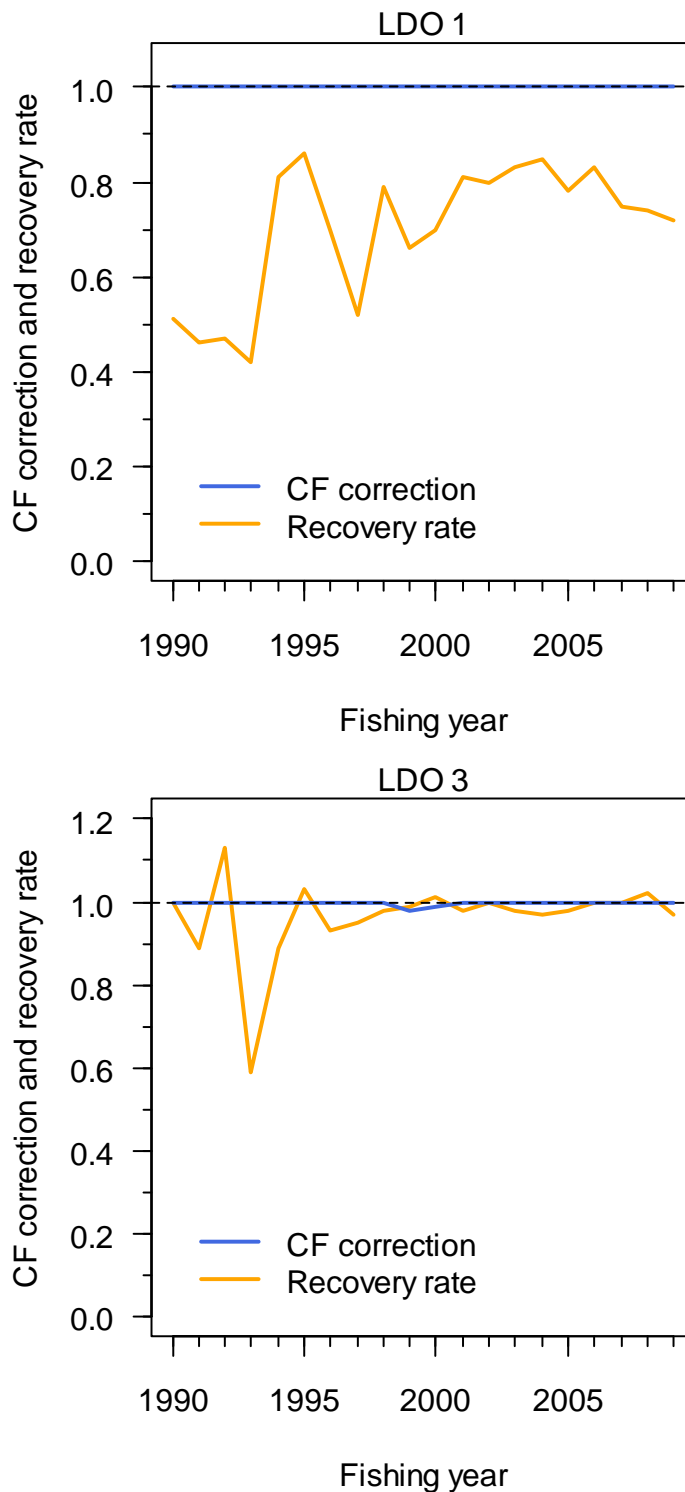
Figure C4: Conversion factor (CF) corrections (by the centroid method), defined as the ratio of annual green weight recalculated using the most recent correction factors for each processed state to the reported green weight, and the recovery rate, defined as the ratio of annual landings in the groomed and merged dataset to those in the groomed and unmerged dataset, for LDO 1, and 3 from the 1990to 2009 fishing year.
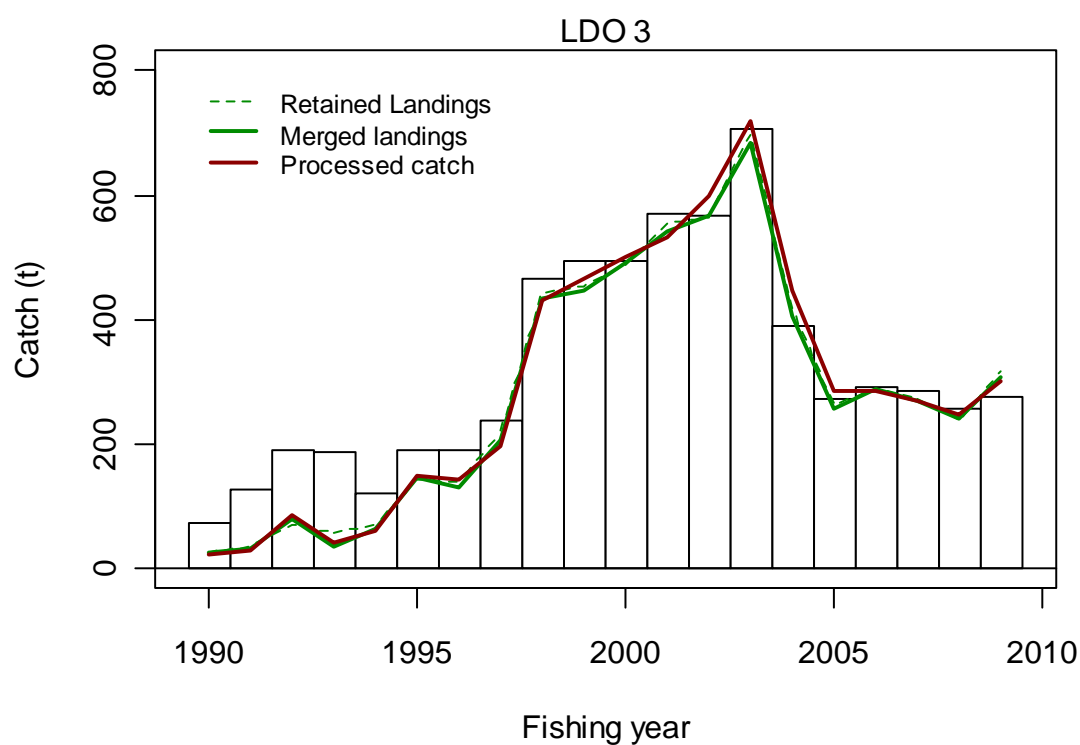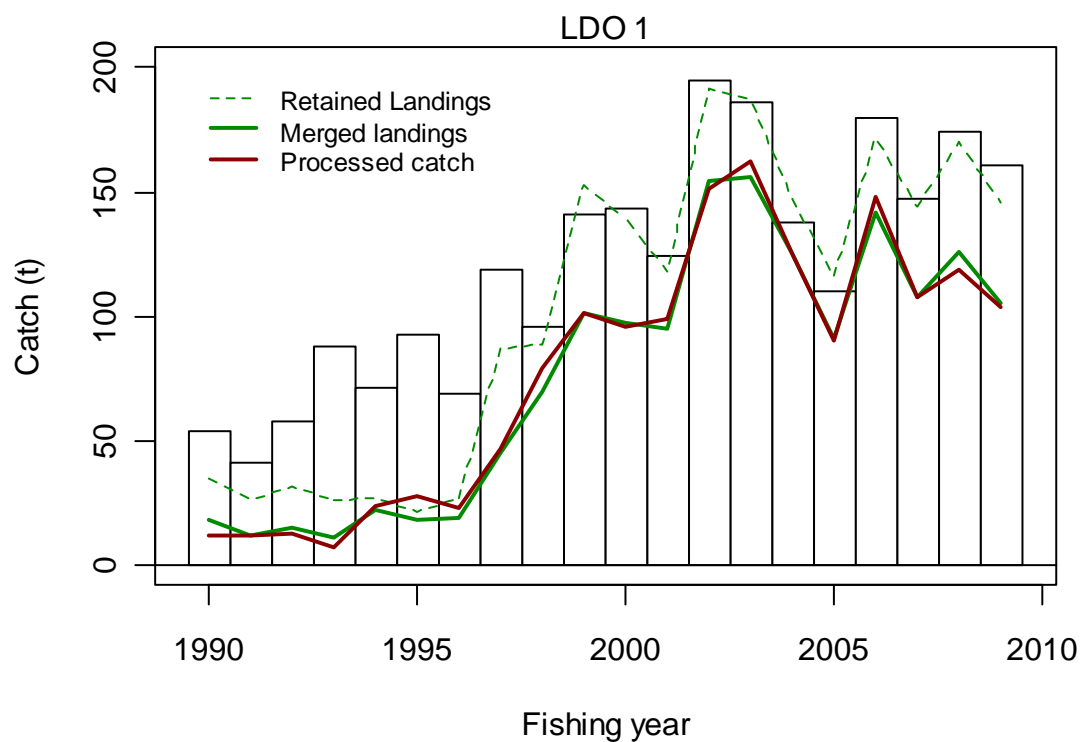
Figure C5: The QMR/MHR landings (white bars), retained landings in the groomed and unmerged dataset (green dashed line), retained landings in groomed and merged dataset (green solid line), and daily processed catch in the groomed and merged dataset (red solid line), using the centroid method, for LDO 1 and 3 from the 1990 to 2009 fishing year.
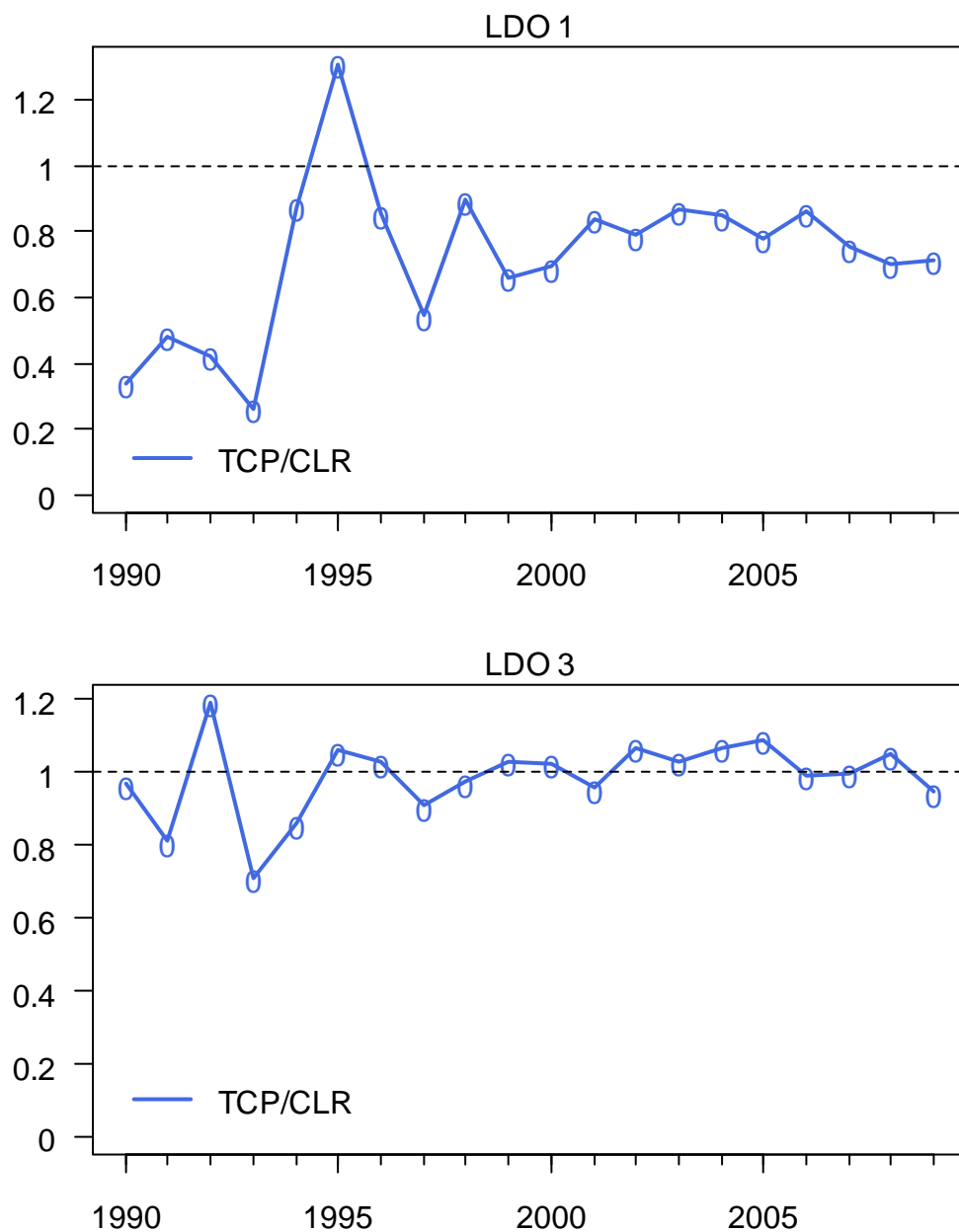
Figure C6: The reporting rate, defined as the ratio of greenweight calculated from annual processed catch as a proportion of retained landings in the groomed and merged dataset, for LDO 1, and 3 from the 1990 to 2009 fishing year.
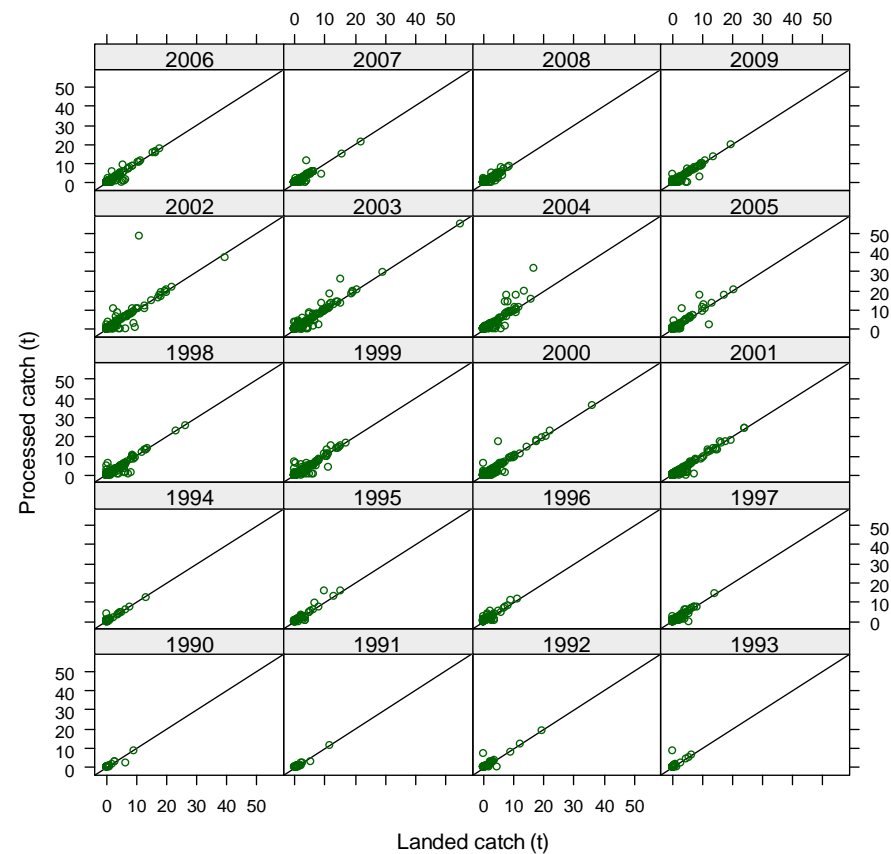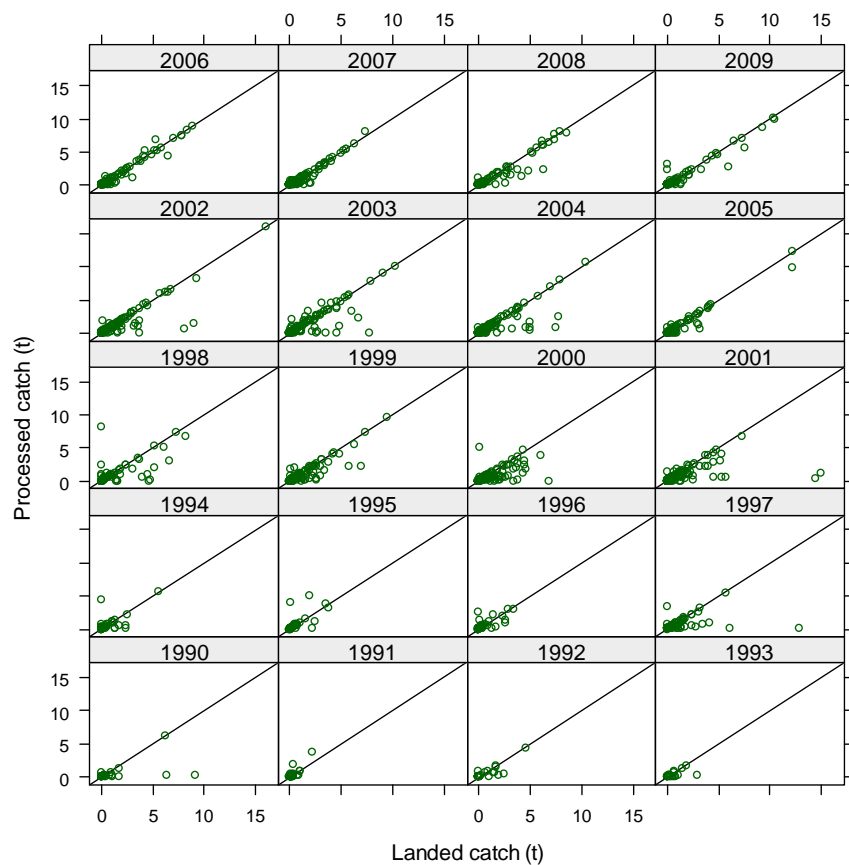
Figure C7: Processed catch vs. reported landings on a trip basis in the groomed and merged dataset, for LDO 1 (left) and LDO 3 (right) from the 1990 to 2009 fishing year.
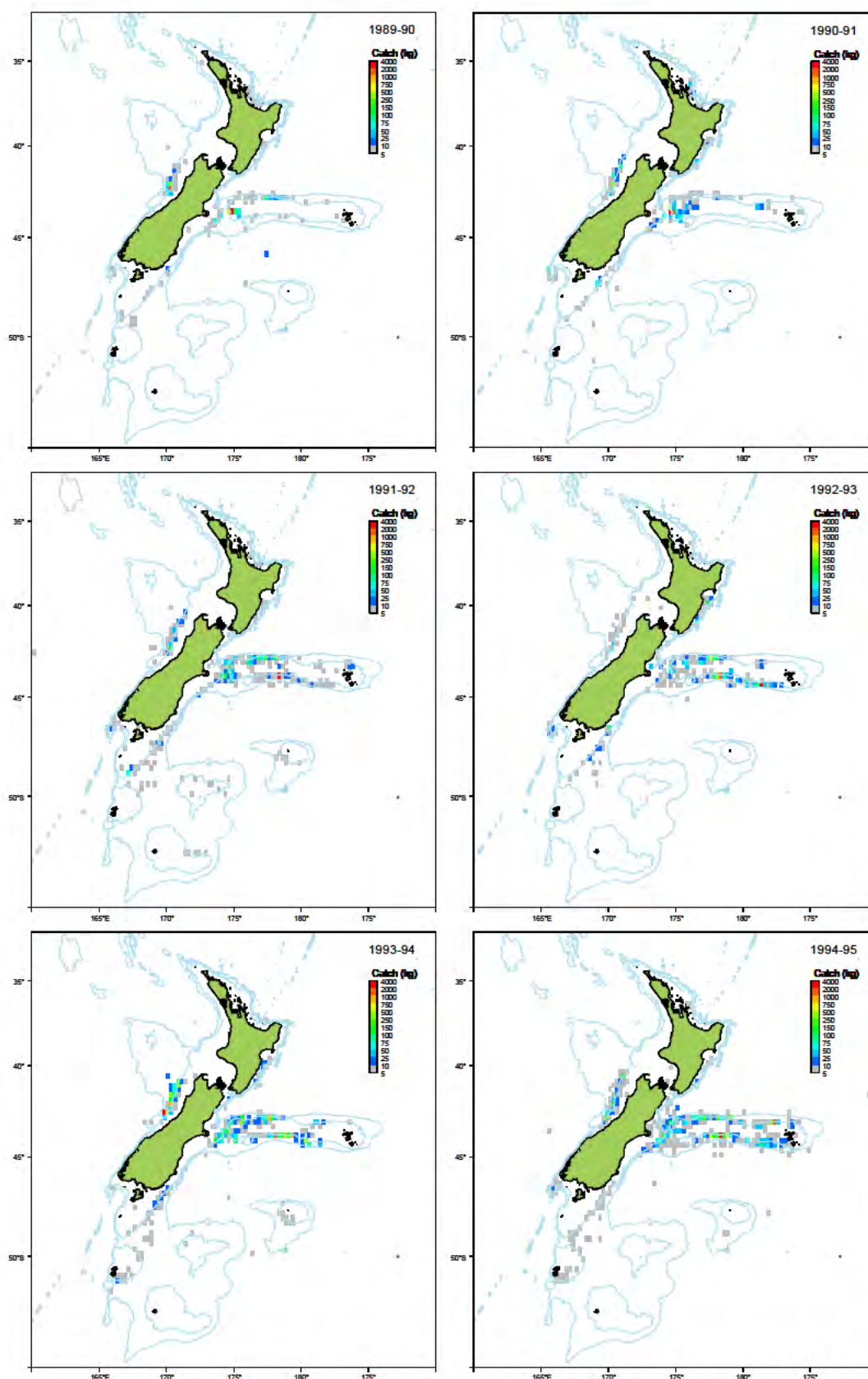
Figure C8: Annual catch (in tonnes) of all commercial lookdown dory catches from TCEPR records by fishing year (1 October to 30 September) 1990 to 2009.
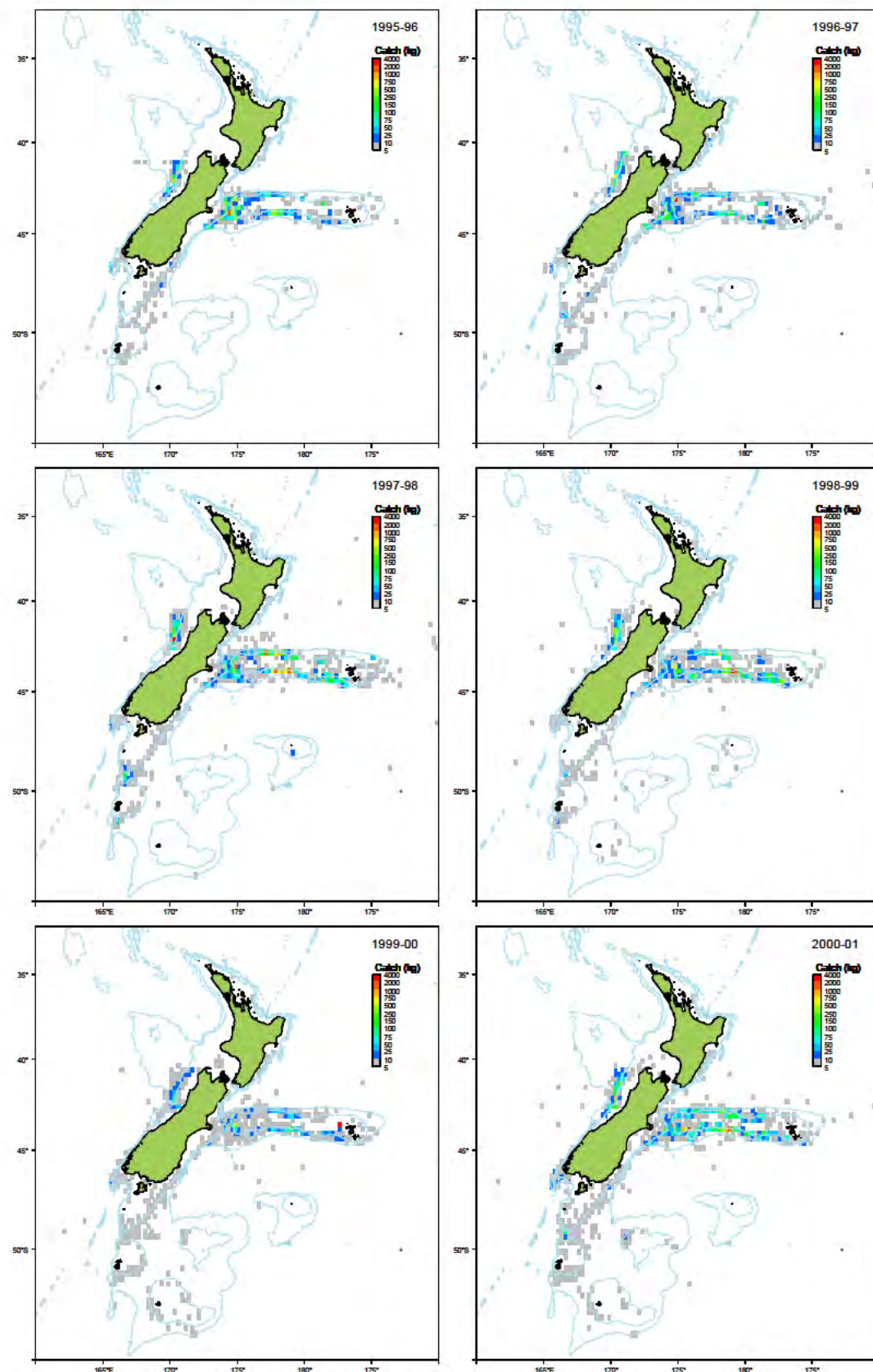
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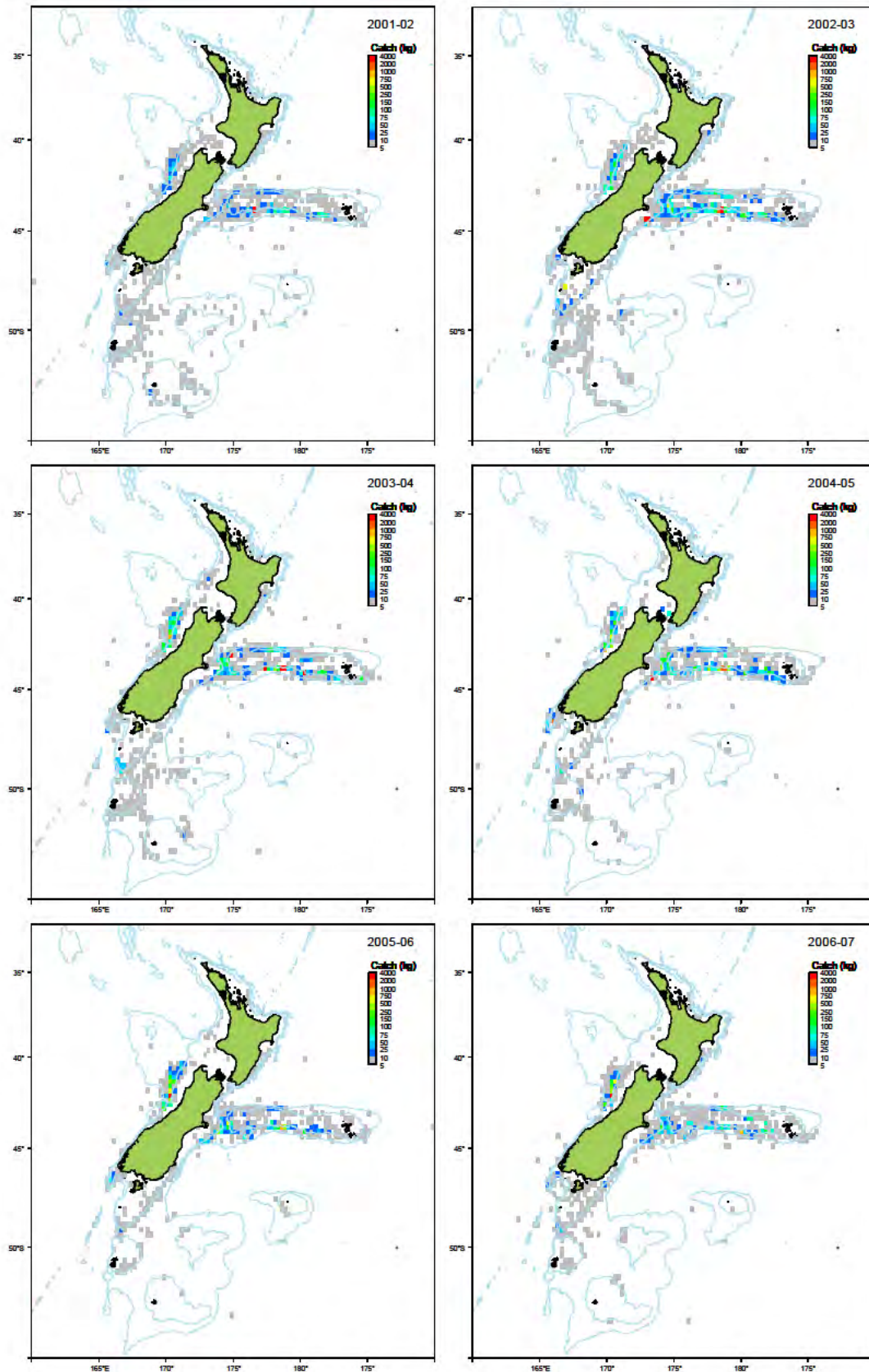
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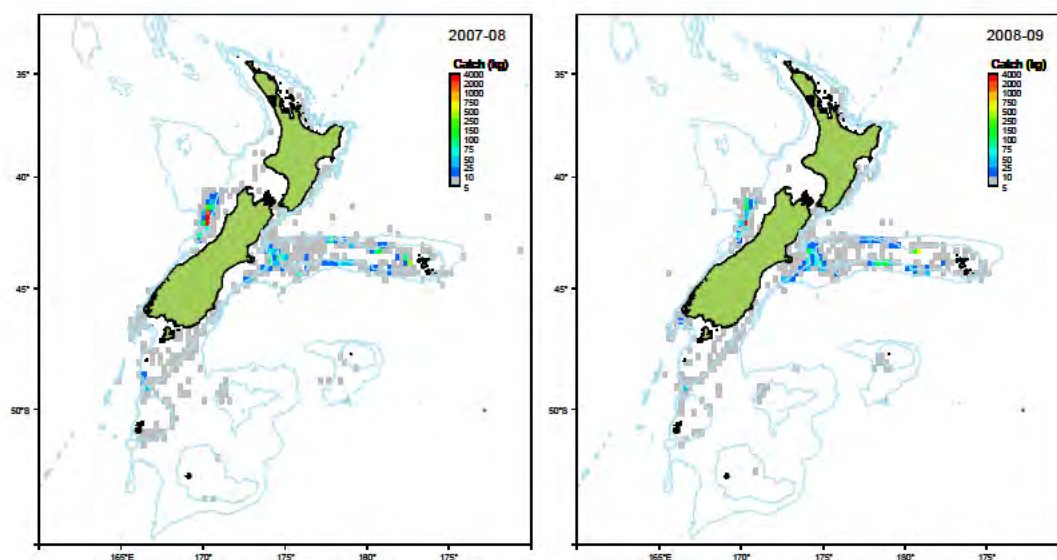
Figure C8: continued.
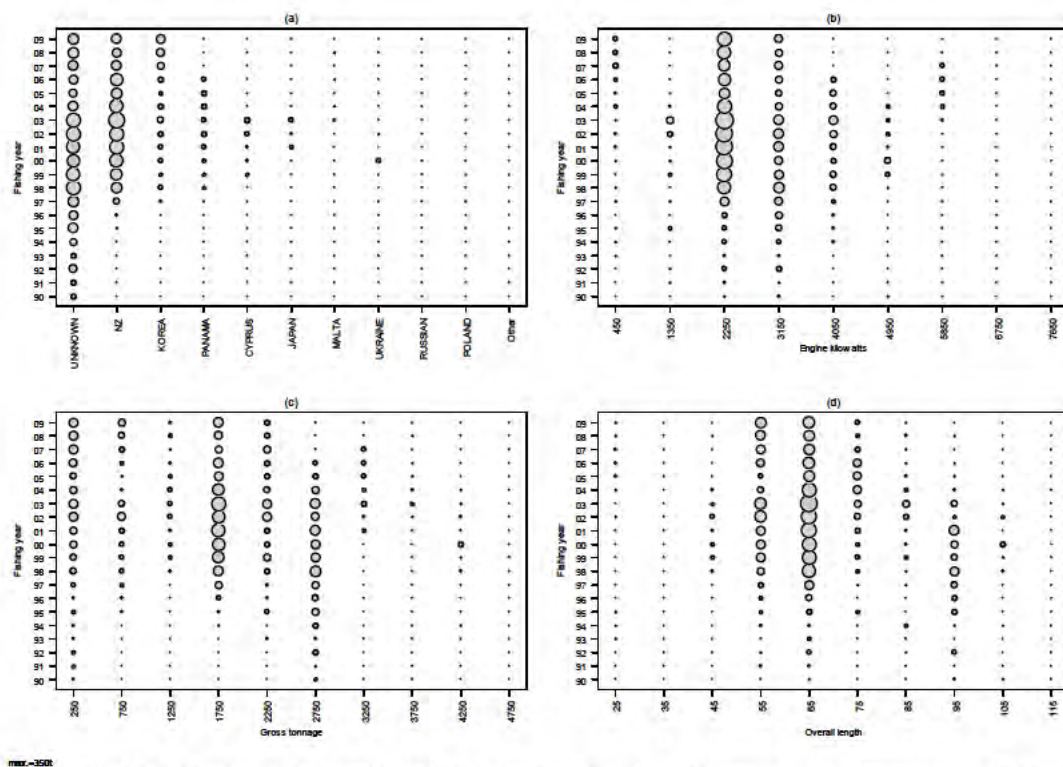
Figure C9: Distribution of annual catch by nationality, vessel power, gross tonnage, and length (m) for all merged data. Circle size is proportional to catch; maximum circle size is indicated in lower left hand corner.
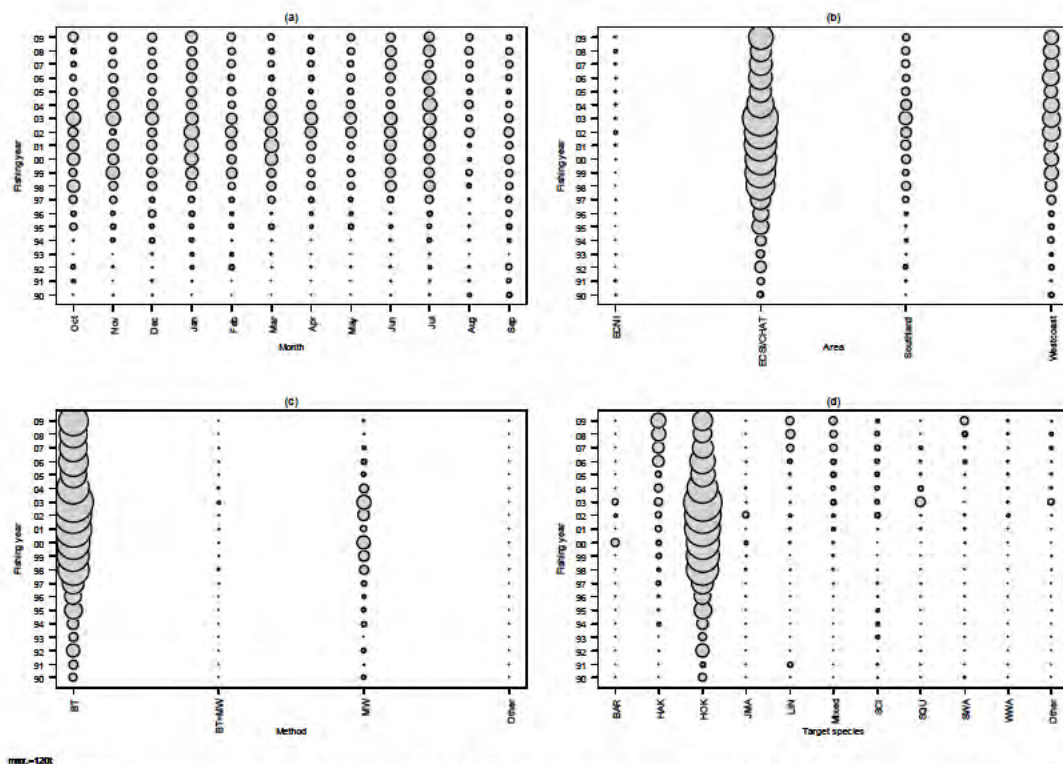
Figure C10: Distribution of annual catch by month, area, method, and target species for all merged data. Circle size is proportional to catch; maximum circle size is indicated in lower left hand corner. NB: BT+MW fishing method are days where there was an even split between the number of bottom and midwater tows.
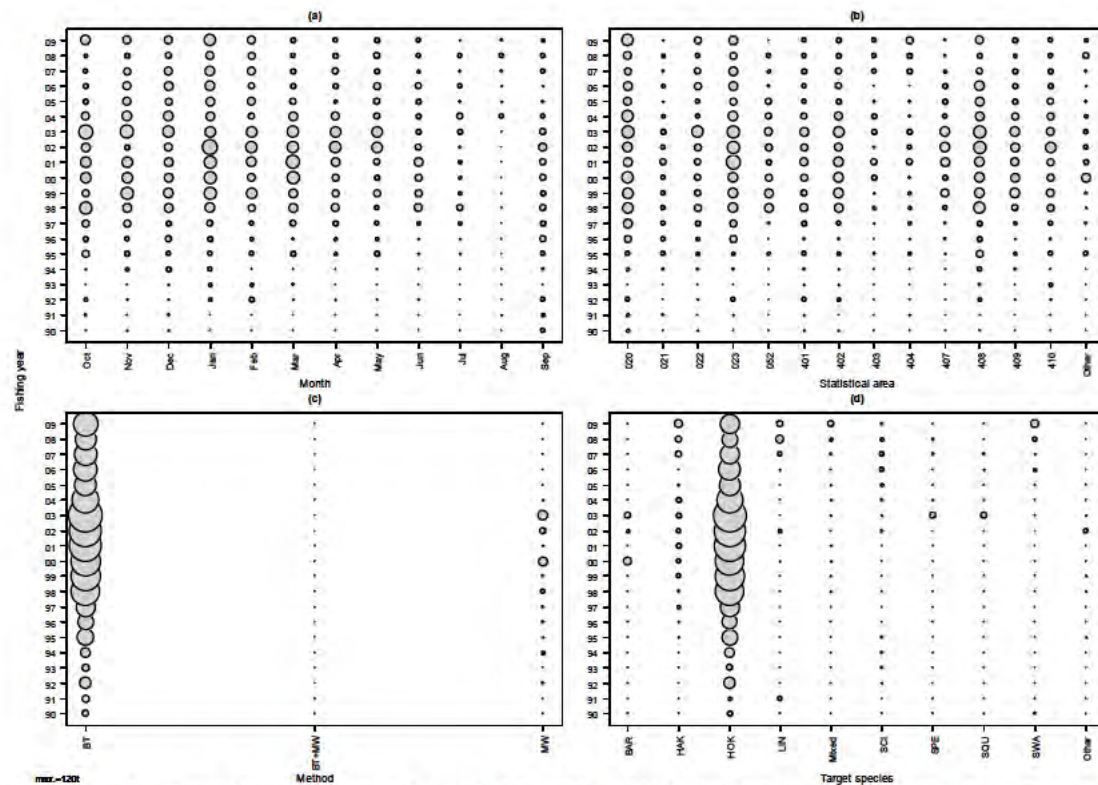
Figure C11: Distribution of annual catch by month, statistical area, method, and target species for ECSI/CHAT merged data. Circle size is proportional to catch; maximum circle size is indicated in lower left hand corner. NB: BT+MW fishing method are days where there was an even split between the number of bottom and midwater tows.
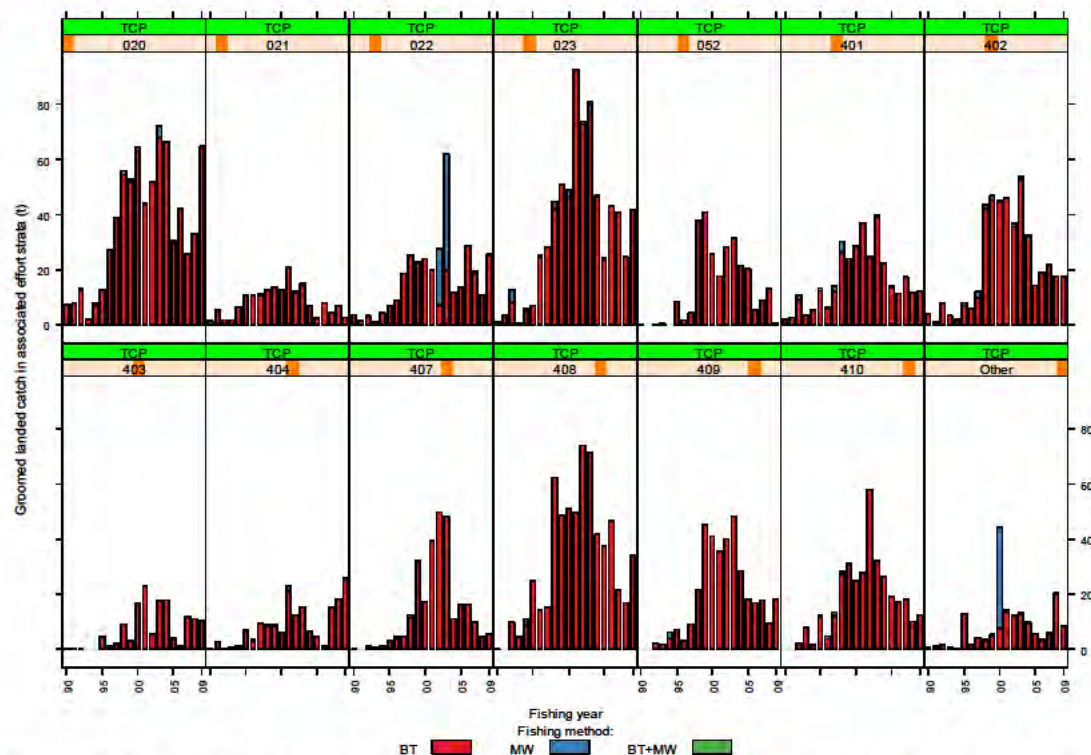
Figure C12a: Distribution of lookdown dory catch in the ECSI/CHAT region in relation to form type and statistical area for fishing years 1990–2009 taken by midwater and bottom trawl gear. NB: BT+MW fishing method are days where there was an even split between the number of bottom and midwater tows.
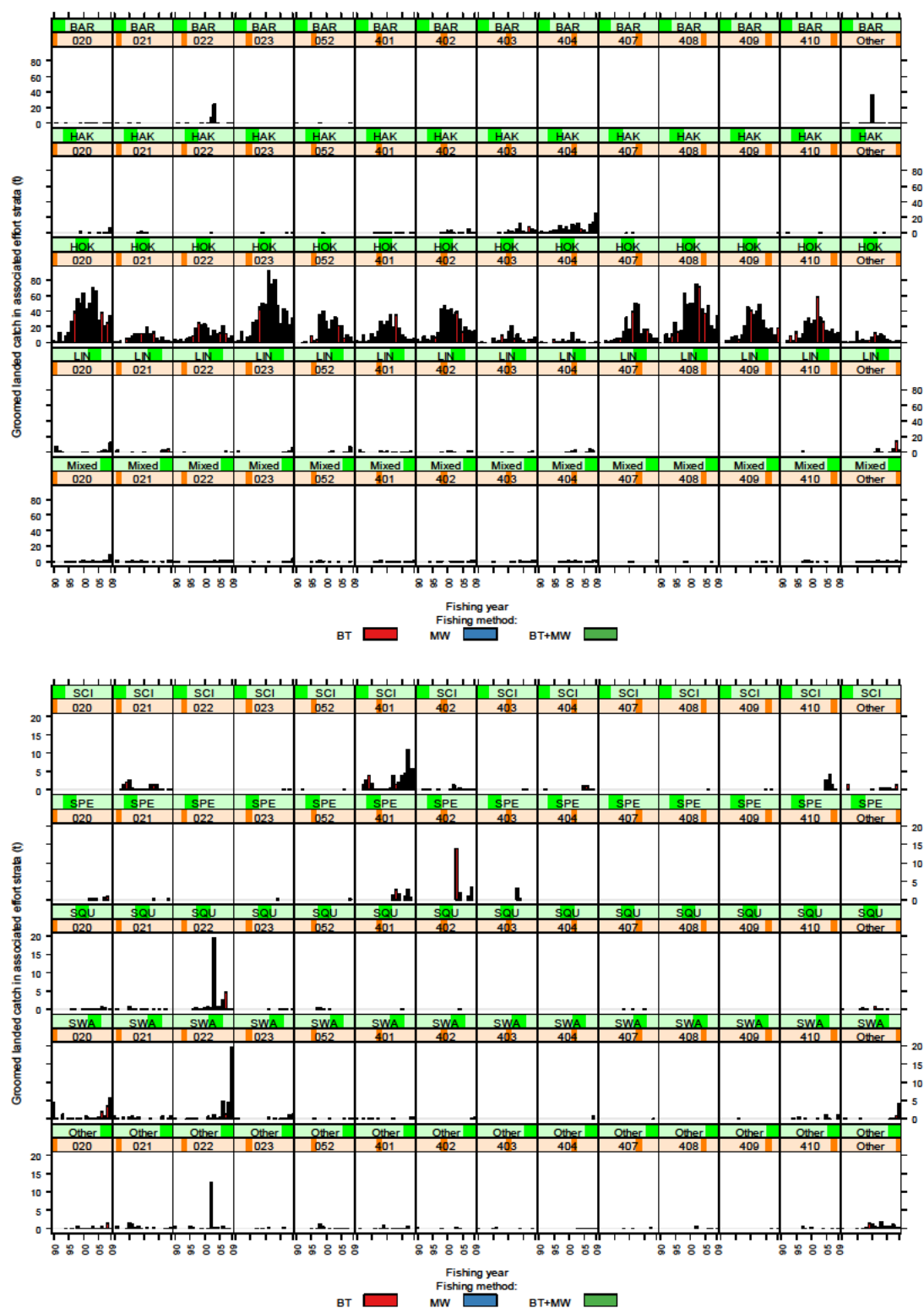
Figure C12b: Distribution of lookdown dory catch in the ECSI/CHAT region in relation to target species and statistical area by fishing method for fishing years 1990–2009 taken by midwater and bottom trawl gear. NB: BT+MW fishing method are days where there was an even split between the number of bottom and midwater tows.
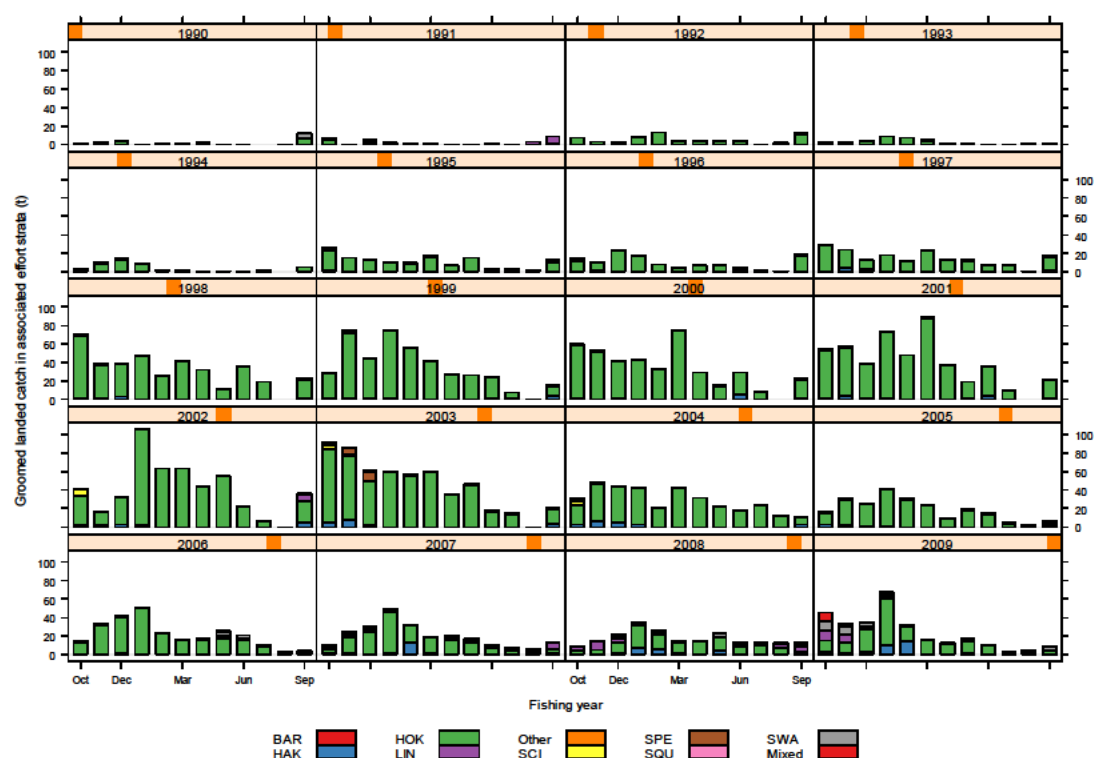
Figure C12c: Distribution of lookdown dory catch in the ECSI/CHAT region in relation to target species and month for fishing years 1990–2009 taken by bottom trawl gear.
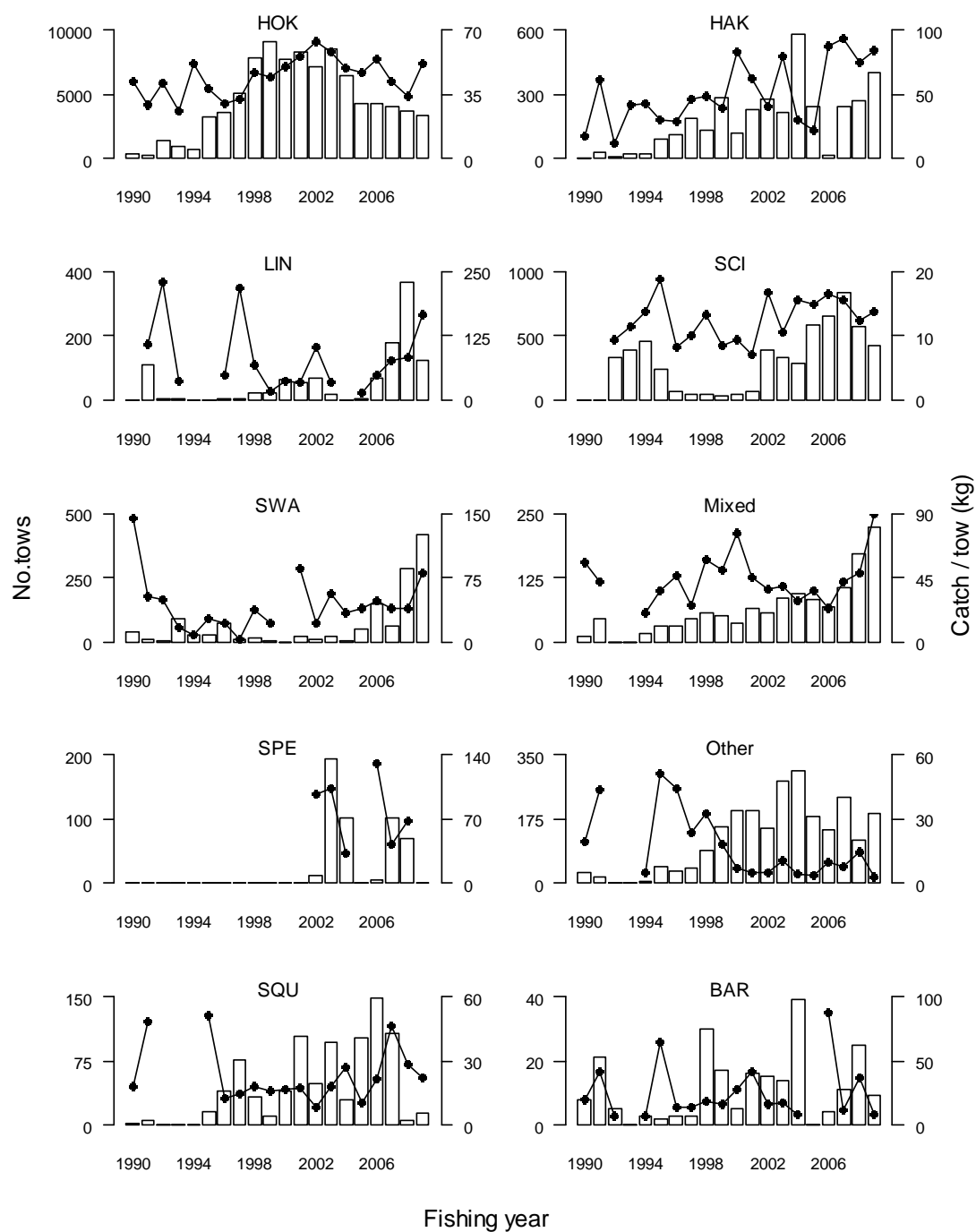
Figure C13: Unstandardised catch rate of LDO for various target species (kg/tow) and the number of tows for the ECSI/CHAT region taken by bottom trawl gear.
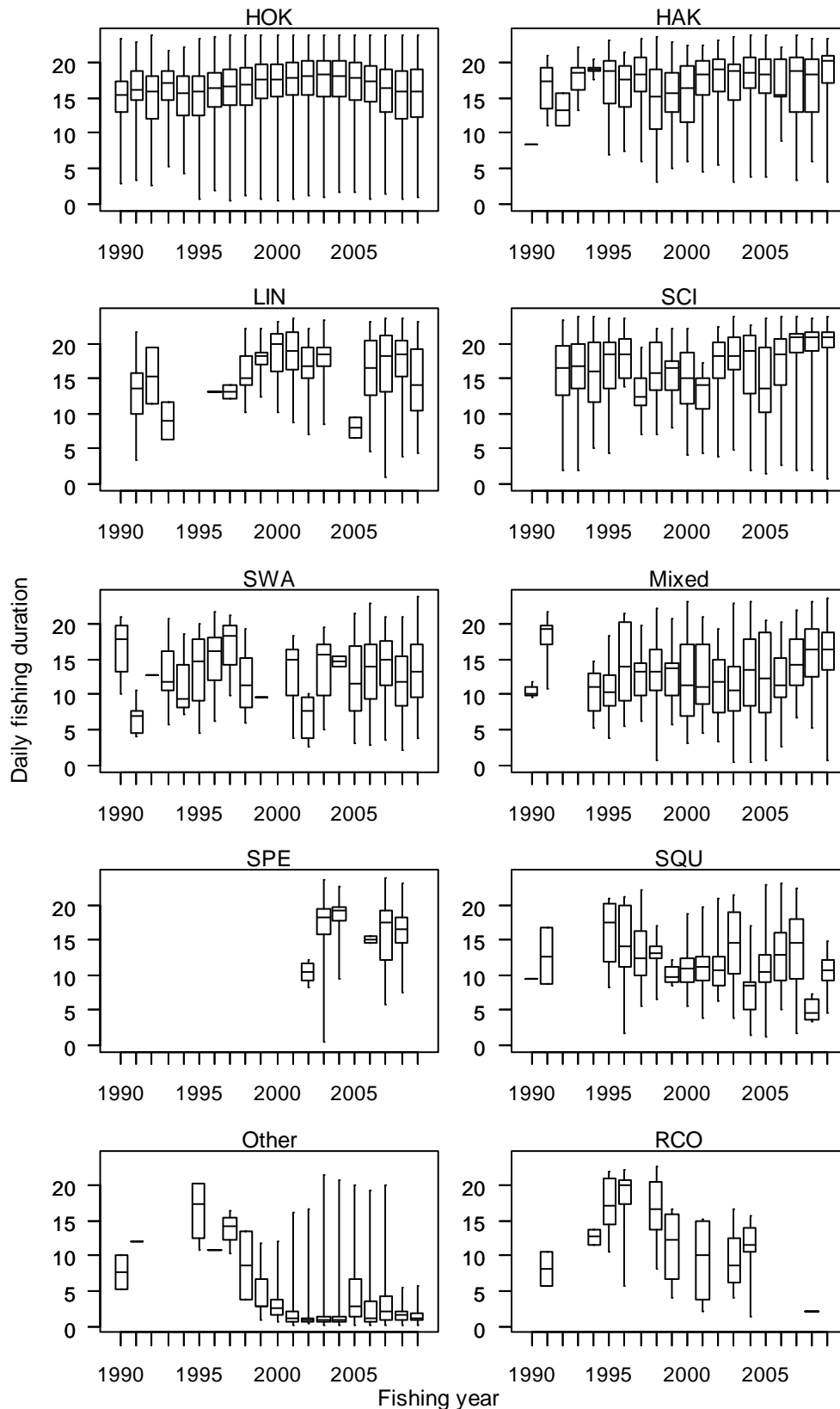
Figure C14: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) for summed daily tow durations (hours) reported for various target species capturing lookdown dory in the ECSI/CHAT region taken by bottom trawl gear.
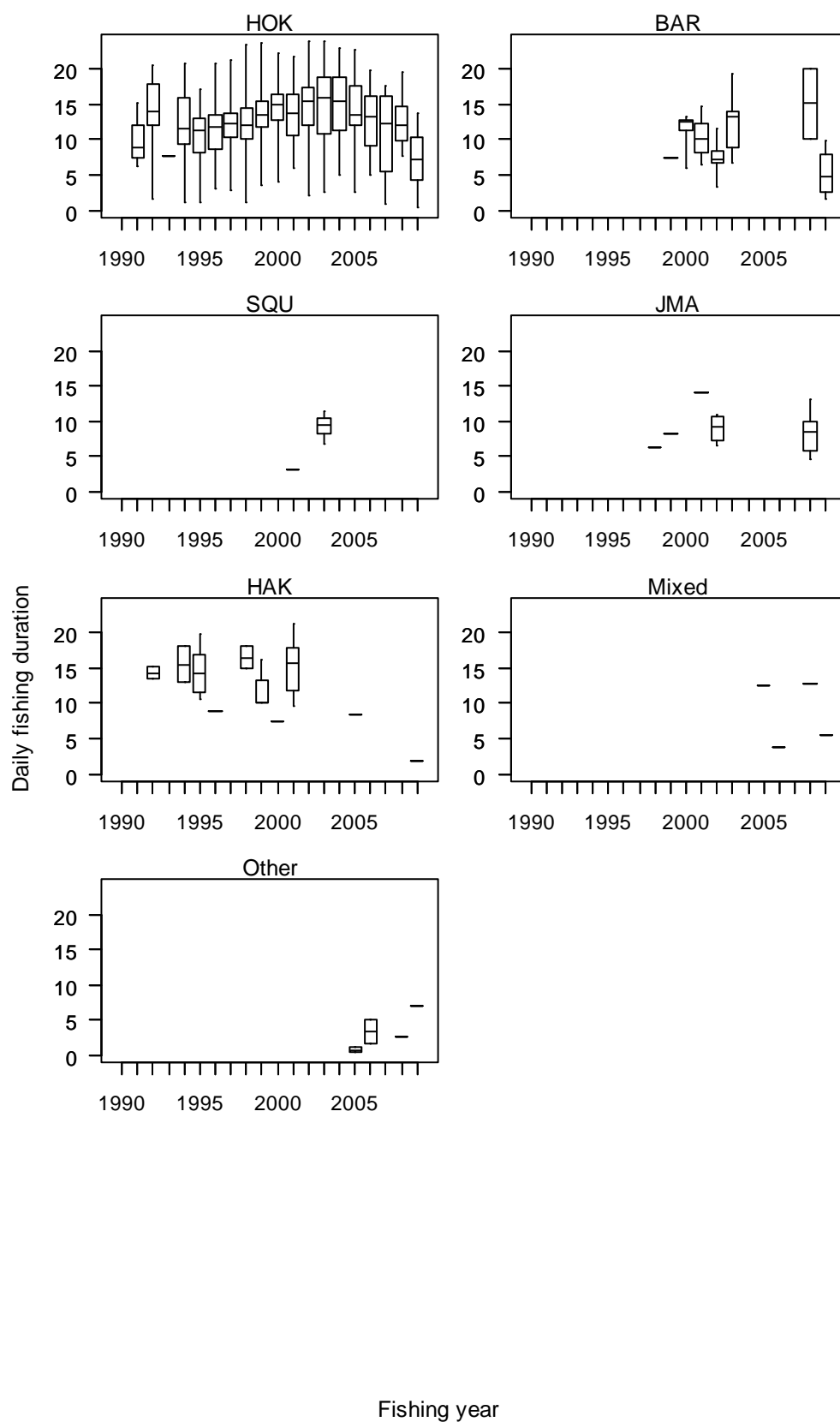
Figure C15: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) for summed daily tow durations (hours) reported for various target species capturing lookdown dory in the ECSI/CHAT region taken by midwater trawl gear.
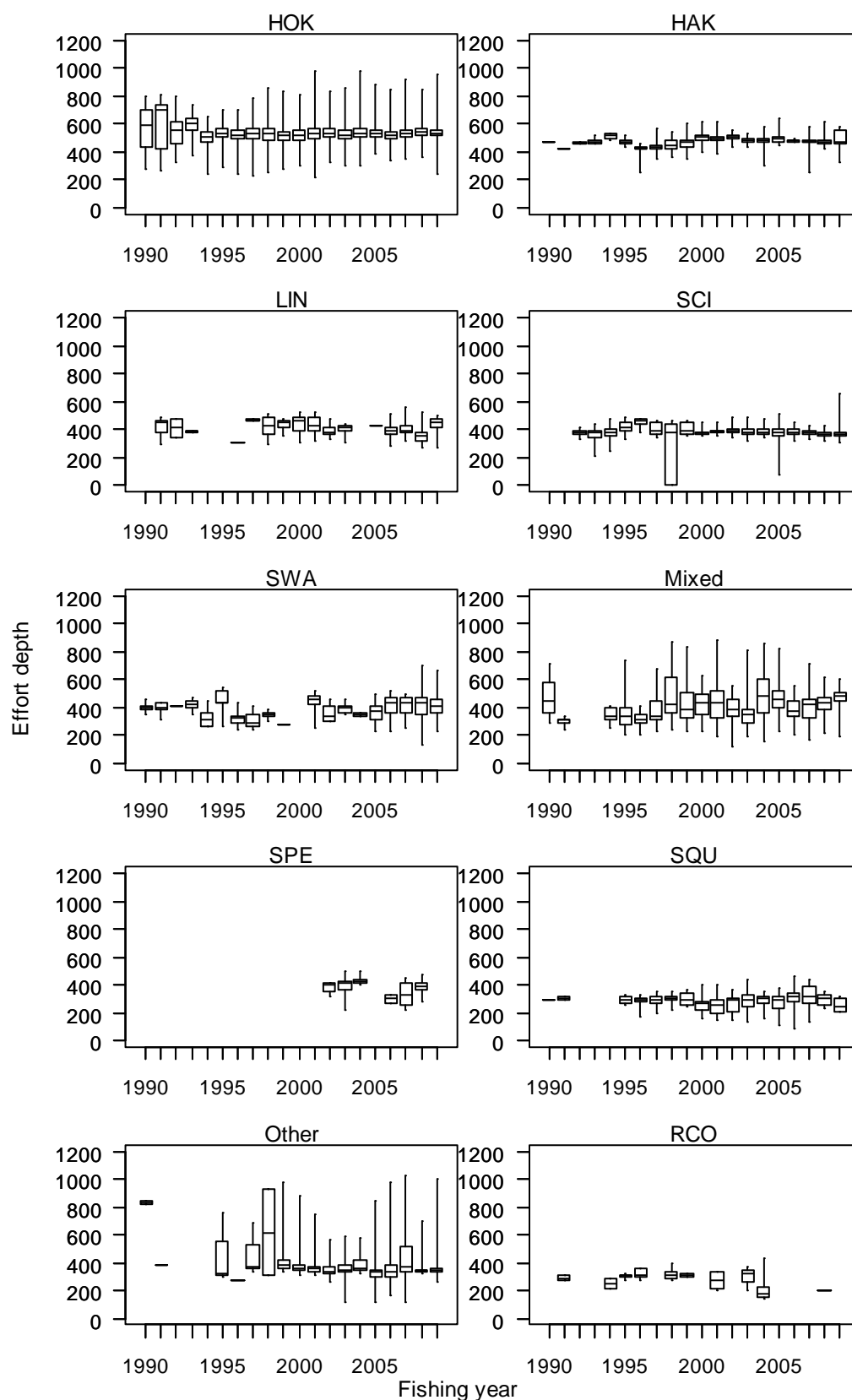
Figure C16: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) for depths (m) fished for various target species capturing lookdown dory in the ECSI/CHAT region for bottom tows.
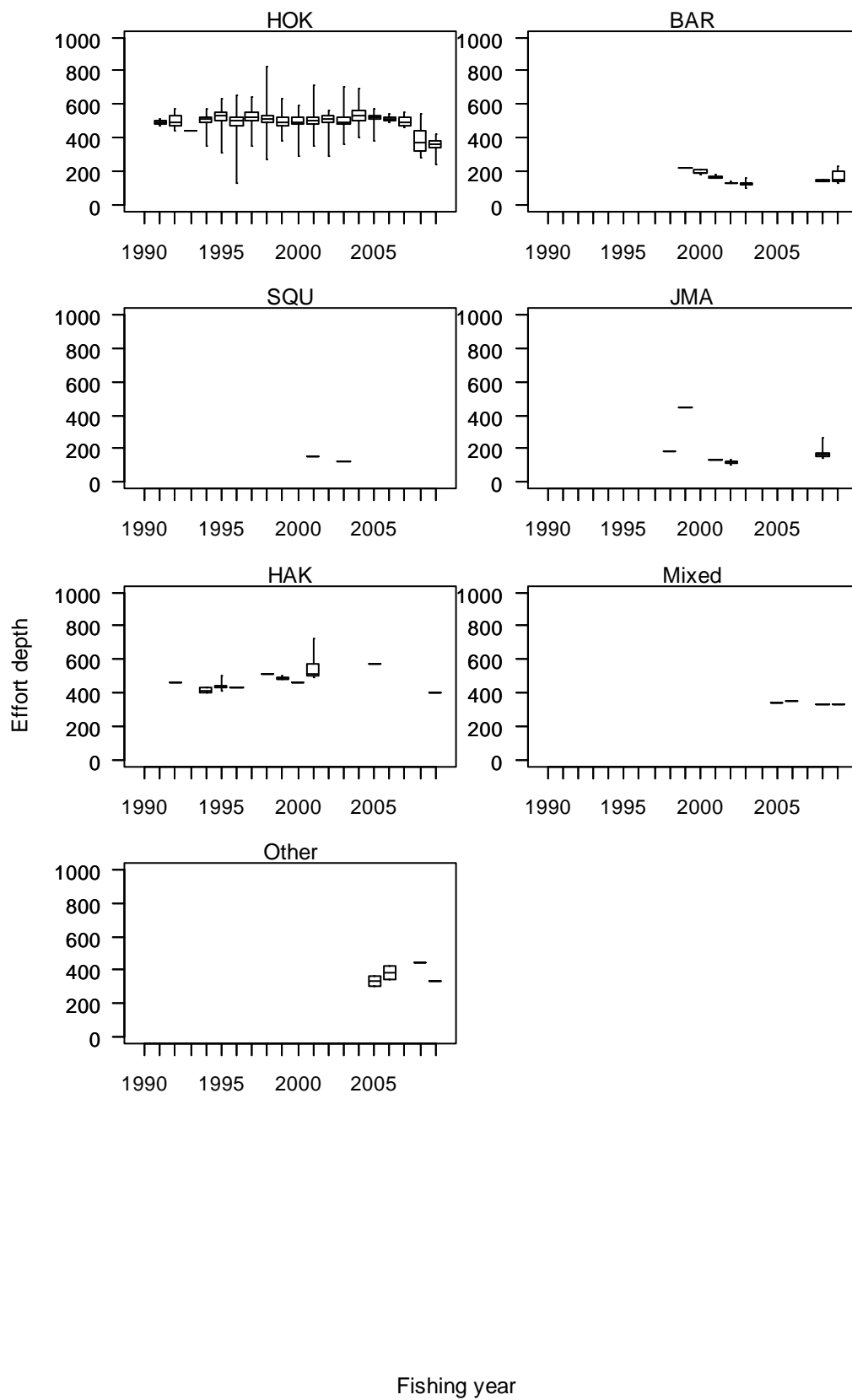
Figure C17: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) for depths (m) fished for various target species capturing lookdown dory in the ECSI/CHAT region for midwater tows.
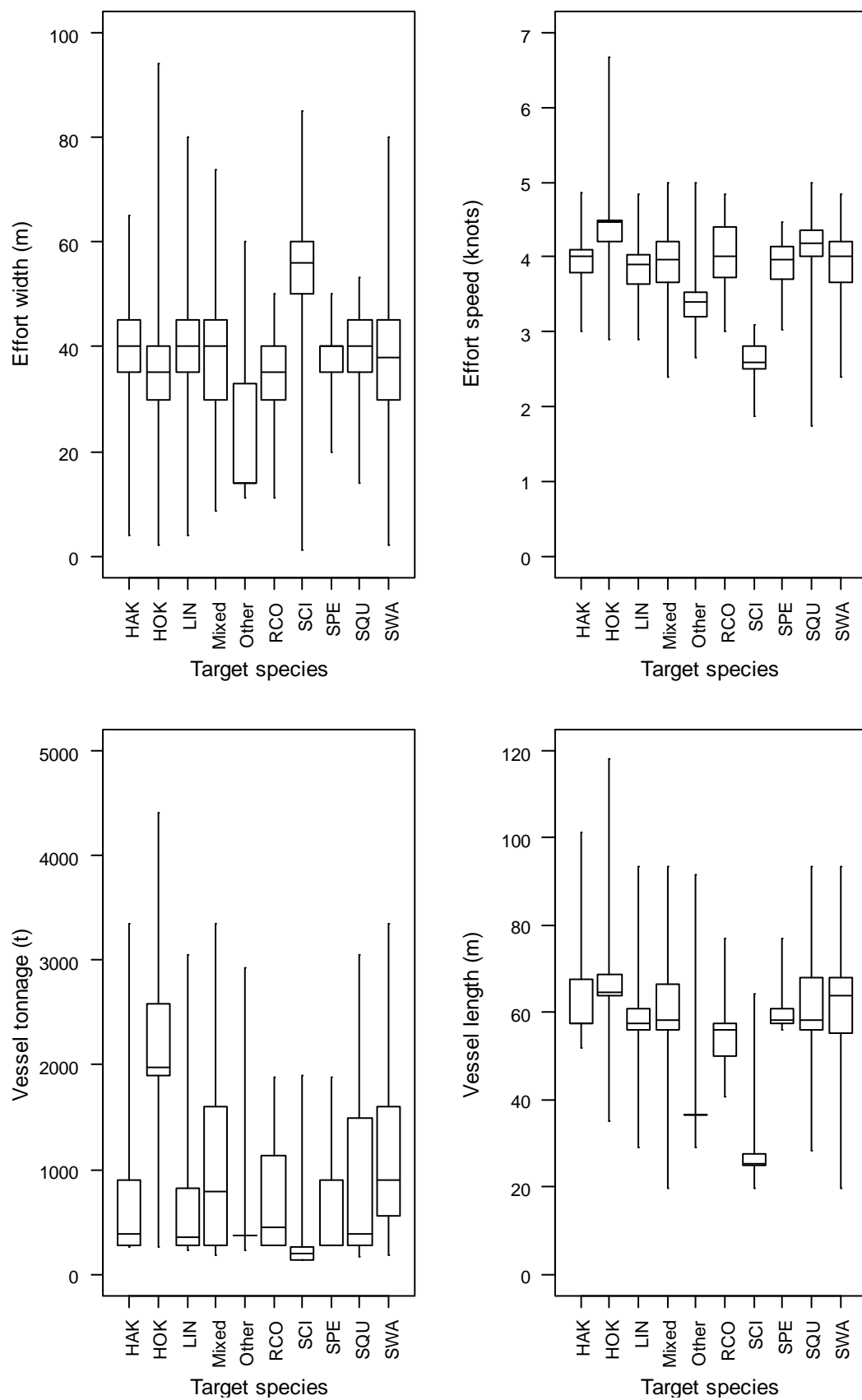
Figure C18: Distribution of fishing effort variables and vessel characteristics for the ECSI/CHAT area for major target species catching lookdown dory taken by bottom trawl gear.
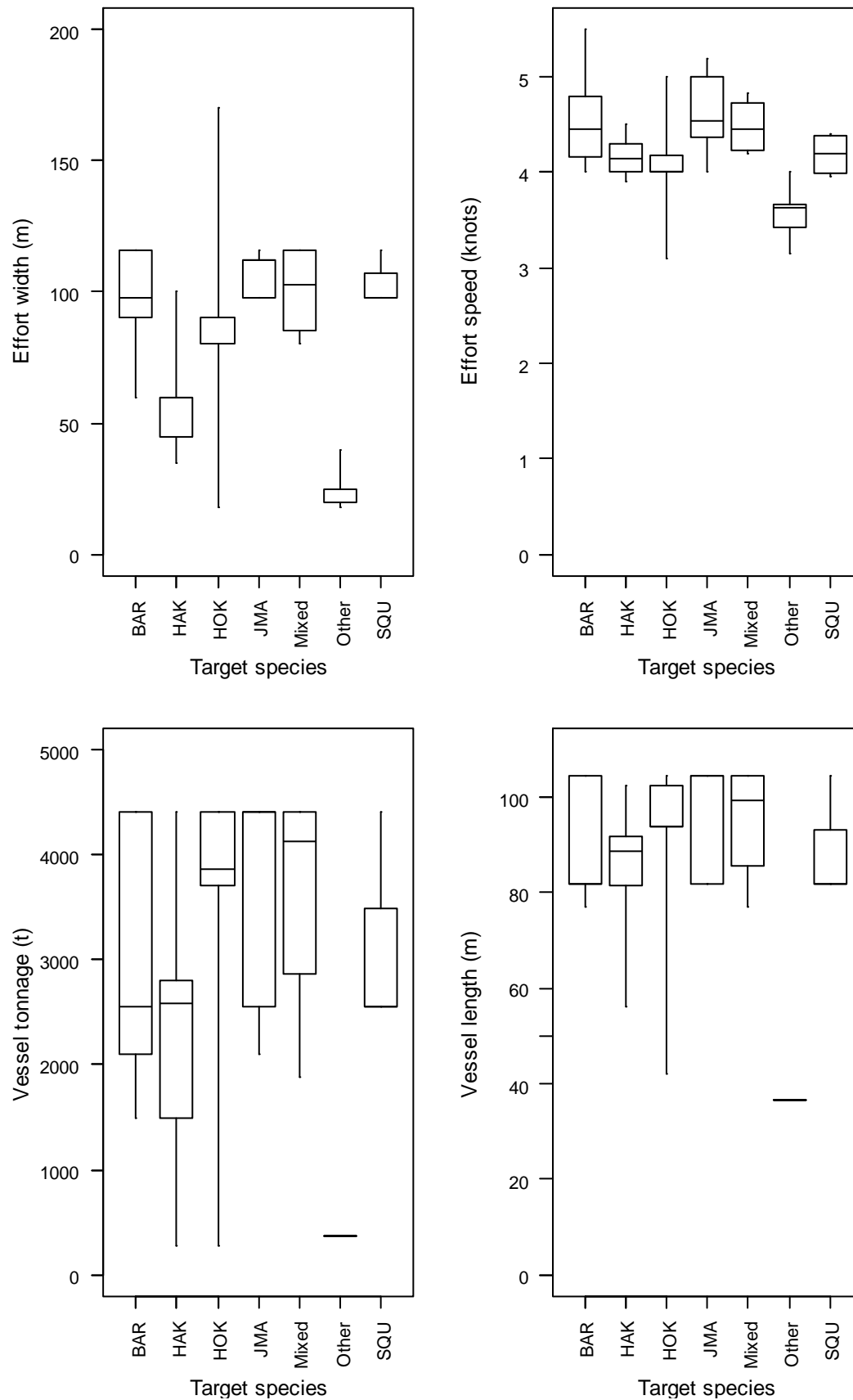
Figure C19: Distribution of fishing effort variables and vessel characteristics for the ECSI/CHAT area for major target species catching lookdown dory taken by midwater trawl gear.
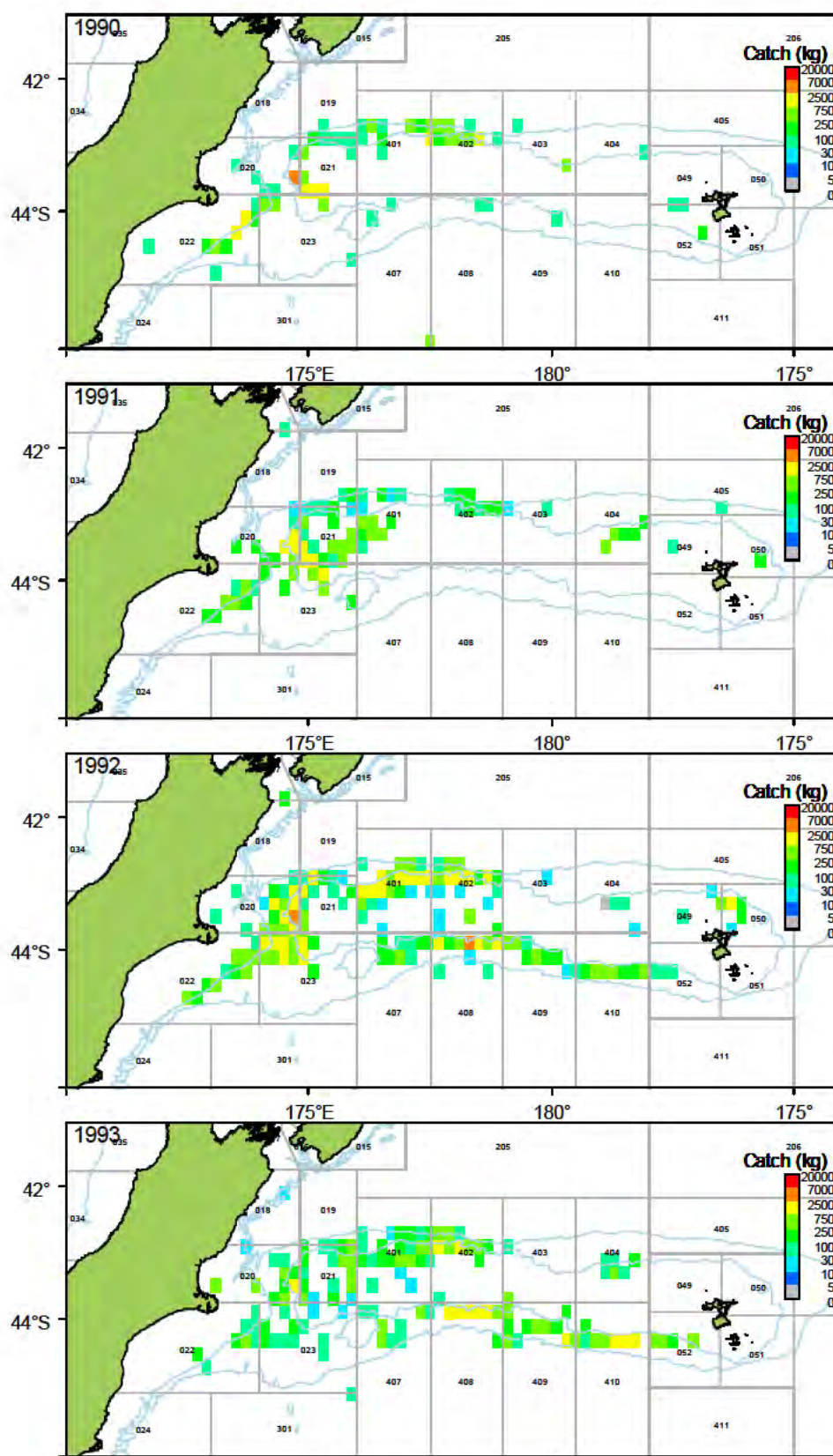
Figure C20: Distribution of lookdown dory catch taken by bottom trawl gear within the ECSI/CHAT region aggregated into 0.2 degree spatial blocks for fishing years 1990–1993 for the TCEPR form.
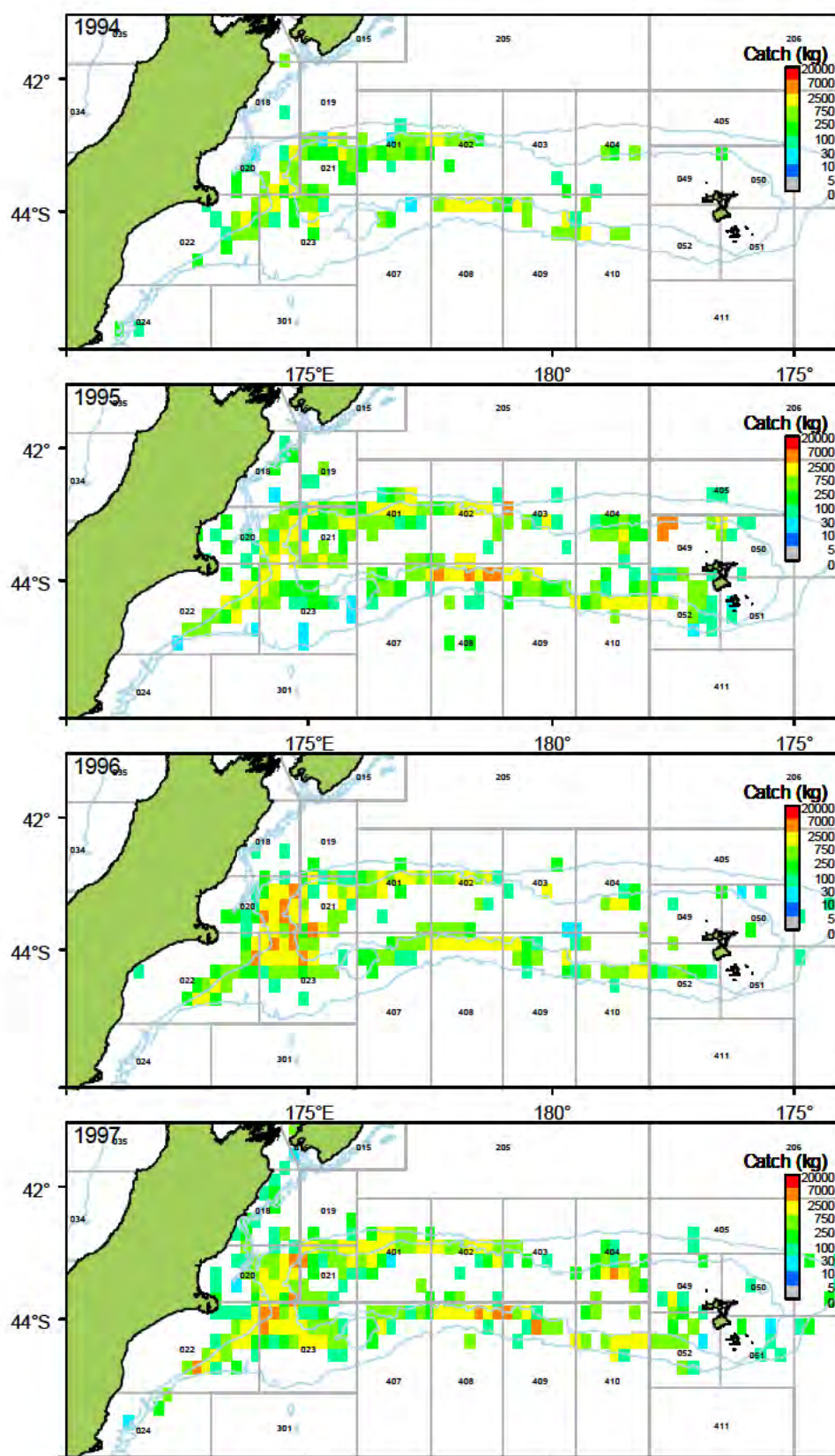
Figure C20 continued: Distribution of lookdown dory catch taken by bottom trawl gear within the ECSI/CHAT region aggregated into 0.2 degree spatial blocks for fishing years 1994–1997 for the TCEPR form.
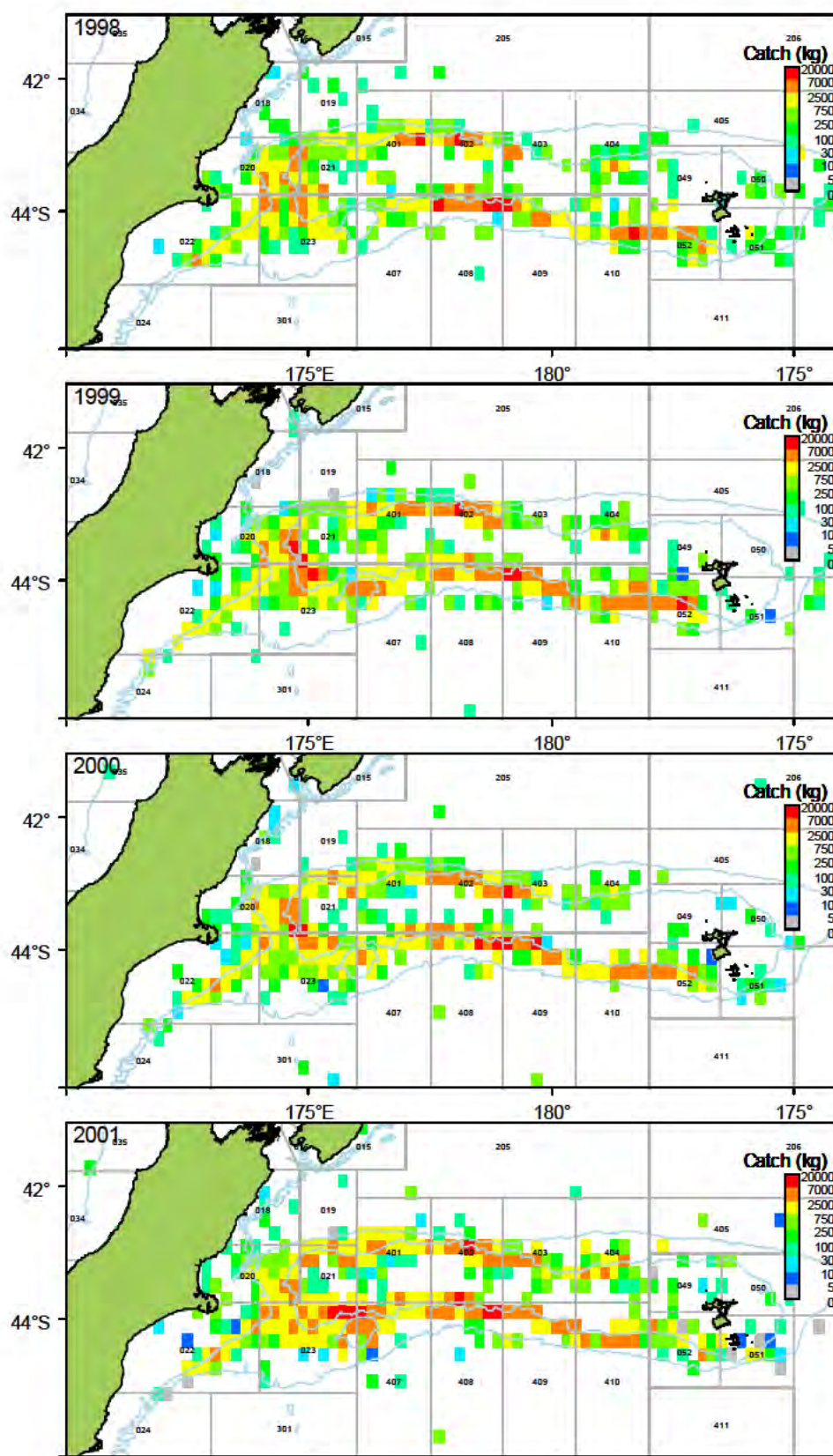
Figure C20 continued: Distribution of lookdown dory catch taken by bottom trawl gear within the ECSI/CHAT region aggregated into 0.2 degree spatial blocks for fishing years 1998–2001 for the TCEPR form.
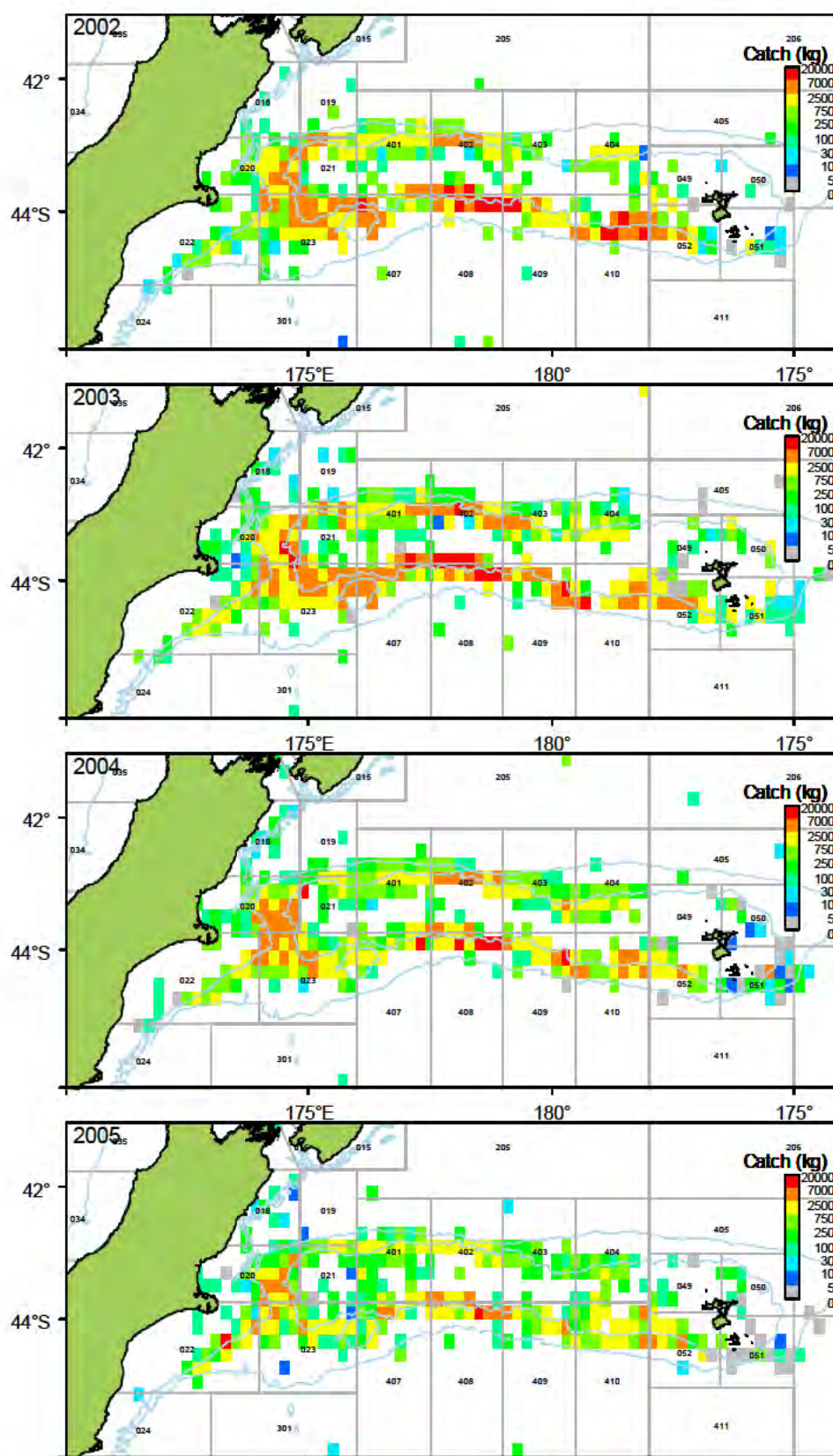
Figure C20 continued: Distribution of lookdown dory catch taken by bottom trawl gear within the ECSI/CHAT region aggregated into 0.2 degree spatial blocks for fishing years 2002–2005 for the TCEPR form.
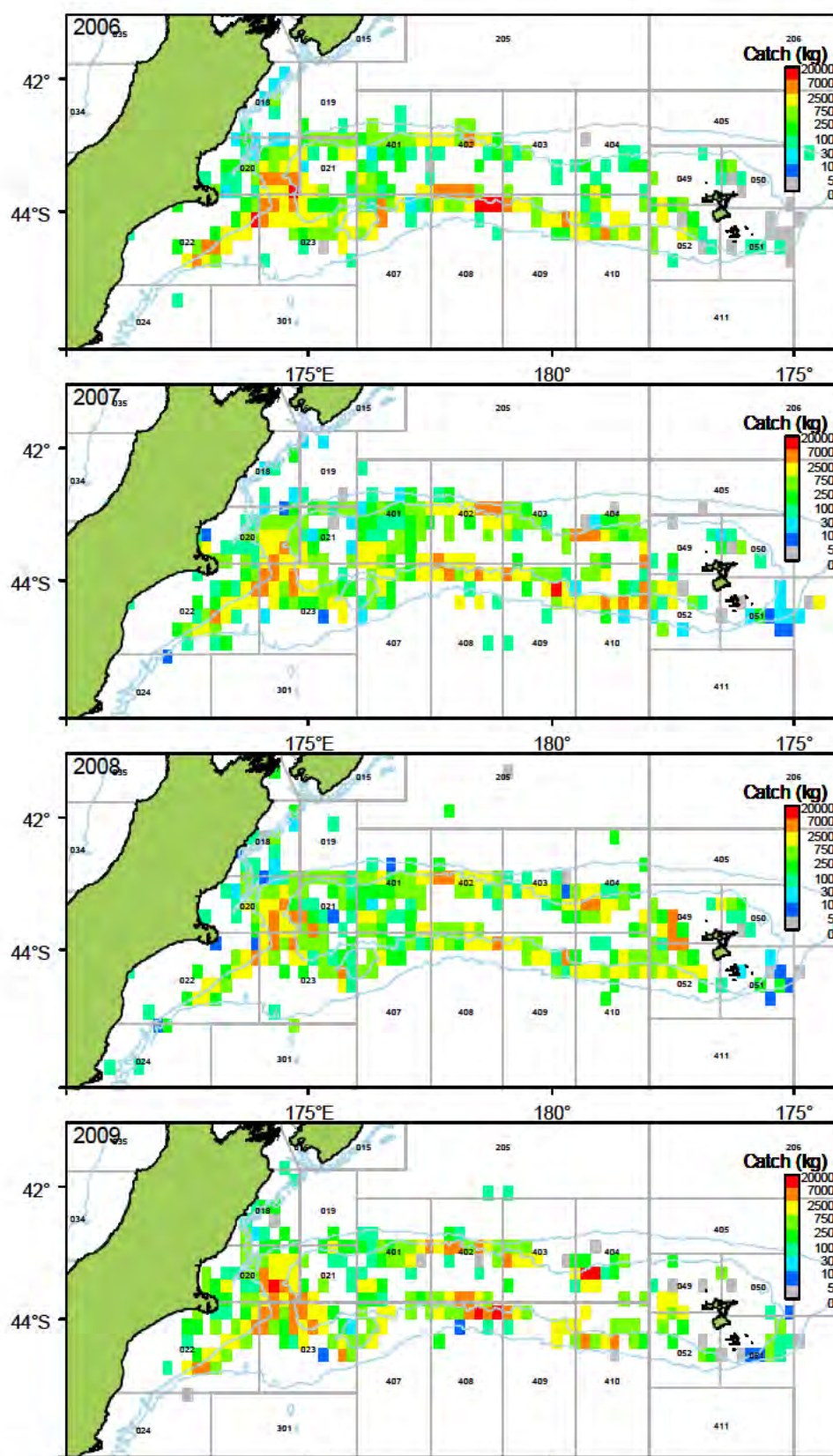
Figure C20 continued: Distribution of lookdown dory catch form taken by bottom trawl gear within the ECSI/CHAT region aggregated into 0.2 degree spatial blocks for fishing years 2006–2009 for the TCEPR.
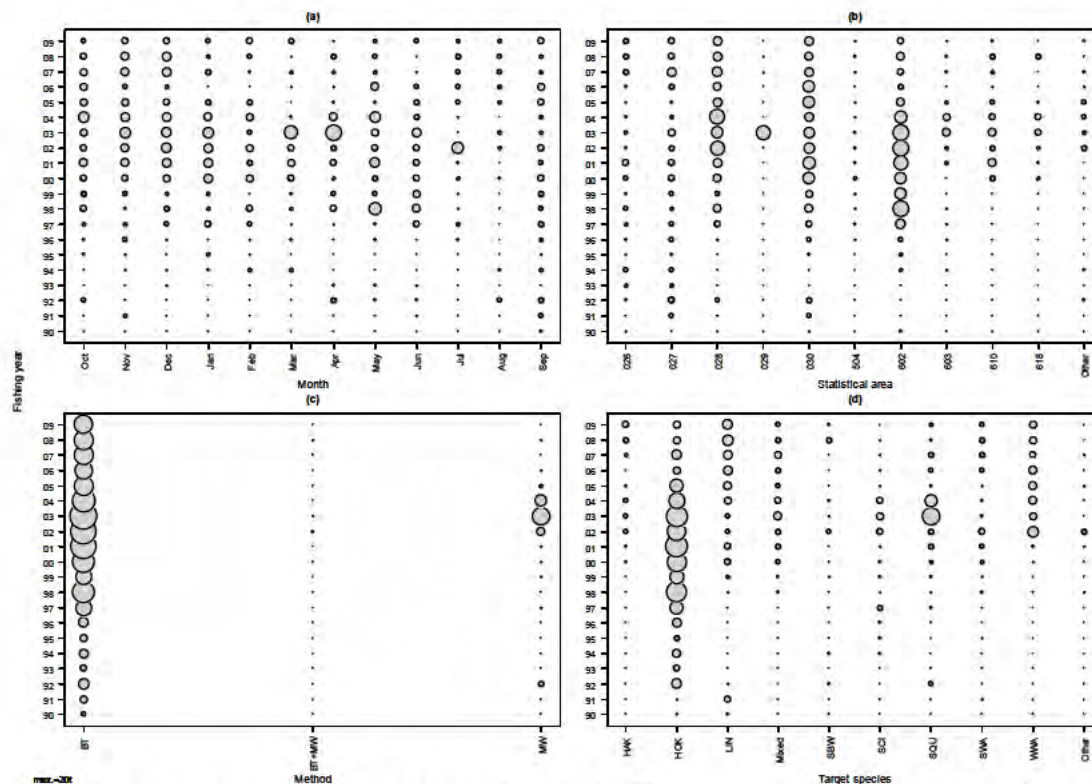
Figure C21: Distribution of LDO catch in the Southland/SUBA region (circle size is proportional to catch for 1990–2009 fishing years in relation to a) month, b) statistical area, c) fishing method, and d) target species. Circle size is proportional to catch; maximum circle size is indicated in lower left hand corner. NB: BT+MW fishing method are days where there was an even split between the number of bottom and midwater tows.
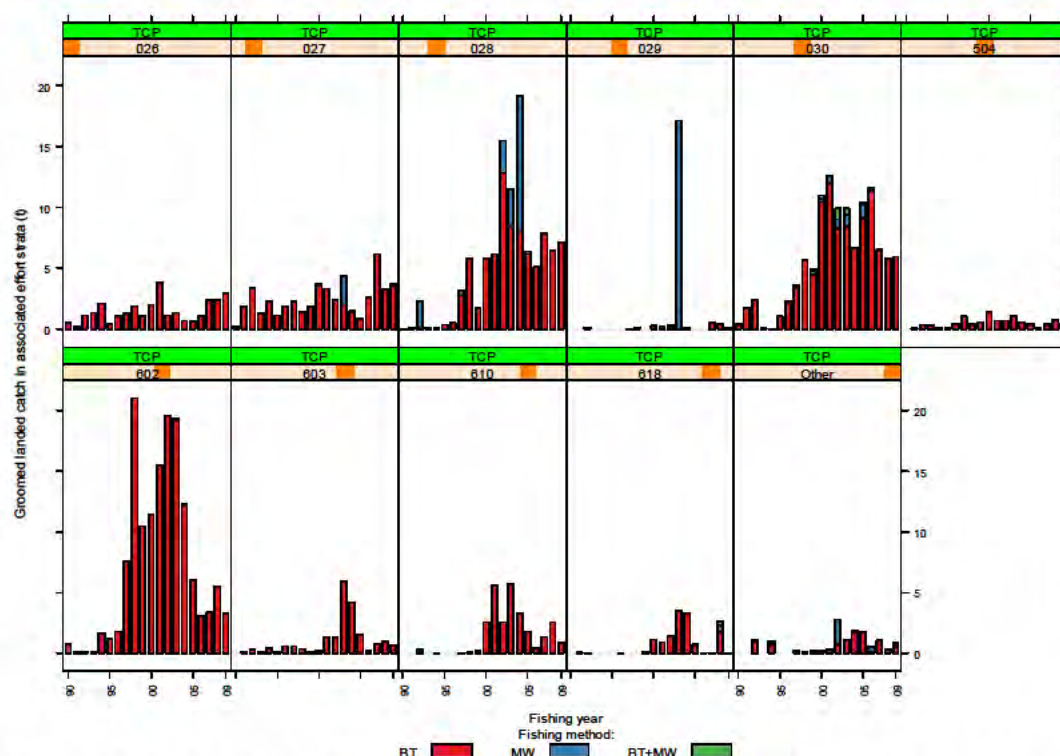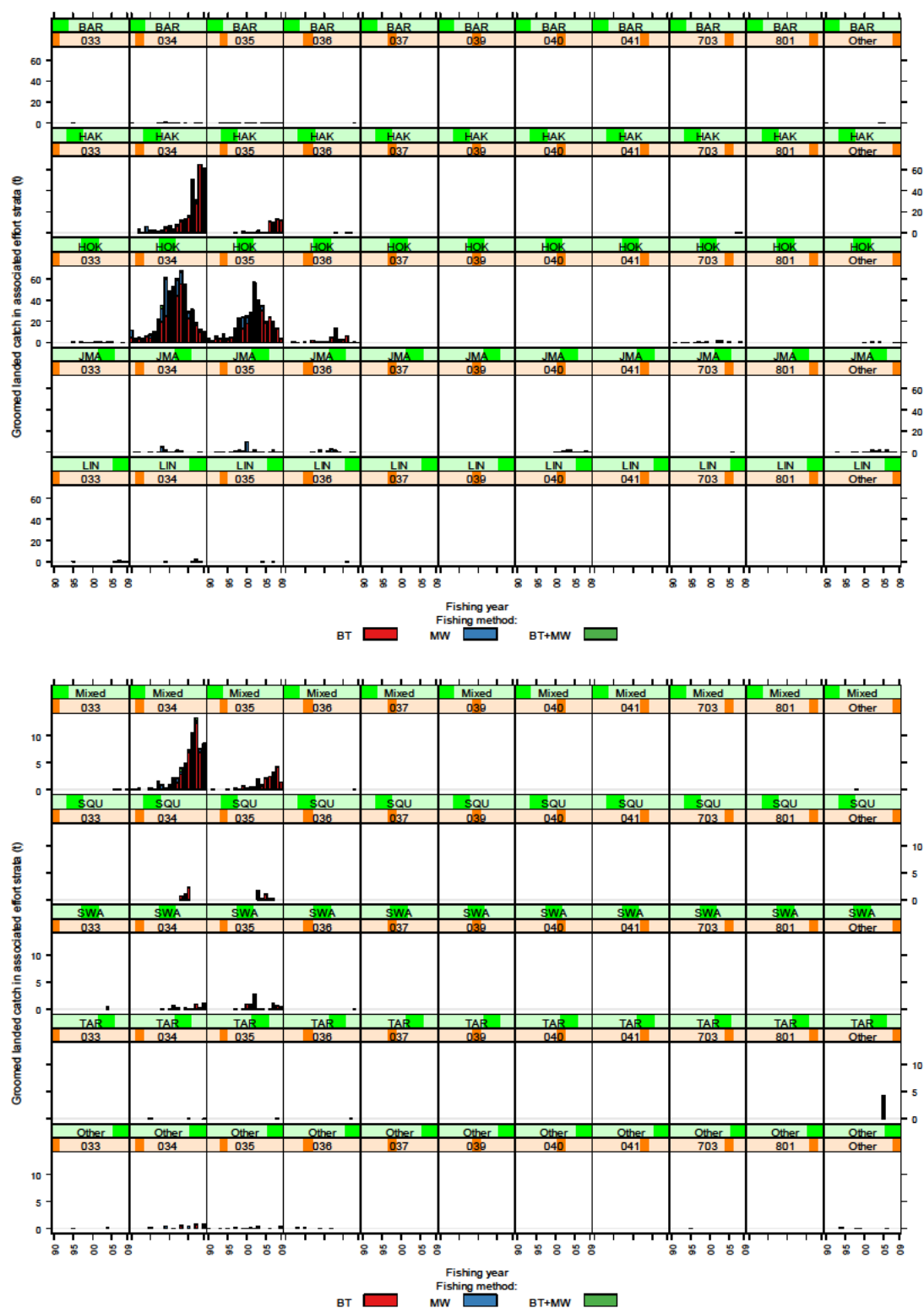

Figure C22a: Distribution of LDO catch in the Southland/SUBA region in relation to form type and statistical area by fishing method for fishing years 1990–2009 taken by midwater and bottom trawl gear. NB: BT+MW fishing method are days where there was an even split between the number of bottom and midwater tows.
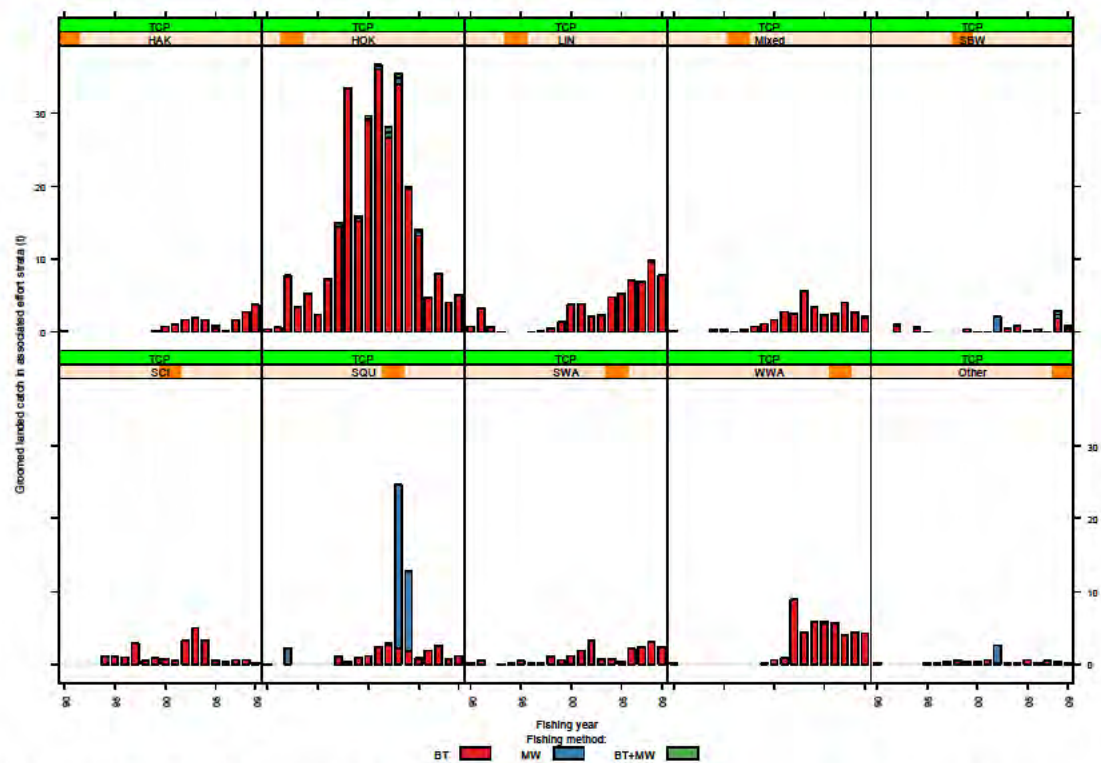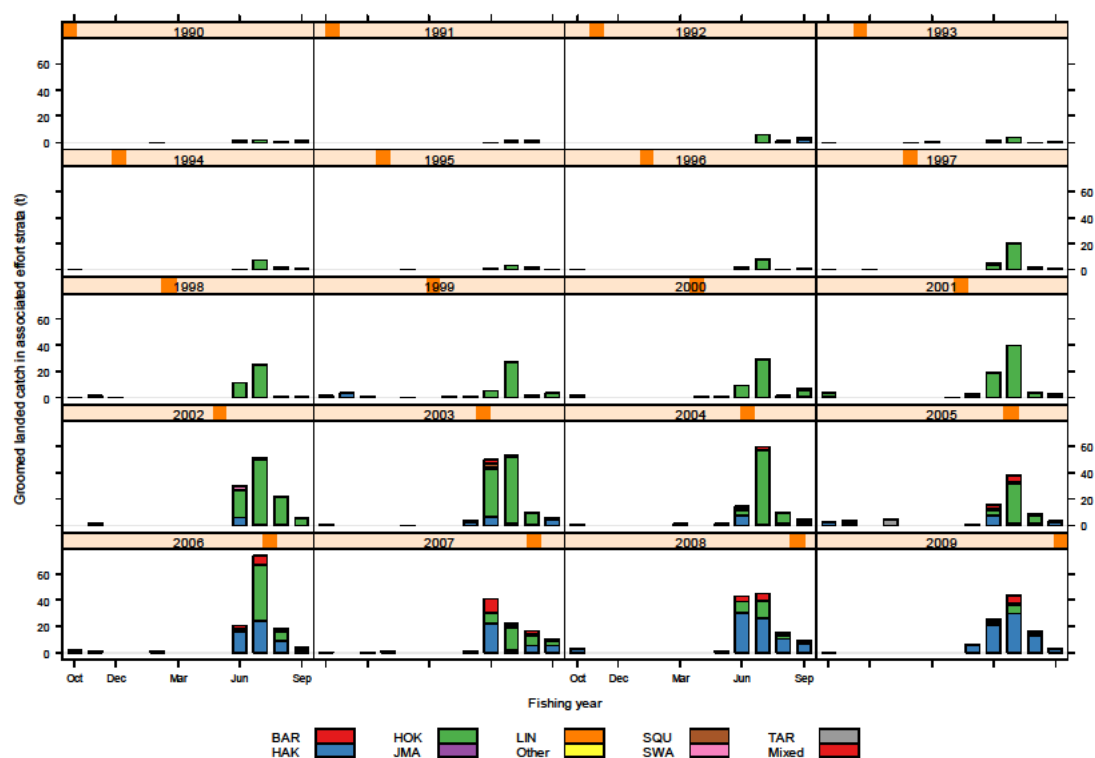
Figure C22b: Distribution of LDO catch in the Southland/SUBA region in relation to form type and target species by fishing method for fishing years 1990–2009 taken by bottom trawl gear. NB: BT+MW fishing method are days where there was an even split between the number of bottom and midwater tows.
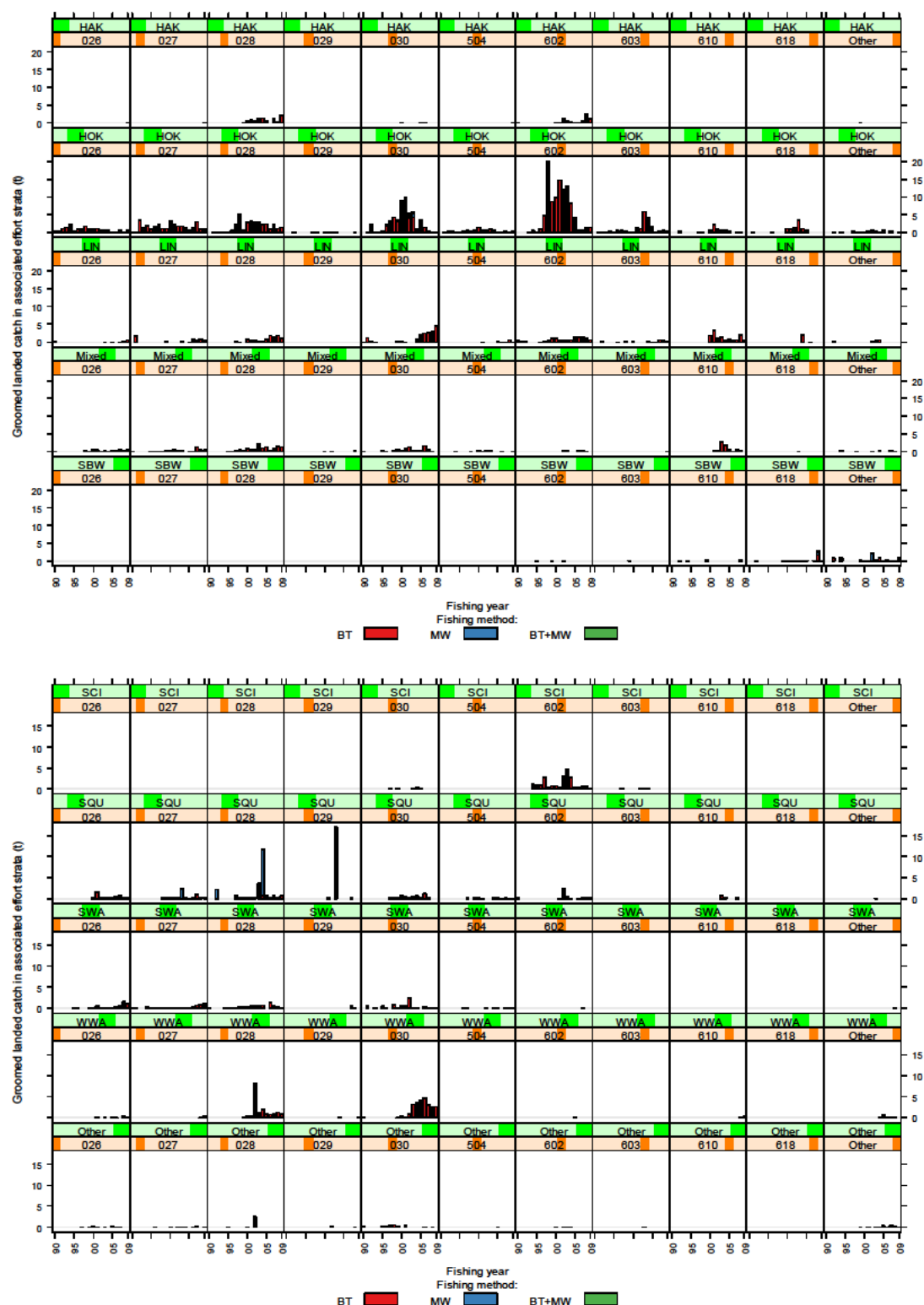
Figure C22c: Distribution of LDO catch in the Southland/SUBA region in relation to target species and statistical area by fishing method for fishing years 1990–2009 taken by midwater and bottom trawl gear. NB: BT+MW fishing method are days where there was an even split between the number of bottom and midwater tows.
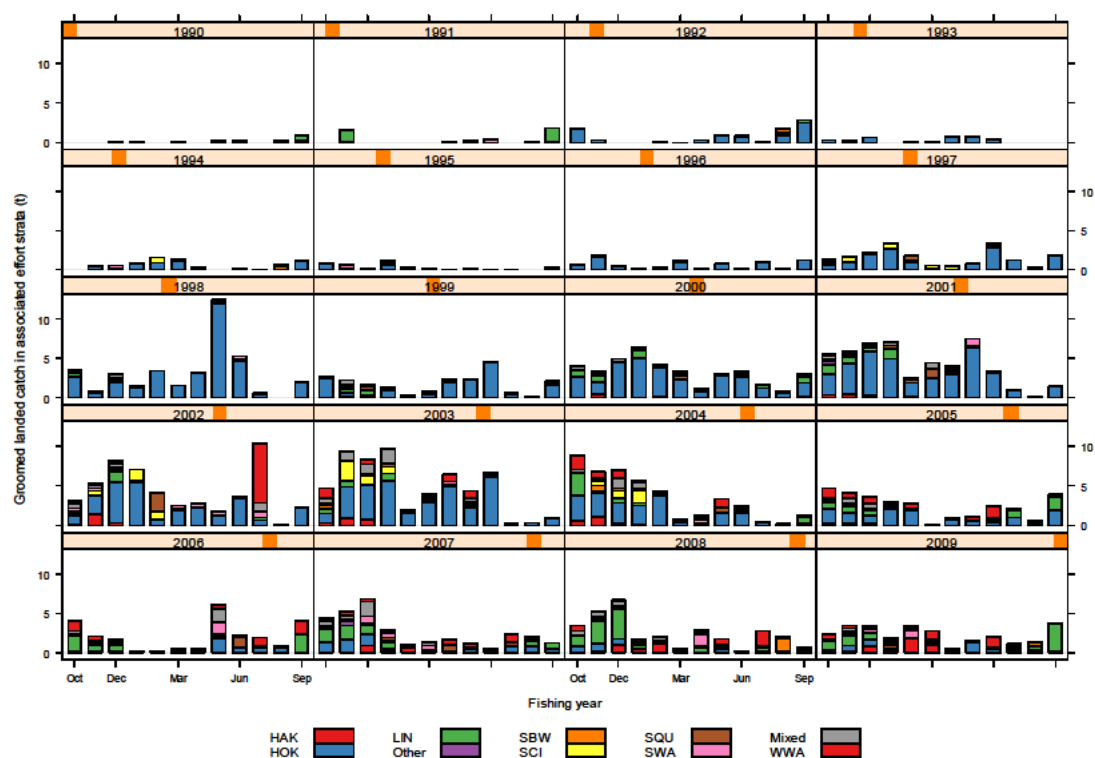
Figure C22d: Distribution of LDO catch in the Southland/SUBA region in relation to target species by month for fishing years 1990–2009 taken by bottom trawl gear.
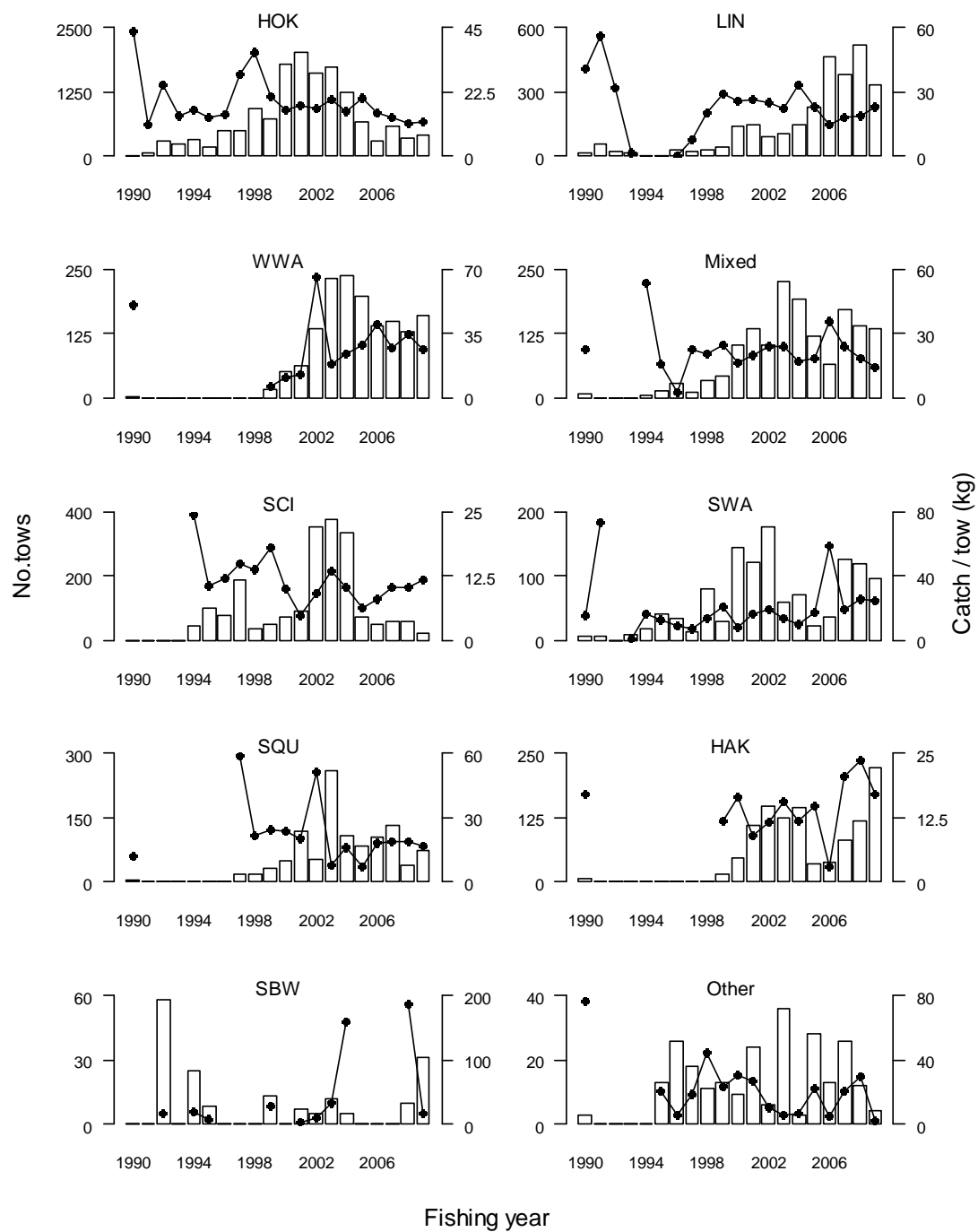
Figure C23: Unstandardised catch rates of LDO for various target species tows in kg (catch/tow) and the number of tows for the Southland/SUBA region taken by bottom trawl gear.
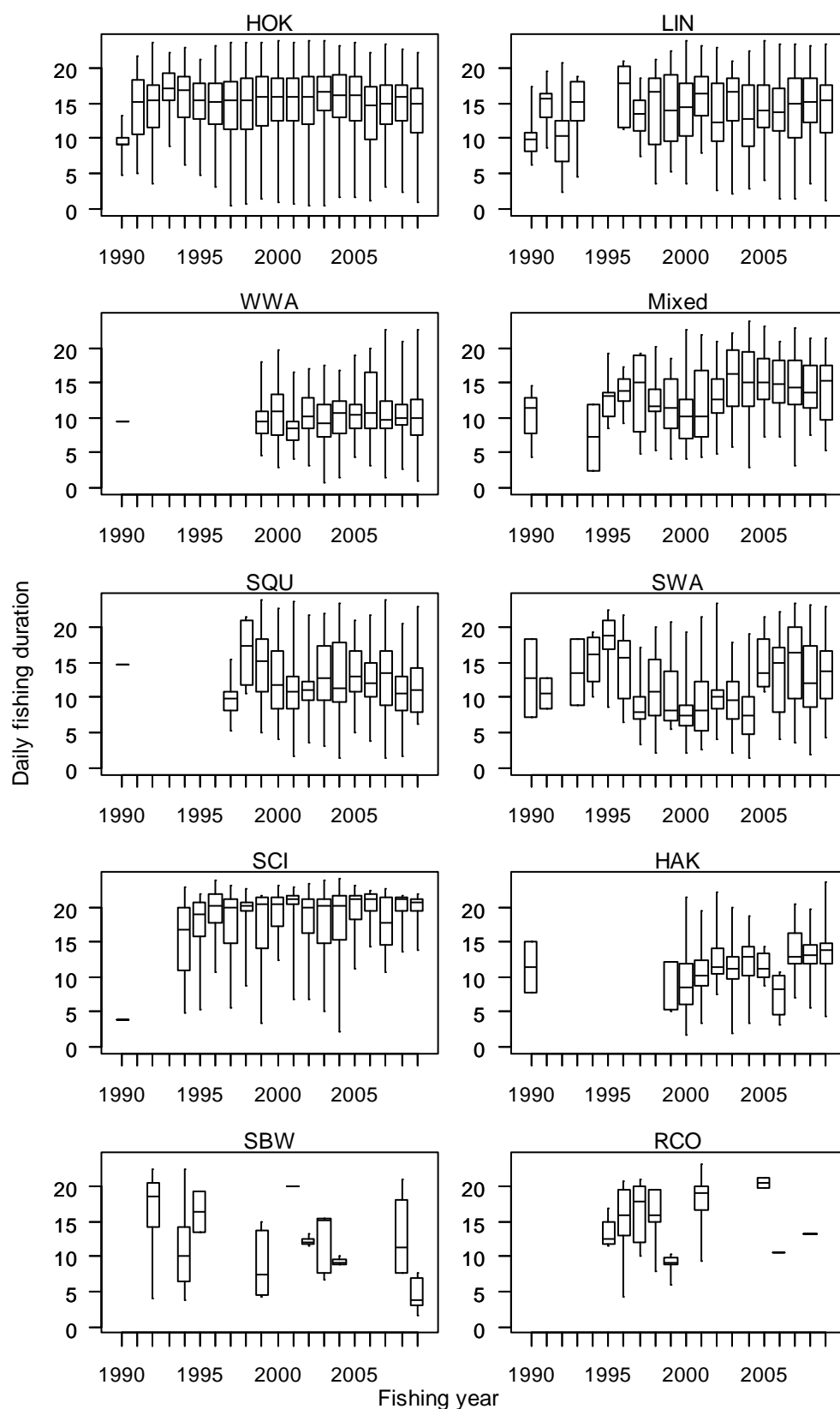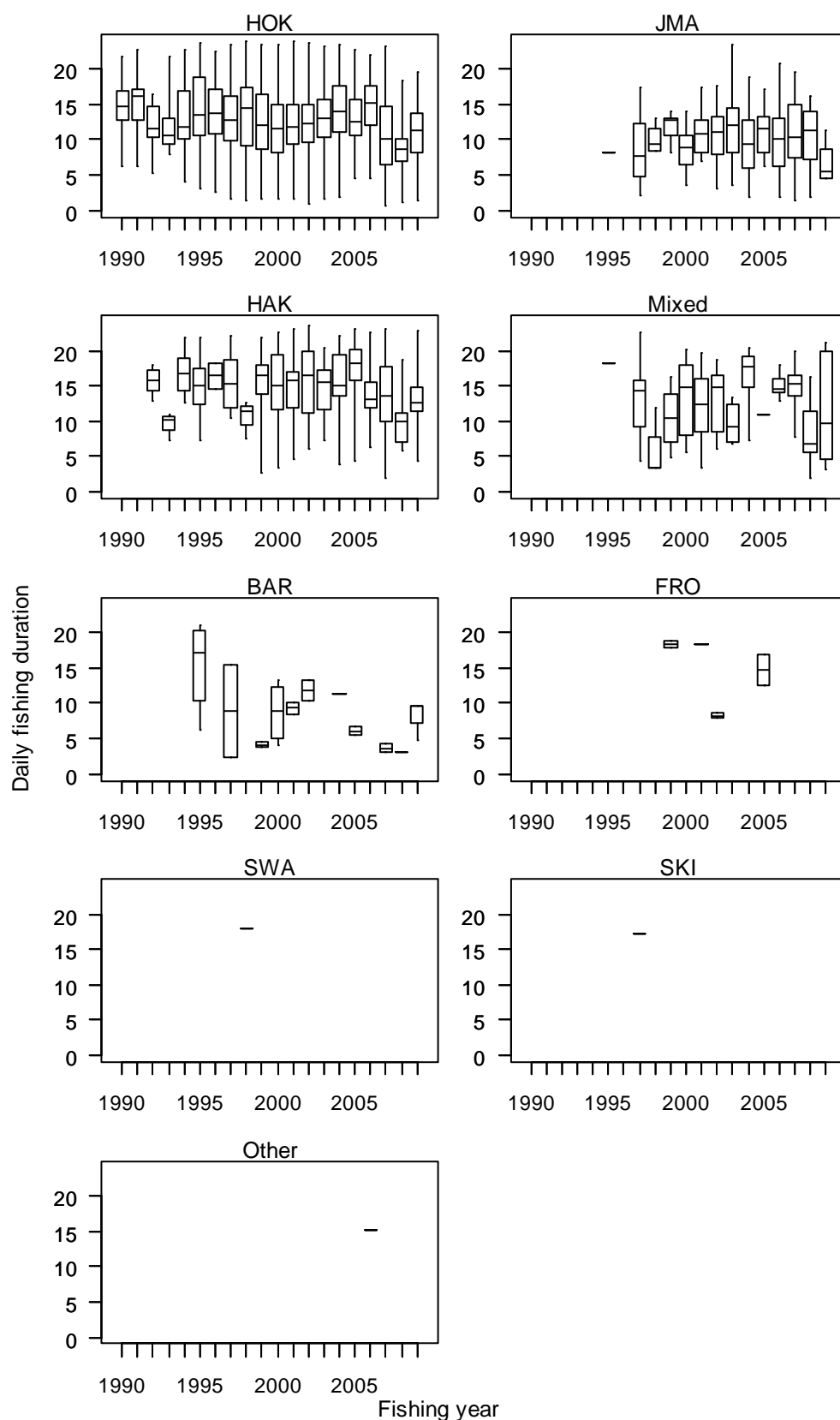
Figure C24: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) for daily tow durations reported for various target species capturing LDO in the Southland/SUBA region taken by bottom trawl gear.
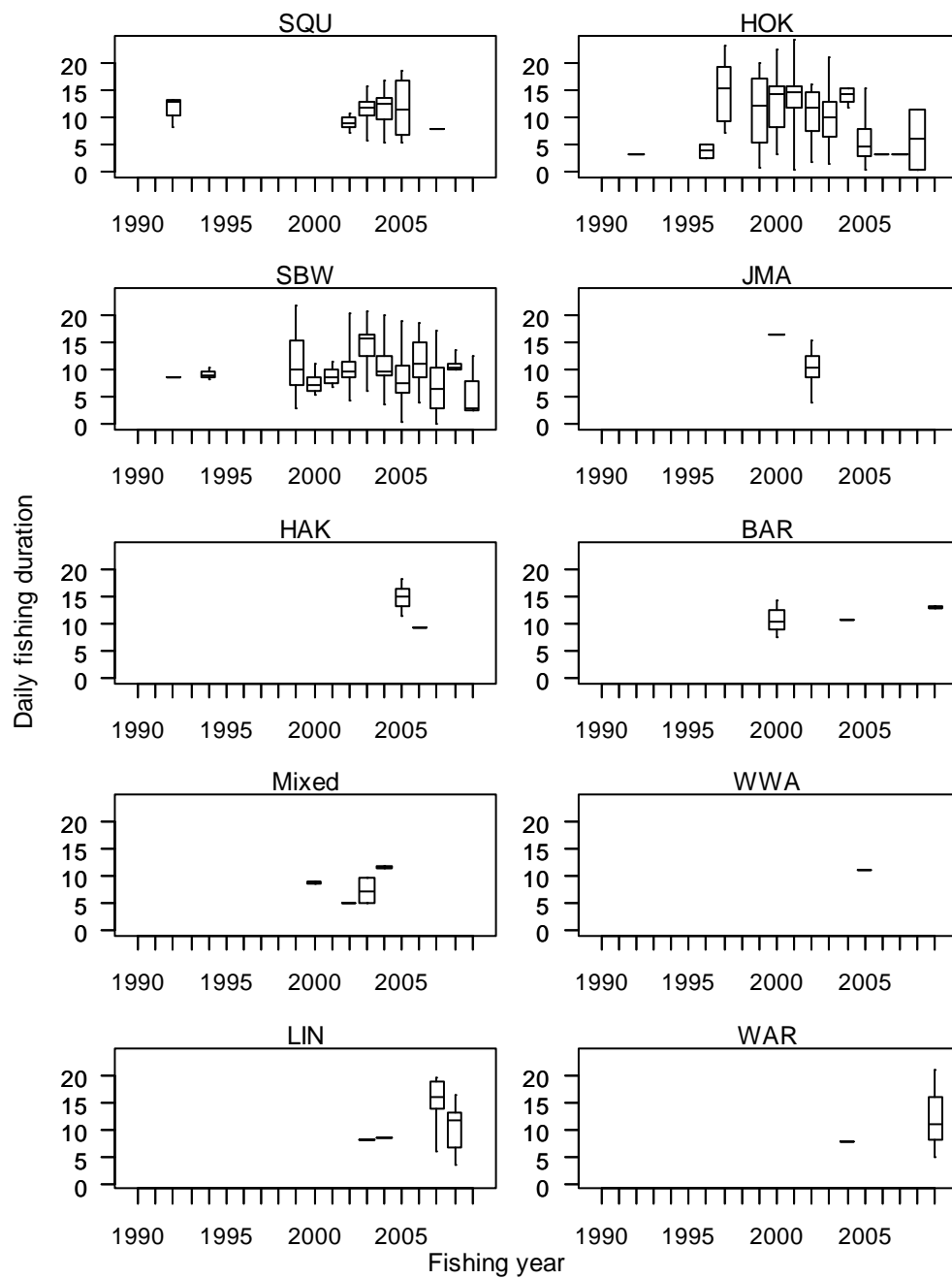
Figure C25: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) for daily tow durations reported for various target species capturing LDO in the Southland/SUBA region taken by midwater trawl gear.
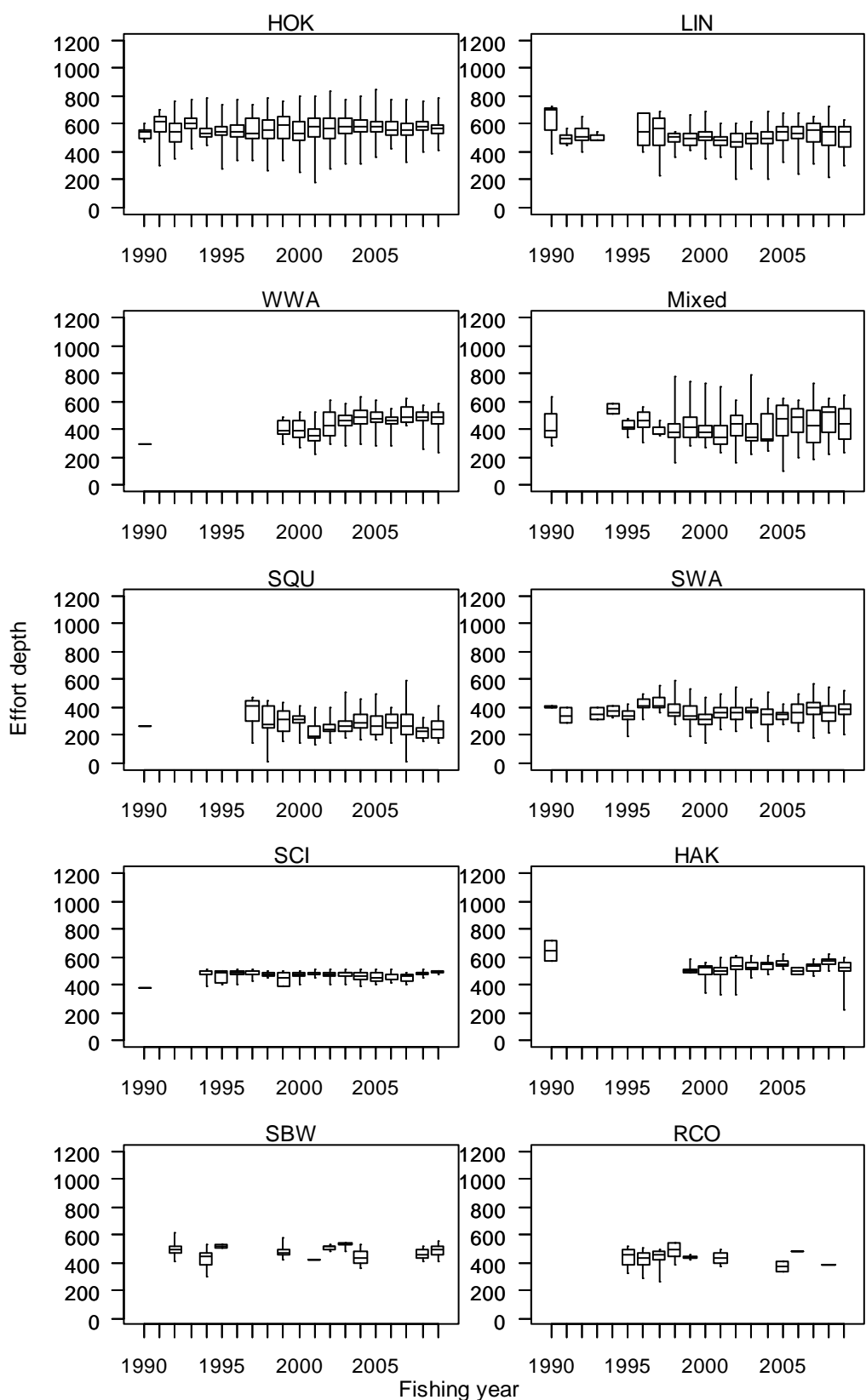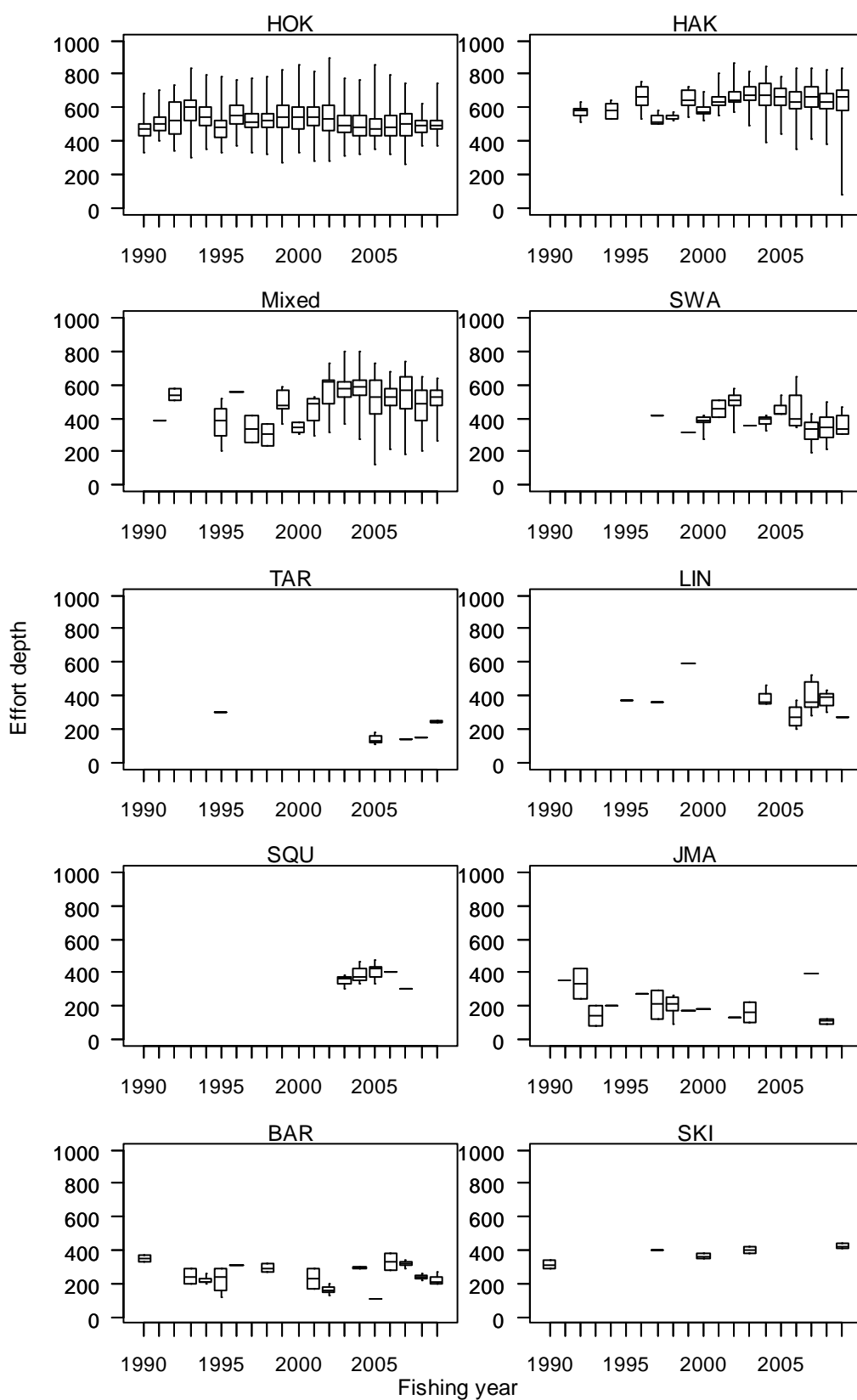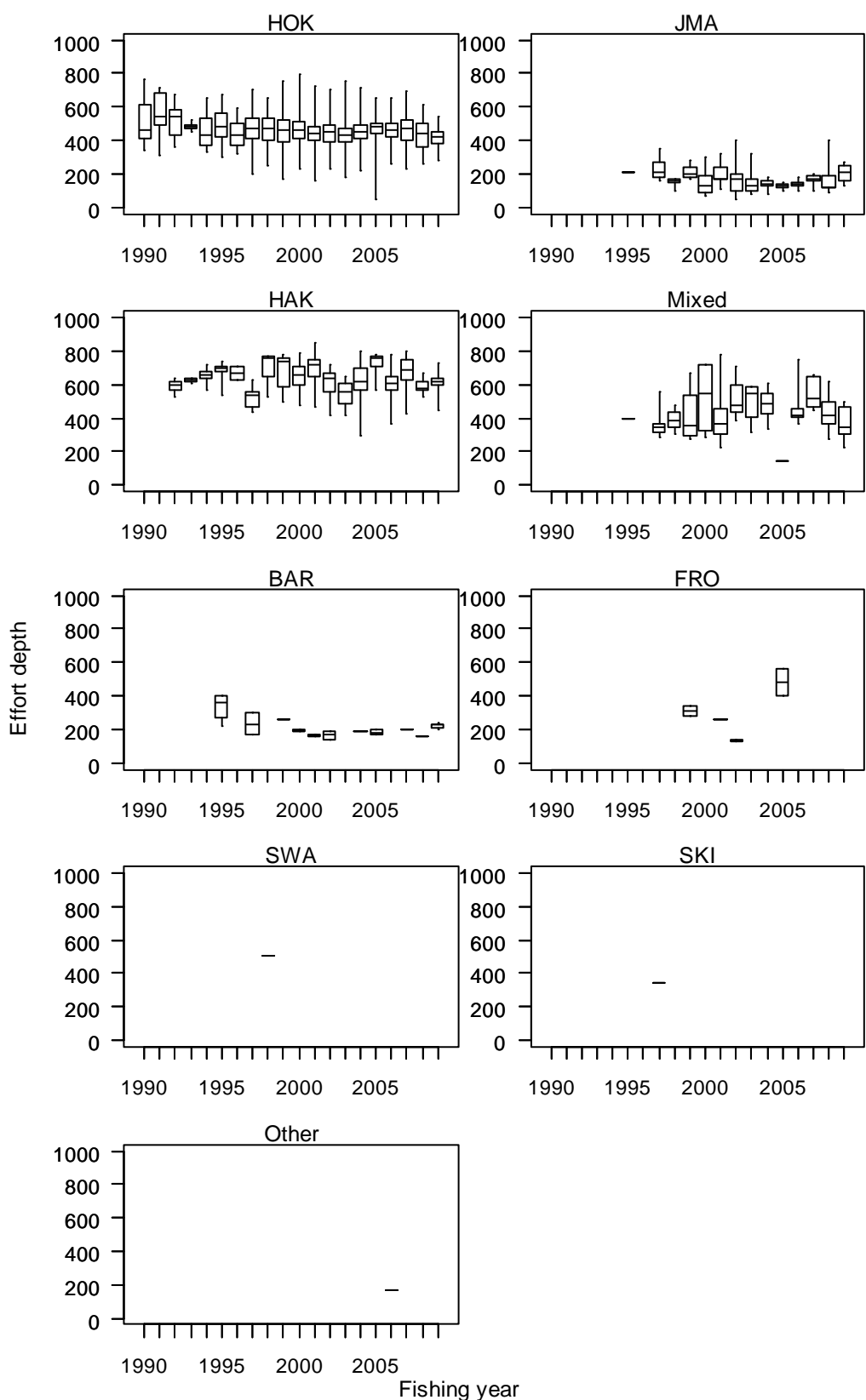
Figure C26: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) for depths (m) fished for various target species capturing LDO in the Southland/SUBA region for bottom tows.
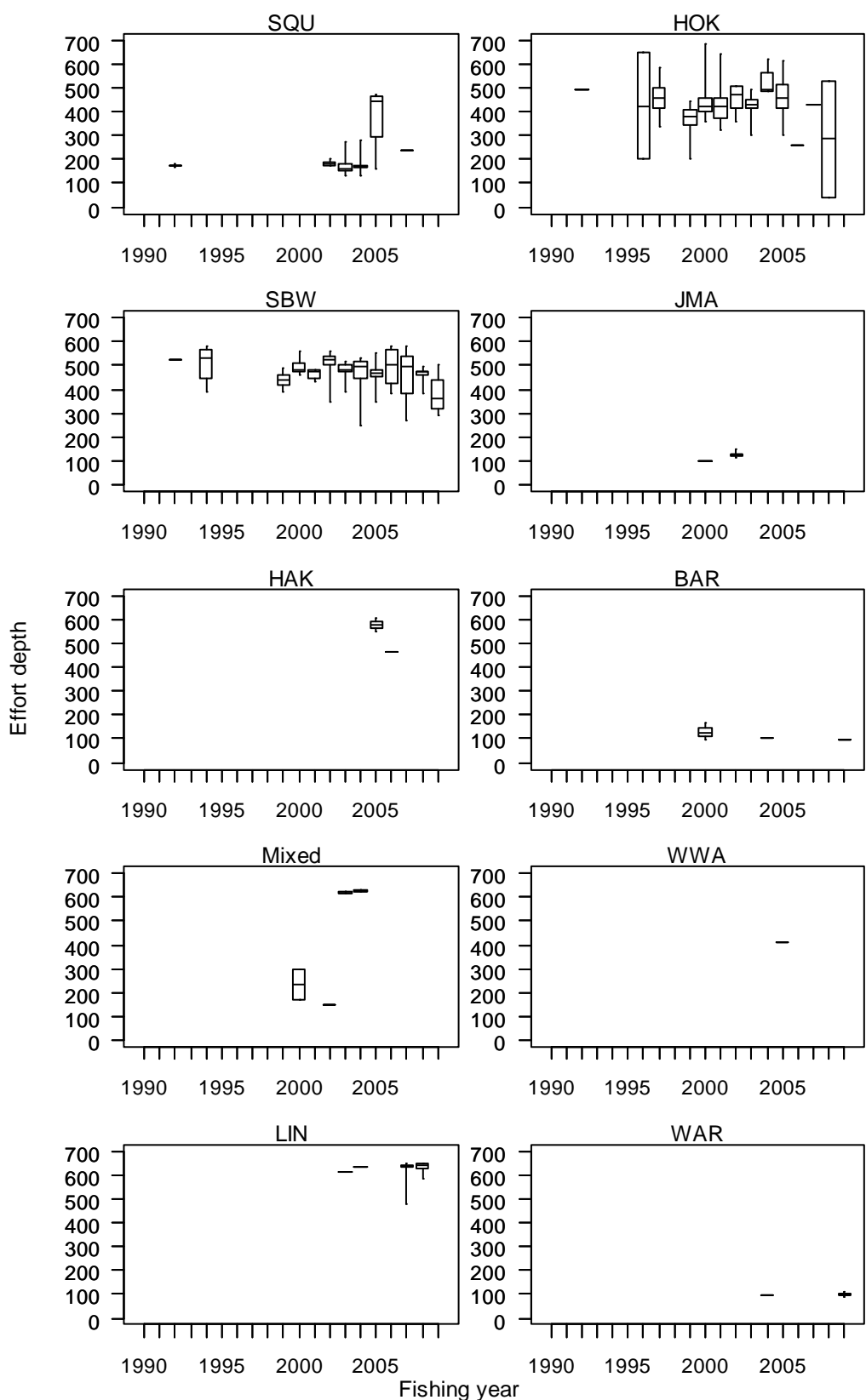
Figure C27: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) for depths (m) fished for various target species capturing LDO in the Southland/SUBA region for midwater tows.
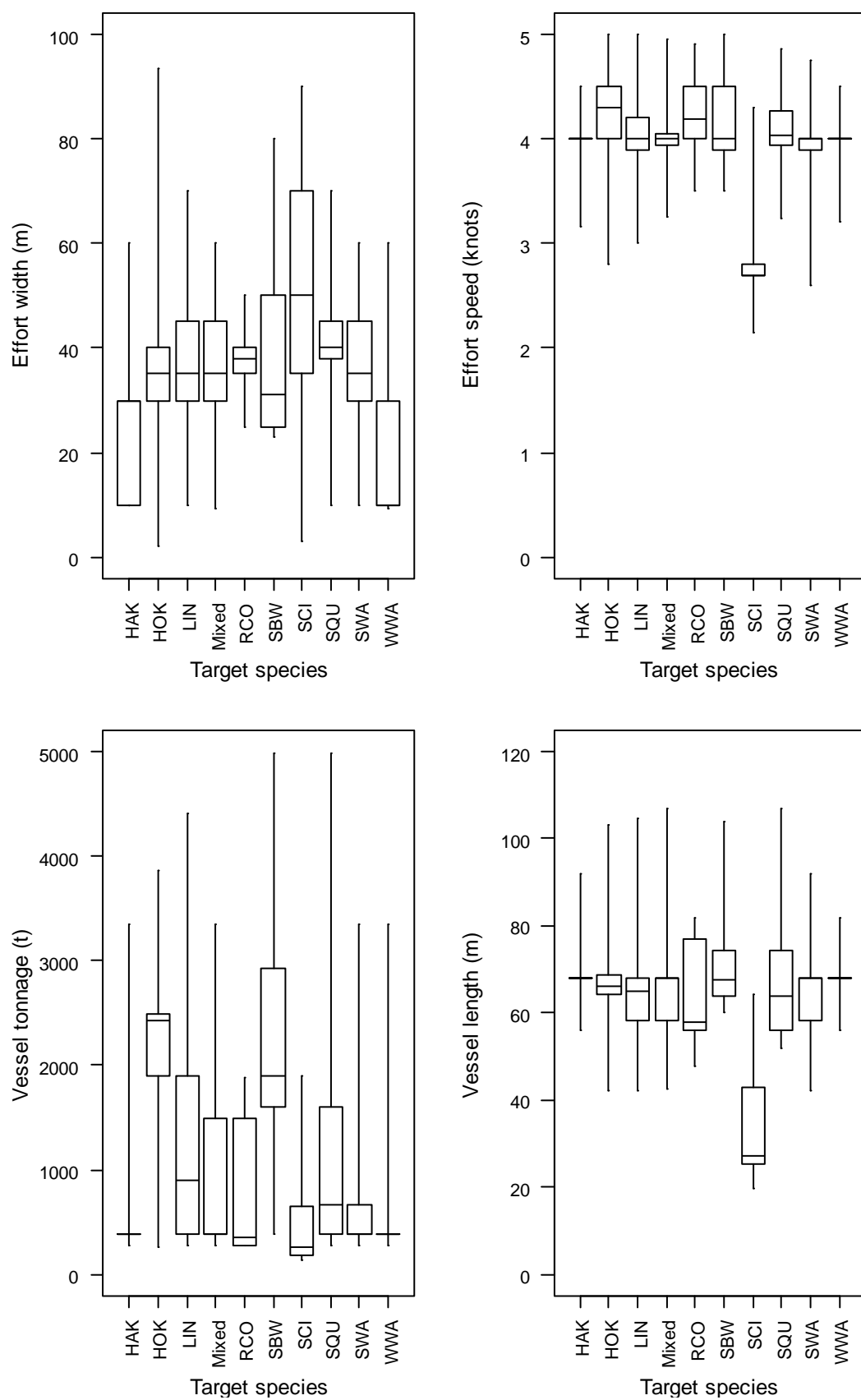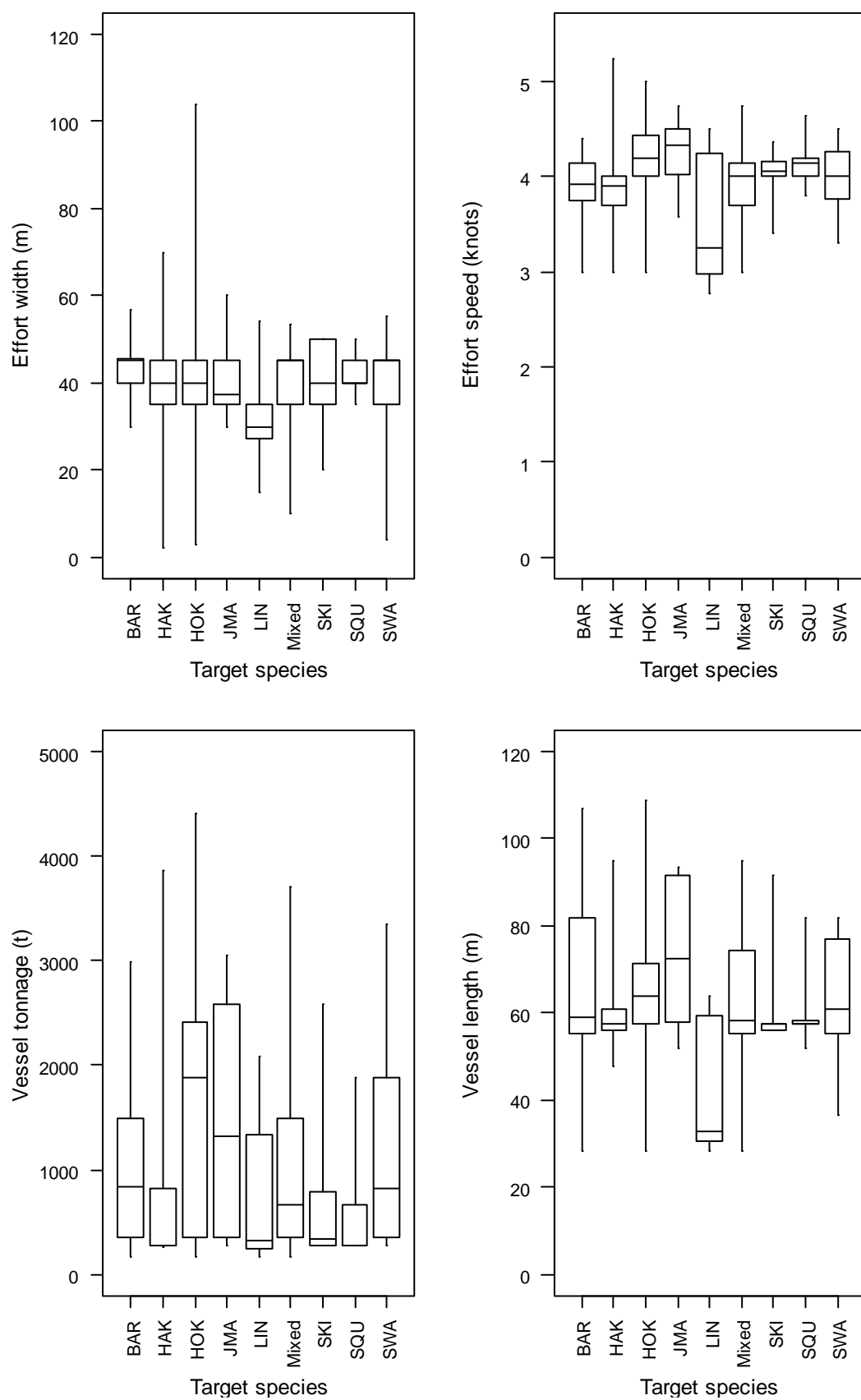
Figure C28: Distribution of fishing effort variables and vessel characteristics for the Southland/SUBA area for major target species taken by bottom trawl gear.
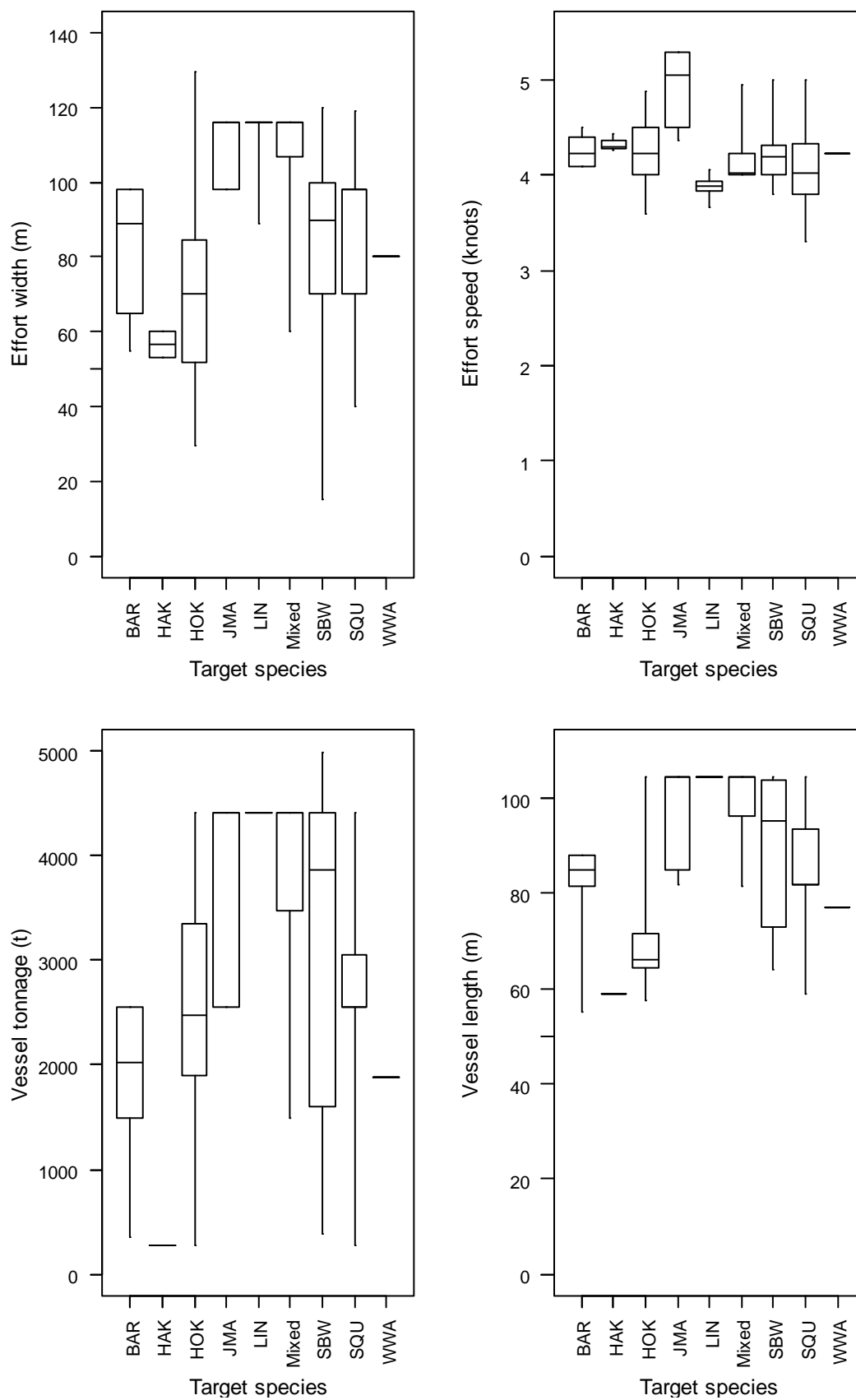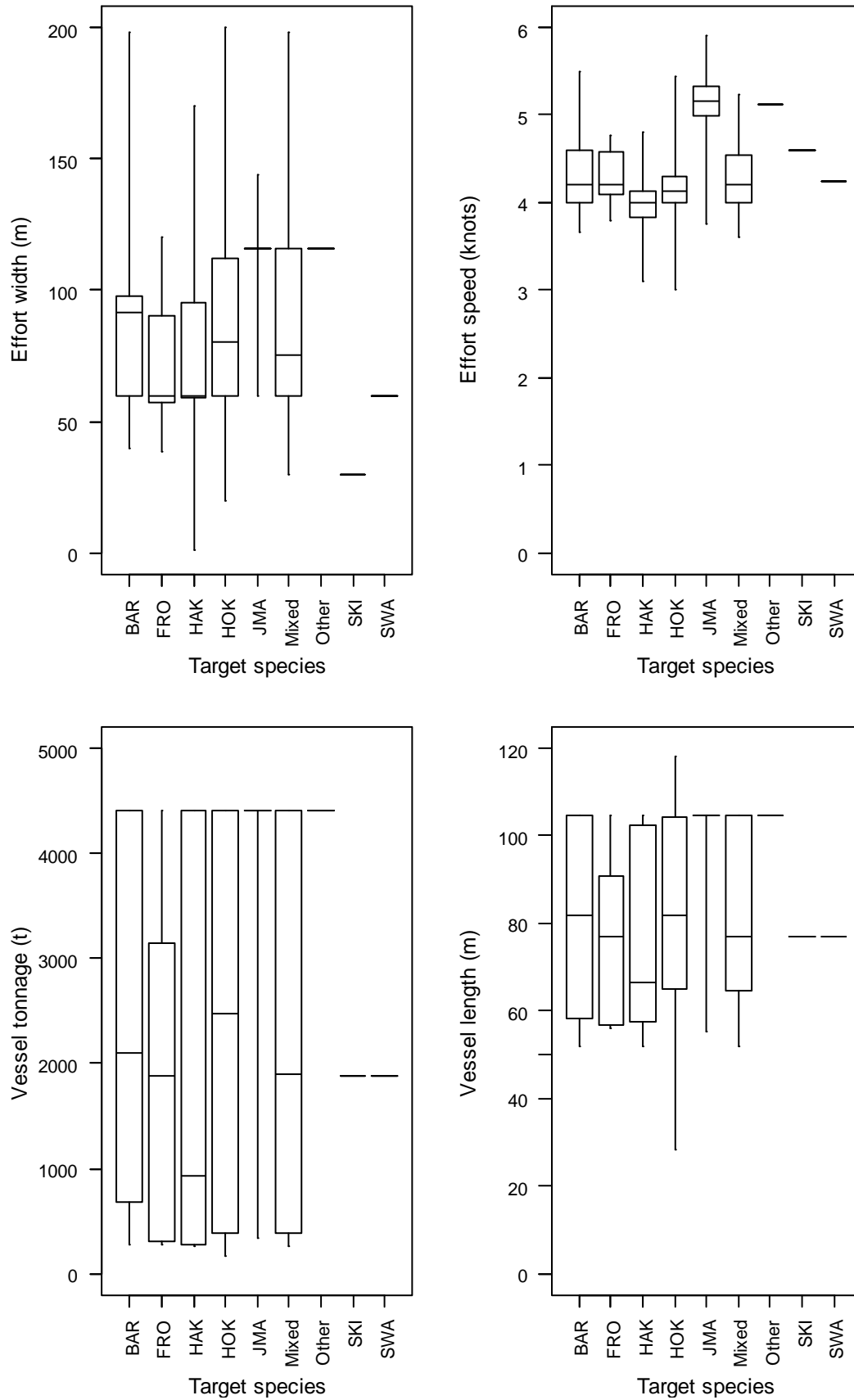
Figure C29: Distribution of fishing effort variables and vessel characteristics for the Southland/SUBA area for major target species taken by midwater trawl gear.
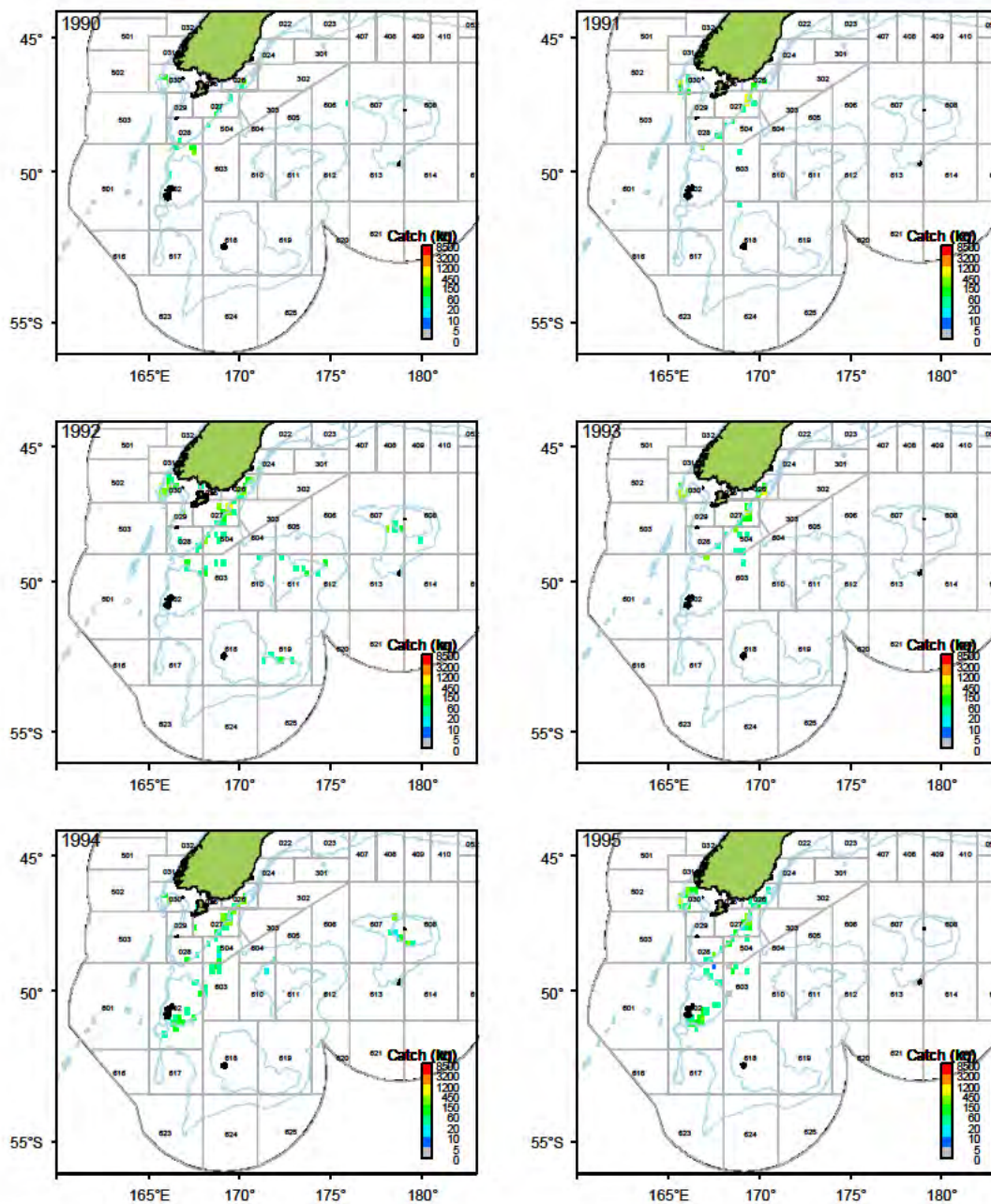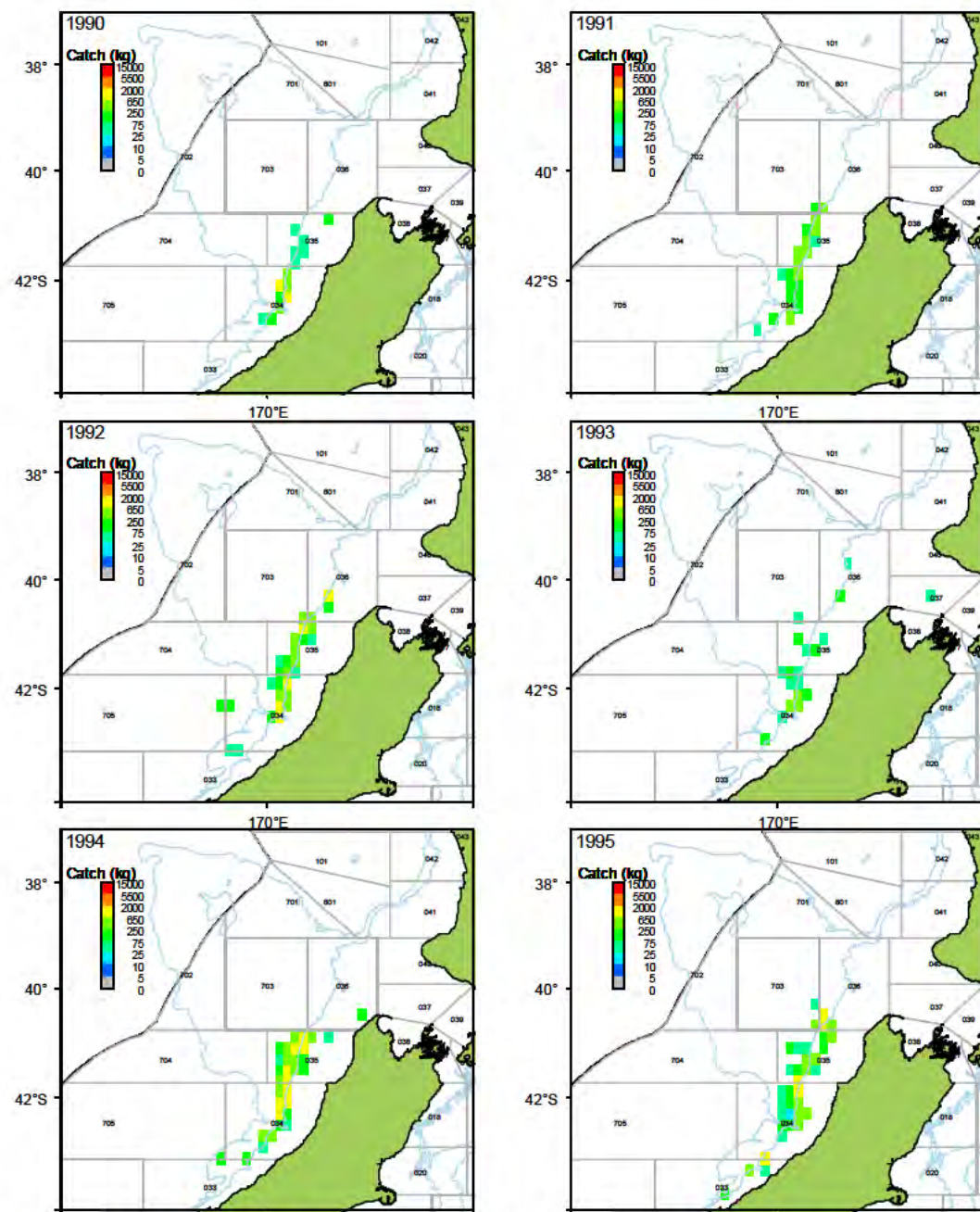
Figure C30: Distribution of LDO catch taken by bottom trawl gear within the Southland/SUBA region aggregated into 0.2 degree spatial blocks for fishing years 1990–1995 for the TCEPR form.

Figure C30 continued: Distribution of LDO catch taken by bottom trawl gear within the Southland/SUBA region aggregated into 0.2 degree spatial blocks for fishing years 1996–2001 for the TCEPR form.

Figure C30 continued: Distribution of LDO catch taken by bottom trawl gear within the Southland/SUBA region aggregated into 0.2 degree spatial blocks for fishing years 2002–2007 for the TCEPR form.
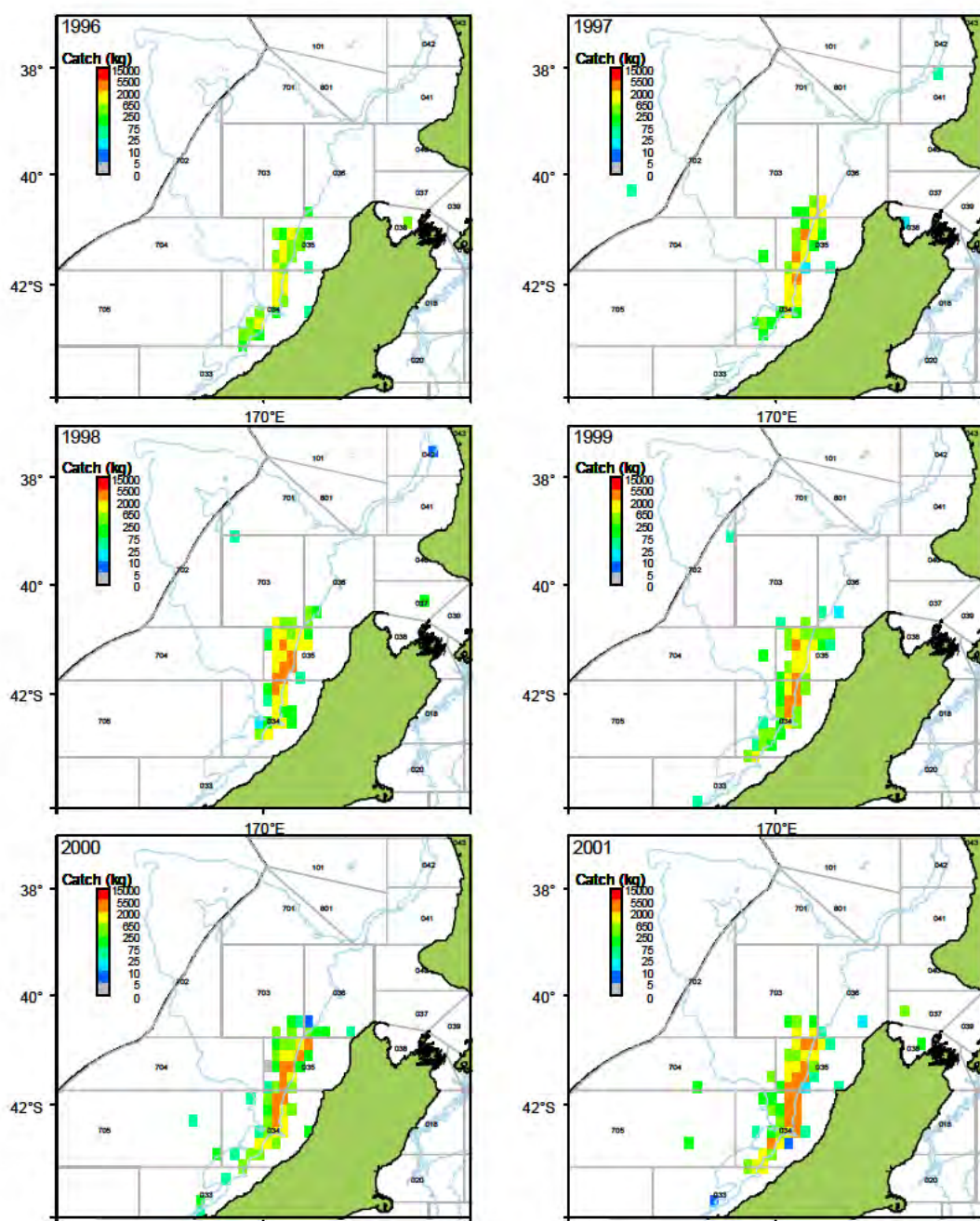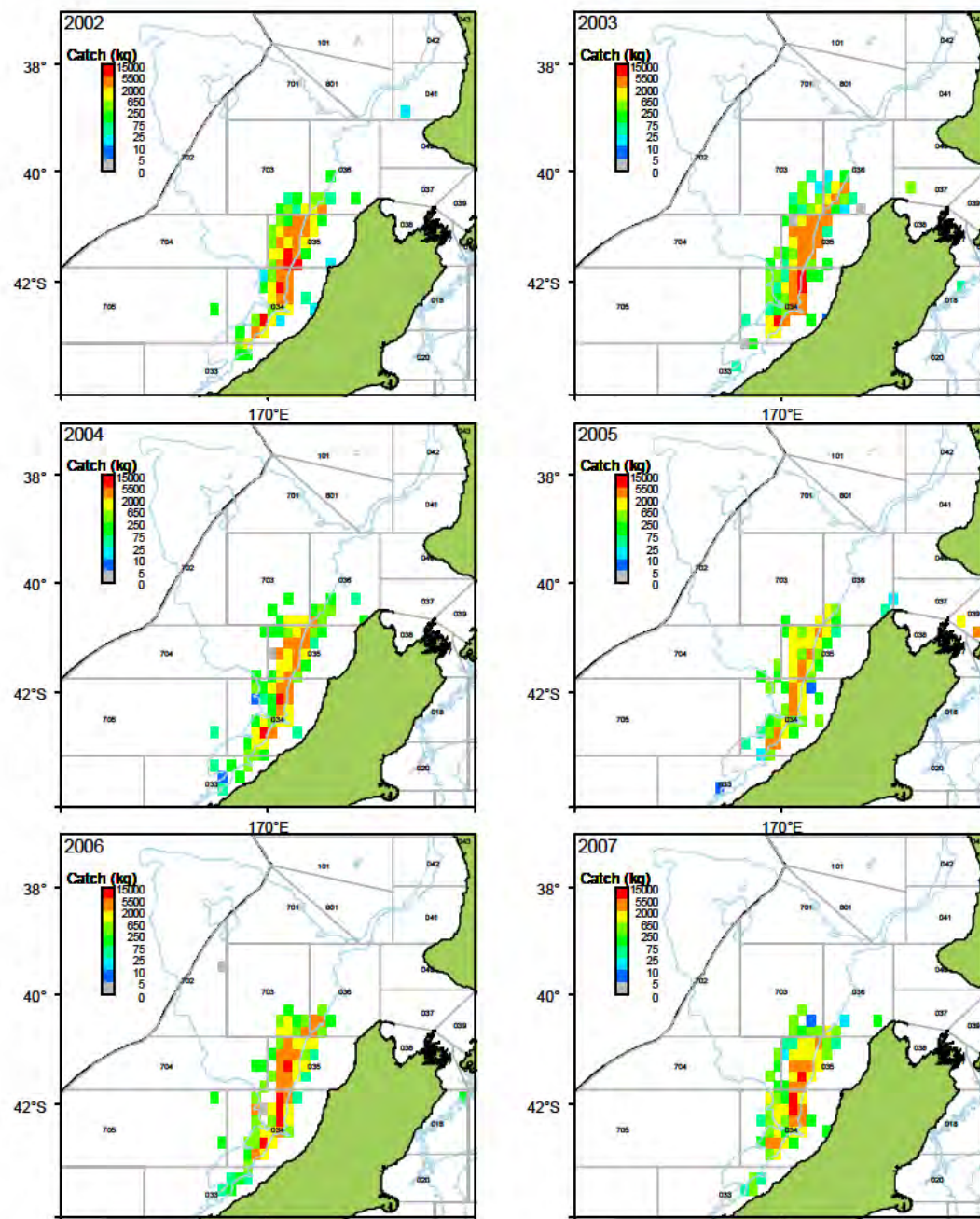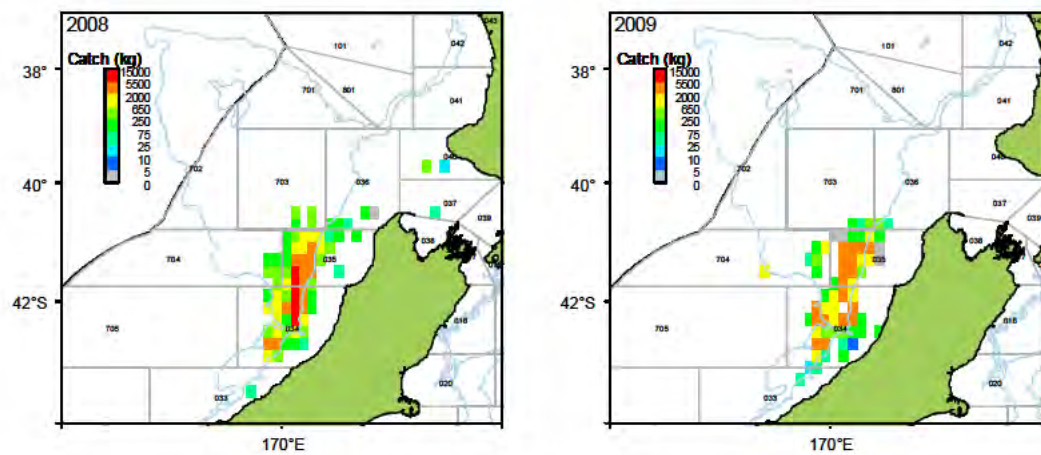
Figure C30 continued: Distribution of LDO catch taken by bottom trawl gear within the Southland/SUBA region aggregated into 0.2 degree spatial blocks for fishing years 2008–2009 for the TCEPR form.

Figure C31: Distribution of LDO catch in the West Coast region (circle size is proportional to catch for 1990–2009 fishing years in relation to a) month, b) statistical area, c) fishing method, and d) target species. Circle size is proportional to catch; maximum circle size is indicated in lower left hand corner. NB: BT+MW fishing method are days where there was an even split between the number of bottom and midwater tows.
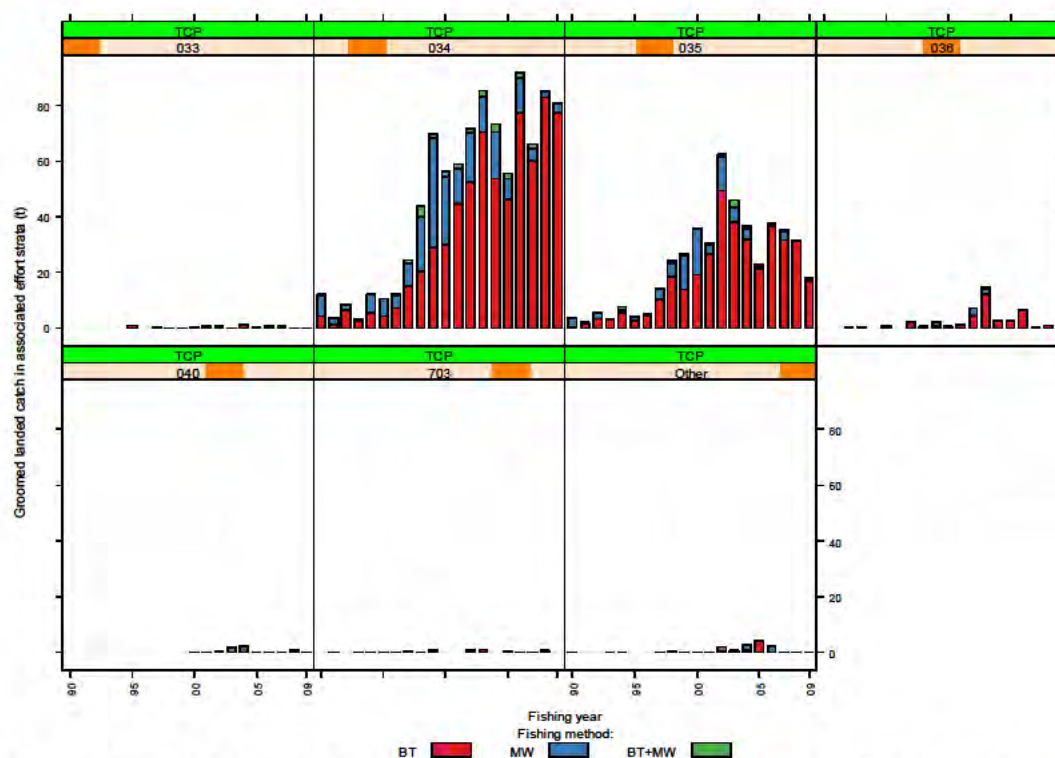
Figure C32a: Distribution of LDO catch in the West Coast region in relation to form type and statistical area by fishing method for fishing years 1990–2009 taken by midwater and bottom trawl gear. NB: BT+MW fishing method are days where there was an even split between the number of bottom and midwater tows.
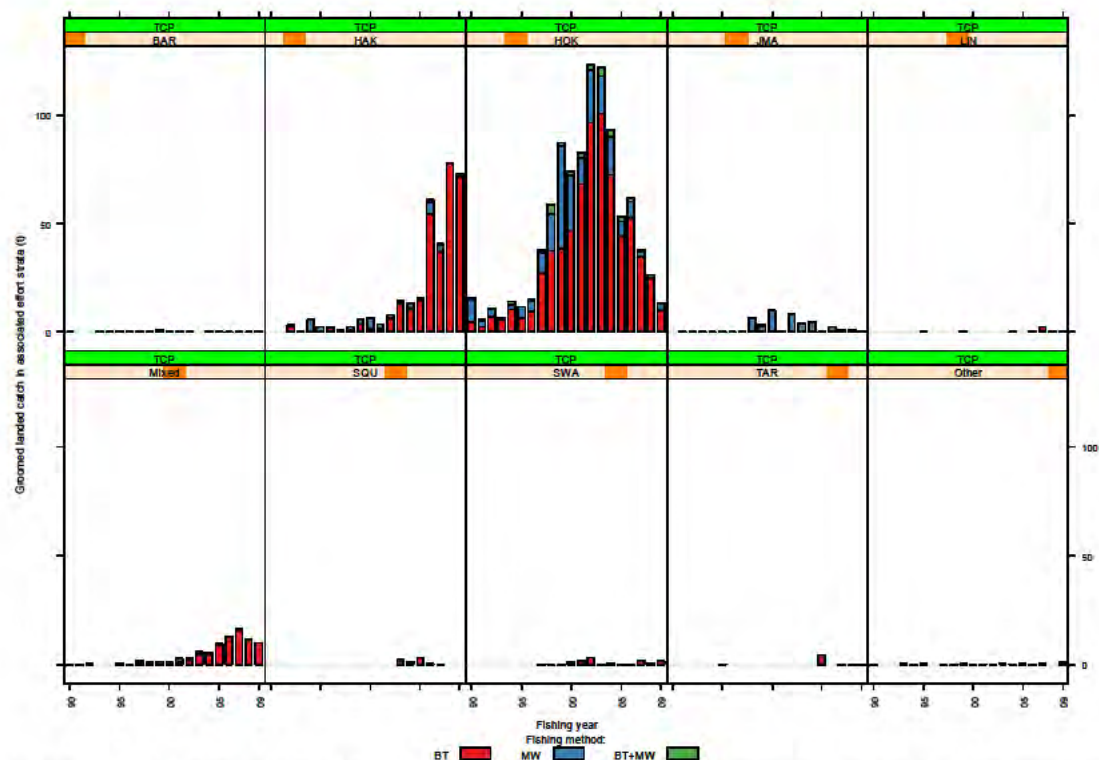
Figure C32b: Distribution of LDO catch in the West Coast region in relation to form type and target species by fishing method for fishing years 1990–2009 taken by midwater and bottom trawl gear. NB: BT+MW fishing method are days where there was an even split between the number of bottom and midwater tows.

Figure C32c: Distribution of LDO catch in the West Coast region in relation to target species and statistical area by fishing method for fishing years 1990–2009 taken by midwater and bottom trawl gear. NB: BT+MW fishing method are days where there was an even split between the number of bottom and midwater tows.

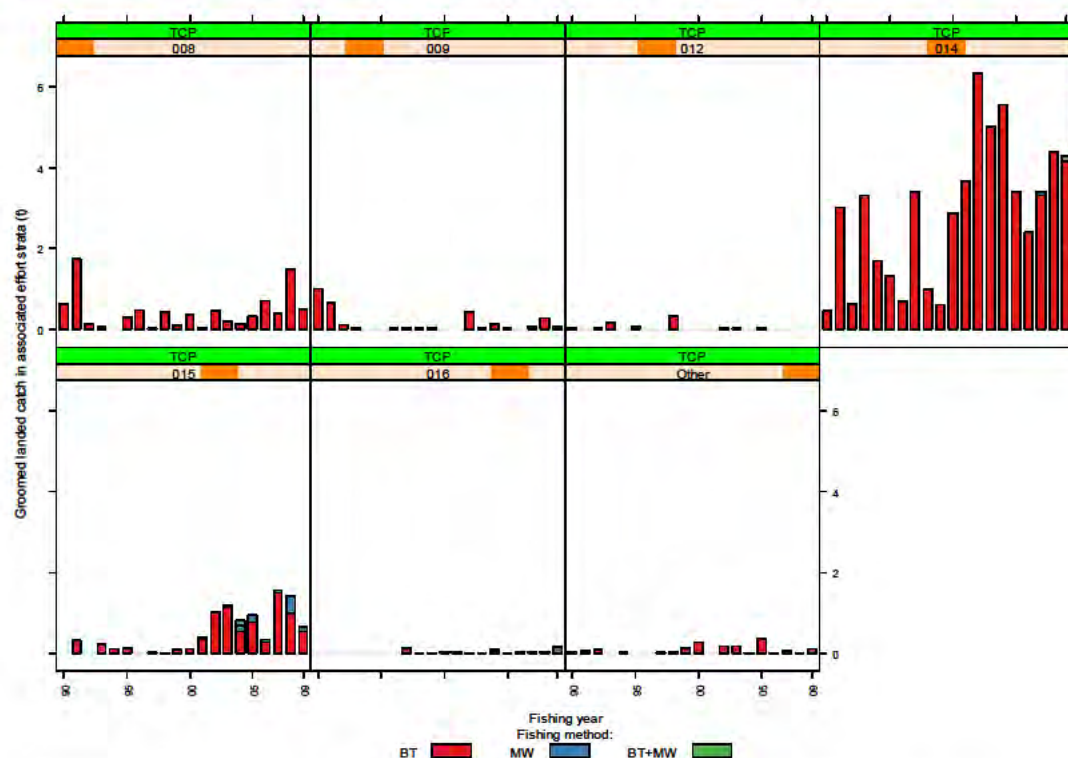**Figure C32d: Distribution of LDO catch in the West Coast region in relation to target species by month for fishing years 1990–2009 taken by bottom trawl gear.**
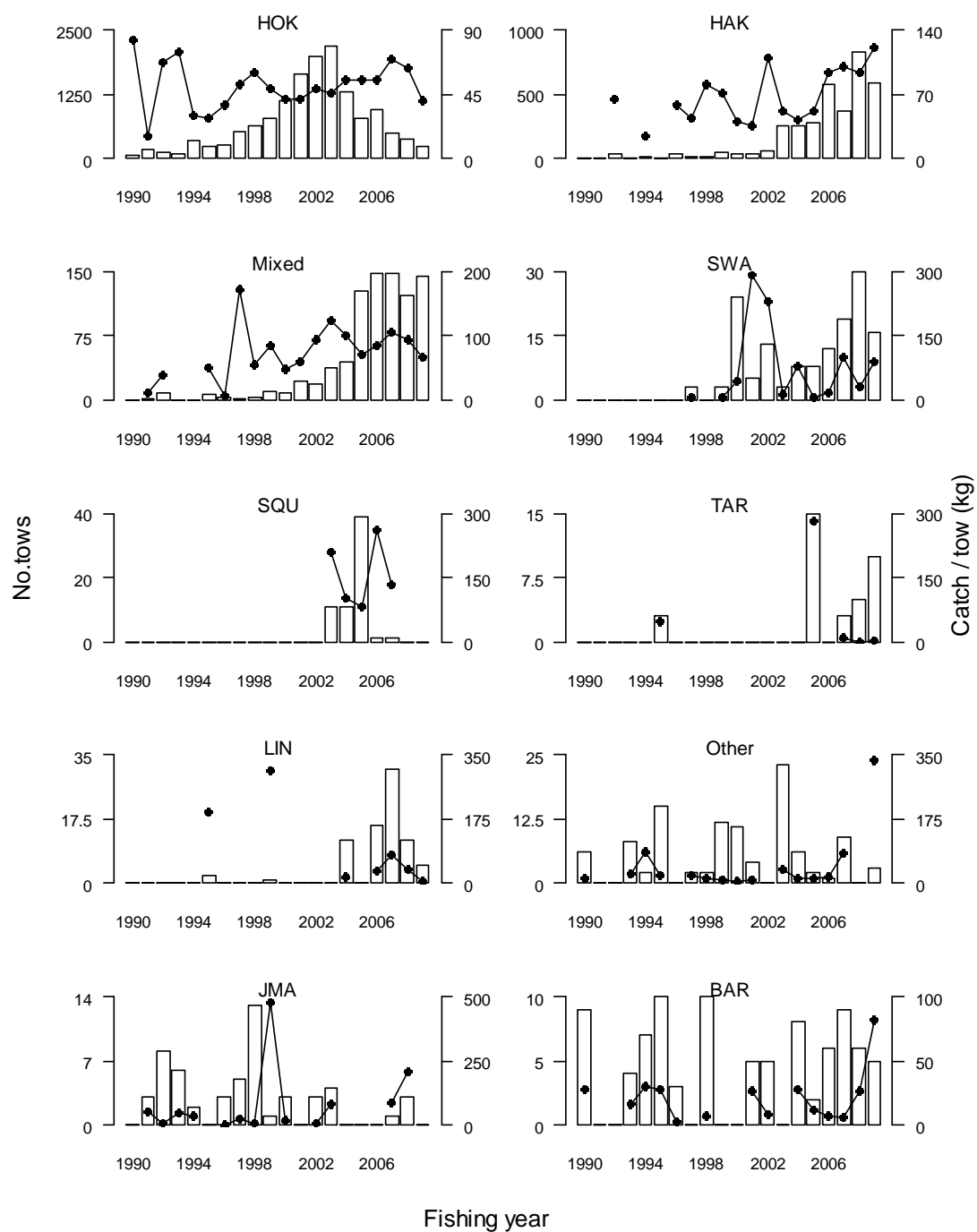
Figure C33: Unstandardised catch rate of LDO for various target species (kg/tow) and the number of tows for the West Coast region taken by bottom trawl gear.
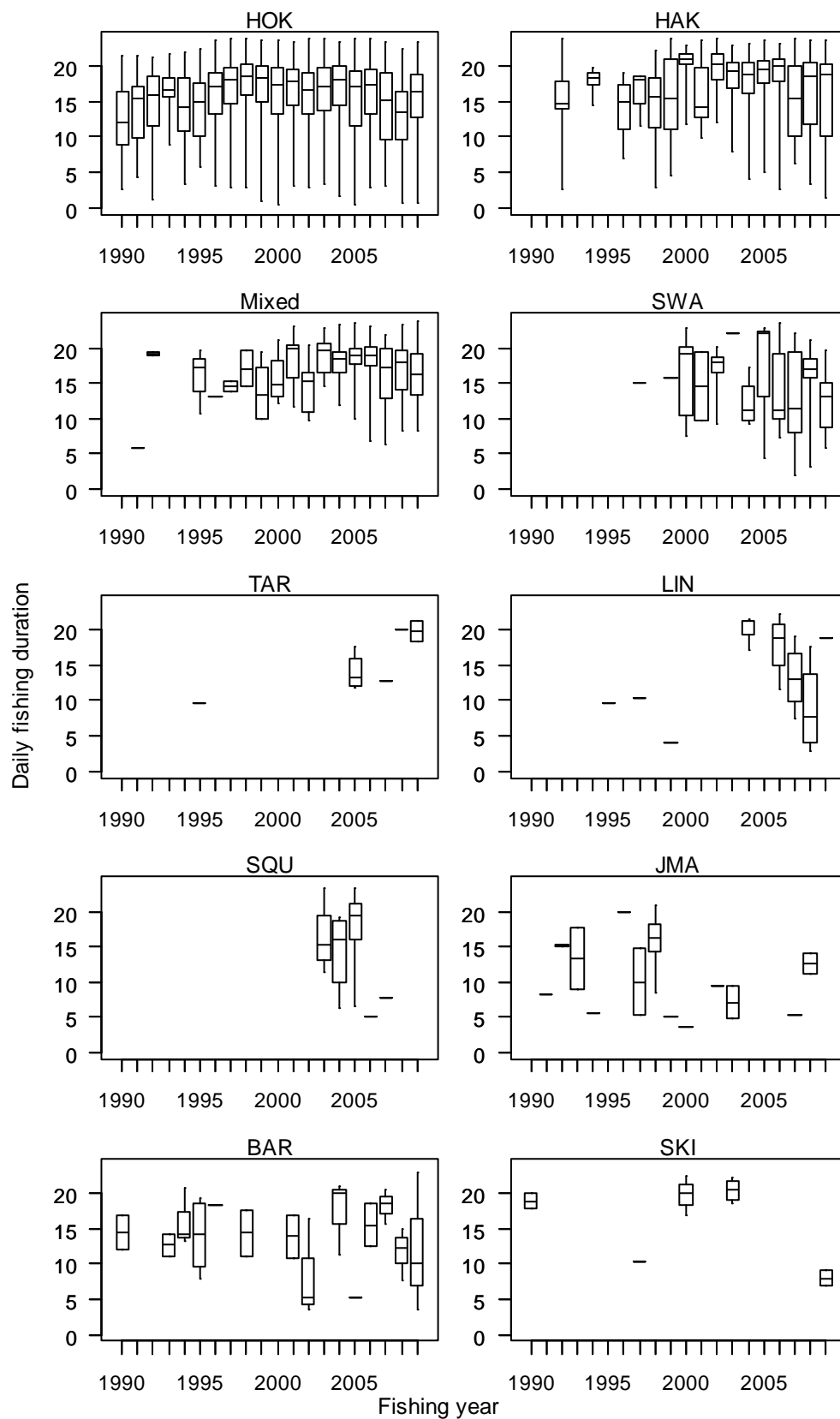
Figure C34: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) for daily tow durations reported for various target species capturing LDO in the West Coast region taken by bottom trawl gear.

Figure C35: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) for daily tow durations reported for various target species capturing LDO in the West Coast region taken by midwater trawl gear.

Figure C36: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) for depths (m) fished for various target species capturing LDO in the West Coast region for bottom tows.

Figure C37: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) for depths (m) fished for various target species capturing LDO in the West Coast region for midwater tows.

Figure C38: Distribution of fishing effort variables and vessel characteristics for the West Coast area for major target species taken by bottom trawl gear.

Figure C39: Distribution of fishing effort variables and vessel characteristics for the West Coast area for major target species taken by midwater trawl gear.

Figure C40: Distribution of LDO catch taken by bottom trawl gear within the West Coast region aggregated into 0.2 degree spatial blocks for the fishing years 1990–1995 for the TCEPR form.

Figure C40 continued: Distribution of LDO catch taken by bottom trawl gear within the West Coast region aggregated into 0.2 degree spatial blocks for the fishing years 1996–2001 for the TCEPR form.

Figure C40 continued: Distribution of LDO catch taken by bottom trawl gear within the West Coast region aggregated into 0.2 degree spatial blocks for the fishing years 2002–2007, for the TCEPR form.

Figure C40 continued: Distribution of LDO catch taken by bottom trawl gear within the West Coast region aggregated into 0.2 degree spatial blocks for the fishing years 2008–2009, for the TCEPR form.

Figure C41: Distribution of LDO catch in the ECNI region (circle size is proportional to catch for 1990–2009 fishing years in relation to a) month, b) statistical area, c) fishing method, and d) target species. Circle size is proportional to catch; maximum circle size is indicated in lower left hand corner. NB: BT+MW fishing method are days where there was an even split between the number of bottom and midwater tows.

Figure C42a: Distribution of LDO catch in the ECNI region in relation to form type and statistical area by fishing method for fishing years 1990–2009 taken by bottom trawl gear. NB: BT+MW fishing method are days where there was an even split between the number of bottom and midwater tows.
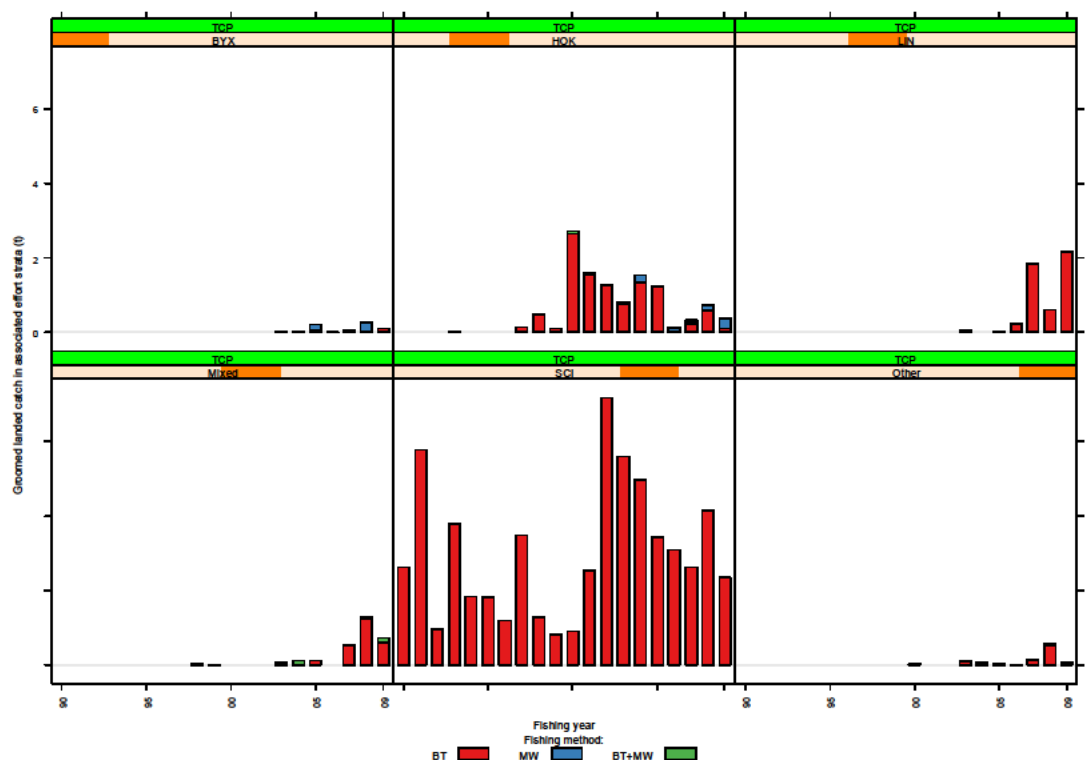
Figure C42b: Distribution of LDO catch in the ECNI region in relation to form type and target species by fishing method for fishing years 1990–2009 taken by bottom trawl gear. NB: BT+MW fishing method are days where there was an even split between the number of bottom and midwater tows.
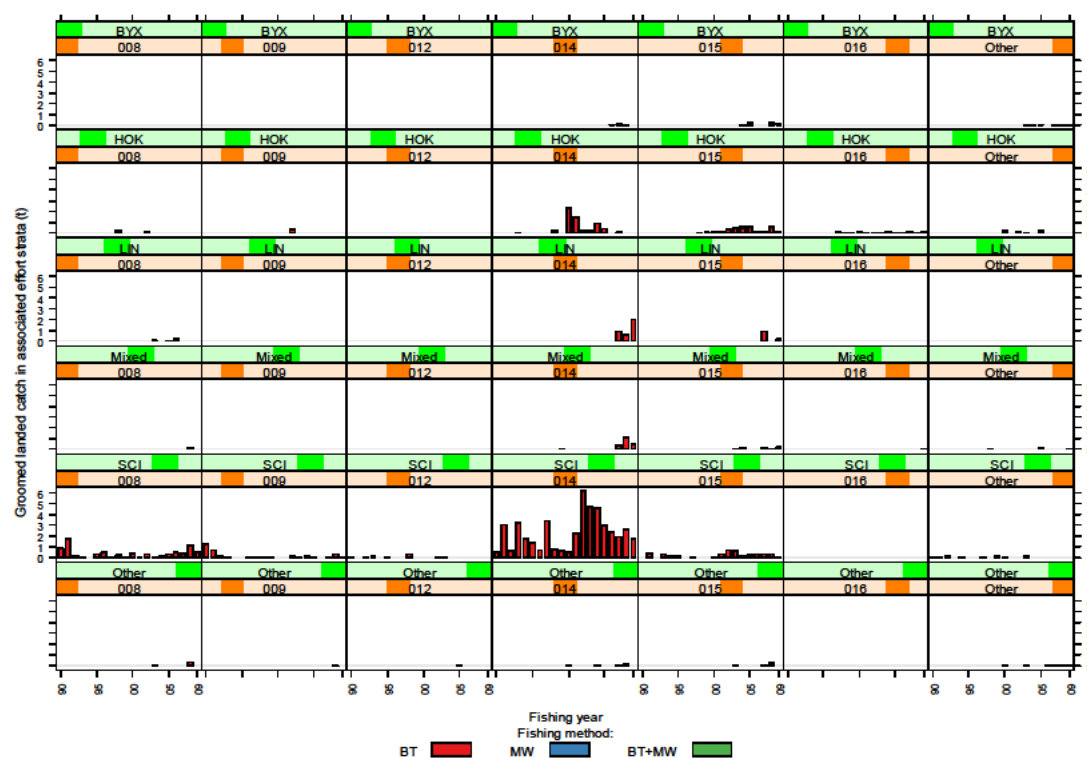
Figure C42c: Distribution of LDO catch in the ECNI region in relation to target species and statistical area by fishing method for fishing years 1990–2009 taken by midwater and bottom trawl gear. NB: BT+MW fishing method are days where there was an even split between the number of bottom and midwater tows.
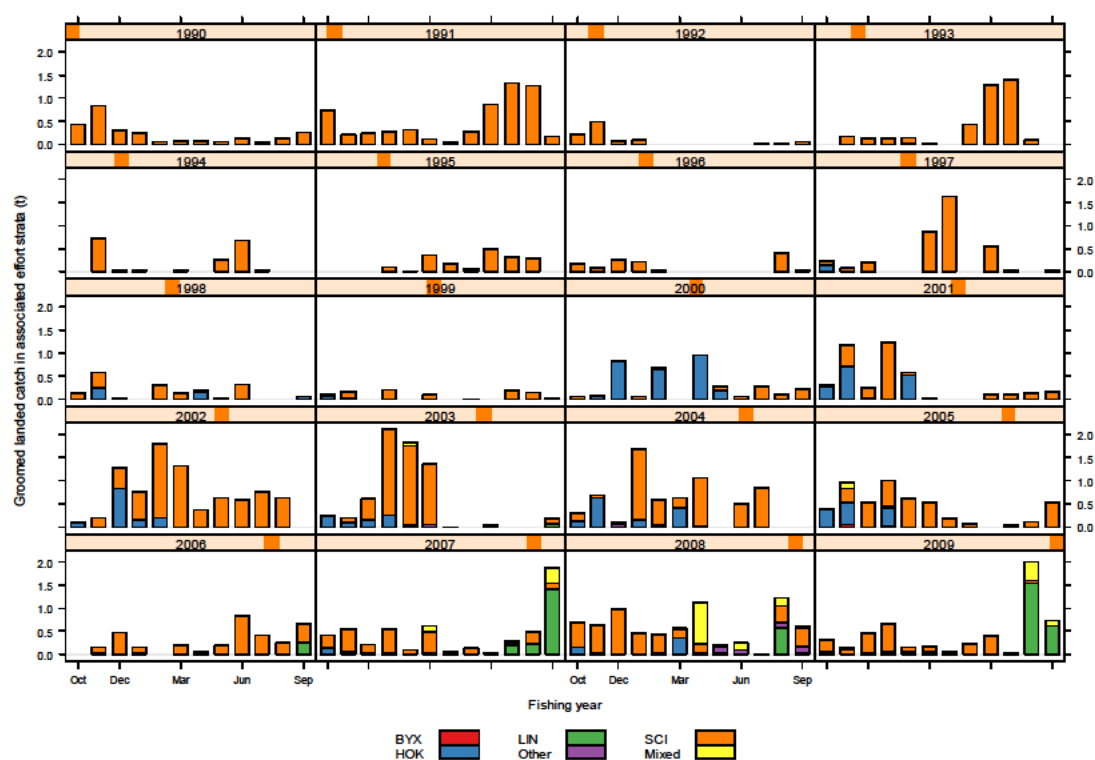
Figure C42d: Distribution of LDO catch in the ECNI region in relation to target species by month for fishing years 1990–2009 taken by bottom trawl gear.
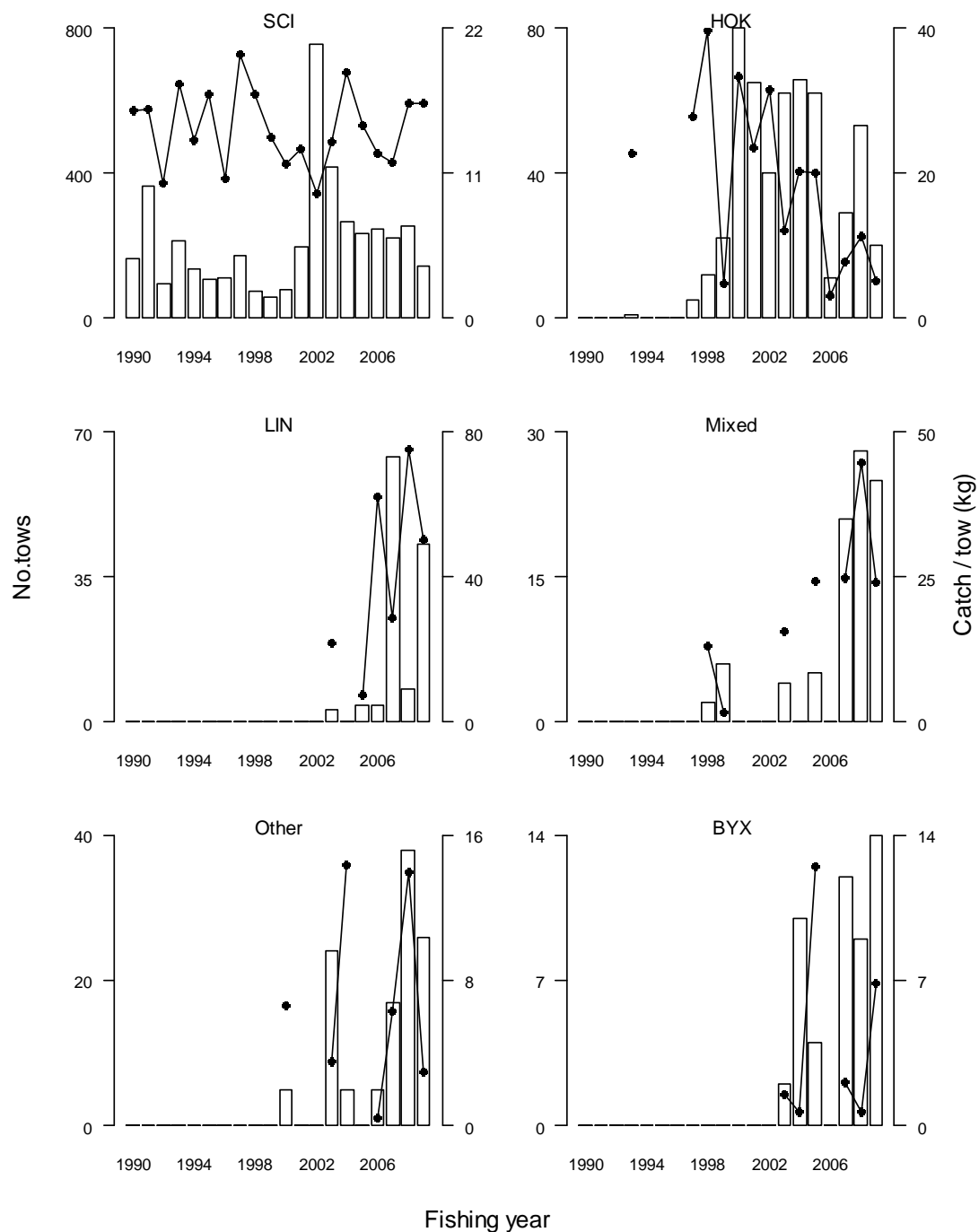
Figure C43: Unstandardised catch rates of LDO for various target species (kg/tow) and the number of tows for the ECNI region taken by bottom trawl gear.
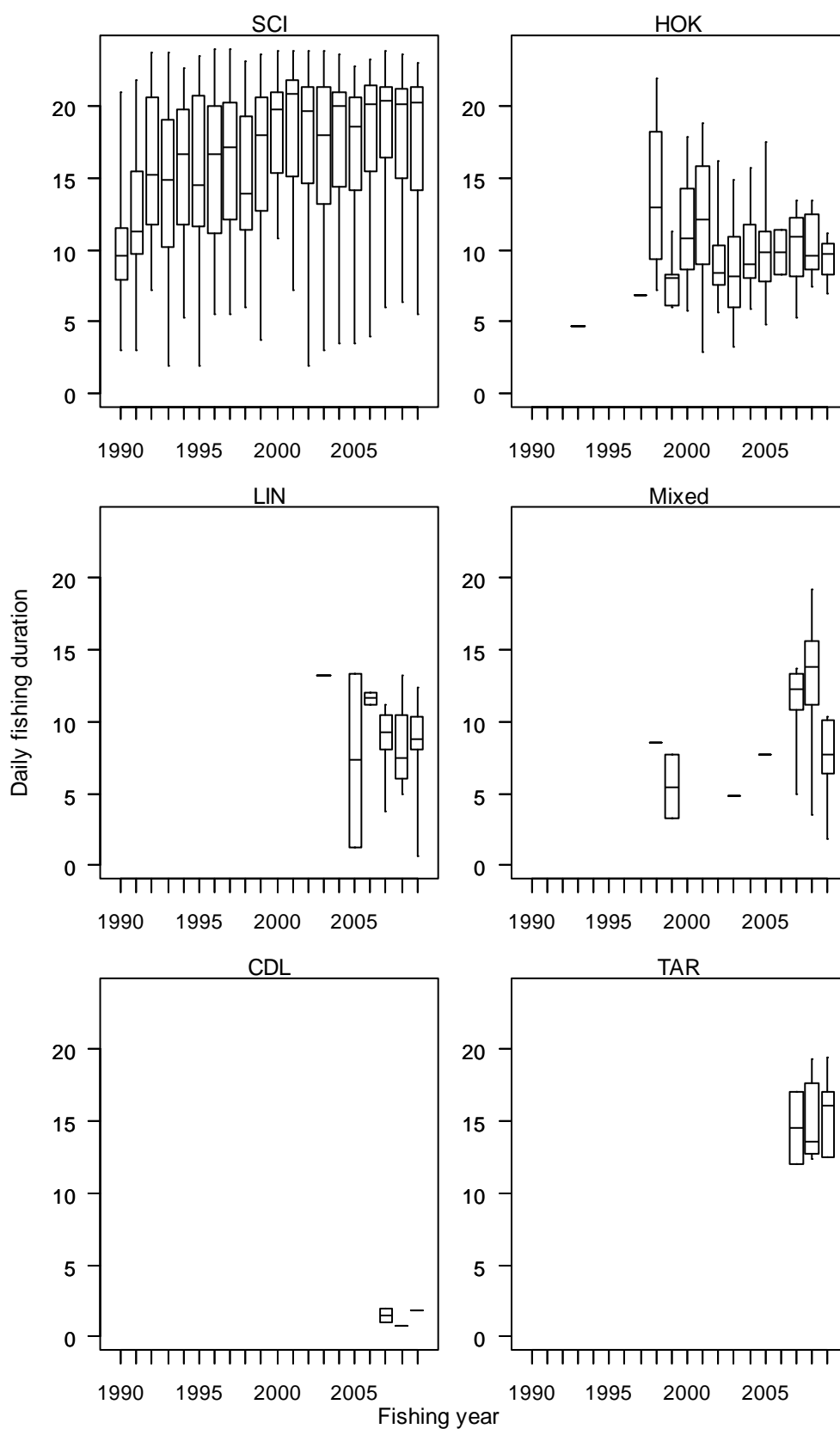
Figure C44: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) for daily tow durations reported for various target species capturing LDO in the ECNI region taken by bottom trawl gear.
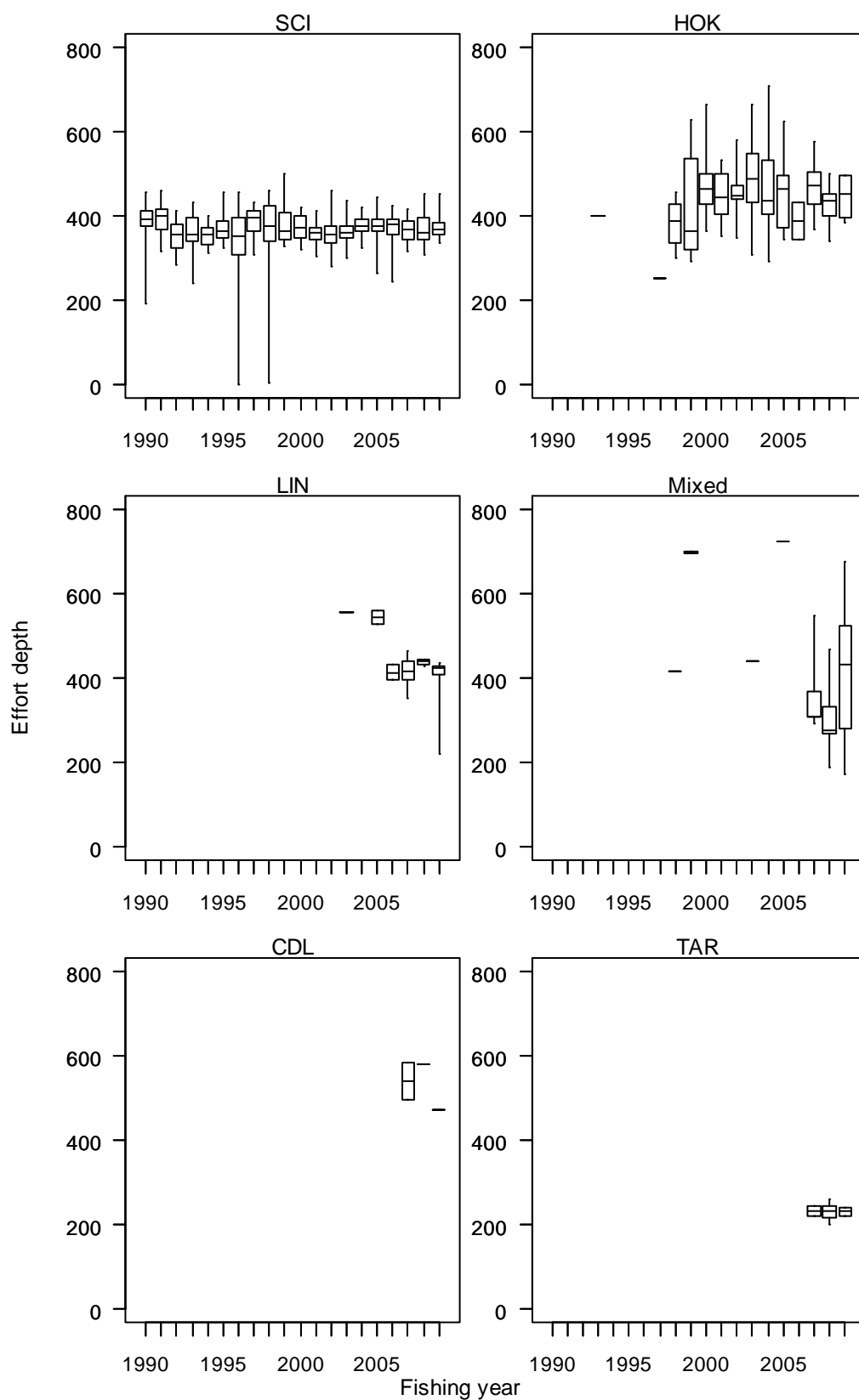
Figure C45: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) for depths (m) fished for various target species capturing LDO in the ECNI region for bottom tows.
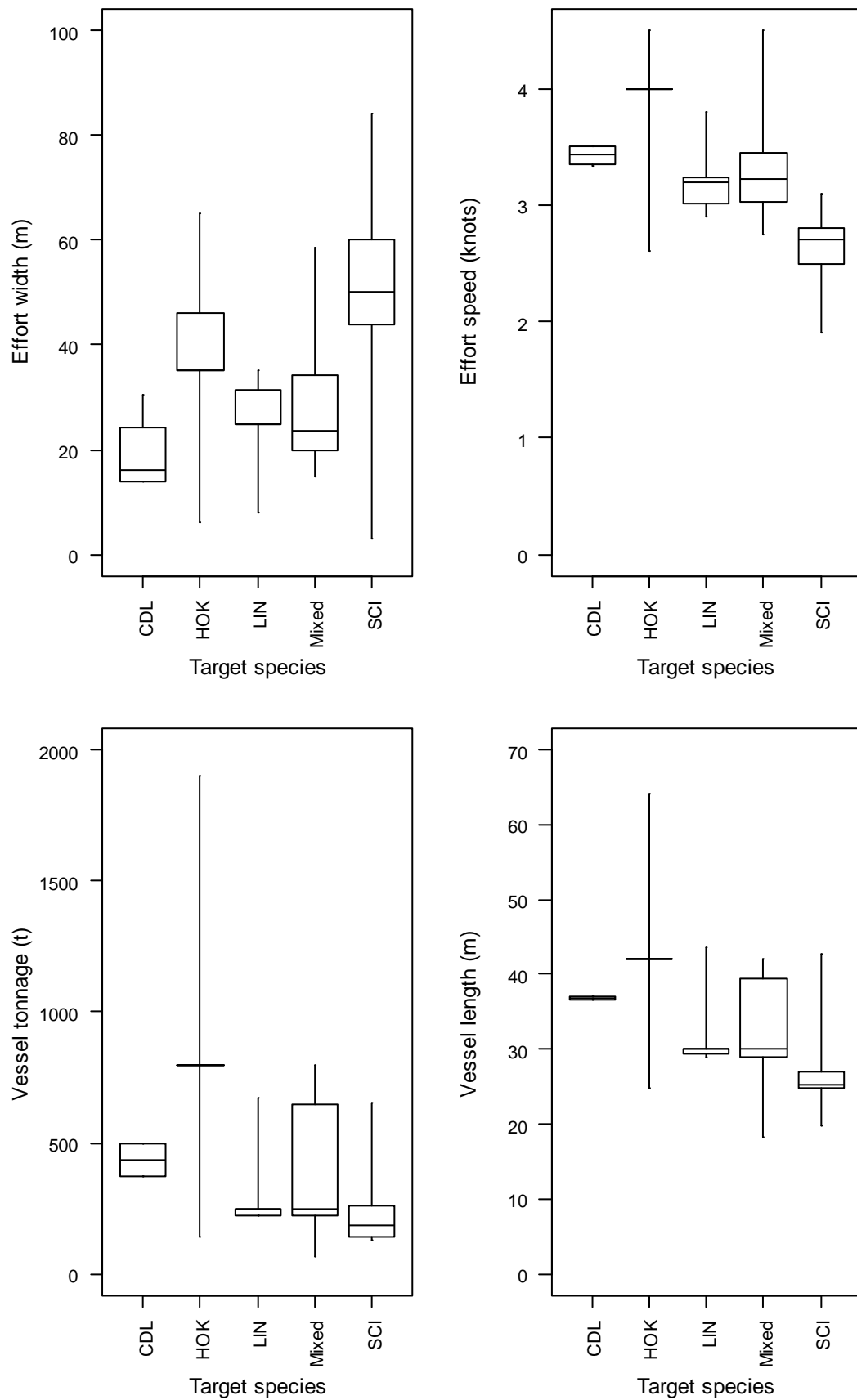
Figure C46: Distribution of fishing effort variables and vessel characteristics for the ECNI area for major target species capturing LDO taken by bottom trawl gear.
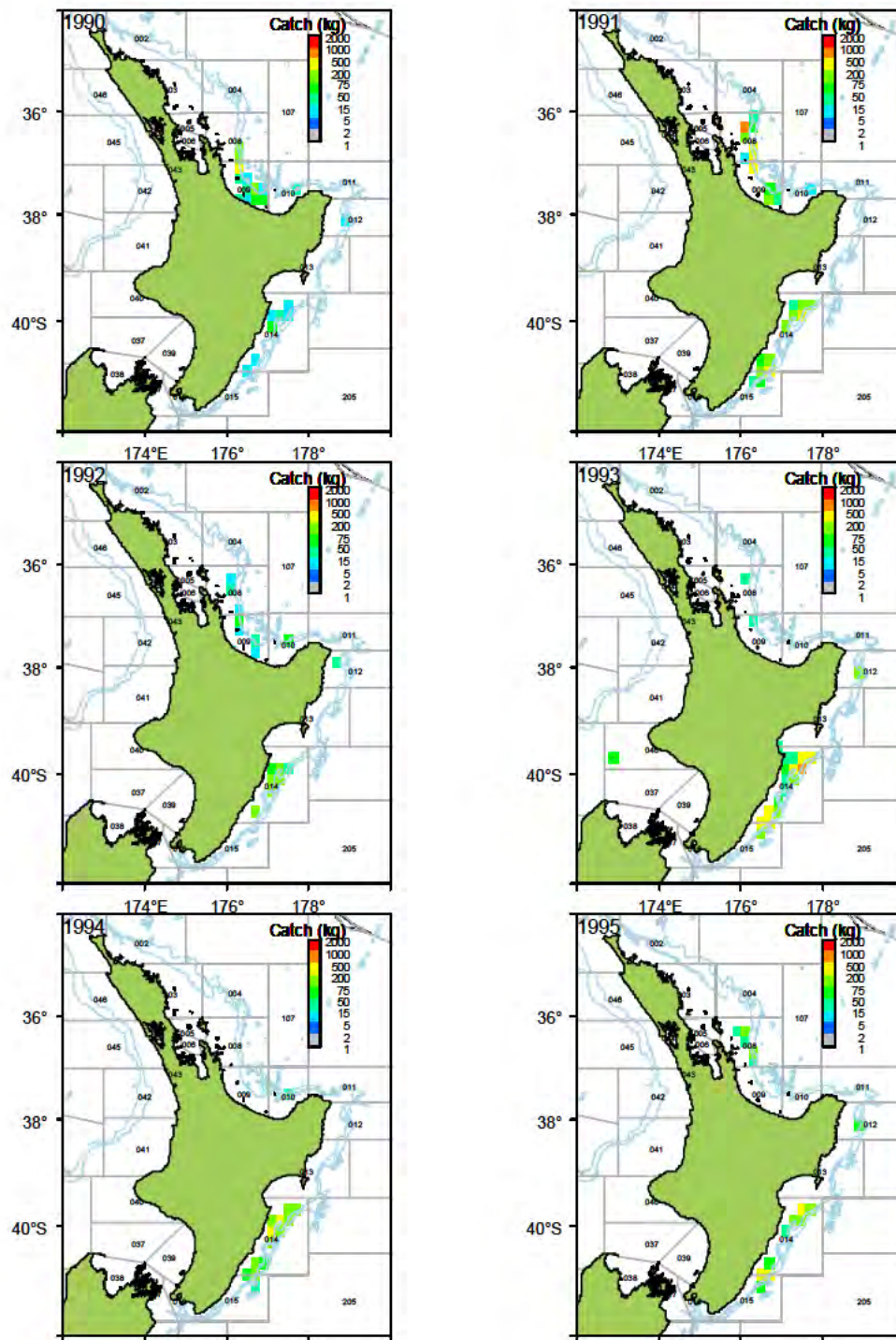
Figure C47: Distribution of LDO catch taken bottom trawl gear within the ECNI region aggregated into 0.2 degree spatial blocks for fishing years 1990–1995 for the TCEPR form.
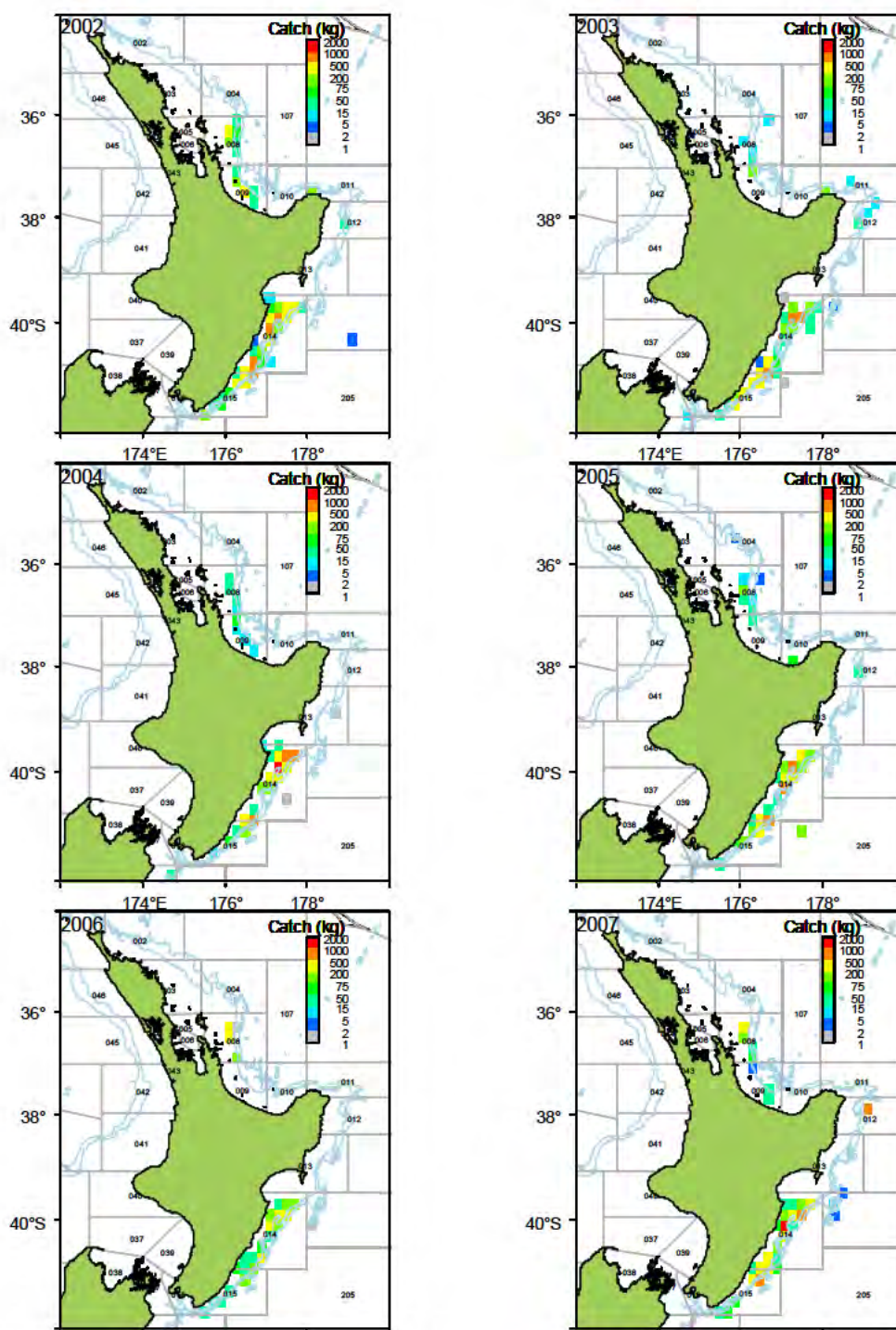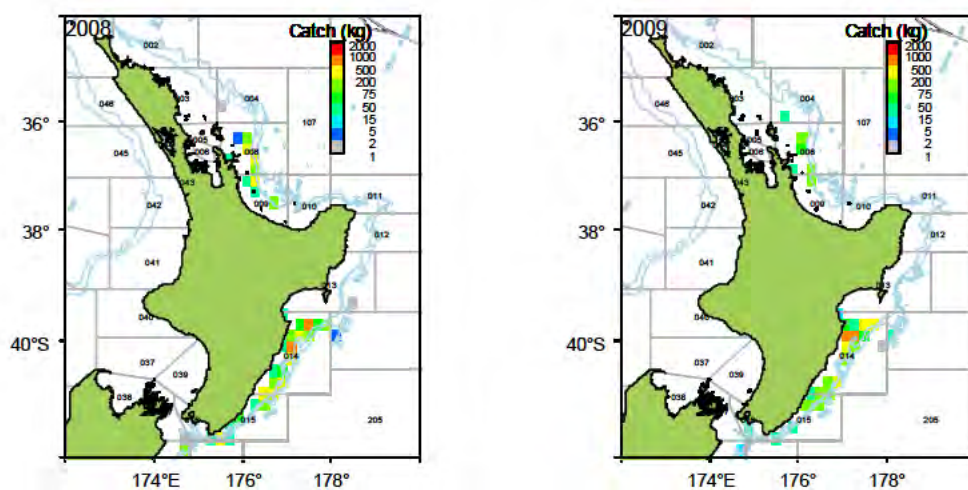
Figure C47 continued: Distribution of LDO catch taken by bottom trawl gear within the ECNI region aggregated into 0.2 degree spatial blocks for fishing years 1996–2001 for the TCEPR form.

Figure C47 continued: Distribution of LDO catch taken by bottom trawl gear within the ECNI region aggregated into 0.2 degree spatial blocks for fishing years 2002–2007 for the TCEPR form.

Figure C47 continued: Distribution of LDO catch taken by bottom trawl gear within the ECNI region aggregated into 0.2 degree spatial blocks for fishing years 2008–2009 for the TCEPR form.

APPENDIX D: CATCH-PER-UNIT-EFFORT ANALYSIS

Table D1: CPUE datasets for all vessels and for core vessels for each year (1999–2009) for ECSI/CHAT CPUE Model 1 (hoki target, bottom trawl, October-September). 'No. records' is the number of daily processed records, 'Zeros' are the proportion of daily processed records with no LDO processed, 'Catch' is the greenweight of LDO caught in tonnes, 'Effort' is the number of daily processed records where LDO has been processed, 'CPUE' is unstandardised catch per non-zero LDO daily processed catch.

					All vessels					Core vessels
Year	No. records	Zeros	Catch	Effort	CPUE	No. records	Zeros	Catch	Effort	CPUE
1998	1857	-	365.5	1848	0.20	1329	-	284.9	1326	0.21
1999	2105	-	400.9	2105	0.19	1660	-	337	1660	0.2
2000	1819	-	385.4	1819	0.21	1656	-	357.6	1656	0.22
2001	2020	-	450.2	2020	0.22	1818	-	407.4	1818	0.22
2002	1716	-	448.3	1715	0.26	1568	-	423.5	1568	0.27
2003	2179	-	488.4	2179	0.22	1878	-	455.6	1878	0.24
2004	1701	-	309.1	1701	0.18	1476	-	276.9	1476	0.19
2005	1230	0.02	199.9	1205	0.17	1043	0.02	190.1	1018	0.19
2006	1219	-	230.8	1219	0.19	1022	-	221.3	1022	0.22
2007	1173	-	171.3	1173	0.15	963	-	163.1	963	0.17
2008	1062	-	122.7	1060	0.12	799	-	106.7	799	0.13
2009	897	-	169.5	897	0.19	698	-	136.7	698	0.2

Table D2: Variables retained in order of decreasing explanatory value for ECSI/CHAT Model 1 and the corresponding total R^2 value.

Variable	R^2
Fishing year	2.10
Stats area	15.17
Vessel key	22.40
Month	25.18

Table D3: ECSI/CHAT Model 1 CPUE estimated values, upper and lower confidence intervals and c.v.s by year.
Overall R-squared : 25.18%

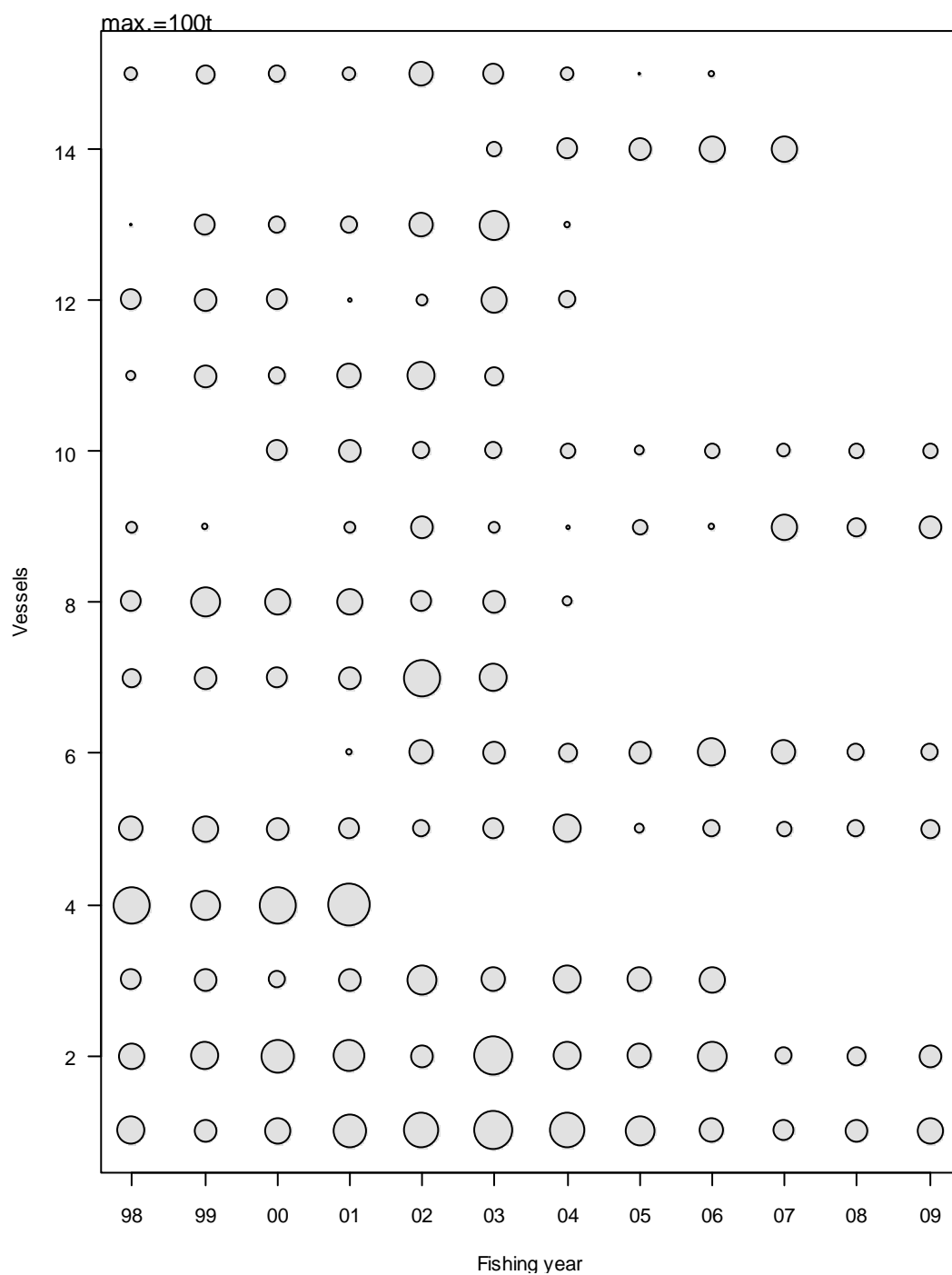| Year	CPUE	Lower CI	Upper CI	CV
1998	0.81	0.76	0.85	0.03
1999	0.67	0.64	0.70	0.03
2000	0.92	0.87	0.96	0.03
2001	1.08	1.03	1.14	0.02
2002	1.36	1.30	1.43	0.03
2003	1.37	1.31	1.43	0.02
2004	1.06	1.01	1.12	0.03
2005	0.98	0.92	1.04	0.03
2006	1.33	1.25	1.42	0.03
2007	0.89	0.84	0.95	0.03
2008	0.78	0.73	0.83	0.03
2009	1.04	0.97	1.12	0.04

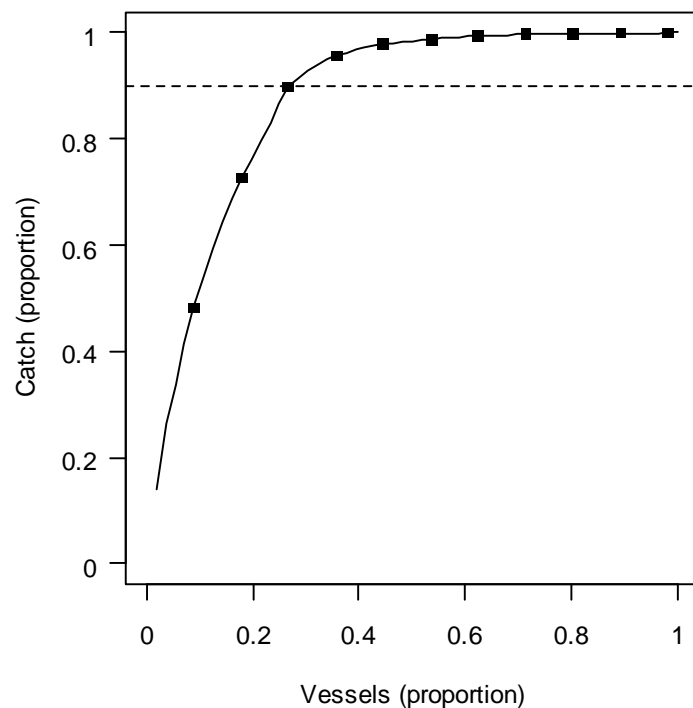**Figure D1: ECSI/CHAT CPUE Model 1: scaled annual LDO catch by core vessel.**

Figure D2: ECSI/CHAT CPUE Model: Cumulative proportion of LDO catch ranked by vessel.
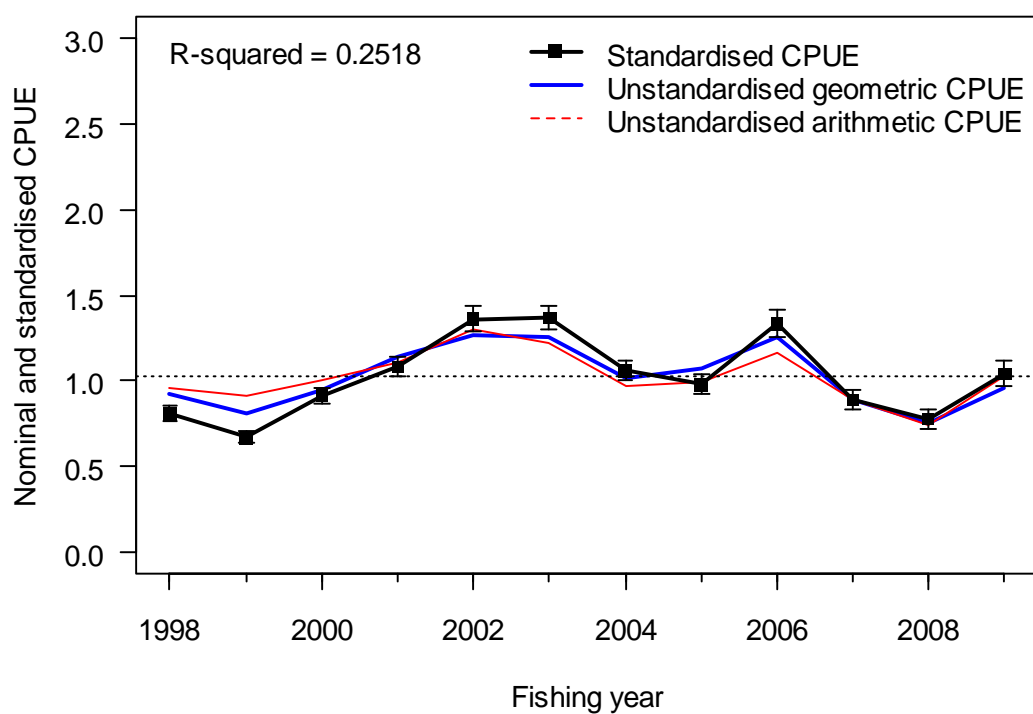

Figure D3a: ECSI/CHAT CPUE Model 1: Standardised, geometric and arithmetic CPUE indices for LDO 1998–2009.
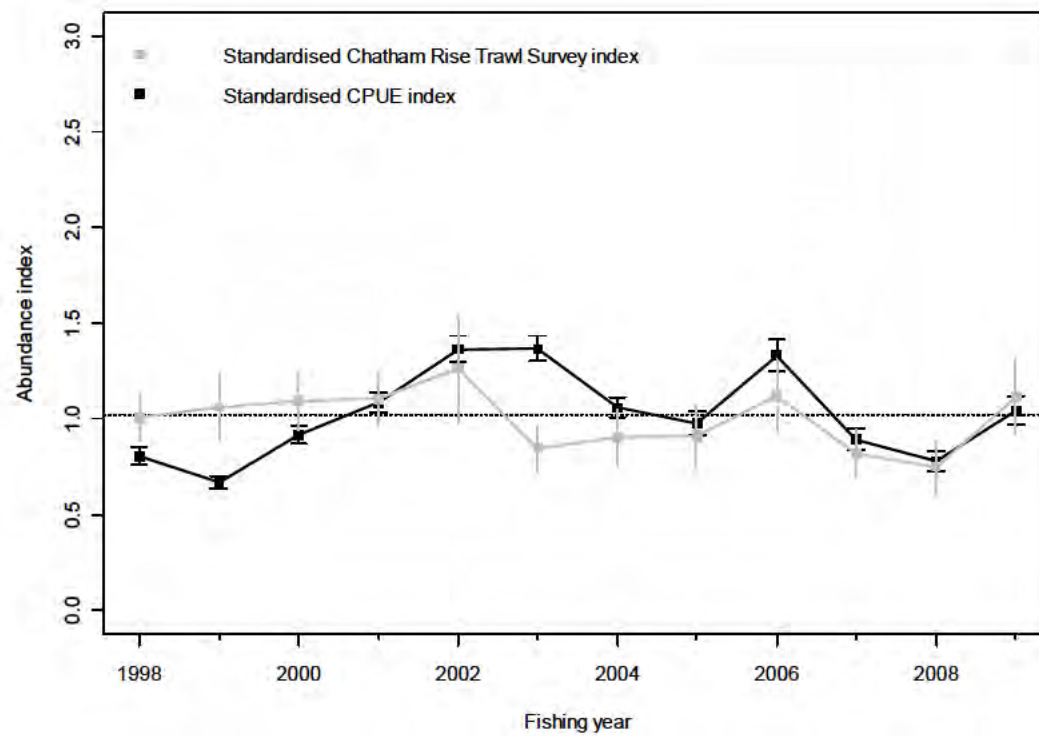
Figure D3b: Comparison of standardised ECSI/CHAT CPUE and standardised Chatham Rise Trawl Survey indices for LDO 1998–2009.
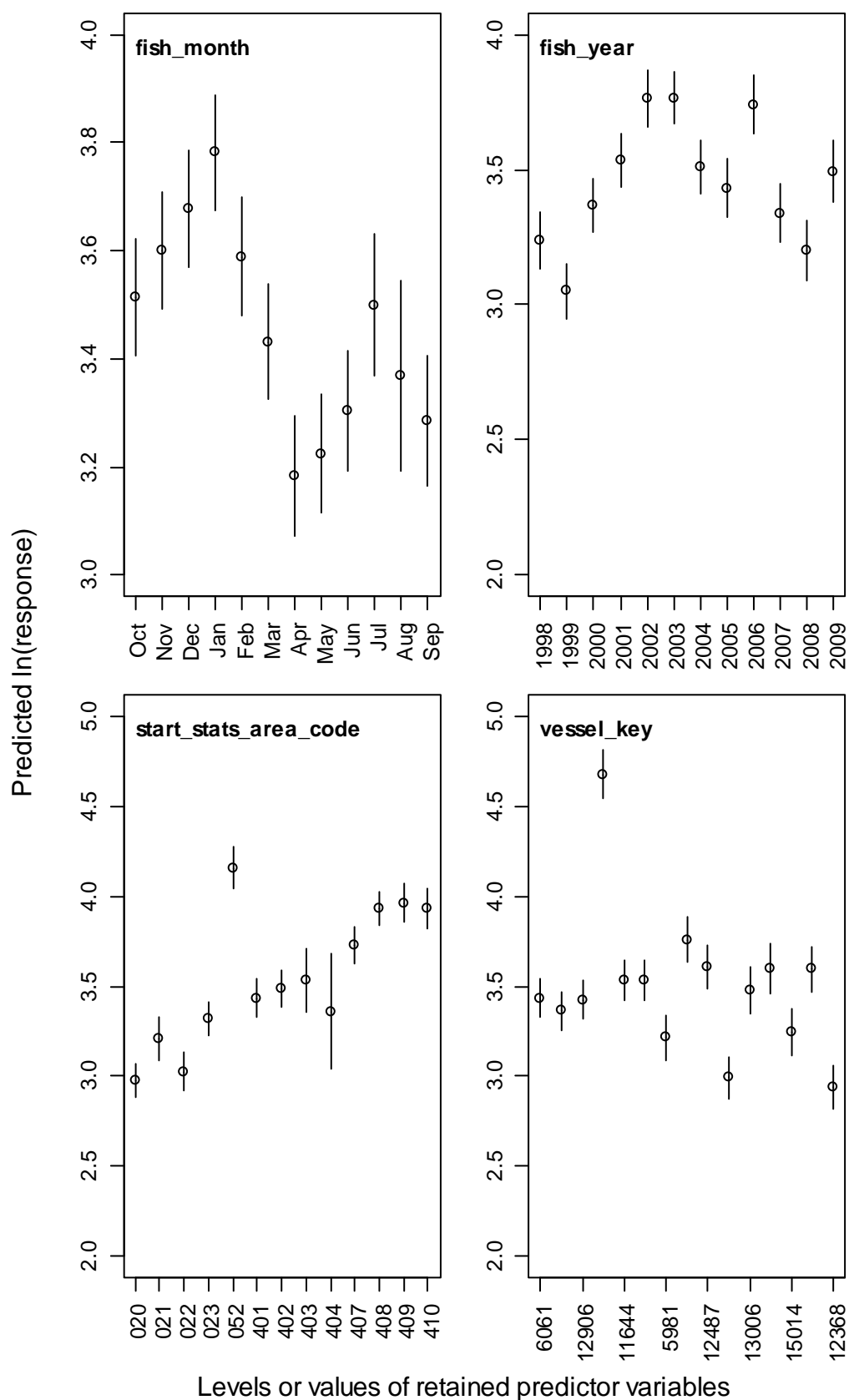
Figure D4: ECSI/CHAT CPUE Model 1 (Predictor variables retained in the GLM analysis and their distributions by factor levels).
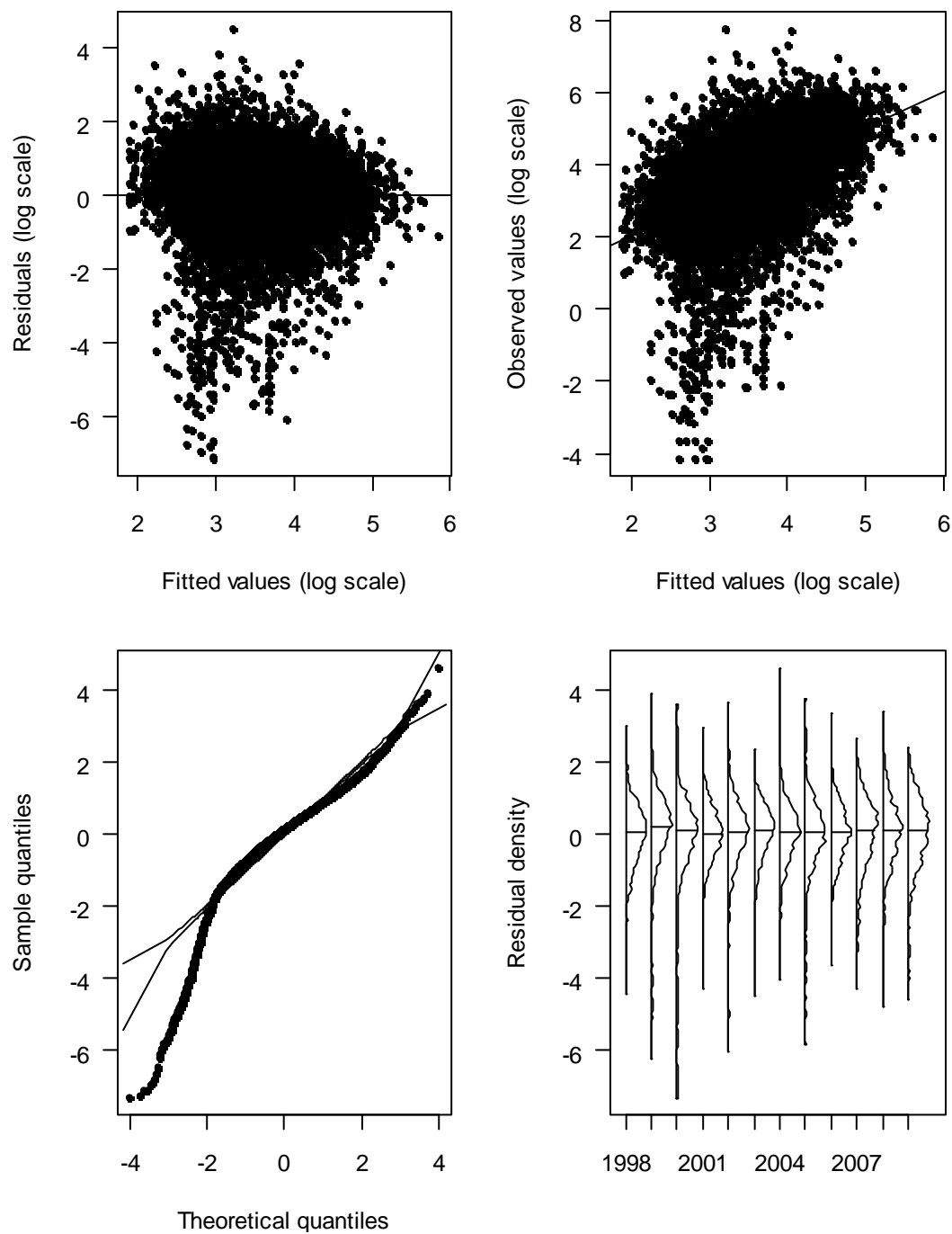
Figure D5: ECSI/CHAT CPUE Model 1: Residual diagnostic plots describing the fit of the GLM CPUE model.