Ministry for Primary Industries
Manatū Ahu Matua

Fishery characterisation and standardised CPUE analyses for gemfish (*Rexea solandri*) in SKI 3 and SKI 7, 1989–90 to 2012–13

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EXECUTIVE SUMMARY

Gemfish occur on the continental shelf and slope in depths of 50–550 m and are rarely caught in waters away from the mainland coastline of New Zealand. Evidence from commercial catch landings, patterns in year class strengths, and evidence of spawning fish suggests that this species has two stocks in New Zealand waters.

Gemfish (*Rexea solandri*) catches in the areas recognised as representing the southern stock in New Zealand waters (SKI 3 and SKI 7) showed a large decline over the fishing years 1989–90 to 2012–13, with most of the decline after the early-1990s. A similar decline was experienced in Australian populations of gemfish at a similar time. Environmental factors affecting recruitment and overfishing are considered the most likely causes.

Most of the SKI 3 catch has come from the Stewart-Snares shelf and Puysegur waters in the southern area of SKI 3, with a smaller proportion from off the east coast of the South Island. Reported annual landings in SKI 3 dropped from 1000–2000 t in the late 1980s to under 500 t in 1991–92 and under 100 t per year for most years since. A slight increase in landings occurred during the early-mid 2000s, but from 2005–06 on landings have generally been less than 30 t. Gemfish catch from SKI 3 was mainly as bycatch from the larger vessel fleet that used bottom trawls to target arrow squid (*Nototodarus* spp.) and a variety of middle depth species, including gemfish. Reported annual landings from SKI 7 were about 1000 t during the late 1980s, about 320–585 t in the early 1990s, about 50–270 t until 2002–03 when for two years the TACC of 300 t was overrun with landings of 542 and 635 t. Since then reported landings have been close to the TACC. The larger vessel fleet caught gemfish when targeting hoki (*Macruronus novaezealandiae*), barracouta (*Thyrsites atun*), silver warehou (*Seriolella punctata*), and gemfish primarily with bottom trawls in Statistical Areas 034 and 035. Gemfish catches from the smaller inshore fleet were mainly from targeting of tarakihi (*Nemadactylus macropterus*), ling (*Genypterus blacodes*), and gemfish in Statistical Areas 033 and 034.

Low catches over most of the time series meant that standardised CPUE was inappropriate for the two main fishery areas of SKI 3. Although catches were inconsistent in SKI 7, several CPUE analyses were run for the larger vessel fleet operating in SKI 7, using core vessel tow-by-tow data from areas 034 and 035 for the fishing years 1999–2000 to 2012–13, for a mixed target (including hoki) bottom trawl, May-September dataset, and a hoki target bottom and midwater trawl dataset for June–September. With r^2 values of 0.47 and 0.55, respectively, each lognormal model selected similar variables, except that a gear effect (headline height and wingspread variables) was evident in the hoki model, with higher catch rates from low headline bottom trawl gear. The trends were generally flat, and the effect of the binomial in the delta-lognormal model was to increase the 2004–05 indices of both models. No trend was detected for a lognormal mixed target model run for the small vessel fleet in areas 033 and 034, for October–June of 2007–08 to 2012–13 — the years for which tow-by-tow data were available. The availability of gemfish since the large decline in abundance and the sporadic nature of catches severely compromises the ability to achieve a useful dataset in either fishery.

Currently, the reported gemfish catch is the main method for monitoring the stock status of gemfish in these areas. The only relevant ongoing trawl survey series is a biennial series conducted in 30–400 m off the west coast South Island during March–April, several months before gemfish are thought to migrate from southern waters to this area to spawn (June-September). The SKI 7 observer data from the main fishing fleet operating during these spawning months, mainly to target hoki, appears to complement the trawl survey data by covering the depths at the deeper end of the gemfish range than the trawl survey. The length frequency data from the observer data provide evidence of a year class moving though from the early 2000s, but with no evidence of a further, following cohort. The combination of these two data sources provide the best resource for monitoring the southern stock of gemfish. Re-introduction of the 'Southland' trawl survey series, which identified the 50% drop in biomass in the mid-1990s, could provide valuable further information.

1. INTRODUCTION

The Ministry for Primary Industries developed a series of projects in 2010 under the 10-Year Research Programme for Deepwater Fisheries to assemble fishery and biological information to characterise the fishery and assess the status of fish stocks for which there is no robust stock assessment. Gemfish (*Rexea solandri*, Cuvier, 1832) is one of the middle depth fish species for which abundance is not routinely monitored or assessed. This report fulfils objective 1 of the Ministry for Primary Industries (MPI) project DEE201007: "To review the status of deepwater and middle depth Fishstocks not routinely assessed" and it summarises the analyses carried out for characterising gemfish fisheries in SKI 3 and SKI 7 up to 2012–13.

The overall specific objectives of this project are:

1. To characterise the fisheries by analysis of commercial catch and effort data, 1989–90 to 2012–13.
2. To carry out standardised CPUE analyses for the major fisheries where appropriate.
3. To review the indices from CPUE analyses, all relevant research trawl surveys and observer logbooks to determine any trends in biomass estimates, size frequency distributions or catch rates.
4. To review stock structure using data accessed above and any other relevant biological or fishery information.
5. To assess the availability and utility of developing a series of age frequency distributions from trawl survey and observer data.
6. To make recommendations on future data requirements (including for annual levels of observer sampling) and methods for monitoring the stocks.

1.1 Overview

Gemfish (also known as southern kingfish) are benthopelagic and occur in shelf and mid-slope waters, in 100–800 m depths, around southern Australia, including Tasmania, and New Zealand. Two distinct stocks of southern gemfish are evident in Australian waters, where commercial catches of gemfish were generally from eastern waters in 250–450 m during the winter spawning migration northwards and from western Tasmania and the Great Australian Bight (see Colgan & Paxton 1997). Two stocks are also proposed for New Zealand waters (Hurst 1988, Horn & Hurst 1999): a northern-east coast stock and a southern-west coast stock.

Hurst & Bagley (1998) summarise the available literature for biology and fishery data during the early 1990s, mainly from Australian studies. Commercial fisheries in both nations resulted in large catches in the 1980s then suffered large declines in subsequent years (Colgan & Paxton 1997, Bruce et al. 2002).

Gemfish fisheries in the southern fish stock areas (delineated as SKI 3 and SKI 7) declined sharply after peak catches of almost 7000 t in 1985–86. The Total Allowable Catch (TAC) of 4330 t was set for the southern stock from October 1986 with the introduction of the Quota Management System (QMS). Southern stock annual catches declined to under 300 t in 1994–95 (Hurst & Bagley 1998) and to 130 t in 1995–96 (Renwick et al. 1998). These catches were generally reported as bycatch from other target fisheries such as hoki (*Macruronus novaezelandiae*) and arrow squid (*Nototodarus sloanii*) (Hurst & Bagley 1998). This gemfish catch from the southern stock comes mainly from the Southland area in summer-autumn and the winter spawning grounds off the South Island west coast.

Hurst & Bagley (1997) reported a statistically significant 50% decline in gemfish biomass between 1993 and 1996 in the Southland area based on annual random trawl surveys.

2. REVIEW OF THE SOUTHERN GEMFISH FISHERIES

2.1 Commercial fisheries

Commercial catch-effort and landings reporting returns from 1989–90 to the 2012–13 fishing year (1 October to 30 September), provide the basis for the data used in this report. Tow-by-tow catch-effort data were reported on Trawl Catch Effort Processing Returns (TCEPRs) by vessels over 28 m long throughout this time period. From 1 October 2007, tow-by-tow catch-effort data were also reported on Trawl Catch Effort Returns (TCERs) by small (6–28 m) trawl vessels. Both these forms have associated landings data reported on Catch Landing Returns (CLRs).

Before 1 October 2007 trawl vessels under 28 m and vessels operating in various other fisheries including longline and setnet used Catch Effort Landing Returns (CELRs) to collect daily catch-effort and landings data by statistical area. The CELR form was replaced by the Lining Catch Effort Return (LCER) for bottom longline vessels over 28 m, a daily form introduced in January 2004, and the Lining Trip Catch Effort Return (LTCER) introduced on 1 October 2007 for smaller bottom longline vessels. The landings data for both these form types are reported on CLRs. Setnet data were reported on CELRs until the introduction of the Netting Catch Effort Landing Return (NCELR) on 1 October 2006.

Gemfish catches before 1986 are summarised by Hurst (1988) and for the southern gemfish fisheries of SKI 3 and SKI 7 by Hurst & Bagley (1998) who documented the drop in catches after the peak from almost 7000 t in 1985–86 to about 280 t in 1994–95. Reported catches by domestic and foreign-licensed fleets for 1978–79 to 1987–88 are given in Table 1; the areas from which these catches were taken are not known. Total Allowable Catch limits were applied to gemfish fisheries from the commencement of the Quota Management System on 1 October 1986. At this time, the gemfish fisheries were considered to be developing and TACs for the five fish stock areas (Figure 1, Table 2) were set at catch levels in 1983 (1984 for SKI 1) (see Fu et al. 2008). These fish stock areas equate to combinations of Fishery Management Areas (FMAs): SKI 1 (FMAs 1 & 9), SKI 2 (FMA 2), SKI 3 (FMAs 3, 4, 5, & 6), and SKI 7 (FMAs 7 & 8), and SKI 10 (FMA 10). The latter area essentially has no catch.

The initial TAC for SKI 3 was set at 2840 t, and there were small increments on an annual or bi-annual basis until 1994–95 and 1995–96 when the TAC peaked at 3355 t. In 1996–97 the TAC was reduced to 1500 t, then to 300 t in 1997–98; it has remained at this low level ever since (Table 2, Figure 2). Annual landings of gemfish in SKI 3 were highest in the 1985–86 fishing year, at 5500 t, then dropped to 1000–2000 t during 1987–88 to 1989–90. Subsequently, annual landings dropped further and in all but two years since 1992–93 less than 100 t were reported annually for SKI 3, with landings from 2004–05 under 35 t a year (see Table 2). Reported landings from SKI 3 have never exceeded the TAC. Only in the late 1980s were the landings equivalent to about 40–50% of the TAC. In the last 10 years, annual reported landings from SKI 3 were between 11 t and 78 t.

The initial TAC for SKI 7 was set at 1490 t, and there were small increments on an annual or bi-annual basis until 1992–93 when the TAC was set at 1663 t where it remained until the end of 1995–96. In 1996–97, it was decreased to 900 t, then dropped further to 300 t in 1997–98 for the remaining years. Annual reported landings from SKI 7 decreased from over 1000 t in the mid-late 1980s, to a low of 44 t in 1997–98. Landings increased subsequently and were generally below the annual TAC of 300 t, except in 2003–04 and 2004–05 when 542 t and 635 t were reported, and again in 2010–11 when landings totalled 301 t.

In summary, SKI 3 reported landings are generally well below the TAC, with annual landings from 2005–06 to 2012–13 generally less than 10% of the TAC of 300 t, whereas annual landings from SKI 7 for those years ranged from 50–100% of the TAC.

This report is for the southern gemfish stock in fish stock areas SKI 3 and SKI 7. To better represent the effort and catch within SKI 3, the area has been divided into a 'Chatham' area, which includes Statistical Areas

018–024, 301, 401–412, 049–052 across the Chatham Rise (FMAs 3 & 4), and a 'South' area consisting of Statistical Areas 025–032, 302, 303, 501–504, and 601–625 (see Figure 1).

Table 1: Reported gemfish catch (t) from 1978–79 to 1987–88. Source - MAF and FSU data. NA = unknown catches. [From Ministry for Primary Industries (2014).]

Fishing year	New Zealand		Foreign Licensed			
	Domestic	Chartered	Japan	Korea	USSR	Total
1978–79*	352	53	1 509	1 079	0	2 993
1979–80*	423	1 174	1 036	78	60	2 771
1980–81*	1 050	NA	NA	NA	NA	> 1 050
1981–82*	1 223	1 845	391	16	0	3 475
1982–83*	822	1 368	274	567	0	3 031
1983–83†	1 617	1 799	57	37	0	3 510
1983–84‡	1 982	3 532	819	305	0	6 638
1984–85‡	1 360	2 993	470	223	0	5 046
1985–86‡	1 696	4 056	2 059	442	0	8 253
1986–87‡	1 603	2 277	269	76	0	4 225 §
1987–88‡	1 016	2 331	90	35	0	3 472 §

* 1 April–31 March.
§ These totals do not match those in Table 2 due to under-reporting to the FSU.
† 1 April–30 September.
‡ 1 October–30 September.

Table 2: Reported landings (t) of gemfish by fish stock from 1983–84 to 2012–13 and actual TACs from 1986–87. [From Ministry for Primary Industries (2014).]

Fishstock FMA (s)	SKI 1 1 &		SKI 2		SKI 3 3, 4, 5, &		SKI 7 7 &		SKI 10 10		Total	
	Landings	TAC	Landings	TAC	Landings	TAC	Landings	TAC	TAC	Landings	TAC	
1983–84*	588	-	632	-	3 481	-	1 741	-	† -	6 442 §	-	
1984–85*	388	-	381	-	2 533	-	1 491	-	† -	4 793 §	-	
1985–86*	716	-	381	-	5 446	-	1 468	-	† -	8 011 §	-	
1986–87	773	550	896	860	2 045	2 840	1 069	1 490	†10	4 783	5 750	
1987–88	696	632	1 095	954	1 664	2 852	1 073	1 543	†10	4 528	5 991	
1988–89	1 023	1 139	1 011	1 179	1 126	2 922	1 083	1 577	†10	4 243	6 827	
1989–90	1 230	1 152	1 043	1 188	1 164	3 259	932	1 609	†10	4 369	7 218	
1990–91	1 058	1 152	949	1 188	616	3 339	325	1 653	†10	2 948	7 342	
1991–92	1 017	1 152	1 208	1 197	287	3 339	584	1 653	†10	3 096	7 350	
1992–93	1 292	1 152	1 020	1 230	371	3 345	469	1 663	†10	3 152	7 401	
1993–94	1 156	1 152	1 058	1 300	75	3 345	321	1 663	†10	2 616	7 470	
1994–95	1 032	1 152	905	1 300	160	3 355	103	1 663	†10	2 169	7 480	
1995–96	801	1 152	789	1 300	49	3 355	81	1 663	†10	1 720	7 480	
1996–97	965	1 152	978	1 300	58	1 500	238	900	†10	2 240	4 862	
1997–98	627	752	671	849	27	300	44	300	†10	1 369	2 211	
1998–99	413	460	336	520	17	300	59	300	†10	825	1 590	
1999–00	409	460	506	520	62	300	107	300	†10	1 083	1 590	
2000–01	335	460	330	520	47	300	87	300	†10	799	1 590	
2001–02	201	210	268	240	72	300	123	300	†10	664	1 060	
2002–03	206	210	313	240	115	300	268	300	†10	902	1 060	
2003–04	221	210	301	240	78	300	542	300	†10	1 142	1 060	
2004–05	234	210	259	240	72	300	635	300	†10	1 199	1 060	
2005–06	230	210	182	240	27	300	248	300	†10	687	1 060	
2006–07	215	210	317	240	26	300	209	300	†10	767	1 060	
2007–08	216	210	249	240	18	300	179	300	†10	662	1 060	
2008–09	191	210	191	240	11	300	213	300	†10	606	1 060	
2009–10	247	210	176	240	20	300	144	300	†10	587	1 060	
2010–11	226	210	300	240	33	300	301	300	†10	860	1 060	
2011–12	212	210	155	240	11	300	260	300	†10	638	1 060	
2012–13	182	210	140	240	23	300	234	300	†10	580	1 060	

* FSU data.
§ The totals do not match those in Table 1 because some fish were not reported by area (FSU data prior to 1986–87).
† No recorded landings
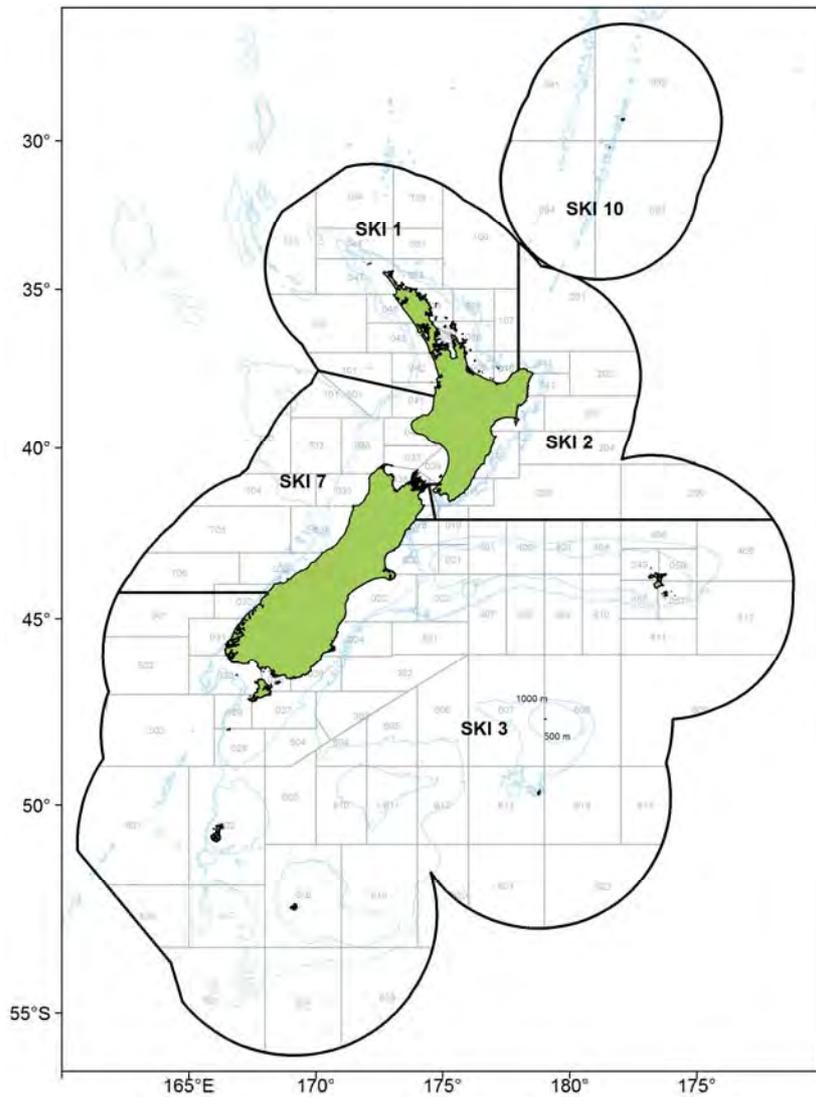
Figure 1: Map showing the administrative fish stock boundaries for SKI 1, 2, 3, 7, and 10, including statistical areas, and the 500 m and 1000 m depth contours.
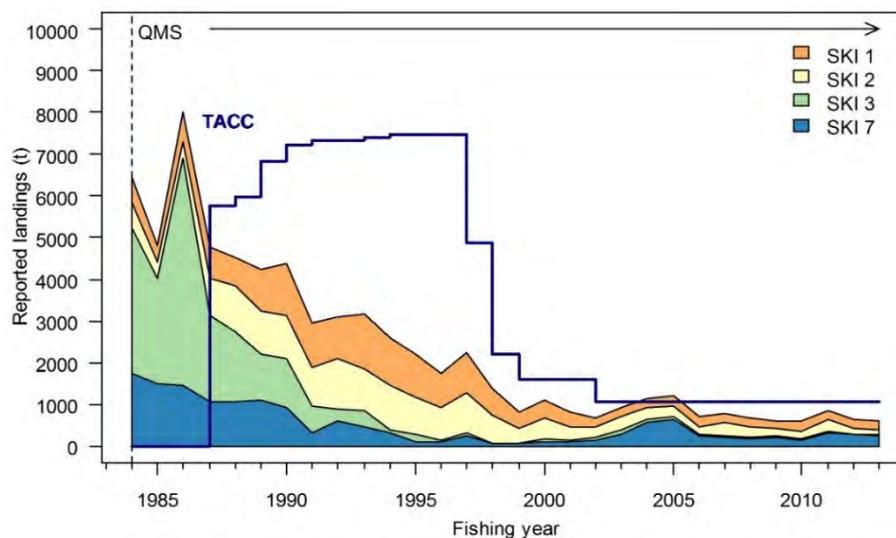

Figure 2: Total reported landings by Fishstock, and the total TACC (solid blue line), for 1983–84 (1984) to 2012–13 (2013).

2.2   Recreational fisheries

There was no recreational catch reported in marine recreational fishing catch and effort surveys of the MAF Fisheries South and Central regions (1991–92 and 1992–93, respectively). There is known to be a target recreational fishery in the Bay of Plenty (i.e., in the northern gemfish stock). The recently completed national panel survey of New Zealand recreational fishing gave an estimated total NZ harvest of just under 3000 fish (MPI unpublished data). There is a national recreational allowance of 10 t per year.

2.3   Customary non-commercial fishery

Quantitative information on the current level of customary non-commercial catch is not available. There is an annual customary allowance of 6 t.

2.4   Illegal and misreported catch

The amount of gemfish misreported is not known and is assumed to be negligible.

2.5   Other sources of mortality

There may have been some gemfish discarded prior to the introduction of the EEZ, but this is likely to have been minimal since the early 1980s because gemfish is a medium value species.

2.6   Regulations affecting the fishery

Current and historical limits on catch and effort in gemfish fisheries are described in Section 2.1. Cod-end minimum mesh size regulations that currently apply to the trawl fisheries are 60 mm for Sub-Antarctic (FMA 6) fisheries and FMA 5 south of 48° S; and 100 mm elsewhere. From 1 October 1977, the cod-end mesh size change took effect at the boundary between the Snares Islands and the Auckland Islands fisheries at 48° 30' S. The management area boundary was changed on 1 October 1983 to 49° S to allow targeting of squid around the Snares Islands (Hurst 1988).

Catches of protected species such as corals, seabirds, and marine mammals are monitored through the government observer programme and all trawl vessels over 28 m were required to deploy seabird mitigation devices to minimise interactions with trawl warps since April 2006. Bottom longline fisheries were also required to mitigate against seabird captures and setnet fishers had area restrictions to mitigate captures of marine mammals, in particular Hector's and Maui's dolphins (*Cephalorhynchus hectori*, *C. hectori maui*). From 1 October 2008, all commercial fishers were required to record on their catch-effort forms whether they caught any non-fish species or protected fish species and to provide details on the Non-fish Protected Species Catch Return. Bottom trawling is prohibited within the Benthic Protected Areas (Ministry for Primary Industries 2014).

3.   BIOLOGY AND DISTRIBUTION

3.1   Distribution

Gemfish occur on the continental shelf and slope mainly in depths of 50–550 m, generally between 34° S and 49° 30' S and 165° E and 177° W (Anderson et al. 1998). The depth distributions of juvenile, immature, and adult gemfish are similar, with most between 250 and 400 m (Hurst et al.

2000). Gemfish appear to be less common away from the mainland New Zealand coast, such as on the Chatham Rise or the Southern Plateau (Hurst 1988).

Presence-absence analyses from bottom trawl surveys undertaken during 1961 to 1997 around New Zealand placed gemfish in depths of 120–550 m between 36° and 48° S in the shelf assemblage which primarily consisted of arrow squid, spiny dogfish (*Squalus acanthius*), barracouta (*Thyrsites atun*), tarakihi (*Nemadactylus macropterus*), school shark (*Galeorhinus galeus),* red cod (*Pseudophycis bachus*), silver warehou (*Seriolella punctata*), and rig (*Mustelus lenticulatus*) (Francis et al. 2002). In the southern waters of the Stewart-Snares shelf (Statistical Areas 025–030), data from trawl surveys in 1983 and 1986 indicated that gemfish were part of a shallow assemblage (in under 300 m) with spiny dogfish, red cod, barracouta, giant stargazer (*Kathetostoma giganteum*), and school shark (Jacob et al. 1998). Beentjes et al. (2002) found that for areas where the above species were found on the outer shelf of the east coast South Island (Statistical Areas 020, 022, and 024), during trawl surveys undertaken in 1991–99, gemfish and school shark were absent in both summer and autumn surveys in 30–400 m.

Gemfish was classified in the "shallow" (200–400 m) species group by Livingston et al. (2003), based on observed and trawl survey data from the Chatham Rise during 1989–90 to 1998–99. The authors reported that estimated gemfish catches were very small at the start of the time period and were almost non-existent by the end.

Gemfish make northward migrations during autumn to winter-early spring spawning grounds (Hurst 1988). Length-frequency data from two seasonal surveys of Southland waters in 1986 showed that fish over 70 cm were not caught in June but were in November (Hurst & Bagley 1998). The commercial catch data indicated that these fish may have migrated to spawn off the South Island west coast in August-September, and observer and research trawl survey data record the presence of ripe and running ripe female gemfish in this area during winter (see Horn & Hurst 1999). Some records of ripe female gemfish were from the Stewart-Snares shelf and the western Chatham Rise. Horn & Hurst (1999) report that young gemfish (15–30 cm long, 6–12 months old) were caught off the South Island west coast.

Catch rates of gemfish indicate a strong diurnal pattern and peak bottom trawl catches were between dawn and dusk based on the mid-1980s to mid-1990s data analysed by Hurst & Bagley (1998).

3.2   Stock structure

Two stocks of gemfish have been proposed for New Zealand waters, based on the analysis of seasonal patterns of commercial catches (Hurst 1988, Hurst & Bagley 1998). The northern stock is caught mainly off the North Island east coast, in SKI 2 during spring-autumn and is thought to migrate north to spawn during winter, to the Bay of Plenty and North Cape in SKI 1. The southern stock is caught in SKI 3, mainly off the Southland coast, during spring-autumn and is thought to migrate to spawn in waters off the South Island west coast (SKI 7) where it is caught during August-September.

Horn & Hurst (1999) used a combination of patterns in year class strengths, trends in commercial landings, and evidence of spawning fish as the basis for the delineation of stocks, and proposed that age-frequency distributions provide the strongest evidence currently available for the existence of at least two stocks of gemfish in New Zealand waters. Their work separates the Southland fish from those caught off the east and west coasts of the North Island, and they note that although the east coast South Island gemfish are included in the southern spawning stock, the data from this area are not substantial enough for an assessment of stock affinity. In a separate study on the effect of climate on gemfish distribution, Renwick et al. (1998) reported the same strong year class patterns from length frequency data from the west coast South Island gemfish to those seen in Southland data. The presence of strong year classes in these two areas was strongly correlated with several climatic variables: less than average strength south-westerly winds off the west coast South Island and higher than average sea surface temperatures (Renwick et al. 1998). Thresher (1994) proposed that declining zonal

westerly winds in the late 1980s which led to a periodic fall in recruitment of gemfish in south-eastern Australian waters, in combination with overfishing, resulted in depletion of the spawning stock.

Biochemical analyses using protein electrophoretic methods and mitochondrial DNA techniques found no clear distinction between gemfish populations from the southern east coast of Australia and those from New Zealand and suggested that there may be a very low level of mixing between the two areas (Colgan & Paxton 1997).

3.3   Spawning

Evidence of spawning in the southern gemfish fisheries comes mainly from the observer data, with most ripe and running ripe female fish reported from observer effort off the west coast of the South Island from tows during the main spawning months of other species including hoki: June–September (see Section 5.0, Figure B6 in Appendix B). Fish are generally mature at over 45 cm (2+ fish, see below).

3.4   Age and growth

Horn & Hurst (1999) calculated age-frequency distributions and von Bertalanffy growth curves (based on a combination of length-based and otolith-based age data for four areas). Female fish grow faster than males and attain a larger size. Gemfish exhibit no geographical differences in overall growth rate throughout New Zealand waters, though the Southland data indicated that growth rates may vary between years (Horn & Hurst 1999). Data from the Southland area suggested that fish at 30, 42, 52, and 59 cm are aged 0.8, 1.8, 2.8, and 3.8 y respectively, based on a birth-date of 1 August.

Horn & Hurst (1999) identified similarities between the age distributions of the two SKI 1 northern spawning fisheries (i.e., west Northland and north-east North Island) and a similar pattern in the SKI 2 fishery. Age distributions from the SKI 3 fishery were slightly different from the northern spawning fisheries, but there were no significant differences in the von Bertalanffy growth parameters calculated for northern and southern gemfish (Horn & Hurst 1999).

3.5   Natural mortality

Horn & Hurst (1999) estimated instantaneous natural mortality (M) for both sexes combined for all areas, as likely to be in the range of 0.2–0.3 y^{-1} using the method of Sparre et al. (1989).

3.6   Length-weight relationship

The length-weight relationship used for southern gemfish is from the MPI *trawl* database and used for the trawl surveys off the west coast of the South Island (see MacGibbon & Stevenson 2013), where $a = 0.001704$ and $b = 3.341944$ for the equation weight (g) $= aL^b$ where L is fork length (cm).

3.7   Feeding and trophic status

Feeding records from 30–105 cm long gemfish caught in Southland waters indicated that teleost fish were the most important prey, with jack mackerel species and hoki the most common prey from those identified (Stevens et al. 2011). Squids were also important and were mainly *Nototodarus* spp. Overall, at least 20 teleost species and three invertebrate groups in three phyla were identified, and there were no consistent differences in diet for different sizes of fish (Stevens et al. 2011). Earlier studies, summarised by Stevens et al. (2011), also found a variety of fish and squids from fish caught at Otago and Cook Strait, with *Munida gregaria* also present in Otago gemfish stomachs.

4.0 FISHERY INDEPENDENT OBSERVATIONS

4.1 Research surveys

Bottom trawl surveys in waters within the depth range of gemfish and in areas within the SKI 3 and SKI 7 fishery areas are summarised in this section. Hurst & Bagley (1998) summarised historical trawl survey catches of gemfish in these areas, noting that catches were reported from towards the edge of the continental shelf around much of the South Island, with few or no catches from across the Chatham Rise or in sub-Antarctic waters. Evidence from trawl surveys undertaken throughout the 2000s confirms this and a short summary is given below for the long-term *Tangaroa* survey series. For other shorter series with relevance to gemfish, the trawl survey data are summarised and presented in Section 4.2 below.

Ongoing *Tangaroa* trawl surveys
The main on-going trawl survey series that have occurred in SKI 3 and SKI 7 are the Chatham Rise and sub-Antarctic trawl surveys. Trawl surveys undertaken by R.V. *Tangaroa* for the core depth range of 200–800 m across the Chatham Rise during January between 1992 and 2010 indicated that few gemfish were caught during these surveys, with catches reported from only 3 of the 19 surveys (O'Driscoll et al. 2011). These catches were from 5 tows from the 1993, 1994, and 1995 surveys and represented a total catch weight of 40.8 kg. No gemfish have been reported from subsequent annual surveys in this series (Stevens et al. 2012, 2013, 2014).

The *Tangaroa* sub-Antarctic trawl survey series (with a core depth range of 300–800 m) confirmed the small catches of gemfish from these depths. Bagley et al. (2013a) summarised 13 years of trawl surveys from this series (November-December, 1991–2010). Although 12 of the 13 surveys recorded gemfish catch, generally only one or two tows had catch and the total catch was under 220 kg. The two subsequent surveys in this series, in 2011 and 2012, caught a total of 36.5 kg from 3 tows (Bagley et al. 2013b, 2014).

A series of winter trawl and acoustic surveys off the west coast South Island to provide estimates for hoki, hake (*Merluccius australis*), and ling (*Genypterus blacodes*) began in 2012 (O'Driscoll et al. 2014). Previously acoustic surveys had been used in this area (reviewed by O'Driscoll 2002), with the last acoustic survey in 2000 (O'Driscoll et al. 2004). The strata used in the earlier acoustic time series were used in 2012 and 2013, and additional strata were included to satisfy other objectives, one of which was to improve the trawl indices for several species including gemfish. Occasional, very small catches of gemfish were reported from the 2012 (57.5 kg) and 2013 (43.6 kg) surveys.

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

4.2.1 Historic Southland trawl survey series using *Tangaroa*, 1993–96

The most appropriate trawl surveys for gemfish sampling were from the Southland area that includes the waters of the Stewart-Snares shelf and off Puysegur Bank (in the FMA 5 area). This series has a small spatial overlap with the sub-Antarctic series (summarised above), particularly near Puysegur Bank, but with the core strata set at depths of 30–600 m the Southland survey covered a larger range of depths preferred by this species than did the sub-Antarctic series.

Hurst & Bagley (1997) summarised the four consecutive annual surveys undertaken by *Tangaroa* in this area during February-March of 1993–1996. This series was optimised for 10 species, including the monitoring of gemfish (Hurst & Bagley 1994). These survey data are summarised in Table 3a and distributions are plotted in Figures A1 and A2 in Appendix A. Catch rates varied from 3.0 kg.km^{-2} to 447 kg.km^{-2}. Most research tows with gemfish were between 46° and 48° 30' S, in depths of 100–200 m, on the Stewart-Snares shelf and Puysegur Bank (see Hurst & Bagley 1997).

There was a statistically significant decline of 50% in gemfish biomass between the 1993 and 1994 surveys, with little change in the annual biomass estimates for the subsequent two surveys (Hurst & Bagley 1997, see also Table 3a and Figure A1). Few differences were found in the male and female biomass each year. A comparison of this survey series with summer/autumn surveys using *Shinkai Maru* in the early-mid 1980s suggested that the biomass a decade earlier was substantially larger than the biomass estimated for 1993 (Hurst & Bagley 1997, 1998).

Length frequency distributions were determined using SurvCalc (Francis & Fu 2012) which involves scaling by the percentage sampled and area trawled to estimate the population in the survey area available to the trawl. The length-weight coefficients used to determine the frequencies are from the reports of each trawl survey listed in Table 3a.

Fish ranged in size from about 55 cm to 108 cm, and most fish over about 90 cm were females (see Figure A2). Two modes were evident in the distribution of the 1993 season data. The length frequency data show the movement of the 1989 year class as age 3+ fish at 60 cm in 1993 through to 6+ fish at about 80 cm in 1996 (Hurst & Bagley 1997). Hurst & Bagley (1997) noted that fish as young as 1+ (about 30 cm) should be able to be sampled by the research trawl gear and that there appeared to be no further cohort moving through. Data from the observer programme appear to show a similar lack of recruitment for this area until 2002 when fish smaller than 40 cm were caught (see Figure B3 in Appendix B). Fish from the catch represented by the observer data were likely to be caught closer to the shelf edge than those from the trawl surveys, based on the target species of most observer data (compare figure 6g and figure 8 of Hurst & Bagley (1997)).

The distributions of length data from all male and female gemfish records in the trawl survey database are shown in Figure A3. Larger fish appear to dominate on the Stewart-Snares shelf, whereas both small and large fish were caught off the west coast South Island. Few fish under 30 cm were reported; fish of this size were mainly from off the northern South Island west coast (males) and the southern part of the Stewart-Snares shelf (females). There were no ripe or running ripe females in the fish staged during surveys in the Southland area (Figure A4).

Table 3a: Relative biomass indices (t) and coefficients of variation (CV) for gemfish from the Southland *Tangaroa* (TAN) trawl survey series* (with assumptions: areal availability, vertical availability, and vulnerability = 1). The estimates were produced using NIWA's research trawl survey analysis program "SurvCalc" (Francis & Fu 2012).

Trip code	Date	Reference	Biomass (t)	% CV
TAN9301	Feb–Mar 1993	Hurst & Bagley (1994))	1 066	17
TAN9402	Feb–Mar 1994	Bagley & Hurst (1995)	406	18
TAN9502	Feb–Mar 1995	Bagley & Hurst (1996a)	539	25
TAN9604	Feb–Mar 1996	Bagley & Hurst (1996b)	530	23

*   A summary of this trawl survey time series is given by Hurst & Bagley (1997).

4.2.2   On-going west coast inshore trawl survey series using *Kaharoa*, 1992–2013

The RV *Kaharoa* surveys in inshore waters during March-April off the west coast of the South Island and Tasman Bay and Golden Bay (core strata 20–400 m) caught gemfish in the west coast strata and the main results from this time series are summarised in Table 3b based on MacGibbon & Stevenson (2013). This series has been conducted on a biennial basis since 2003, with few differences between subsequent annual biomass estimates at about 100–150 t, other than in 2005, when the estimate was much greater, but not significantly different due to the large CV (Table 3b, Figure A5).

Length frequency data from this March-April survey series indicate that smaller fish are caught in this survey (Figure A6). There appears to be some progression of a year class from 1992 (at about 45 cm) of fish that Stevenson & Hanchet (1999) suggest represent 2+ fish from the strong 1989 year class

through to 6+ fish in 1997 (at 80 cm). A similar pattern is seen in the trawl survey data from 2003 through to 2007, although fewer than 50 fish were measured in 2007 and in each of the subsequent three surveys. The observer data from June-September suggest that the 1989 year class was first captured in 1991 (length mode about 45 cm) and that the 1992 data represent the 3 year-old fish at about 53 cm (compare Figure A6 with Figure B4 in Appendix B). There is a similar modal progression from 2003 to 2007 evident in the observer data (see Figures A6 and B4).

No female fish from these March-April surveys were staged as ripening or running ripe (see Figure A4).

Table 3b: Relative biomass indices (t) and coefficients of variation (CV) for gemfish from the west coast South Island inshore *Kaharoa* (KAH) trawl survey series* (with assumptions: areal availability, vertical availability, and vulnerability = 1). The biomass estimates are from MacGibbon & Stevenson (2013), based on the "SurvCalc" analysis program (Francis & Fu 2012).

Trip code	Date	Reference	Biomass (t)	% CV
KAH9204	Mar–Apr 1992	Drummond & Stevenson (1995a)	145	18
KAH9404	Mar–Apr 1994	Drummond & Stevenson (1995b)	68	29
KAH9504	Mar–Apr 1995	Drummond & Stevenson (1996)	21	55
KAH9701	Mar–Apr 1997	Stevenson (1998)	704	83
KAH0004	Mar–Apr 2000	Stevenson (2002)	120	30
KAH0304	Mar–Apr 2003	Stevenson (2004)	137	23
KAH0503	Mar–Apr 2005	Stevenson (2006)	474	49
KAH0704	Mar–Apr 2007	Stevenson (2007)	101	19
KAH0904	Mar–Apr 2009	Stevenson & Hanchet (2010)	143	29
KAH1104	Mar–Apr 2011	Stevenson (2012)	101	34
KAH1305	Mar–Apr 2013	MacGibbon & Stevenson (2013)	113	28

Comparison of the raw length data from an acoustic trawl survey off the South Island west coast using *Tangaroa* in late June-early July, then late July to late August 2000 indicated a similar size range to that from the *Kaharoa* survey series.

For both the Southland survey in February-March using *Tangaroa*, and the March-April west coast survey using *Kaharoa*, fish under 40 cm were infrequently sampled. No clear information was gained on gemfish recruitment, with some year classes completely, or near to, absent; although there did appear to be evidence of a 2000 year class in the mid-2000s off the South Island west coast.

Catches of gemfish in other trawl survey series were infrequent and small, and hence no other trawl survey series are included in this section.

5.0   FISHERY DEPENDENT OBSERVATIONS

5.1   Observer data

All tables and figures relating to MPI observer data collected from southern gemfish fisheries are provided in Appendix B (Tables B1–B7, Figures B1–B7). The observed effort is presented for SKI 3 and SKI 7. The SKI 3 area is split into two subareas, where 'Chatham' is the effort across the Chatham Rise between latitudes 42° and 46° S and 'South' is the area south of 46° S off the east coast and south of 44° 11' S off the west coast. The distribution of this observed effort is shown in Figure B1. The number of observed trips and tows, including those with gemfish catches, are given by fishing year for each area in SKI 3 (Chatham and South) and SKI 7 in Table B1. Most of the Chatham observed tows with gemfish catch were off the shelf west of 175° E. Data were analysed by fishing year (1 October to 30 September), and each fishing year referred to as the most recent year (that is, 1990 for the 1989–90 fishing year).

Observed trips in SKI 7 were more likely to have gemfish catches: 65% of observed trips in SKI 7 caught gemfish (annual range 31–81%) compared with 22% in the SKI 3 Chatham area (4–41%) and 46% in the SKI 3 South area (21–67%).

The amount of observer effort in these areas has been relatively steady throughout the time series, with a slightly increasing trend in the number of trips for SKI 7 and a more pronounced increase for SKI 3 South. In 2013, all areas showed a large increase in observer effort. There were marked differences in the observed effort reported from the SKI 3 areas and SKI 7. The amount of effort was greatest in the SKI 3 South fishery area; median number of observed tows for a year was 3012 for SKI 3 South, 1846 for the SKI 3 Chatham area, and 1684 for SKI 7.

The total observed catch from SKI 7, at 760 t, was three times that from South, which in turn was 10 times that from the Chatham area. Generally under 4.0% of the annual observed tows in Chatham reported gemfish catches (median of 1.1%) and under 10% of annual observed tows in South reported gemfish (median of 6.5%). In comparison, the median percentage of annual observed tows with gemfish catches from SKI 7 was 19.2%, with higher percentages of successful tows in fishing years 1990–96, 2002–06, and 2009–13. The fishing years with the highest annual observed catches from SKI 7 were 1990–94 (32–65 t per year), 2004–06 (36–94 t), and 2012 and 2013 (78–82 t per year). This pattern of catches was similar to that reported from South, though the South catches were relatively small in comparison.

Most observed effort in the Chatham area of SKI 3 targeted middle depths and deepwater species, and the target species with the greatest number of tows with gemfish catch were hoki, barracouta, arrow squid, and silver warehou (Table B2). Overall, 1.8% of the observed tows had gemfish records. Similar target species effort was observed in the South area and 7.4% of observed tows had gemfish catch, and 75% of observed tows with gemfish catch targeted arrow squid. The effort observed in SKI 7 was primarily targeted at hoki and hake (68% over the time period), with the remainder mainly for jack mackerels (25%). Of the SKI 7 observed tows, 21% caught gemfish, and 90% of these targeted hoki and hake.

For fishing years 1990 to 2013, 2% of the 1019 t of total gemfish catch reported by observers in SKI 3 and SKI 7 was from the Chatham part of SKI 3, 23% from South, and 75% from SKI 7. Gemfish catches reported by observers were generally small, with median catch weights per tow of 10–17 kg depending on the area (Table B3).

About 56% of the catch from SKI 3 Chatham was from arrow squid effort (mainly April-May) and barracouta (mainly October-February), with another 36% from effort targeted at hoki (most in October), silver warehou (October-December, April), and spiny dogfish (December-January) (see Table B3). Over 62% of the observed gemfish catch in the SKI 3 South fishery area was from tows that targeted arrow squid (with most catch during January-April), another 15% from barracouta tows (mainly November-April), and 14% from white warehou (most in November) and silver warehou tows (November-March). In SKI 7, over 65% of the observed gemfish catch was from hoki tows (mainly in July-September), another 19% from barracouta tows (mostly in September and October), and the remainder from hake, gemfish, silver warehou, and jack mackerel tows, with most catch during July-October.

The spread of the observed catch relative to the commercial catch, for each area, is shown in Figure B2 by month for each fishing year. For all areas, there is a mismatch for the months outside fishing seasons for the main target species. For example, in SKI 3 South, where squid is the main target in observed effort and effort is generally February to April, there is under-sampling of the catch from early summer (November-January) and late autumn (May). In SKI 7, the relative amounts of catch for commercial and observed data are reasonably well matched until the mid-2000s when a larger proportion of the commercial catch was from months outside the main winter spawning period when fisheries occur in this area, and generally there is greater observer coverage (July–September). This catch, for a large part, represents the catch taken by vessels targeting other species such as ling, gemfish, silver warehou, and tarakihi during late summer-autumn (see Figure C32 in Appendix C).

Observers measured, sexed, and staged a proportion of the observed gemfish catch (Tables B4–B7). This sampling is dependent on the size of the catch and varied greatly by year in each area. Overall, 423 fish were sampled from 93 tows in SKI 3 Chatham; 6287 gemfish from 1147 tows in SKI 3 South; and 11 896 from 1805 tows in SKI 7. The months with the most tows sampled, by area, were March–May for Chatham, January–April for South, and July–September for SKI 7. In both South and SKI 7, the most consistent years in which gemfish were sampled (across the main months of the target fisheries) were the early 1990s and in the early-mid 2000s. Since the mid-2000s the numbers sampled have been variable in both areas, in numbers of fish as well as the months from which the samples were taken. In the SKI 3 areas, more females were generally sampled than males (see Table B6), whereas in SKI 7 this effect was not so pronounced, though generally more females than males were measured in the main months of observation (and sampling), i.e., July-September.

In total, the reproductive stages of 11 095 female gemfish were recorded, 2% from SKI 3 Chatham, 38% from SKI 3 South, and 60% from SKI 7 (Table B7). In each area there was large variation in the numbers of females staged, by year and by month.

5.1.1 Length frequency distributions

Scaled length frequency distributions were determined using the 'catch-at-age' software (Bull & Dunn 2002) which scales the length frequency from each catch up to the tow catch, sums over catches in each stratum, scales up to the total stratum catch, and then sums across the strata, to yield overall length frequency distributions. Numbers of gemfish were estimated from catch weights using an overall length-weight relationship from the MPI *trawl* database and used by MacGibbon & Stevenson (2013). Length data from tows with more than 5 measured gemfish were used to generate the length frequency plots shown in Figures B3 and B4, for SKI 3 South and SKI 7. This resulted in some years having too few data to plot (for example, fishing years 1998, 1999, and from 2007 to 2013 for SKI 3 South, and from 1997 to 2000, 2008, and 2010 for SKI 7 (during June-September).

Fish measured during 1993 appeared to be from the same older cohort of larger fish (80–100 cm) that were sampled during the 1993 Southland trawl survey (see Figures A2 and B3), but there was no evidence of the 1989 cohort. There also appears to be a 2000 year class progressing through between 2002 and 2005. Data from the observed fisheries in SKI 7 show several years of the progression of the 1989 year class and confirm the existence of the 2000 year class for data from 2001 to 2007 and through to 2013. There is little evidence of a further cohort developing, but the data in later years are relatively few and smaller fish may be less vulnerable to capture than larger fish. These data match the data from the *Kaharoa* trawl surveys for corresponding years (see Section 4.2.2).

6. DESCRIPTIVE ANALYSIS OF CATCH

6.1 Catch and effort data sources

Catch-effort, daily processed, and landed data were requested from the Ministry for Primary Industries catch-effort database "warehou" as extract 9384 (Table C1). The dataset consists of all fishing and landing events associated with a set of fishing trips that reported a positive catch or landing of gemfish in SKI fish stock areas (see Figure 1) between 1 October 1989 and 30 September 2013. Data were analysed by fishing year (1 October to 30 September), and each fishing year referred to as the most recent year (that is, 1990 for the 1989–90 fishing year).

The estimated catches associated with the fishing events were reported on the Ministry for Primary Industries CELRs, TCERs, TCEPRs, LCERs, LTCERs, and NCERs (see section 2.1). The greenweight associated with landing events was reported on the bottom part of the CELRs and NCELRs, or on the associated Catch Landing Return (CLR) where fishing was reported on TCEPRs or TCERs.

The TCEPR and TCER forms record tow-by-tow data and summarise the estimated catch for the top five species and eight species respectively (by weight) for individual tows, together with latitude and longitude of the tow. CELR forms summarise daily fishing effort and catch, which are further stratified by statistical area, method of capture, target species and estimates of the top five species. NCELR forms record set-by-set data and summarise the estimated catch for the top eight species (by weight) for individual sets, together with latitude and longitude.

Information on total harvest levels were provided via the Quota Management Report/Monthly Harvest Return (QMR/MHR) system, but only at the resolution of Quota Management Area. Concerns were expressed (e.g., Phillips 2001) that bycatch species, such as gemfish, may not be well reported at the fishing event level on TCEPRs (and, this may also be true for TCERs, since 1 October 2008). The daily processed part of the TCEPR contains information regarding the catch of all quota species caught and processed that day, and these data may provide a more accurate account of low and zero catch observations. However, it is not possible to assign processed catch to a specific day or amount of effort because catch is not always processed on the day it is caught and can be split among days. The daily processed catch data were examined as a comparison to the estimated catch data.

The extracted data were groomed and restratified to derive the datasets required for the characterisation and CPUE analyses using a variation of the data processing method developed by Starr (2007). The method allows catch-effort and landings data collected using different form types that record data with different spatial and temporal resolutions to be combined. It also overcomes the main limitation of the CELR, TCER, and TCEPR reporting systems, i.e., frequent non-reporting of species that make up only a minor component of the catch. The procedure was developed for monitoring bycatch species in the Adaptive Management Programme and is comprehensively described by Manning et al. (2004) and Starr (2007). The major steps are as follows.

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

Step 2:   The fishing effort within each valid trip is restratified by statistical area, method, and target species.

Step 3:   The greenweight landings for each fish stock for each trip are 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.

Step 4:   The greenweight landings are allocated to the effort strata using the total estimated catch in each effort stratum as a proportion of the total estimated catch for the trip. If estimated catches are not recorded for the trip, but a landing was recorded for the trip, the total fishing effort in each effort stratum as a proportion of the total fishing effort for the trip is used to allocate the greenweight landings.

Step 5:   Data for many species are reported using a combination of form types. The original intent of the merging process was to allow trip level landings data to be mapped to CELR effort strata. The grooming and merging process also allows an evaluation of the amount of catch and effort that is not captured using TCEPR and TCER forms at the fishing event level. If this is substantial, the best characterisation dataset is likely to be the merged trip level data. If the amount of lost catch and effort is predictable, minor, and stable over time and area, the estimated catch at the level of the fishing event provides a much more detailed dataset for characterisation and CPUE analysis.

Processed product weights are converted to greenweight catches using species and product-form-specific conversion factors. Some product form conversion factors for gemfish have changed since the full

implementation of the QMS; with the result that different amounts of greenweight catch are associated with the same amount of processed catch for particular product forms throughout the database. During the grooming process, these changes are standardised relative to the latest conversion factor defined for each product state, based on the assumption that the changes in conversion factors reflect improving estimates of the actual conversion when processing, rather than real changes in processing methodology across the fleet. The catch-consistency checking algorithm designed by Blackwell et al. (2005) is used to systematically compare the different catch weights recorded for a particular fishing trip against one another, and this returns the single most consistent catch type for each trip. The following adjustments were made for several conversion factors, apart from the minor adjustment of 5.556 to 5.6 for fishmeal on 1 October 1990. From 1 October 1991, the value for "DRE" (dressed) was changed from 1.6 to 1.55, and from 1 October 1993 the value "FIL" (filleted) was changed from 2.3 to 2.15.

The landings data kept in the dataset and adjusted for any changes in conversion factors were allocated using the 'centroid' method to the effort strata, based on the statistical areas within each fish stock. Thus, the midpoint of each statistical area was used to allocate the data to the larger fish stock area, for example, statistical areas 018 and 019 were allocated to SKI 3.

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

Note that no attempt has been made here to standardise across all forms with respect to the number of catch species recorded on a form. Thus, the TCER catch data include the top 8 species. The breakdown of gemfish catches by TCER form is provided in each area summary below.

6.2   Summary of catches

All tables and figures for the characterisation of gemfish fisheries are in Appendix C (Tables C1–C12, Figures C1–C43). Table C1 provides a summary of the data requested from MPI for this characterisation which focusses on SKI 3 and SKI 7.

The reported QMR/MHR landings, ungroomed catch-effort landings, and TACCs for fish stocks SKI 3 and SKI 7 are shown in Figure C1. The ungroomed catch-effort landings in SKI 3 were similar to the reported QMR/MHR landings for 1990–2013 fishing years. Both sets of landings data for SKI 3 were lower than the TACCs throughout this time series. Some inconsistencies were evident in the SKI 7 data. Ungroomed catch-effort landings for SKI 7 exceeded QMR/MHR landings data in many of the fishing years, in particular in 1993, 1995, 1998, 2001, and 2008 when the ratio of QMR/MHR landings to catch-effort landings was between 0.30 and 0.63. The ungroomed catch-effort landings data exceeded the TACCs during 2003, 2004, 2005, and 2013; in 2004 and 2005 both sets of landings data were about double the TACC. Both data sources indicated that in subsequent fishing years, annual landings were close to the TACC limit.

Landings of catch-effort data reported on TCEPRs and TCERs are recorded on CLRs. In both of the southern gemfish fishery areas, the increase in landing events recorded on CLR from 2008 onwards reflects the change in form type used by 6–28 m trawl vessels (from CELR to TCER) (Table C2). In SKI 3, landing events on CLRs were coded as "L" (landed to New Zealand) and "R" (retained on board) throughout the time series, although most annual landing events had the destination code "L". The destination code "T" (transferred to another vessel) was used up until the end of the 1998 fishing year. Landing code "L" was the main code used on the CELR/NCELRs for data from SKI 3, and a small number of events were recorded as "F" (landed under approval from MPI). For all years combined,

most SKI 3 landings (in terms of weight) were coded as "L" (2233.4 t) and as "T" (1003.8 t) (Table C3). Landings with destination codes of "B", "D", and "R", or where the code was missing, were ignored for the final landings dataset: these represented about 8% of the landings by weight and 3.8% of the landing events. These codes are described as "interim" codes (Starr 2007), and although landings coded as "T" are often considered as "interim", a relatively large proportion of the catch before 1998 was assigned to this code and the associated landings were retained in the dataset.

In SKI 7, the majority of landing records from CLRs were assigned to the "L" destination code, although in the early-mid 1990s, similar numbers of records were coded to "L", "T", and "R". Few records were assigned to "T" after 1997, but the destination code "R" was used throughout the time series, although since 2000, the use of "R" was diminished relative to the use of "L" (see Table C3). For all years combined, most SKI 7 landings (in terms of weight) were coded as "L" (4857.7 t), "T" (1331.2 t), and "R" (1232.2 t). Landings with destination codes of "B", "D", and "R", or where the code was missing, were ignored for the final landings dataset: these represented about 15.5% of the landings by weight and 5% of the landing events.

Details of the data corrections by imputation and removal of invalid records during the grooming process are given in Table C4. The grooming process excluded trips with invalid codes in fishing method, target species, statistical area, and trip date which could not be fixed using the median imputation method. The estimated catch and landings removed from the dataset in this process resulted in about 80% of both the effort catch and the landings catch being retained in the dataset. The retained landings, interim landings, and total landings dropped during data grooming are shown in Figure C2. The reported MHR landings do not match well with the retained landings for a number of fishing years, with the most obvious inconsistencies in SKI 7, in 1993 in particular.

The main processed state for retained landings of gemfish in both SKI 3 and SKI 7 fish stocks was "DRE" (dressed weight) (Figure C3). The "DRE" code use reflects the catch of larger vessels that operate more offshore and process fish onboard. Details of the retained landings in unmerged and merged datasets and processed catches in the groomed and merged datasets are given in Table C5. The recovery rates, defined as the groomed and merged landings as a proportion of the groomed and unmerged landings (after Manning et al. 2004), are plotted in Figure C4. The recovery rates were close to 100% in most years for SKI 3, indicating a consistent match between the recorded statistical areas on the catch forms and the stocks reported on landings forms on a trip basis. However, for SKI 7, the match is not as good for the years before 1998; though in subsequent fishing years the data appeared to be more consistent, apart from 2003 and 2006.

Annual QMR/MHR landings, groomed retained landings, merged landings, and merged estimated catches are plotted in Figure C5 and summarised in Table C5. In SKI 3, the groomed retained landings were similar to or lower than the QMR/MHR landings, particularly in the early to mid-1990s. In SKI 7, the groomed retained and QMR/MHR landings were inconsistent throughout much of the time series. It appears that the groomed retained landings data for later years were more likely to be lower than the QMR/MHR landings. Some inconsistences in SKI 7 may result from catch being allocated to the wrong fishing year for trips that straddle fishing years. In both fish stock areas, merged estimated catches generally followed the same trend as merged landings and the groomed retained landings, but were consistently lower than landings. Estimated catches tend not to be recorded when catches are small (because vessels only report the top five species caught on TCEPRs and top eight on TCERs). The merged estimated catches were generally lower than 50–60% of the harvest reported via the MHR/QMR system for SKI 3 and generally over 60%, although variable, for SKI 7 (see Table C5).

The reporting rate, defined to be the ratio of the annual estimated catch to the retained landings in the groomed and merged dataset is shown in Figure C6 for the main form types. The TCEPR/CLR reporting rate for SKI 3 has been variable, but has generally declined over the time series to less than 50% since 2005 and under 40% since 2010. In contrast, the reporting rate for these form types in SKI 7 has generally been between 60% and 80%, though since 2010 the rate was generally below 60%. Any gemfish catches by vessels reporting on TCERs and TCEPRs not in the top 8 species by estimated catchweight per tow

(for TCER) or top five (for TCEPR) will be in the merged landings data, but not in the merged estimated data. The value of this ratio also depends on how well the statistical areas recorded on the TCEPRs and TCERs are matched to the stocks reported on the CLR on a trip basis. The reporting rates for the TCER/CLR data were about 80% in SKI 7 compared with about 60% in most years for SKI 3. For both areas the reporting rates on TCEPR/CLR and TCER/CLR were consistently higher than those reported on CELR/CELR forms apart from years in the early part of the time series.

Comparisons of the annual estimated catches and retained landings by form type for each fish stock are shown in Figure C7. For SKI 3, larger catches and landings were from TCEPR and CLR forms respectively, and very little catch or landings were reported from CELR forms after the 1996 fishing year. There was virtually no estimated catch data from the TCERs. For SKI 7, TCEPR and TCER forms accounted for the majority of the annual catches and landings (on CLRs). Before the introduction of the TCER on 1 October 2007, relatively small amounts of catch and landings were reported on CELRs.

Over the time series an increasing percentage of CELR trips that reported landings of gemfish in SKI 3 reported estimated catches (Table C6). The percentage of zero estimated catch (when gemfish is landed) on TCEPR reported trips was generally greater than 75% and as high as 87% for most years after the mid-1990s. On TCER-recorded trips, 60–87% trips with landed catch had no estimated catch. In contrast, trips that reported gemfish catch in SKI 7 generally had a lower percentage of zero trips, for all form types. The annual percentage of CELRs with zero estimated gemfish catch was generally between about 50 and 75%, about 40–65% for TCEPRs, and about 34% for TCER trips.

There was a reasonably close match between estimated catch and reported landings at trip level, in most years (Figure C8). Most discrepancies, that is, where the landings data were greater than the estimated data, were in the early years of the time series.

6.3   Southern gemfish fishery summary

Gemfish catches in the combined southern gemfish fishery of SKI 3 and SKI 7 were from shelf waters off the east coast of the South Island and on the Stewart-Snares shelf in SKI 3 and off the west coast of the South Island in SKI 7 (Figures C9a–C9c). The density of gemfish catches where data were reported on TCEPRs (for fishing years 1990 to 2013 combined) was greatest in SKI 7 generally between the 250 m and 500 m contours, and off Puysegur Point on the south west edge of the South Island. The remainder of the catches were from the edge of the Stewart-Snares shelf and off the east coast South Island from around Banks Peninsula to south Canterbury Bight – in 250–500 m. For the TCER catches (for 2008 to 2013 combined), the density was also highest in SKI 7, but generally more inshore than the TCEPR catches. Small catches from TCERs were also evident in waters west of Farewell Spit and in Cook Strait. The total estimated catch (all form types) for these fisheries during 1990 to 2013 is shown by Statistical Area in Figure C9b. Annual estimated catches by fish stock are given in Table C7.

The composition of the fleet nationalities that reported gemfish catches has changed over the time series. Vessels from Japan, Korea, and New Zealand reported most of the annual gemfish catch before 1996 (Figure C10, Table C8). Since then, Korean and domestic vessels accounted for most of the annual catch. Concomitant with this is the change in the distribution of catch by vessel size, with an increasing amount of catch reported by smaller, generally less powerful vessels since 2000. The increase in catch during the mid-2000s was mainly from Korean vessels (see Table C8). Since then Korean catches have been patchy compared with the more consistent catches from domestic vessels.

In the southern gemfish fisheries, gemfish was caught throughout the year, primarily by bottom trawls, with most of the annual catch caught in the SKI 7 fishery off the west coast of the South Island, particularly since the mid-1990s (Figure C11). In the early years of the time series, the largest annual catches were from the target gemfish fishery and as bycatch from barracouta, hoki, and arrow squid target fisheries. After 2000, catches were more evenly spread across a number of target species, including the ones listed above, as well as silver warehou, ling, and tarakihi. The distribution of catches by month has changed

from most months of the year in the early-mid 1990s, when catches came from SKI 3 and SKI 7, to mainly the winter months as the main catch spatial distribution changed in subsequent years.

6.3.1   SKI 3 fisheries

Catches in SKI 3 have been very small since the early-1990s (see Table C7) when October–May were the months of the highest catches of gemfish, from TCEPR and CELR effort targeted primarily at barracouta, red cod, gemfish, arrow squid, and silver warehou (Figure C12a). The SKI 3 fish stock is presented separately, as the two subareas, Chatham and South.

6.3.1.1 Chatham fishery

The total catch from the Chatham fishery was 1279.8 t for 1990 to 2013 (see Table C7). In the early 1990s, most of the catch was captured on CELRs and TCEPRs and caught during December–May in Statistical Areas 018 and 022 from effort that targeted barracouta, gemfish, red cod, arrow squid, and tarakihi (Figure C12b, Tables C9a–C9d). In subsequent years, the small amount of catch (2–8 t per year after 2004) was captured mainly on TCEPRs in Areas 020 and 022, with patchy representation by target and month. Bottom trawl was the main fishing method that caught gemfish in Chatham, with a small percentage of catch from set-nets, midwater gear towed near the seafloor, and bottom longlines.

The spatial distributions of the main target species and the effort that caught gemfish, relative to the gemfish targeted effort, are shown in Figures C13a and C13b for TCEPR and TCER form types. Note that there was no gemfish target effort reported on TCERs. The patchiness of the catch distributions by target species by Statistical Area and month is indicative of the bycatch nature of this Chatham gemfish catch (Figures C14a and C14b, Tables C9a and C9b).

For the vessel trip-level strata based on TCEPR bottom trawls (merged dataset), the percentage of zero gemfish catches for effort strata that targeted barracouta, hoki, red cod, gemfish, and arrow squid generally decreased over the time series to under 20% (Figure C15). The general low level of gemfish catch from this area indicates that most trips had at least one small gemfish catch, as indicated by the low annual unstandardised catch rates shown with the annual number of tows in Figure C16 and the very high proportion of tows with zero catches shown by fishing year for the main target species (Figure C17).

The annual distributions of bottom tow duration for the main target fisheries show some changes over the time series (Figures C18a and C18b). For TCEPR bottom trawls there was little variation in tow length during the time series, other than a slight increase in silver warehou tow duration and a decrease in red cod tow duration towards the end of the time series. For some species the targeted effort represents a few vessels only; for example, for jack mackerel, spiny dogfish, and gemfish. Similar tow durations were reported from TCER bottom trawls, for comparable years.

Effort depth data for the main target species included the preferred depth range of gemfish (Figures C19a and C19b). For TCEPR and TCER bottom trawls, median target depths were generally about 100 m for tarakihi tows; 100–200 m for barracouta and red cod; 200–300 m for arrow squid effort; 200–400 m for silver warehou; and 450–550 m for hoki. Gemfish was targeted in depths of about 100–300 m.

Fishing gear variables and vessel characteristics for trawl effort in the Chatham fishery that resulted in gemfish catch are shown in Figures C20a and C20b. Both TCEPR and TCER bottom trawl effort had the following median values: 20–40 m wingspreads; headline heights of about 2–4 m; speeds of 3.0–4.0 kn.; and tow lengths of 18–30 km, with data from TCER vessels usually nearer the lower end of the ranges given. Vessel size data reflect the form type used and the species targeted: a wider range of TCEPR vessel sizes targeted barracouta and arrow squid, whereas vessels for most other main targets were more similar in size.

The distribution of the small gemfish catches from Chatham bottom trawl vessels is patchy from year to year, with all catches within the 500 m contour (Figure C21).

6.3.1.2 South fishery

Overall, about 1540 t of gemfish were reported from the South area of SKI 3 (see Table C7), and 51% of that catch was from fishing years 1990–1993. During the early 1990s, the gemfish catch was primarily from bottom trawls reported on TCEPRs when the targets were arrow squid, barracouta, and silver warehou in areas 027–030 during November to April (Figure C22, Tables C10a–C10d). Other catch during these years came mainly from ling and gemfish targets in area 030 (Figure C23a and C23b). Arrow squid remained the most important target species in subsequent years, with most catch reported from February to May in the early to mid-2000s from Statistical Area 030. Since 2007, the small catches have been from areas 028–030. The spatial distributions of the main targeted effort reported on TCEPRs are shown in Figure C24, with catches predominantly from the effort close to the edge of the Stewart-Snares shelf and off Puysegur. Very few tows with gemfish catch were from waters beyond the continental shelf.

Statistical Area 030, where most of the gemfish targeted effort caught gemfish, accounted for 41% of the total gemfish catch in South, and areas 027–029 combined accounted for another 44% (Table C10b). The largest annual catches from tows that targeted gemfish were made in April, May, and August. Other target species with catches in area 030 included hoki, ling, arrow squid, and silver warehou. Since the mid-1990s, small occasional catches have been caught during targeting for ling (October–December), hoki (most months), silver warehou (October–May), mainly from areas 026–030.

For the vessel trip-level strata based on TCEPR bottom trawls (in the merged dataset), the percentage of zero gemfish catches for effort strata that targeted barracouta, hoki, ling, gemfish, arrow squid, and silver warehou generally decreased over the time series to under 20% of effort strata with no gemfish catch after 2008 (Figure C25). A pattern of generally low catches similar to that observed in the Chatham area was evident in South based on the unstandardised catch rates and the tow-level percentage of zero catches shown in Figures C26 and C27, respectively.

Tow durations for some of the main target species have increased over the time series, for example, arrow squid, barracouta, and silver warehou for bottom trawls (Figure C28a) and arrow squid and barracouta for midwater trawls (Figure C28b). Gemfish catches were relatively low in years where tows were longer. The depth ranges of the targeted effort covered the full range of the depths preferred by gemfish, between 100 and 600 m (Figures C29a and C29b). Most depth data showed little annual variation, although depths fished by hoki bottom trawls were slightly deeper from 2001 than in previous years. Generally there was little variation in the main effort and vessel variables for the main target species (Figures C30a and C30b).

The distribution of the gemfish catches from South bottom trawl vessels is patchy from year to year, with catches mainly within the 500 m contour (Figure C31).

6.3.2 SKI 7 fishery

The SKI 7 fishery accounted for most of the gemfish catch throughout the time series (see Table C7). The distinct differences noted for SKI 3 in time periods within fishing years 1990 to 2013 are also apparent in SKI 7, although less marked because of the generally larger and more consistent annual catches in the SKI 7 fishery. Gemfish catch from this area was predominantly from TCEPRs where barracouta, hoki, and gemfish were targeted with bottom trawls before 1996 (Figure C32, Tables C11a–C11d). Most of this annual catch was from areas 034 and 035 during August-September. From the 1996 to 2001 fishing years, annual catches were relatively small compared with previous years, with most from hoki and barracouta target effort. Annual catches increased again during the mid-2000s, mainly from hoki effort, as well as barracouta, arrow squid, and silver warehou effort in areas 034 and 035. Subsequently, the annual catches

have been spread across more months as the catches have come from a wider variety of target species: barracouta, gemfish, hake, hoki, ling, red cod, arrow squid, silver warehou, and tarakihi.

The spatial distribution of the effort reported on TCEPRs and TCERs by target species relative to gemfish targeted effort is shown in Figures C33a and C33b. Most TCEPR tows that caught gemfish as bycatch were in waters where gemfish targeting took place, with some differences for species such as giant stargazer, red cod, and tarakihi which caught gemfish in more inshore waters. Barracouta, jack mackerel, and tarakihi tows also caught gemfish to the north of the main gemfish fishing area. The gemfish catches from TCER targeted effort were similar in their spatial distribution to those reported on TCEPRs and included not only inshore waters but extended south to area 033 and north and east to area 017 (Cook Strait) for some targets. The proportion of the SKI 7 TCER tow data with gemfish in the top five species of the catch records represented 9.9% of the TCER tows included in this dataset: the catch from these tows represented 90% of the catch from all the TCERs. Seventeen percent of the TCER tows had gemfish catch in the top 8 species. Of the vessels that used TCERs, one vessel used TCEPRs from 2006–08 inclusive, then used TCERs from 2010–13.

The distribution of gemfish catches by Statistical Area and month are shown in Figures C34a and C34b for the main target species reported on TCEPRs. No target shows a consistent catch of gemfish over the time series, even within the main Statistical Areas 034 and 035. Catches from gemfish targeted effort were small after the mid-1990s, whereas catches from hoki target tows were largest in the mid-2000s. Catches from barracouta effort appeared to increase in the two most recent years of the time series, whereas those from jack mackerel effort were small compared with those obtained in the early 1990s. Gemfish catches from silver warehou effort were similar in size to those from hoki tows during the mid-late 2000s, but only very small catches were reported since then. Most of these catches are from July–September.

The smaller dataset from TCERs indicates that gemfish catches from most TCER target species are very small, with the largest catches from gemfish (in Statistical Area 034 from November to June), tarakihi (mainly in 034, but extending to 033, 036, and 039 from September to May), and ling effort in 033 and 034 mainly during March–June (Figure C34c). Although gemfish catches were very small, tows for a variety of target species that were reported on TCERs caught gemfish over a number of months, with the smallest catches reported from July, August, and September each year.

The TCEPR vessels with the most gemfish catch had targeted effort for the main species outlined above. The proportion of trips with zero catches of gemfish by year for each target species and form type shown in Figure C35 indicates the sporadic nature of encountering gemfish. For targets with the most effort data, such as barracouta, jack mackerels, and hoki for TCEPR data and barracouta and tarakihi for TCER data, generally 20–50% of trips had no reported gemfish catch.

Examination of the tow duration variable for TCEPR bottom trawl effort in SKI 7 shows variation throughout the time series for most of the main target species (Figure C36a), median annual values were generally between 3 and 5 h. Hoki bottom tows were longer during the mid-2000s; barracouta and jack mackerel tows were longer in 2007–09, hake tow durations increased markedly after 1999 with tow durations closer to 10 h. Most tows in the TCER data had median duration times of close to 5 h (Figure C36b). Midwater tows reported on TCEPRs were generally shorter in duration than bottom trawls (Figure C36c).

The depths at which gemfish catches were made varied by TCEPR and TCER target species (Figures C37a–C37c). Catches from jack mackerel tows were from 100–150 m; about 200 m for barracouta, stargazer, and tarakihi tows; 200–400 m for gemfish, ling, and silver warehou tows; and about 400–500 m for hoki tows. There appeared to be little variation from year to year for each form type-method-target species combination.

The TCEPR vessels that operated bottom trawls show similarities in gear and vessel specification data across the main target species with gemfish catch; the biggest discrepancy shown in the tarakihi data,

where the vessels were more in the size range of TCER vessels than those targeting other species (Figures C38a and C38b). The headline heights used to target gemfish by TCEPR bottom trawlers were similar to jack mackerel bottom trawls and generally higher than for other bottom trawl targets. Tows reported on TCERs generally used smaller gear towed at a slightly slower speed and for shorter distances than for TCEPR tows. However the "distance" data shown here are derived differently, depending on form type: for TCEPRs, the distance is the straight line measure between the start and finish positions, whereas the distance towed for TCERs is based on reported speed and the fishing duration of a tow. Comparisons of the data for midwinter targets showed that hoki and hake midwater trawls generally had larger headline heights than did other midwater targets and that the longest distance towed was during gemfish targeted tows (Figure C38c).

Annual gemfish catch rates varied during the time series, but were greatest for bottom trawl effort for the main target species during the mid-1900s and the mid-2000s (Figures C39a and C39b). The smaller vessels that reported on CELRs and TCERs also appeared to obtain higher catch rates during 2008–12, depending on the species being targeted. The generally erratic nature of gemfish catches is evident in the plots showing the proportion of bottom tows with zero gemfish catches (Figure C40).

The spatial distribution of the TCEPR and TCER bottom trawl annual gemfish catch in SKI 7 is shown in Figure C41 and the spread of catches represents the location of the target species effort and the more inshore nature of the TCER effort, especially for ling, gemfish, and tarakihi (see also Figures C33a and C33b).

6.4 Summary

A summary of the characterisations by fishery area is given in Table 4, and the catch information summarises the groomed estimated catch. Although some gemfish targeting has occurred, it is often a bycatch species and has been reported on the three main trawl forms: CELR, TCER, and TCEPR. A comparison of the groomed estimated catch by form type for each area is shown in Figure C43. The Merged column provides the groomed estimated catch from all three forms on a trip basis. A further comparison is given for the TCEPR data by the inclusion of the processed catch data, on a vessel-trip-day basis.

The dominant fishing method is by bottom trawl with small amounts taken by midwater trawl. Other fishing methods also catch gemfish, but in negligible amounts.

The largest annual gemfish catches were from fishing years 1990–94 and 2003–07. Of the total catch from the southern gemfish fisheries during fishing years 1990 to 2013, about 67% has come from SKI 7, where 82% of the 4524 t was reported on TCEPRs and 15% of the catch was from gemfish-targeted effort. Another 20% is from South part of SKI 3 where almost 100% of the gemfish catch is from TCEPR, but almost 70% of the TCEPR catch is from fishing years 1990 to 1993. The catch from SKI 3 Chatham represents about 13% of the total southern gemfish catch, and 96% of the catch from this area was from 1990 to 1996, reported mainly on CELRs.

The main target fishery is in SKI 7, but in that area most of the catch comes from hoki TCEPR effort during July-September and from TCER tarakihi, ling, and gemfish effort during October-June. Since the introduction of the TCER there appears to be more catch on TCER than was reported on CELRs; however, the TCER data include the top 8 species catch records, whereas the CELR data include only the top 5 catch species collated on a daily basis. For the SKI 7 TCER data, during fishing years 2008–13, 92% of the total gemfish catch from areas 033 and 034 was from tows with gemfish reported in the top 5 catch species (by weight). In areas 035 and 036, 85% of the gemfish catch was from tows with gemfish reported in the top 5 catch species.

In the TCEPR data, the pattern of gemfish catch seen in Figure C43 is driven mainly by the catch from hoki effort, especially the peak between 2003 and 2006 (peak in 2004 at about 250 t). During those

years, there was a redistribution of hoki fishing effort from the west coast South Island to eastern waters as a result of an agreement with the then Minister of Fisheries that 40% of the hoki catch should come from the western stock areas (which include the west coast South Island). Also during this period, gemfish catches from silver warehou effort became more important, with a peak in 2005 of about 100 t. The catch from barracouta, jack mackerel, and gemfish targeted effort was important in the early 1990s, but little catch was obtained from effort for the latter two species subsequently.

For the other areas, annual catches were generally inconsistent and patchy by target and fishing year. Over 75% of the vessel that reported effort on TCEPRs in SKI 7 also reported effort from South. Vessels were active in SKI 3 South mainly during October–June and in SKI 7 during July–September.

The SKI 7 is the only region with a distinct time of year in which gemfish was caught (the winter spawning season for several species including hoki and gemfish). On the basis of this characterisation, only the SKI 7 area is considered for a standardised CPUE analysis. In this area, catches have been large enough at certain periods and the trends in catches appear to be similar to trends off the Australian east coast (see Bruce et al. 2002, Hobday et al. 2008) that may reflect the availability of the species.

Table 4: Summary of features of the SKI 3 and SKI 7 fisheries, based on the unmerged estimated catch data, where TCEPR is Trawl Catch Effort Processing Return, TCER is Trawl Catch Effort Return, and BT is bottom trawl. Area definitions are shown in Figure 1 and Figure C9a; species codes in Table C12.

QMA area	SKI 3 Chatham	SKI 3 South	SKI 7
General characteristics			
Key fishery areas	East Coast South Island	Stewart-Snares shelf/Puysegur	West Coast South Island
Key statistical areas	018,022	027–030 (TCEPR)	034,035 (TCEPR) 033, 034 (TCER)
Secondary statistical areas	020	026, 502, 504 (TCEPR)	036 (TCEPR) 017, 035, 036,039 (TCER)
Season	Oct–May	Oct-Jun (TCEPR)	Jul-Sep (TCEPR) Oct-Jun (TCER)
Gear type (% catch)	BT (92%)	BT (92%)	BT (81%)
Target species			
Key target species	SQU, HOK, RCO	SQU (TCEPR)	HOK (TCEPR) TAR, LIN, SKI (TCER)
Secondary target species	SKI	BAR, SWA (TCEPR)	BAR, SKI, SWA (TCEPR) BAR, STA, GSH (TCER)
Target SKI catch trends	NA	8–10 y availability?	8–10 y availability?
Total area catch (% total from SKI target effort)	899 t (42%)	1341 t (13%)	4524 t (15%)
Total area catch (% total by TCEPR)	899 t (38%)	1341 t (99%)	4524 t (82%)

7. CPUE ANALYSES

Most data in the SKI 7 fishery come from TCEPR forms where bottom trawl is the main gear type and the estimated catch data show similar trends to that of the processed data. Although there are more catch data in the processed data, the nature of the processed data results in a dataset that is at a coarser resolution than the tow-level resolution of the estimated catch data. This means that some variables normally available for CPUE analyses require summing over the day or converting to a daily mean. The use of tow-by-tow estimated catch 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).

Annual unstandardised (raw) CPUE indices were calculated as the mean of the catch per tow (kg) for tow by tow data. Estimates of relative year effects were obtained from a stepwise multiple regression method, where the data were fitted using a lognormal model using log transformed non-zero catch-effort data. A forward stepwise multiple-regression fitting algorithm (Chambers & Hastie 1991) implemented in the R statistical programming language (R Development Core Team 2013) was used to fit all models. The algorithm generates a final regression model iteratively and used the year term as the initial or base model in all cases. The reduction in residual deviance (denoted r^2) was calculated for each single term added to the base model. The term that resulted in the greatest reduction in the residual deviance was then added to the base model, where the change was at least 1%. The algorithm was then repeated, updating the base model, until no more terms were added. A stopping rule of 1% change in residual deviance was used as this results in a relatively parsimonious model with moderate explanatory power. Alternative stopping rules or error structures were not investigated.

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

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

The main CPUE analyses presented here for SKI 7 are listed in Table D2:
1. a mixed target TCEPR bottom trawl dataset defined by Statistical Areas 034 and 035 and the months of May–September to incorporate the main target species in the gemfish catch data;
2. a hoki target TCEPR bottom and midwater trawl dataset in Statistical Areas 034 and 035 for June–September, the months of the hoki spawning fishery, to acknowledge the existence of the midwater fleet in this spawning fishery as well as bottom trawl vessels;
3. a mixed target TCER bottom trawl dataset defined by Statistical Areas 033 and 034 and the months of October–June to incorporate the main target species in the gemfish catch data for the small vessels.

It should be noted here that the annual catches in this area were inconsistent and relatively small (Table D3) and thus the results may offer little explanation for this species which appears to be more present in some periods than others and is more likely a bycatch than a target species.

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

For the TCEPR vessels, it was obvious that there were two distinct time periods in the full 1990–2013 datasets, as shown by the data in Figure D1 where the annual effort data and catch data for all vessels and for those that had at least 7 years of gemfish catch over the full time period. Many of the vessels that fished and caught gemfish before the late 1990s did not appear in the dataset post-2000. Thus, the TCEPR CPUE datasets were restricted to the fishing years 2000–2013.

The TCER data are modelled separately because they represent the inshore fleet of smaller vessels and include the top 8 catch species. Although they are only available for six years, these data provide information on different target species in generally shallower waters for months outside the main spawning fishery period of June–September.

Model fits to the model were investigated using standard residual diagnostics. For each model, a plot of residuals against fitted values and a plot of residuals against quantiles of the standard normal distribution were produced to check for departures from the regression assumptions of homoscedasticity and normality of errors in log-space (i.e., lognormal errors). Binomial and a combination of the lognormal and binomial (delta-lognormal models) were also run, but only the indices are provided in this report.

7.1 SKI 7 standardised TCEPR CPUE Model

(a) Mixed target bottom trawl

The number of records, proportion of zeros, catch, effort and unstandardised CPUE for model 1 are listed in Table D3. Standardised model results are shown in Tables D4–D5 and Figures D2–D8.

A total of 56 unique vessels (range 15–36 vessels each year) caught an estimated 1321 t of gemfish during 2000–2013 from 23 702 bottom trawl tows (Table D3, Figure D2). The percentage of zero tows was high, ranging between 68 and 96% (Table D3). Estimated gemfish catches ranged from 15–332 t annually, and the number of annual tows ranged between 1059 and 2969. Seventeen core vessels (range 8–16 per year) accounted for 67% of the bottom tows made by all vessels and caught an estimated 1082 t of gemfish, representing 90% of the total catch for 2000–13. Most core vessels had their largest catches during 2003–05 (see Figure D2).

For the tow-by-tow estimated catch core data analysis, six variables were selected into the lognormal model, resulting in a total r^2 of 46.8%, with *vessel* explaining 31.5% of the residual deviance (Table D4). The other variables selected were *day of fishing year*, *bottom depth*, *mid-time of tow*, *tow duration*, and *target species*.

CPUE series from the lognormal models are presented in Table D5 and Figure D4a. The tow-by-tow estimated catch index showed no real trend over the 14 fishing years, though there were several small peaks: one in the mid-2000s and one in 2009. The influence of the larger proportion of non-zero catches seen in the binomial model during the mid-2000s resulted in a large peak in the indices for the delta-lognormal model (Figure D4b).

The effects of the addition of the selected variables on the unstandardised catch rate are shown in Figure D5, and the effects of the selected variables on the expected catch rates of gemfish are shown in Figure D6 and the influence plots (after Bentley et al. 2012) in Figures D7a–D7f. Catch rates were higher in 2004–06 and 2008–09, in late August–September, during daylight hours, and with longer tow durations. Four vessels had substantially higher expected catch rates. Few differences were evident in the expected annual catch rates by target species, other than that hake target had a lower rate. However, the influence of the higher catch rates from increased silver warehou target effort in 2008 and 2009 is evident in Figure D7f, as is the opposite in the following years when more of the tows were for target hake.

The influence of vessel was tempered by the years in which the vessels with the higher catch rates conducted more tows. Higher numbers of tows in periods when the catch rates were higher had a positive influence on the catch rate. When there was more effort in 200–400 m there was a positive influence on the gemfish catch rate, as there was when more effort was expended during the middle of the day.

The diagnostics indicate that the very small and very large catches are not particularly well modelled (Figure D8).

(b)   Hoki target bottom and midwater – June–September

The number of records, proportion of zeros, catch, effort and unstandardised CPUE for model 2 are listed in Table D3. Standardised model results are shown in Tables D4–D5 and Figures D9–D15.

A total of 71 unique vessels (range 19–57 vessels each year) caught an estimated 834 t of gemfish during 2000–2013 from 44 604 bottom trawl tows (Table D3, Figure D9). The percentage of zero tows was high, ranging between 77 and 97% (Figure D10). Estimated gemfish catches ranged from 7–234 t annually, and the number of annual tows ranged between 975 and 6205. Twenty-three core vessels (range 6–22 per year) accounted for 44% of the bottom tows made by all vessels and caught an estimated 685 t of gemfish, representing 82% of the total catch for 2000–13. Most core vessels expended most effort and had their largest annual catches during 2003–05 (see Figure D9).

For the tow-by-tow estimated catch core data analysis, six variables were selected into the lognormal model, resulting in a total r^2 of 54.5%, with *vessel* explaining 32% of the residual deviance (Table D4). The other variables selected were *headline height*, *day of fishing year*, *wingspread*, *mid-time of tow*, and *tow duration*.

CPUE series from the lognormal models are presented in Table D5 and Figure D11a. The tow-by-tow estimated catch index showed no real trend over the 14 fishing years. The delta-lognormal model resulted in higher indices for the mid-2000s in response to the higher proportion of non-zero catches (Figure D11b).

The effects of the addition of the selected variables on the unstandardised catch rate are shown in Figure D12, and the effects of the selected variables on the expected catch rates of gemfish are shown in Figure D13. The influence plots are shown in Figures D14a–D14f. For those variables selected in the mixed target model and this hoki one, the effects were similar, as outlined here. Catch rates were slightly higher in 2004–06 and in 2008–09 (though in these latter years only 6 vessels were included as core vessels). Expected catch rates were slightly higher in June and September, during daylight hours, and with longer tow durations. Four vessels had substantially higher expected catch rates. The effect of the use of bottom trawl or midwater trawl was evident in the higher catch rates expected with a low headline height (less than 12 m, bottom trawl gear) and with wingspreads of about 100–120 m (Figures D13 and D14b).

The influence of vessel was tempered by the years in which the vessels with the higher catch rates had conducted more tows. In 2009, most of the 6 core vessels fishing in that year had low catch rates resulting in a large negative influence on the unstandardised catch rate (see Figure D14a). The greater number of bottom trawl tows each year (see Figure D14b) had the greatest positive influence on the unstandardised catch rate. Higher numbers of tows in periods (days of fishing year) when the catch rates were higher had a larger positive influence on the catch rate (see Figure D14c). Lower catch rates from effort with shorter tow durations (for example, less than 5 h) resulted in a negative influence in the years when shorter tows were more numerous (particularly after 2009, see Figure D14f).

The diagnostics indicate that the very small and very large catches are not particularly well modelled (Figure D15).

(c)   TCER mixed target bottom trawl – October–June

The number of records, proportion of zeros, catch, effort and unstandardised CPUE for model 3 are listed in Table D3. Standardised lognormal model results are shown in Tables D4–D5 and Figures D16–D22.

A total of 21 unique vessels (range 11–16 vessels each year) caught an estimated 391 t of gemfish during 2008–2013 from 4941 bottom trawl tows (Table D3, Figure D16). The percentage of zero tows was moderate, at about 60% each year (Figure D17). Estimated gemfish catches ranged from 42–102 t for October to June for each fishing year, and the number of tows for that time period was between 673 and 969. Ten core vessels (9–10 per year) accounted for 98% of the bottom tows made by all vessels and caught an estimated 387 t of gemfish, representing 99% of the total catch for 2008–13.

Seven variables were selected into the lognormal model, resulting in a total r^2 of 49.8%, with *target species* explaining 26.6% of the residual deviance (Table D4). The other variables selected were *vessel*, *bottom depth*, *mid-time of tow*, *tow duration*, *day of fishing year*, and *start latitude*.

A flat trend is shown by the lognormal indices for the 6 years of available data (Table D5, Figure D18). The effect of the addition of the selected variables is shown in Figure D19. Figures D20 and D21a–D21g show the effects of the selected variables. The catch rate from gemfish targeted tows is significantly higher than that for ling and tarakihi, and the relatively small amount of effort targeted at gemfish in 2008–10 has a negative effect on the unstandardised catch rate. Expected catch rates vary by vessel. Higher catch rates were likely in 300–400 m, in the middle of the day, between December and March, and between 42.5° and 43.5° S. For most variables the influences are relatively small.

The diagnostics suggest that the very small and very large catches are not particularly well modelled (Figure D22).

7.2   CPUE summary for SKI 7

Standardised CPUE of gemfish was attempted for the estimated catch from a subset of SKI 7: Statistical Areas 034 and 035 for TCEPR records and 033 and 034 for TCER records. The analyses were limited by the often low and inconsistent catches through the time period. Many vessels that caught gemfish pre-2000 were not in the post-2000 data; thus the CPUE analyses were restricted to 2000–13.

Gemfish catch resulted from a range of target species that were fished for in depths preferred by gemfish. These targets varied by fleets, with the larger TCEPR vessels (representing different nations and using bottom trawl and midwater trawl gear) mainly targeting arrow squid, barracouta, hoki, hake, ling, silver warehou, and some gemfish. Much of the gemfish catch from these target fisheries is from the June-September fishing effort. The smaller TCER vessels targeted mainly ling, tarakihi, gemfish, and barracouta using bottom trawls in depths slightly shallower than the main effort of the TCEPR vessels. The TCER effort is mostly in the months of October–June.

The TCEPR estimated catch records were considered close enough to the processed catch to just do an estimated catch CPUE model; this assumes that gemfish occurs in the top five catch species on the TCEPRs. This also allowed for tow-by-tow data to be used. Similarly, with the TCER data, where all the 8 catch species records were used. Analysis of these records on their own allows a separate summary of the generally smaller vessel fleet, though some vessels of similar size may fill out TCEPRs. However, the TCER data show that these vessels target different species and fish in different areas, at different times of the year. A comparison of the three indices is given in Figure 3.

Fishing year (as represented by the season within each fishing year) was forced into every CPUE model; it rarely explained more than a few percent of the null model deviance. The overall r^2 values for each CPUE core model was relatively high (47–55%). Some explanatory variables were consistent for all models, with *vessel* entering every model, and *mid-time of tow, day of fishing year,* and *tow duration* entering most models. *Target species* entered the mixed species models and was most

important in the TCER model because of the effect from the relatively small number of gemfish tows that had high catch rates compared with the larger amount of effort for ling and tarakihi that had relatively low catch rates. Overall, there is little evidence in any of the models of a trend over the years analysed, and it appeared that the extremes in the captures were not particularly well modelled.

The mixed target bottom trawl TCEPR model accounts for 1082 t of gemfish compared with the 685 t of gemfish from the hoki bottom trawl and midwater trawl TCEPR model and appears to better represent the years in the mid-2000s when the TACC of 300 t was overrun. This mixed target model also better represents the most recent years of the time series when the catch was distributed across different target species. The trend in biomass indices shown for the biennial *Kaharoa* trawl survey off the west coast South Island, mostly in areas 033 and 034, in depths out to 400 m during March-April is fairly flat other than a peak, with large confidence intervals, in 2005. This matches the peak seen in mixed target TCEPR model which covers the months of May-September. The TCER data are more likely to reflect the depths covered by this west coast trawl survey. Although the TCER model showed higher catch rates in December-March, it may be that this west coast survey is limited in use as an indicator of gemfish abundance because of the sporadic nature of catches, which may be as much to do with availability as with selectivity. However, the continued monitoring of the spawning fisheries off the west coast by observers may provide some value in assessing the gemfish catch by the larger TCEPR vessels (see Section 5.0).
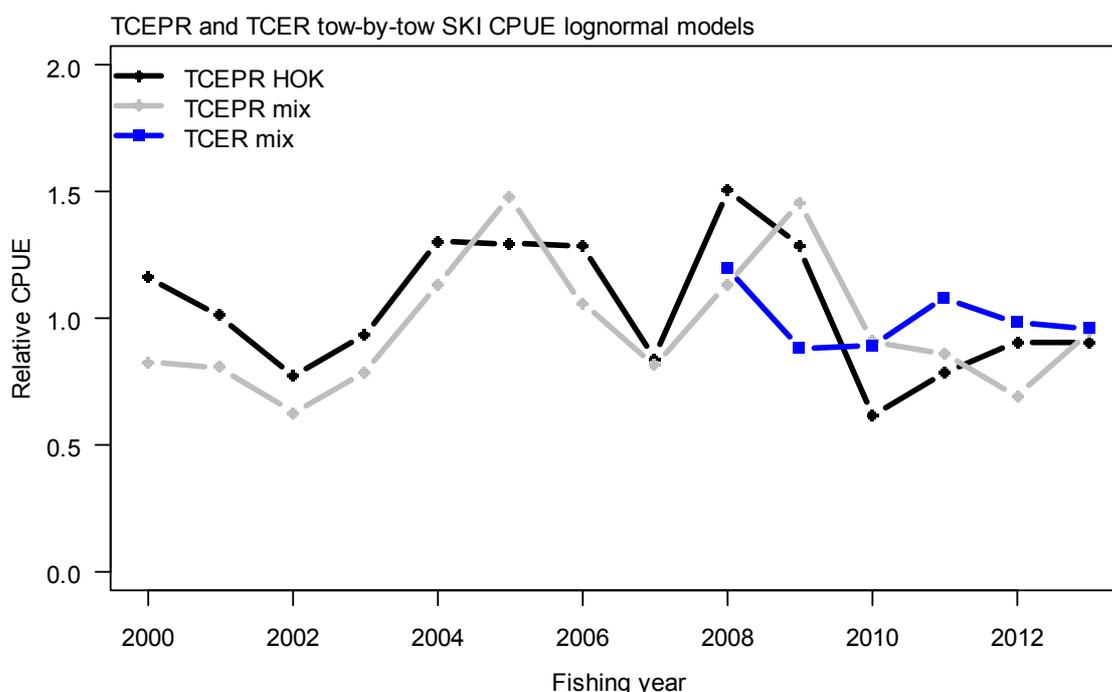
Figure 3: Comparison of the SKI 7 CPUE indices for 2000–13 fishing years, where the "TCEPR HOK" series is the model for Statistical Areas 034 and 035 based on hoki bottom and midwater trawl TCEPR data, "TCEPR mix" is the model for Statistical Areas 034 and 035 based on main target species bottom trawl data, and "TCER mix" is for Statistical Areas 033 and 034 based on the main target species bottom trawl TCER data (2008–13).

8.   SUMMARY AND RECOMMENDATIONS

Most of the SKI 3 catch has come from the Stewart-Snares shelf and Puysegur waters in the southern area of SKI 3, with a smaller proportion from off the east coast of the South Island. Reported annual landings in SKI 3 dropped from 1000–2000 t in the late 1980s to under 500 t in 1991–92, and under 100 t per year for most years since. A slight increase in landings occurred during the early-mid 2000s,

but from 2005–06 on landings have generally been less than 30 t. Gemfish catch from SKI 3 was mainly as bycatch from the larger vessel fleet that used bottom trawls to target arrow squid and a variety of middle depth species, including gemfish. Reported annual landings from SKI 7 were about 1000 t during the late 1980s, about 320–585 t in the early 1990s, about 50–270 t until 2002–03 when for two years the TACC of 300 t was exceeded with landings of 542 and 635 t. Since then reported landings have been close to the TACC. The larger vessel fleet caught gemfish when targeting hoki, barracouta, silver warehou, and gemfish primarily with bottom trawls in Statistical Areas 034 and 035. Gemfish catches from the smaller inshore fleet were mainly from targeting of tarakihi, ling, and gemfish in Statistical Areas 033 and 034.

Low catches over most of the time series meant that standardised CPUE was inappropriate for the two main fishery areas of SKI 3. Although catches were inconsistent in SKI 7, several CPUE analyses were run for the larger vessel fleet operating in SKI 7, using core vessel tow-by-tow data from areas 034 and 035 for the fishing years 1999–2000 to 2012–13, for a mixed target (including hoki) bottom trawl May-September dataset, and a hoki target bottom and midwater trawl dataset for June–September. With r^2 values of 0.46 and 0.55, respectively, each lognormal model selected similar variables, except that the gear effect (through headline height and wingspread variables) was evident in the hoki model, with higher catch rates from low headline bottom trawl gear. The indices were generally flat, and the effect of the binomial in the delta-lognormal model was to decrease the 2004–05 indices of both models. No trend was detected for a lognormal mixed target model run for the small vessel fleet in areas 033 and 034, for October–June of 2007–08 to 2012–13 — the years for which tow-by-tow data were available. The availability of gemfish since the large decline in abundance and the sporadic nature of catches severely compromises the ability to achieve a useful dataset in either area.

8.1   Biology and status of the stocks

Gemfish occur on the continental shelf and slope mainly in depths of 50–550 m in the southern gemfish fisheries. The change in abundance over the last 30 years has been well documented. The most likely reason for the sudden decline is overfishing coupled with times of very low recruitment or recruitment failure that may be linked to larval dispersal being adversely affected by sustained environmental conditions of lighter winds and higher sea surface temperatures (e.g., see Renwick et al. 1998). A similar stock "crash" occurred in Australian gemfish stocks, coincident with the one here (e.g., Thresher 1994). Australian data also indicate a slight increase in the availability of gemfish in the early 2000s (see Hobday et al. 2008).

8.2   Trawl survey and observer information

In the absence of consistent catches in the TCEPR data, the best way of monitoring gemfish in the southern waters may be to utilise trawl survey and observer data; though it is not certain whether fish present during March-April (trawl survey period) are the same population as spawning fish in late winter-early spring (when observer data are collected). Currently, the best trawl survey opportunity to capture data on gemfish is from the biennial survey by *Kaharoa* off the west coast of the South Island during March-April. This survey provides information on waters of 30–400 m depths in areas that are fished predominantly by the small inshore vessel TCER fleet that targets species such as tarakihi, ling, barracouta, giant stargazer, and gemfish during October-June. This fleet is unlikely to provide data via the observer programme unless some method such as electronic monitoring is implemented.

However, the observer coverage of the larger vessel fleet operating during the main winter spawning fishery for hoki during June-September is generally well-covered in terms of effort and catch. It may be that the two data sources can provide some form of monitoring of the southern gemfish stock by analysis of length frequency data and year class progression. Together the trawl survey information and the observer data indicate that both small and larger fish are present in the SKI 7 waters, and that progression of year classes is evident when enough fish were measured. This is especially evident in

the SKI 7 observer data for the 1+ cohort (about 30 cm) which can be tracked from 2001 throughout the 2000s through to 80–100 cm length.

Consideration should also be given to the re-introduction of the "Southland" trawl survey series which provided evidence of the significant decline in biomass in the mid-1990s. This survey provided a lot of valuable information about a large variety of species that frequent depths of under 600 m, many of which are caught as bycatch in the main commercial target fisheries.

Thus, continued data collection from the trawl survey and the observer programme, including the collection of otoliths, given that there is a well-developed ageing protocol (Horn & Hurst 1999), length frequency and gonad stage information may help in further determination of the stock structure. It is likely that the west coast area provides the best collection location for this southern gemfish stock.

9.   ACKNOWLEDGMENTS

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APPENDIX A: RELEVANT TRAWL SURVEY DATA SUMMARIES
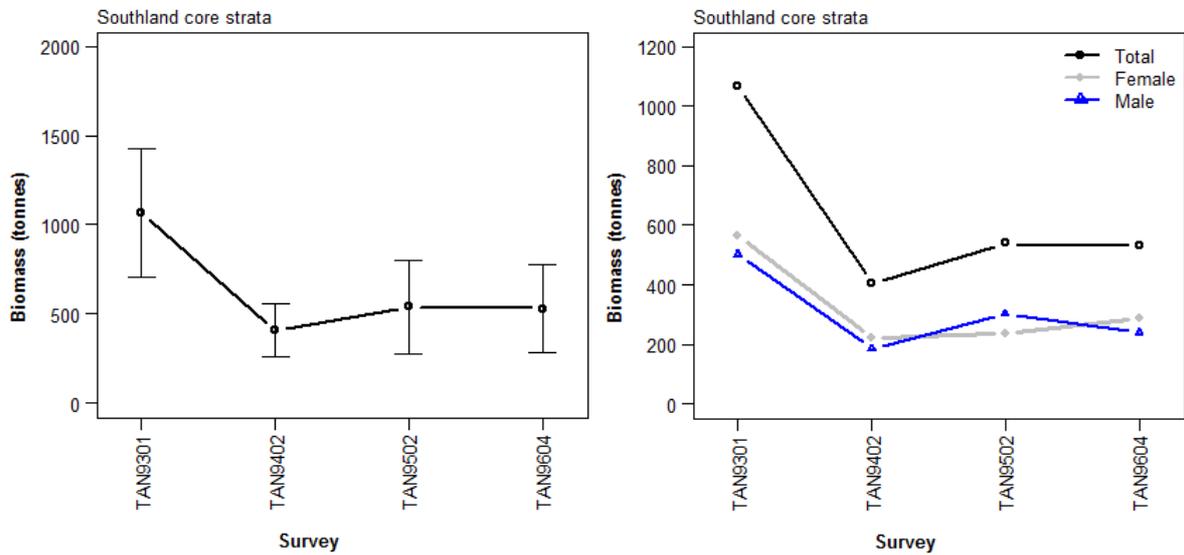
Figure A1: Doorspread biomass estimates (t) for all gemfish (± CV, left) and by sex (right), from the Southland R.V. *Tangaroa* surveys on the Stewart-Snares shelf, 1993–96.
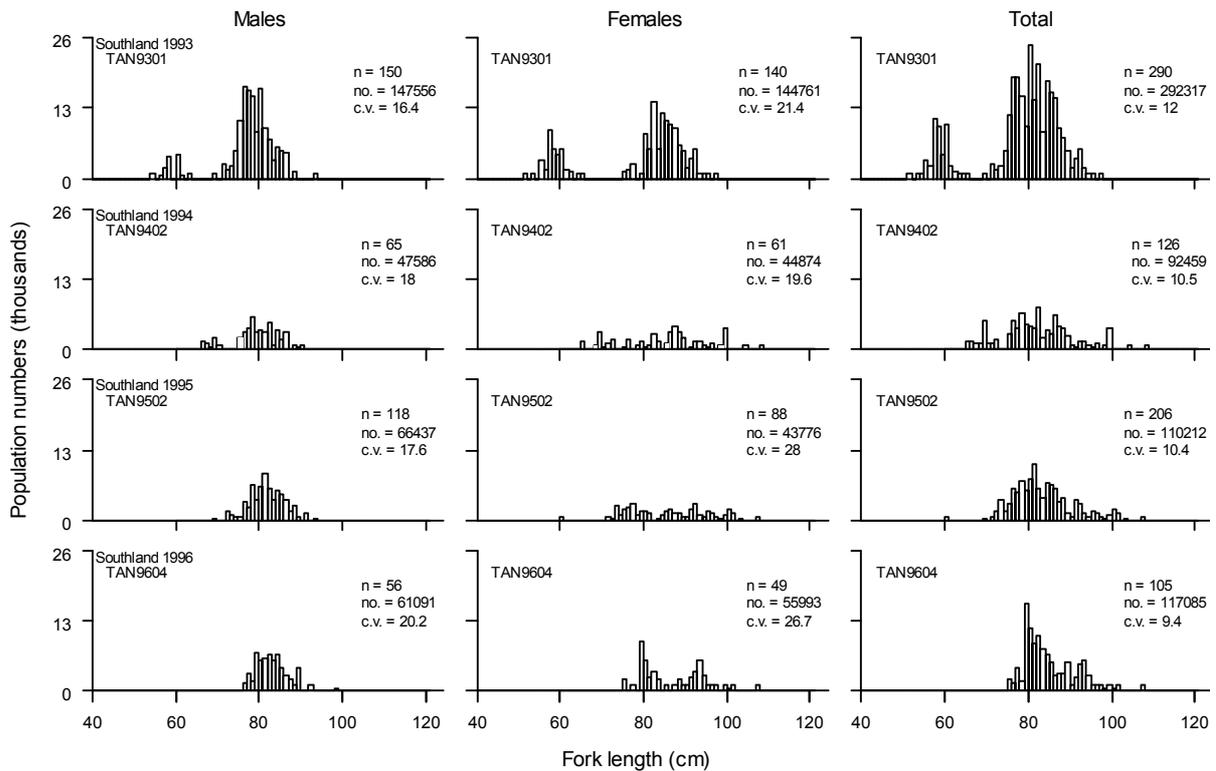
Figure A2: Scaled length frequency distributions for gemfish from the *Tangaroa* Southland annual trawl surveys during 1993–96.
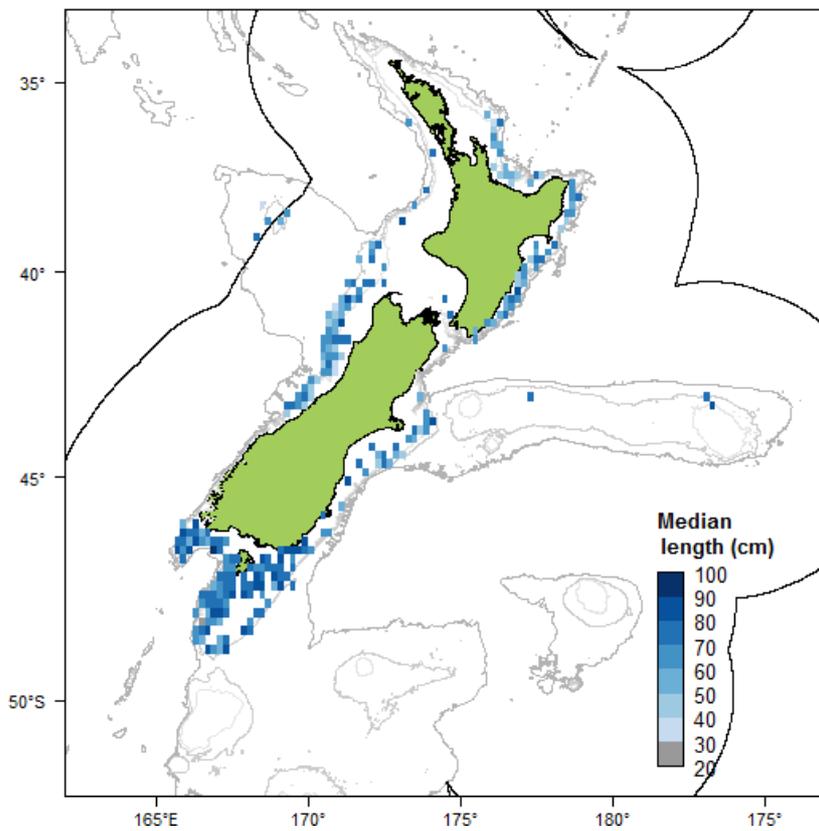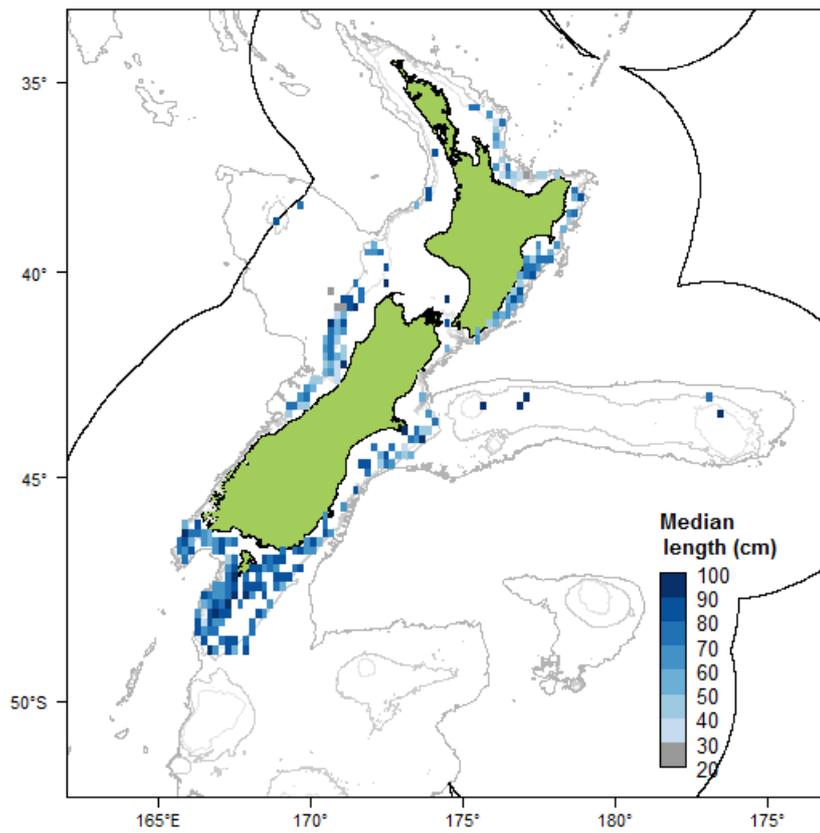
Figure A3: Distribution of female gemfish (upper) and male gemfish (lower) length data from all trawl surveys, presented as the median length per 0.2° latitude × longitude cell.
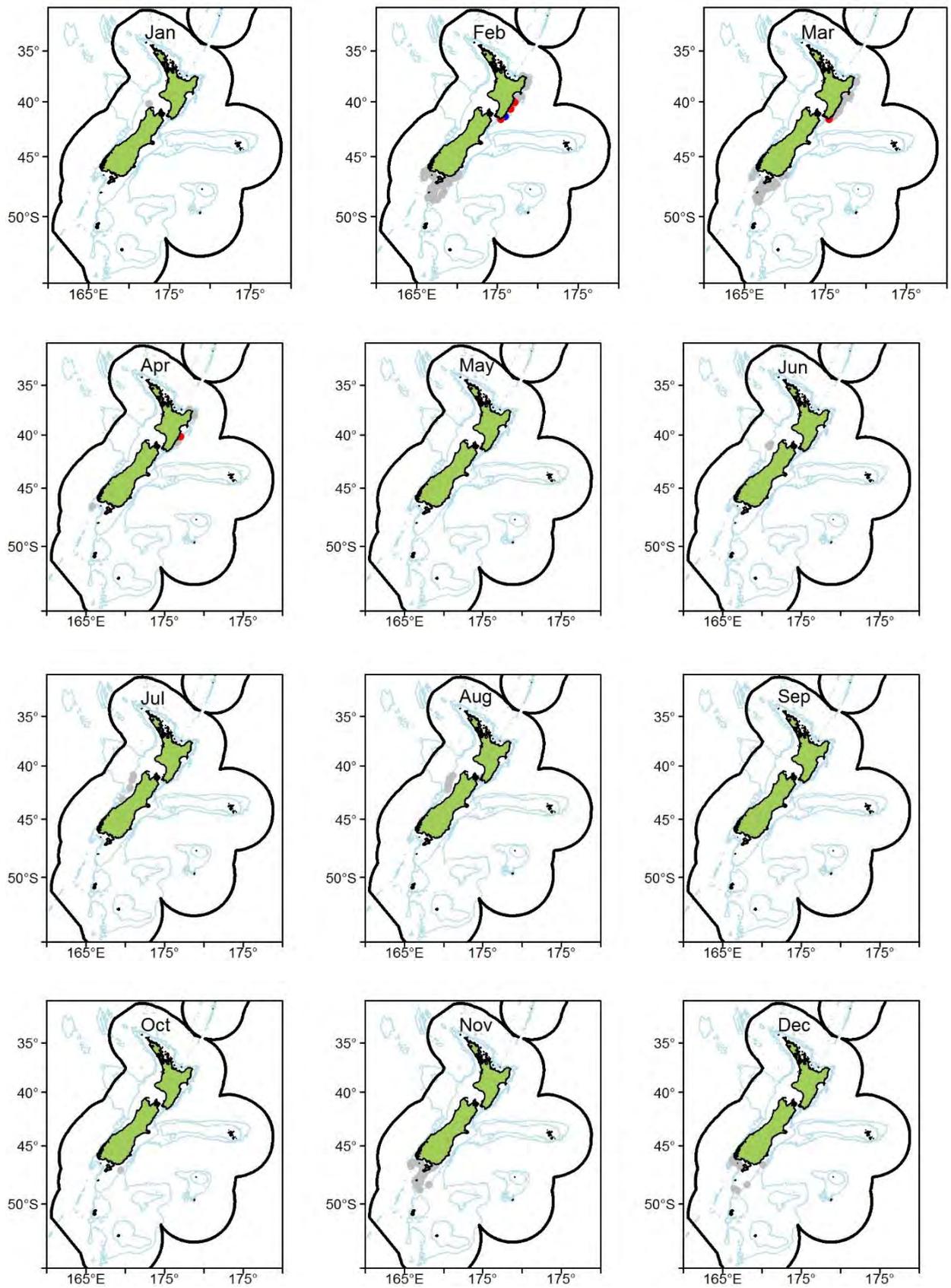
Figure A4: Distribution of female gemfish reproductive stage data from all trawl surveys, by month, where grey circles represent immature females, blue circles are ripe fish, and red circles are running ripe fish. A total of 963 females were staged, 98% of which were immature.
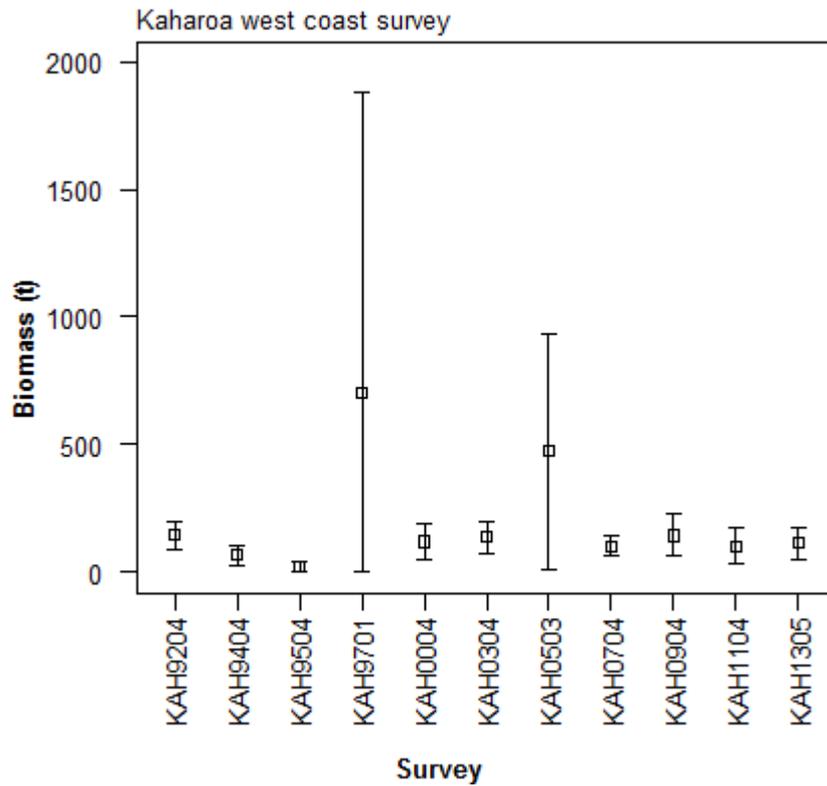
Figure A5: Doorspread biomass estimates (t) for all gemfish (± CV), from the west coast South Island RV *Kaharoa* surveys undertaken during March-April of 1992, 1994, 1995, 1997, 2000, 2003, 2005, 2007, 2009, 2011, and 2013. Note that the year of the survey is the given in the survey name, e.g., KAH9204 is 1992, KAH1305 is 2013.
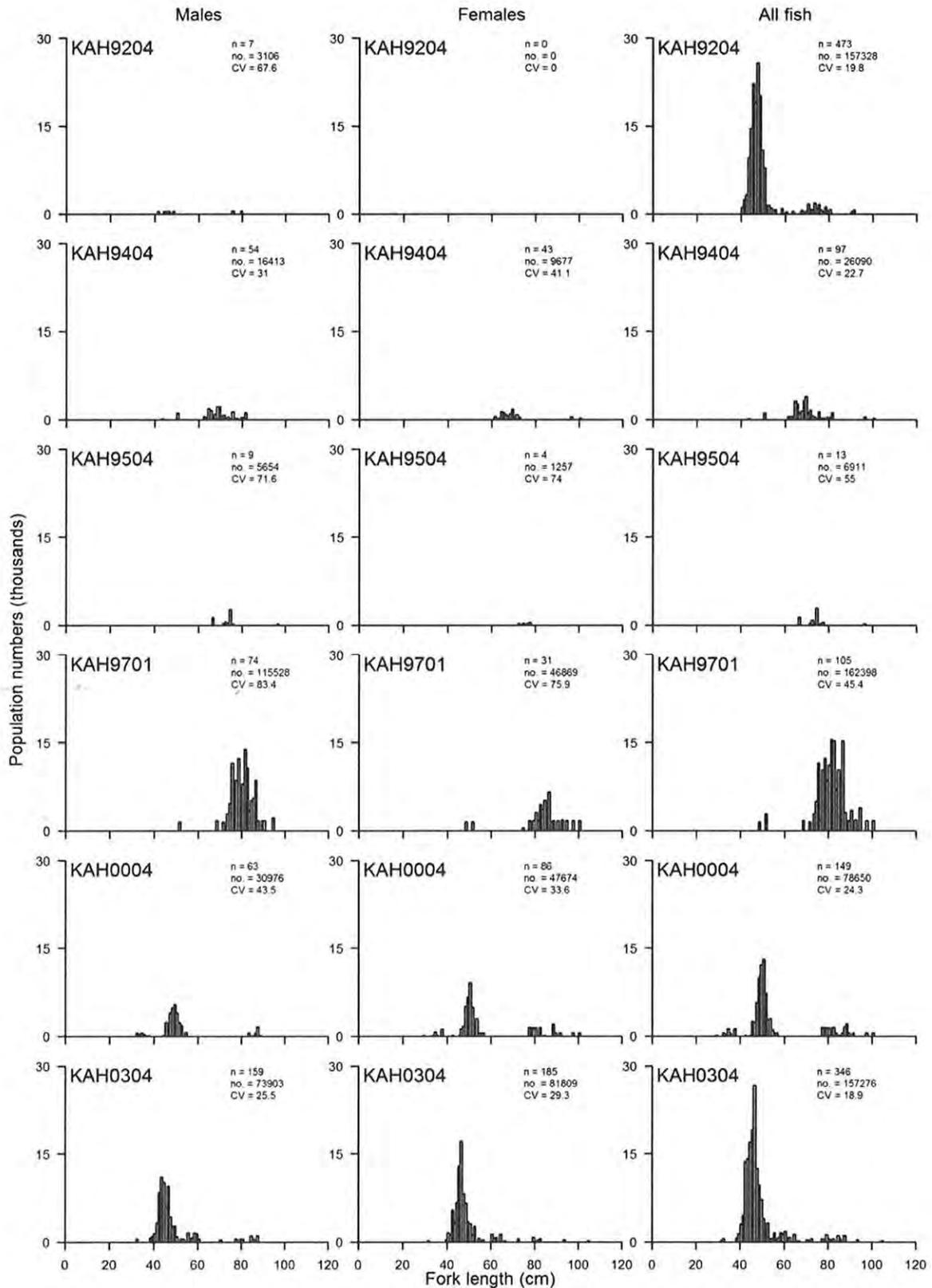
Figure A6: Scaled length frequencies for gemfish from the *Kaharoa* west coast South Island trawl surveys during March-April of 1992, 1994, 1995, 1997, 2000, 2003, 2005, 2007, 2009, 2011, and 2013. Note that the year of the survey is the given in the survey name, e.g., KAH9204 is 1992, KAH1305 is 2013. [From MacGibbon & Stevenson (2013)]
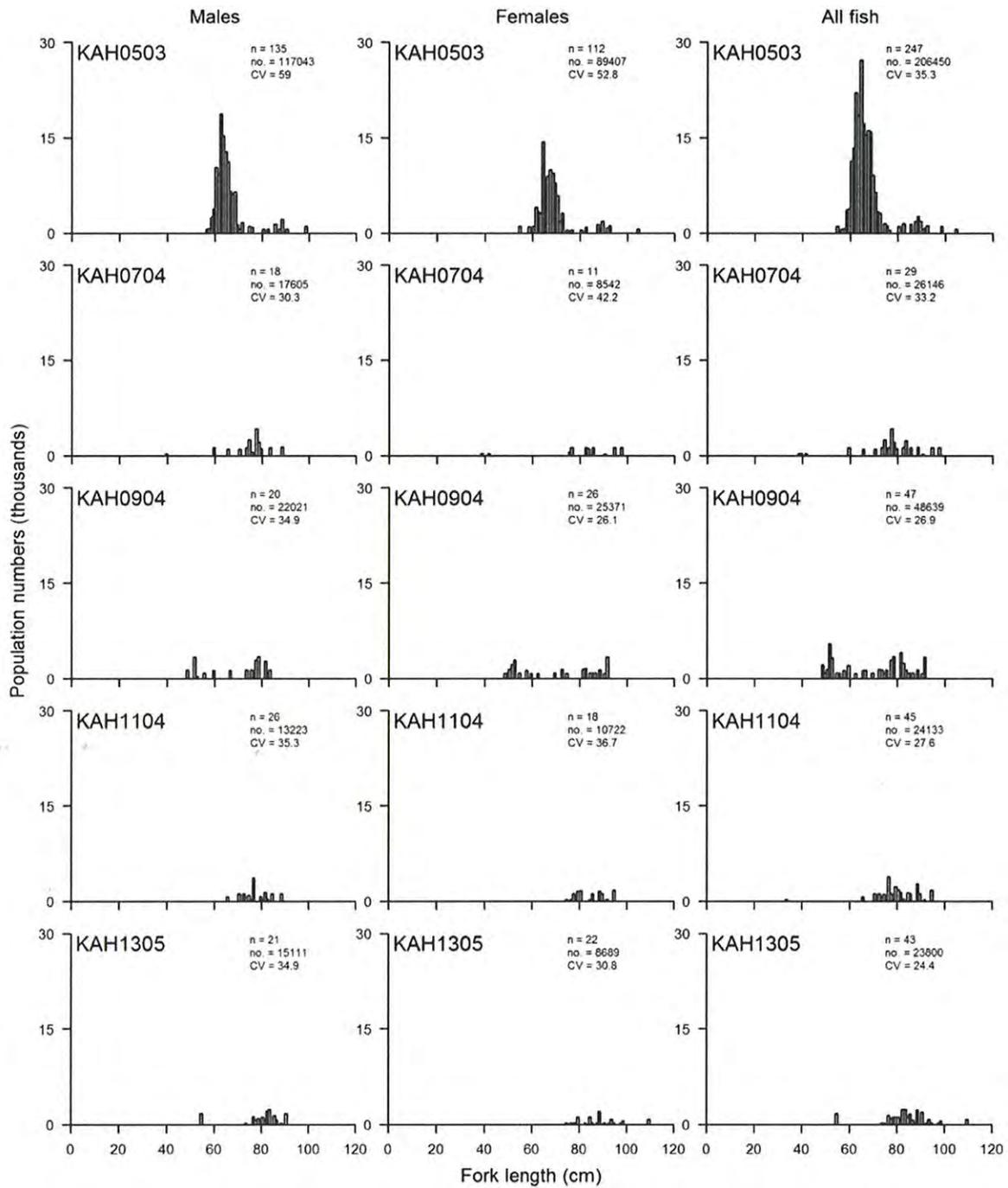
Figure A6 – *continued.*

APPENDIX B: OBSERVER DATA SUMMARIES FOR SKI 3 AND SKI 7, 1989–90 TO 2012–13

Table B1: Number of observed trips and observed tows in SKI 3 (Chatham and Southland) and SKI 7, including the number where gemfish catch was observed and sampled for gemfish length and sex, and number of gemfish measured (total, females, males) for length collected from SKI 3 and SKI 7, 1989–90 (1990) to 2012–13 (2013).

(a) SKI 3 Chatham

Fishing year	No. trips	No. trips with gemfish	No. tows	No. tows with gemfish	Gemfish catch (t)	No. tows sampled	No. gemfish sampled	No. females sampled	No. males sampled
1990	23	9	992	81	1.9	8	15	14	1
1991	22	9	1 799	147	6.3	16	189	109	69
1992	21	7	1 148	15	0.2	5	6	2	1
1993	23	5	1 016	39	0.9	5	17	12	5
1994	43	9	2 502	58	0.7	5	16	14	2
1995	36	3	1 854	4	0.01	0	0	0	0
1996	23	1	1 118	1	<0.01	0	0	0	0
1997	24	1	1 022	1	<0.01	0	0	0	0
1998	38	5	2 451	6	0.05	2	7	3	4
1999	36	3	1 839	8	0.06	7	7	3	4
2000	34	3	1 699	3	<0.01	1	1	1	0
2001	50	7	2 595	22	0.2	12	55	38	14
2002	37	5	1 938	31	2.2	3	27	18	9
2003	45	14	2 137	62	4.1	7	31	26	5
2004	34	6	1 522	8	0.1	1	1	1	0
2005	32	7	1 925	18	0.3	3	4	2	2
2006	34	8	1 682	14	0.1	2	2	2	0
2007	41	10	1 913	27	0.3	2	7	2	5
2008	39	5	2 556	9	0.1	–	0	0	0
2009	40	6	2 369	15	0.1	–	0	0	0
2010	36	13	2 258	77	0.8	10	25	18	7
2011	43	11	1 553	64	1.1	–	0	0	0
2012	54	8	1 809	27	0.2	–	0	0	0
2013	80	32	2 574	92	2.1	4	13	9	4
Total	854	185	44 271	781	21.8	93	423	274	132

(b) SKI 3 South

Fishing year	Total observed trips	Trips with gemfish	Total observed tows	Tows with gemfish	Observed gemfish catch (t)	Observed tows sampled	Total gemfish sampled	Females sampled	Males sampled
1990	24	14	1 905	185	16.9	11	92	47	43
1991	21	14	2 138	614	19.3	14	139	97	42
1992	36	16	2 867	312	29.5	75	804	425	293
1993	40	24	3 330	684	38.2	138	447	282	163
1994	37	13	2 188	179	6.5	122	568	383	182
1995	25	6	1 378	192	3.6	148	565	343	222
1996	25	6	1 424	64	0.5	58	100	71	28
1997	36	11	2 234	67	1.5	29	78	51	27
1998	44	11	2 531	76	3.2	37	148	111	37
1999	43	14	2 654	86	1.3	48	67	38	29
2000	53	11	3 457	99	17.4	52	373	295	78
2001	70	30	4 691	58	0.7	18	31	25	6
2002	46	15	3 477	300	21.2	75	619	433	178
2003	42	23	2 775	578	34.6	134	1 369	984	385
2004	52	22	2 958	213	2.5	53	140	92	48
2005	54	29	3 605	271	10.5	64	308	215	93
2006	40	24	2 679	158	3.5	40	279	204	75
2007	57	21	3 255	94	1.2	15	23	15	8
2008	52	19	3 687	83	1.1	1	3	3	0
2009	46	23	3 169	69	2.1	1	1	1	0
2010	51	24	3 334	172	3.8	5	7	7	0
2011	57	29	3 066	217	8.6	7	102	94	8
2012	62	30	3 340	114	1.9	1	14	2	12
2013	118	59	5 242	419	9.4	1	10	9	1
Total	1 053	488	71 384	5 304	238.9	1 147	6 287	4 227	1 958

(c) SKI 7

Fishing year	Total observed trips	Trips with gemfish	Total observed tows	Tows with gemfish	Observed gemfish catch (t)	Observed tows sampled	Total gemfish sampled	Females sampled	Males sampled
1990	30	21	2 142	777	84.8	25	77	42	15
1991	21	17	1 652	440	38.0	89	936	300	332
1992	22	16	1 346	438	31.8	92	869	497	354
1993	30	19	2 084	488	38.6	39	274	134	140
1994	33	23	2 389	789	65.1	282	2 570	1 703	835
1995	19	13	1 346	219	3.3	97	289	131	141
1996	22	14	1 367	225	5.9	99	420	269	150
1997	18	14	1 164	91	3.3	34	107	73	34
1998	32	10	1 448	31	0.5	28	65	26	39
1999	33	12	1 971	71	10.4	64	612	310	300
2000	28	13	1 474	175	12.4	109	533	442	90
2001	39	24	1 554	190	4.1	81	259	111	127
2002	31	19	1 667	357	11.7	102	499	263	229
2003	25	16	1 362	517	26.0	171	994	481	512
2004	25	19	1 599	901	94.1	167	1 239	591	636
2005	36	17	1 758	541	69.9	121	857	383	474
2006	34	24	1 937	429	36.5	78	317	132	174
2007	41	30	1 749	198	3.8	38	81	60	21
2008	39	28	1 861	162	5.3	4	6	4	2
2009	36	25	1 701	321	16.7	23	177	97	80
2010	45	28	1 878	248	7.9	2	5	4	1
2011	28	22	1 283	309	29.5	9	161	140	21
2012	50	33	2 672	278	82.0	17	229	168	61
2013	84	65	3 989	780	78.4	34	320	268	52
Total	775	507	43 393	8 975	759.9	1 805	11 896	6 629	4 820

Table B2: Number of observed tows and the number of observed tows with gemfish catch, by main target species for 1989–90 to 2012–13, for SKI 3 (Chatham and Southland) and SKI 7. BAR is barracouta; BYX is alfonsino, EMA is blue mackerel, FRO is frostfish, HAK is hake, HOK is hoki, JMA is jack mackerel species, LIN is ling, OEO is oreo species, ORH is orange roughy, RBT is redbait, RCO is red cod, SBW is southern blue whiting, SCI is scampi, SKI is gemfish, SQU is squid species, SWA is silver warehou, TAR is tarakihi, WAR is blue warehou, WWA is white warehou. [Scientific names of target species are given in Table C12.]

(a) SKI 3 Chatham

All observed tows

	BAR	BYX	HAK	HOK	JMA	LIN	OEO	ORH	RCO	SCI	SQU	SPD	SWA	WWA	Other	All
1990	63	0	19	319	0	7	91	430	3	0	0	2	25	29	4	992
1991	115	0	42	669	2	131	311	450	1	3	0	38	25	0	12	1 799
1992	16	0	5	481	0	1	32	487	0	110	0	0	6	1	9	1 148
1993	47	0	52	212	161	0	3	374	29	108	28	0	0	0	2	1 016
1994	0	3	15	901	45	0	40	909	0	327	261	0	1	0	0	2 502
1995	45	48	10	495	6	0	132	954	0	155	1	0	4	0	4	1 854
1996	0	0	0	746	94	0	78	135	0	61	4	0	0	0	0	1 118
1997	37	0	15	414	11	0	70	470	0	0	4	0	1	0	0	1 022
1998	10	4	19	1 640	10	0	152	527	0	85	4	0	0	0	0	2 451
1999	41	0	6	1 309	22	0	143	186	2	110	19	0	0	0	1	1 839
2000	73	0	10	774	22	0	412	241	7	91	60	0	3	0	6	1 699
2001	66	9	24	1 377	32	0	467	470	6	36	93	0	11	0	4	2 595
2002	56	0	0	972	85	0	129	501	8	123	52	0	4	0	8	1 938
2003	20	48	9	877	27	1	86	643	1	327	51	0	16	4	27	2 137
2004	0	0	33	589	0	0	92	537	3	238	3	0	6	0	21	1 522
2005	5	21	9	803	3	0	152	791	0	77	57	0	4	0	3	1 925
2006	17	36	1	742	56	0	167	521	0	97	11	0	31	0	3	1 682
2007	80	10	73	804	16	0	164	529	0	152	29	11	18	0	27	1 913
2008	142	0	25	796	23	21	194	1 127	6	182	1	7	29	0	3	2 556
2009	22	0	64	579	2	18	330	1 065	0	202	1	0	84	0	2	2 369
2010	127	105	1	687	14	32	294	808	0	106	2	12	68	0	2	2 258
2011	76	68	6	770	24	2	215	148	0	115	16	0	110	1	2	1 553
2012	192	71	1	957	57	23	192	123	0	100	4	0	54	4	31	1 809
2013	310	0	4	1 632	221	3	57	43	0	118	12	0	131	4	39	2 574
All	1 560	423	443	19 545	933	239	4 003	12 469	66	2 923	713	70	631	43	210	44 271

SKI 3 Chatham observed tows with gemfish catch

	BAR	BYX	HAK	HOK	JMA	LIN	OEO	ORH	RCO	SCI	SPD	SQU	SWA	WWA	Other	Total
1990	20	0	0	44	0	1	0	0	2	0	0	0	9	4	1	81
1991	39	0	1	73	1	0	0	0	0	0	27	0	4	0	2	147
1992	6	0	0	7	0	0	0	0	0	1	0	0	0	0	1	15
1993	8	0	0	0	2	0	0	0	22	1	0	6	0	0	0	39
1994	0	0	0	12	0	0	0	0	0	4	0	42	0	0	0	58
1995	0	0	0	3	0	0	0	0	0	1	0	0	0	0	0	4
1996	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
1997	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
1998	0	0	0	3	0	0	0	0	0	1	0	2	0	0	0	6
1999	0	0	0	6	0	0	0	0	0	0	0	2	0	0	0	8
2000	0	0	0	2	0	0	0	0	0	0	0	1	0	0	0	3
2001	0	0	0	2	0	0	0	0	0	0	0	20	0	0	0	22
2002	0	0	0	2	1	0	0	0	0	0	0	27	1	0	0	31
2003	2	0	0	11	4	0	0	0	0	2	0	37	6	0	0	62
2004	0	0	0	5	0	0	0	0	0	0	0	2	1	0	0	8
2005	2	0	0	4	1	0	0	0	0	0	0	11	0	0	0	18
2006	0	0	0	7	3	0	1	0	0	0	0	2	1	0	0	14
2007	8	0	0	7	0	0	0	0	0	0	0	10	2	0	0	27
2008	1	0	0	7	0	1	0	0	0	0	0	0	0	0	0	9
2009	3	0	0	9	0	0	0	0	0	0	0	0	3	0	0	15
2010	21	1	0	29	3	0	0	0	0	0	10	0	13	0	0	77
2011	28	0	0	9	0	0	0	0	0	0	0	0	27	0	0	64
2012	15	0	0	3	7	0	0	0	0	0	0	0	2	0	0	27
2013	39	0	0	18	14	1	0	0	0	1	0	1	18	0	0	92
All	192	1	1	263	36	3	1	1	24	11	37	164	87	4	4	829

(b) SKI 3 South

All observed tows

	BAR	HAK	HOK	JMA	LIN	OEO	ORH	RBT	RCO	SBW	SCI	SKI	SPD	SQU	SWA	WAR	WWA	Other	All
1990	30	0	356	0	18	21	0	0	0	345	0	0	5	1 084	28	0	0	18	1 905
1991	96	0	548	38	44	8	0	0	0	187	0	0	1	1 193	2	9	0	12	2 138
1992	110	1	976	6	63	0	33	0	1	723	292	0	0	588	34	22	12	6	2 867
1993	68	10	784	68	13	51	16	0	1	410	162	2	0	1 684	58	0	1	2	3 330
1994	23	14	418	3	0	11	392	0	0	226	281	0	7	800	13	0	0	0	2 188
1995	10	0	241	17	0	46	45	0	0	239	50	0	0	725	5	0	0	0	1 378
1996	10	0	292	69	0	32	62	0	0	144	67	0	0	740	6	1	0	1	1 424
1997	9	0	132	94	0	86	204	0	3	249	227	0	0	1 229	0	0	0	1	2 234
1998	82	0	330	255	3	113	299	0	0	418	155	0	0	874	0	0	0	2	2 531
1999	57	1	825	207	0	166	42	0	1	342	23	0	1	976	6	7	0	0	2 654
2000	62	31	1 171	373	4	539	47	0	0	316	74	1	0	790	0	26	22	2	3 457
2001	62	8	811	174	0	106	116	0	0	388	84	0	0	2 907	17	3	14	1	4 691
2002	9	33	810	117	15	408	29	0	2	332	160	0	0	1 428	78	6	47	3	3 477
2003	83	0	634	42	13	224	17	0	0	279	153	0	0	1 249	33	23	20	5	2 775
2004	25	55	285	3	14	285	57	0	1	251	169	0	0	1 765	7	0	41	0	2 958
2005	39	0	157	9	91	325	187	0	0	337	0	0	0	2 442	9	1	7	1	3 605
2006	230	85	183	2	111	189	133	0	0	217	118	0	0	1 325	76	2	7	1	2 679
2007	69	55	215	0	150	906	179	0	0	224	101	0	0	1 232	68	4	40	12	3 255
2008	52	50	461	5	219	838	136	0	1	331	94	0	0	1 451	18	15	16	0	3 687
2009	74	80	420	25	123	565	45	11	0	299	61	0	0	1 284	65	3	113	1	3 169
2010	68	189	440	46	130	673	74	2	0	396	92	0	0	1 054	57	3	110	0	3 334
2011	30	94	319	63	105	397	25	0	0	433	208	0	0	1 238	81	0	70	3	3 066
2012	96	139	354	89	99	238	8	15	0	669	119	0	0	1 325	44	36	109	0	3 340
2013	201	102	857	92	237	99	1	23	0	791	136	0	0	2 237	310	31	125	0	5 242
All	1 595	947	12 019	1 797	1 452	6 326	2 147	51	10	8 546	2 826	3	14	31 620	1 015	192	753	71	71 384

SKI 3 South observed tows with gemfish

	BAR	HAK	HOK	JMA	LIN	RBT	RCO	SBW	SCI	SKI	SPD	SQU	SWA	WAR	WWA	Other	All
1990	18	0	9	0	18	0	0	2	0	0	0	101	27	0	0	10	185
1991	57	0	14	3	1	0	0	0	0	0	0	534	0	5	0	0	614
1992	56	0	72	0	8	0	0	0	14	0	0	124	25	6	5	2	312
1993	26	0	28	16	7	0	1	0	4	2	0	555	44	0	0	1	684
1994	4	0	9	1	0	0	0	0	0	0	6	157	2	0	0	0	179
1995	2	0	1	1	0	0	0	0	0	0	0	186	2	0	0	0	192
1996	3	0	4	1	0	0	0	0	0	0	0	56	0	0	0	0	64
1997	1	0	0	5	0	0	0	0	1	0	0	60	0	0	0	0	67
1998	13	0	7	12	0	0	0	0	0	0	0	44	0	0	0	0	76
1999	3	0	2	3	0	0	0	0	0	0	0	76	1	1	0	0	86
2000	13	0	1	53	2	0	0	0	0	0	0	10	0	1	19	0	99
2001	1	0	17	2	0	0	0	0	0	0	0	32	1	0	5	0	58
2002	0	0	0	17	1	0	1	0	0	0	0	259	13	0	9	0	300
2003	9	0	12	18	0	0	0	0	1	0	0	528	6	0	4	0	578
2004	4	0	3	0	0	0	1	0	1	0	0	192	1	0	11	0	213
2005	4	0	1	2	2	0	0	0	0	0	0	257	5	0	0	0	271
2006	43	0	2	0	5	0	0	0	0	0	0	91	17	0	0	0	158
2007	12	1	3	0	6	0	0	0	0	0	0	62	8	0	2	0	94
2008	5	1	0	0	5	0	0	0	0	0	0	70	2	0	0	0	83
2009	8	0	2	1	1	0	0	0	0	0	0	33	7	0	17	0	69
2010	6	4	2	15	7	0	0	0	0	0	0	104	7	0	27	0	172
2011	4	6	6	3	7	0	0	0	0	0	0	162	17	0	12	0	217
2012	14	1	3	3	8	1	0	0	0	0	0	68	4	0	12	0	114
2013	7	5	19	5	22	0	0	0	0	0	0	249	93	0	19	0	419
All	313	18	217	161	100	1	3	2	21	2	6	4 010	282	13	142	13	5 304

(c) SKI 7

All observed tows

	BAR	EMA	FRO	HAK	HOK	JMA	LIN	ORH	RCO	SCI	SKI	SQU	SWA	TAR	WAR	Other	All
1990	58	0	0	0	1 569	349	0	162	0	0	0	0	1	0	1	2	2 142
1991	75	9	7	0	1 276	283	0	0	0	0	0	0	0	0	2	0	1 652
1992	34	0	0	78	787	353	0	62	0	0	25	0	4	0	1	2	1 346
1993	113	0	0	220	1 295	380	0	53	0	0	16	0	3	0	0	4	2 084
1994	56	0	0	55	1 614	606	0	51	0	0	4	0	2	0	1	0	2 389
1995	18	0	0	37	812	394	0	83	0	1	0	0	0	0	0	1	1 346
1996	70	0	0	11	1 102	137	3	43	0	0	0	0	0	0	0	1	1 367
1997	40	0	9	11	689	243	0	172	0	0	0	0	0	0	0	0	1 164
1998	1	1	0	0	1 097	198	0	148	0	0	0	0	0	0	0	3	1 448
1999	16	0	5	20	1 361	369	0	200	0	0	0	0	0	0	0	0	1 971
2000	0	0	0	1	1 324	102	0	40	0	0	0	7	0	0	0	0	1 474
2001	10	0	0	21	1 324	192	3	1	0	0	0	0	0	0	3	0	1 554
2002	18	4	0	4	1 479	150	0	2	0	10	0	0	0	0	0	0	1 667
2003	2	0	0	35	1 058	266	0	0	0	0	0	0	0	0	0	1	1 362
2004	22	0	0	73	1 444	60	0	0	0	0	0	0	0	0	0	0	1 599
2005	105	8	1	108	1 091	378	1	53	0	0	0	0	8	0	0	5	1 758
2006	29	20	1	350	847	586	0	1	0	2	0	0	22	16	0	63	1 937
2007	64	7	0	158	711	734	0	2	25	0	0	2	4	28	10	4	1 749
2008	67	4	1	315	663	721	0	0	0	0	0	0	21	25	0	44	1 861
2009	24	33	1	209	671	682	0	67	0	0	0	0	6	0	1	7	1 701
2010	21	7	0	129	933	663	3	81	0	0	0	0	11	28	0	2	1 878
2011	14	0	1	97	672	423	0	72	0	0	0	0	3	0	0	1	1 283
2012	81	34	0	82	1 151	1 237	1	69	0	0	0	0	0	7	1	9	2 672
2013	61	47	0	413	1 970	1 406	1	84	0	0	0	0	0	0	0	7	3 989
All	999	174	26	2 427	26 940	10 912	12	1 446	25	13	45	9	85	104	20	156	43 393

SKI 7 observed tows with gemfish catch

	BAR	EMA	FRO	HAK	HOK	JMA	LIN	RCO	SCI	SKI	SQU	SWA	TAR	WAR	Other	All
1990	14	0	0	0	699	62	0	0	0	0	0	1	0	1	0	777
1991	39	1	7	0	384	9	0	0	0	0	0	0	0	0	0	440
1992	7	0	0	33	315	55	0	0	0	25	0	3	0	0	0	438
1993	25	0	0	52	371	23	0	0	0	13	0	3	0	0	1	488
1994	43	0	0	16	660	64	0	0	0	4	0	2	0	0	0	789
1995	6	0	0	0	149	63	0	0	1	0	0	0	0	0	0	219
1996	10	0	0	0	208	4	3	0	0	0	0	0	0	0	0	225
1997	11	0	4	1	64	11	0	0	0	0	0	0	0	0	0	91
1998	0	0	0	0	19	12	0	0	0	0	0	0	0	0	0	31
1999	5	0	4	1	52	9	0	0	0	0	0	0	0	0	0	71
2000	0	0	0	0	172	3	0	0	0	0	0	0	0	0	0	175
2001	0	0	0	10	175	2	2	0	0	0	0	0	0	1	0	190
2002	1	0	0	0	345	5	0	0	6	0	0	0	0	0	0	357
2003	0	0	0	5	500	12	0	0	0	0	0	0	0	0	0	517
2004	3	0	0	7	888	3	0	0	0	0	0	0	0	0	0	901
2005	9	0	0	26	492	5	1	0	0	0	0	8	0	0	0	541
2006	1	0	0	52	340	15	0	0	1	0	0	20	0	0	0	429
2007	5	0	0	2	158	17	0	1	0	0	1	0	14	0	0	198
2008	3	0	0	23	99	18	0	0	0	0	0	12	7	0	0	162
2009	3	0	0	28	236	49	0	0	0	0	0	5	0	0	0	321
2010	3	0	0	15	194	18	3	0	0	0	0	10	5	0	0	248
2011	5	0	0	36	253	12	0	0	0	0	0	3	0	0	0	309
2012	30	0	0	24	197	26	1	0	0	0	0	0	0	0	0	278
2013	10	0	0	139	598	32	1	0	0	0	0	0	0	0	0	780
All	233	1	15	470	7 568	529	11	1	8	42	1	67	26	2	1	8 975

Table B3: Total observed gemfish catch (kg), by main target species and month, for SKI 3 (Chatham and South) and for SKI 7, for the fishing years 1989–90 to 2012–13 combined. BAR is barracouta; BYX is alfonsino, EMA is blue mackerel, FRO is frostfish, HAK is hake, HOK is hoki, JMA is jack mackerel species, LIN is ling, OEO is oreo species, ORH is orange roughy, RBT is redbait, RCO is red cod, SBW is southern blue whiting, SCI is scampi, SKI is gemfish, SQU is squid species, SWA is silver warehou, TAR is tarakihi, WAR is blue warehou, WWA is white warehou. [Scientific names of target species are given in Table C12.]

(a) **SKI 3 Chatham: for observed tows with gemfish, catch weight per tow ranged from 1 kg to 565 kg (median of 10 kg, mean of 26 kg, 1st quartile of 6 kg, 3rd quartile of 50 kg)**

Target	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	All
BAR	1 346	511	1 315	501	1 561	270	126	57	0	2	0	7	5 696
BYX	0	0	0	0	0	6	0	0	0	0	0	0	6
HAK	0	0	0	5	0	0	0	0	0	0	0	0	5
HOK	1 886	85	159	78	149	267	187	447	34	2	17	232	3 543
JMA	5	0	0	2	22	383	105	5	0	0	0	0	522
LIN	0	4	0	0	0	0	0	0	0	0	0	7	11
OEO	0	0	0	0	0	0	0	0	0	0	15	0	15
ORH	0	0	0	0	0	0	0	0	0	0	0	2	2
RCO	153	0	0	0	0	0	590	0	0	0	0	0	743
SCI	40	16	8	0	0	0	75	9	0	0	0	0	148
SPD	0	33	1 377	276	0	0	0	0	0	0	0	0	1 686
SQU	0	5	72	35	95	72	3 689	2 520	20	0	0	0	6 508
SWA	408	677	822	0	15	2	785	12	0	0	0	9	2 730
WAR	0	0	0	0	0	50	0	0	0	0	0	0	50
WWA	0	0	0	0	0	0	0	65	0	0	0	0	65
Other	21	0	19	19	0	0	0	0	0	0	0	0	59
	3 859	1 331	3 772	916	1 842	1 050	5 557	3 115	54	4	32	257	21 789

(b) SKI 3 South: for observed tows with gemfish, catch weight per tow ranged from 1 kg to 9088 kg (median of 12 kg, mean of 45 kg, 1st quartile of 5 kg, 3rd quartile of 30 kg)

Target	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	All
BAR	726	3 092	2 591	3 456	7 485	4 315	14 815	149	0	0	0	0	36 629
HAK	20	58	67	166	0	10	0	0	0	0	0	0	321
HOK	125	98	121	25	37	495	916	164	198	341	110	718	3 348
JMA	0	0	8	33	464	3 492	835	0	0	0	0	0	4 832
LIN	386	5 905	382	0	0	2	0	4	0	10	79	72	6 840
RBT	0	0	0	0	4	0	0	0	0	0	0	0	4
RCO	0	0	0	0	0	12	20	0	0	0	0	0	32
SBW	0	0	0	0	0	0	0	0	0	0	0	74	74
SCI	133	62	0	118	0	0	0	0	0	0	0	14	327
SKI	0	0	0	0	0	0	653	0	0	0	0	0	653
SPD	0	0	0	0	111	0	0	0	0	0	0	0	111
SQU	0	118	598	10 467	38 607	41 419	47 300	6 400	3 789	14	0	0	148 712
SWA	666	2 455	2 857	729	221	4 422	743	855	152	19	0	2 324	15 443
WAR	97	0	0	54	0	2 090	10	0	0	0	0	0	2 251
WWA	709	14 566	568	306	473	547	60	220	162	0	0	136	17 747
Other	256	0	0	0	1 227	0	3	55	0	0	0	0	1 541
All	2 862	26 354	7 192	15 354	47 402	56 804	65 352	7 792	4 301	384	189	3 338	237 324

(c) SKI 7: for observed tows with gemfish, catch weight per tow ranged from 1 kg to 9916 kg (median of 17 kg, mean of 85 kg, 1st quartile of 5 kg, 3rd quartile of 21 kg)

Target	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	All
BAR	42 299	40	0	0	0	0	0	0	105	112	3 788	97 374	143 718
EMA	0	0	0	0	0	0	0	0	0	0	8	0	8
FRO	0	0	0	0	0	0	0	0	0	0	354	618	972
HAK	734	30	0	0	0	0	0	1 245	1 755	664	2 816	33 640	40 884
HOK	372	150	70	124	14	0	172	12 346	23 295	82 579	261 564	115 383	496 069
JMA	2 768	3 581	1 223	810	10	120	3	40	203	137	700	11 457	21 052
LIN	186	3	0	0	0	0	0	0	0	13	253	204	659
RCO	0	0	0	0	3	0	0	0	0	0	0	0	3
SCI	4	0	0	0	0	0	0	165	95	19	0	0	283
SKI	4 111	0	0	0	0	0	0	0	0	0	0	24 244	28 355
SQU	0	0	0	0	0	0	3	0	0	0	0	0	3
SWA	888	10	0	0	0	0	0	0	698	1 214	17 274	6 735	26 819
TAR	225	34	0	0	270	21	542	0	0	0	0	0	1 092
WAR	0	0	0	0	0	50	0	0	0	0	0	6	56
Other	0	0	0	0	0	0	0	0	0	0	2	0	2
All	51 587	3 848	1 293	934	297	191	720	13 796	26 151	84 738	286 757	289 661	759 973

Table B4: Number of observer trawl tows sampled for length and sex measurements by month for each fishing year, 1990–2013, for SKI 3 (Chatham and South) and SKI 7.

(a) SKI 3 Chatham

Fishing year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1990	0	0	0	0	0	0	0	7	1	–	–	0	8
1991	5	0	5	6	0	0	0	0	0	–	–	0	16
1992	0	1	0	0	1	0	2	1	0	–	–	0	5
1993	0	0	0	0	0	0	5	0	0	–	–	0	5
1994	0	0	0	0	0	0	2	3	0	–	–	0	5
1995	–	–	–	–	–	–	–	–	–	–	–	–	0
1996	–	–	–	–	–	–	–	–	–	–	–	–	0
1997	–	–	–	–	–	–	–	–	–	–	–	–	0
1998	0	0	0	1	0	0	1	0	0	–	–	0	2
1999	0	0	2	1	0	0	3	1	0	–	–	0	7
2000	0	0	0	0	0	0	0	1	0	–	–	0	1
2001	0	0	0	0	3	8	0	0	0	–	–	1	12
2002	0	0	0	0	0	0	2	1	0	–	–	0	3
2003	1	0	0	0	0	0	3	3	0	–	–	0	7
2004	0	0	0	0	0	0	1	0	0	–	–	0	1
2005	0	0	0	0	0	0	0	2	0	–	–	1	3
2006	0	0	0	0	0	2	0	0	0	–	–	0	2
2007	0	1	1	0	0	0	0	0	0	–	–	0	2
2008	–	–	–	–	–	–	–	–	–	–	–	–	–
2009	–	–	–	–	–	–	–	–	–	–	–	–	–
2010	0	0	0	0	1	9	0	0	0	–	–	0	10
2011	–	–	–	–	–	–	–	–	–	–	–	–	–
2012	–	–	–	–	–	–	–	–	–	–	–	–	–
2013	0	0	0	0	2	2	0	0	0	–	–	0	4
Total	6	2	8	8	7	21	19	19	1	–	–	2	93

(b) SKI 3 South

Fishing year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1990	0	7	0	0	0	0	0	3	0	0	1	0	11
1991	0	0	0	0	8	1	1	4	0	0	0	0	14
1992	2	1	0	10	35	15	10	0	0	2	0	0	75
1993	8	0	0	0	17	87	26	0	0	0	0	0	138
1994	0	0	0	0	16	63	42	0	0	0	0	1	122
1995	0	0	0	7	120	20	1	0	0	0	0	0	148
1996	0	0	0	9	35	5	9	0	0	0	0	0	58
1997	0	0	0	2	0	22	5	0	0	0	0	0	29
1998	0	0	3	4	12	15	3	0	0	0	0	0	37
1999	0	0	8	5	18	8	9	0	0	0	0	0	48
2000	0	6	0	0	5	38	3	0	0	0	0	0	52
2001	3	0	0	2	6	4	0	0	0	0	0	3	18
2002	0	0	0	1	14	50	10	0	0	0	0	0	75
2003	0	1	0	19	55	19	26	7	3	0	1	3	134
2004	0	0	0	23	23	4	2	0	0	0	1	0	53
2005	0	0	0	9	17	5	17	6	10	0	0	0	64
2006	0	2	4	2	5	19	5	3	0	0	0	0	40
2007	0	1	0	2	6	3	3	0	0	0	0	0	15
2008	0	0	0	1	0	0	0	0	0	0	0	0	1
2009	0	0	0	0	1	0	0	0	0	0	0	0	1
2010	0	0	0	0	2	3	0	0	0	0	0	0	5
2011	0	0	0	1	1	0	5	0	0	0	0	0	7
2012	1	0	0	0	0	0	0	0	0	0	0	0	1
2013	0	0	0	0	0	0	1	0	0	0	0	0	1
Total	14	18	15	97	396	381	178	23	13	2	3	7	1 147

(c) SKI 7

Fishing year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1990	0	0	0	0	–	–	–	0	4	9	12	0	25
1991	0	0	0	0	–	–	–	0	0	21	48	20	89
1992	0	0	0	0	–	–	–	0	0	29	54	9	92
1993	1	0	0	0	–	–	–	0	0	5	26	7	39
1994	11	0	0	0	–	–	–	0	0	60	190	21	282
1995	0	0	2	28	–	–	–	0	0	11	31	25	97
1996	0	0	0	0	–	–	–	0	0	1	32	66	99
1997	0	0	0	0	–	–	–	0	0	0	25	9	34
1998	0	11	5	0	–	–	–	0	0	3	7	2	28
1999	0	0	0	0	–	–	–	0	0	13	42	9	64
2000	2	0	0	0	–	–	–	0	2	15	45	45	109
2001	5	0	0	0	–	–	–	0	1	17	49	9	81
2002	1	0	0	0	–	–	–	1	3	26	71	0	102
2003	3	0	0	0	–	–	–	0	0	49	98	21	171
2004	0	0	0	0	–	–	–	0	0	51	111	5	167
2005	0	0	0	0	–	–	–	0	0	46	59	16	121
2006	0	0	3	0	–	–	–	0	7	14	43	11	78
2007	0	0	1	1	–	–	–	0	3	4	28	1	38
2008	0	1	2	0	–	–	–	0	0	0	1	0	4
2009	1	1	3	0	–	–	–	0	1	13	4	0	23
2010	0	0	0	0	–	–	–	0	0	0	1	1	2
2011	0	0	0	0	–	–	–	0	1	0	5	3	9
2012	0	0	0	0	–	–	–	1	3	3	3	7	17
2013	3	0	0	0	–	–	–	12	8	2	5	4	34
Total	27	13	16	29	0	0	0	14	33	392	990	291	1 805

Table B5: Number of gemfish sampled for length and sex measurements by month for each fishing year, 1990–2013, for SKI 3 (Chatham and South) and SKI 7.

(a) SKI 3 Chatham

Fishing year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	All
1990	0	0	0	0	0	0	0	14	1	–	–	0	15
1991	92	0	45	52	0	0	0	0	0	–	–	0	189
1992	0	1	0	0	1	0	3	1	0	–	–	0	6
1993	0	0	0	0	0	0	17	0	0	–	–	0	17
1994	0	0	0	0	0	0	2	14	0	–	–	0	16
1995	–	–	–	–	–	–	–	–	–	–	–	–	0
1996	–	–	–	–	–	–	–	–	–	–	–	–	0
1997	–	–	–	–	–	–	–	–	–	–	–	–	0
1998	0	0	0	6	0	0	1	0	0	–	–	0	7
1999	0	0	2	1	0	0	3	1	0	–	–	0	7
2000	0	0	0	0	0	0	0	1	0	–	–	0	1
2001	0	0	0	0	8	45	0	0	0	–	–	2	55
2002	0	0	0	0	0	0	7	20	0	–	–	0	27
2003	4	0	0	0	0	0	7	20	0	–	–	0	31
2004	0	0	0	0	0	0	1	0	0	–	–	0	1
2005	0	0	0	0	0	0	0	3	0	–	–	1	4
2006	0	0	0	0	0	2	0	0	0	–	–	0	2
2007	0	4	3	0	0	0	0	0	0	–	–	0	7
2008	–	–	–	–	–	–	–	–	–	–	–	–	0
2009	–	–	–	–	–	–	–	–	–	–	–	–	0
2010	0	0	0	0	1	24	0	0	0	–	–	0	25
2011	–	–	–	–	–	–	–	–	–	–	–	–	0
2012	–	–	–	–	–	–	–	–	–	–	–	–	0
2013	0	0	0	0	2	11	0	0	0	–	–	0	13
Total	96	5	50	59	12	82	41	74	1	0	0	3	423

(b) SKI 3 South

Fishing year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	All
1990	0	65	0	0	0	0	0	9	0	0	18	0	92
1991	0	0	0	0	107	13	2	17	0	0	0	0	139
1992	11	1	0	178	346	94	168	0	0	6	0	0	804
1993	30	0	0	0	48	239	130	0	0	0	0	0	447
1994	0	0	0	0	36	196	335	0	0	0	0	1	568
1995	0	0	0	56	370	138	1	0	0	0	0	0	565
1996	0	0	0	15	68	5	12	0	0	0	0	0	100
1997	0	0	0	3	0	70	5	0	0	0	0	0	78
1998	0	0	105	4	18	17	4	0	0	0	0	0	148
1999	0	0	8	8	30	12	9	0	0	0	0	0	67
2000	0	182	0	0	5	178	8	0	0	0	0	0	373
2001	10	0	0	3	11	4	0	0	0	0	0	3	31
2002	0	0	0	1	39	482	97	0	0	0	0	0	619
2003	0	1	0	74	769	93	231	166	31	0	1	3	1 369
2004	0	0	0	48	59	18	8	0	0	0	7	0	140
2005	0	0	0	19	35	14	105	53	82	0	0	0	308
2006	0	3	9	2	6	58	78	123	0	0	0	0	279
2007	0	2	0	2	10	4	5	0	0	0	0	0	23
2008	0	0	0	3	0	0	0	0	0	0	0	0	3
2009	0	0	0	0	1	0	0	0	0	0	0	0	1
2010	0	0	0	0	4	3	0	0	0	0	0	0	7
2011	0	0	0	1	1	0	100	0	0	0	0	0	102
2012	14	0	0	0	0	0	0	0	0	0	0	0	14
2013	0	0	0	0	0	0	10	0	0	0	0	0	10
Total	65	254	122	417	1963	1638	1308	368	113	6	26	7	6 287

(c) SKI 7

Fishing year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1990	0	0	0	0	–	–	–	0	9	20	48	0	77
1991	0	0	0	0	–	–	–	0	0	36	476	424	936
1992	0	0	0	0	–	–	–	0	0	167	555	147	869
1993	30	0	0	0	–	–	–	0	0	18	182	44	274
1994	100	0	0	0	–	–	–	0	0	450	1 862	158	2 570
1995	0	0	5	104	–	–	–	0	0	22	70	88	289
1996	0	0	0	0	–	–	–	0	0	2	105	313	420
1997	0	0	0	0	–	–	–	0	0	0	67	40	107
1998	0	32	19	0	–	–	–	0	0	3	7	4	65
1999	0	0	0	0	–	–	–	0	0	17	84	511	612
2000	2	0	0	0	–	–	–	0	3	16	188	324	533
2001	10	0	0	0	–	–	–	0	2	54	170	23	259
2002	1	0	0	0	–	–	–	6	6	135	351	0	499
2003	12	0	0	0	–	–	–	0	0	339	529	114	994
2004	0	0	0	0	–	–	–	0	0	275	936	28	1 239
2005	0	0	0	0	–	–	–	0	0	314	392	151	857
2006	0	0	6	0	–	–	–	0	40	40	182	49	317
2007	0	0	2	2	–	–	–	0	3	8	59	7	81
2008	0	2	3	0	–	–	–	0	0	0	1	0	6
2009	10	1	7	0	–	–	–	0	20	100	39	0	177
2010	0	0	0	0	–	–	–	0	0	0	4	1	5
2011	0	0	0	0	–	–	–	0	1	0	100	60	161
2012	0	0	0	0	–	–	–	20	55	4	10	140	229
2013	60	0	0	0	–	–	–	151	74	2	8	25	320
Total	225	35	42	106	–	–	–	177	213	2 022	6 425	2 651	11 896

Table B6: Total numbers of sampled gemfish and percentage of sampled gemfish that were females, by month for each fishing year, 1990–2013, for SKI 3 (Chatham and South) and SKI 7.

(a) **SKI 3 Chatham**

Fishing year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total no. fish
1990	0.0	0.0	0.0	0.0	0.0	0.0	0.0	92.9	100.0	–	–	0.0	15
1991	66.3	0.0	48.9	50.0	0.0	0.0	0.0	0.0	0.0	–	–	0.0	189
1992	0.0	0.0	0.0	0.0	0.0	0.0	66.7	0.0	0.0	–	–	0.0	6
1993	0.0	0.0	0.0	0.0	0.0	0.0	70.6	0.0	0.0	–	–	0.0	17
1994	0.0	0.0	0.0	0.0	0.0	0.0	50.0	92.9	0.0	–	–	0.0	16
1995	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	–	–	0.0	0
1996	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	–	–	0.0	0
1997	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	–	–	0.0	0
1998	0.0	0.0	0.0	33.3	0.0	0.0	100.0	0.0	0.0	–	–	0.0	7
1999	0.0	0.0	100.0	0.0	0.0	0.0	0.0	100.0	0.0	–	–	0.0	7
2000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	–	–	0.0	1
2001	0.0	0.0	0.0	0.0	37.5	75.6	0.0	0.0	0.0	–	–	50.0	55
2002	0.0	0.0	0.0	0.0	0.0	0.0	57.1	70.0	0.0	–	–	0.0	27
2003	75.0	0.0	0.0	0.0	0.0	0.0	71.4	90.0	0.0	–	–	0.0	31
2004	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	–	–	0.0	1
2005	0.0	0.0	0.0	0.0	0.0	0.0	0.0	66.7	0.0	–	–	0.0	4
2006	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	–	–	0.0	2
2007	0.0	25.0	33.3	0.0	0.0	0.0	0.0	0.0	0.0	–	–	0.0	7
2008	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	–	–	0.0	0
2009	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	–	–	0.0	0
2010	0.0	0.0	0.0	0.0	100.0	70.8	0.0	0.0	0.0	–	–	0.0	25
2011	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	–	–	0.0	0
2012	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	–	–	0.0	0
2013	0.0	0.0	0.0	0.0	100.0	63.6	0.0	0.0	0.0	–	–	0.0	13
Total	92	5	49	59	12	82	41	74	1	0	0	3	423

(b) SKI 3 South

Fishing year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total no. fish
1990	0.0	50.8	0.0	0.0	0.0	0.0	0.0	55.6	0.0	0.0	50.0	0.0	92
1991	0.0	0.0	0.0	0.0	68.2	84.6	50.0	70.6	0.0	0.0	0.0	0.0	139
1992	36.4	0.0	0.0	49.4	39.0	60.6	80.4	0.0	0.0	100.0	0.0	0.0	804
1993	96.7	0.0	0.0	0.0	52.1	59.8	65.4	0.0	0.0	0.0	0.0	0.0	447
1994	0.0	0.0	0.0	0.0	30.6	65.3	72.5	0.0	0.0	0.0	0.0	100.0	568
1995	0.0	0.0	0.0	42.9	61.9	64.5	100.0	0.0	0.0	0.0	0.0	0.0	565
1996	0.0	0.0	0.0	53.3	79.4	60.0	50.0	0.0	0.0	0.0	0.0	0.0	100
1997	0.0	0.0	0.0	33.3	0.0	67.1	60.0	0.0	0.0	0.0	0.0	0.0	78
1998	0.0	0.0	81.0	50.0	55.6	70.6	50.0	0.0	0.0	0.0	0.0	0.0	148
1999	0.0	0.0	87.5	75.0	36.7	66.7	66.7	0.0	0.0	0.0	0.0	0.0	67
2000	0.0	84.1	0.0	0.0	80.0	74.7	62.5	0.0	0.0	0.0	0.0	0.0	373
2001	100.0	0.0	0.0	100.0	81.8	75.0	0.0	0.0	0.0	0.0	0.0	0.0	31
2002	0.0	0.0	0.0	100.0	84.6	69.3	67.0	0.0	0.0	0.0	0.0	0.0	619
2003	0.0	0.0	0.0	75.7	75.9	64.5	68.8	63.3	58.1	0.0	0.0	66.7	1 369
2004	0.0	0.0	0.0	54.2	69.5	88.9	62.5	0.0	0.0	0.0	57.1	0.0	140
2005	0.0	0.0	0.0	31.6	40.0	50.0	80.0	96.2	64.6	0.0	0.0	0.0	308
2006	0.0	33.3	88.9	0.0	83.3	53.4	79.5	78.9	0.0	0.0	0.0	0.0	279
2007	0.0	0.0	0.0	100.0	60.0	75.0	80.0	0.0	0.0	0.0	0.0	0.0	23
2008	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3
2009	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1
2010	0.0	0.0	0.0	0.0	100.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	7
2011	0.0	0.0	0.0	100.0	100.0	0.0	92.0	0.0	0.0	0.0	0.0	0.0	102
2012	14.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14
2013	0.0	0.0	0.0	0.0	0.0	0.0	90.0	0.0	0.0	0.0	0.0	0.0	10
Total	65	254	122	417	1963	1638	1308	368	113	6	26	7	6 287

(c) SKI 7

Fishing year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total no. fish
1990	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	44.4	45.0	60.4	0.0	77
1991	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.0	49.4	13.2	936
1992	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	48.5	58.4	62.6	869
1993	40.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	44.4	54.4	34.1	274
1994	46.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	60.2	69.9	53.2	2 570
1995	0.0	0.0	60.0	32.7	0.0	0.0	0.0	0.0	0.0	59.1	45.7	55.7	289
1996	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	64.8	63.9	420
1997	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	77.6	52.5	107
1998	0.0	31.2	36.8	0.0	0.0	0.0	0.0	0.0	0.0	66.7	42.9	100.0	65
1999	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	47.1	27.4	54.6	612
2000	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	43.8	75.0	89.5	533
2001	90.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	42.6	38.8	47.8	259
2002	0.0	0.0	0.0	0.0	0.0	0.0	0.0	66.7	66.7	51.9	52.7	0.0	499
2003	58.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	47.5	47.8	52.6	994
2004	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	37.5	50.7	46.4	1 239
2005	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	31.5	47.4	64.9	857
2006	0.0	0.0	50.0	0.0	0.0	0.0	0.0	0.0	62.5	42.5	36.8	40.8	317
2007	0.0	0.0	50.0	0.0	0.0	0.0	0.0	0.0	100.0	87.5	71.2	100.0	81
2008	0.0	50.0	66.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	6
2009	60.0	100.0	71.4	0.0	0.0	0.0	0.0	0.0	80.0	52.0	43.6	0.0	177
2010	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	75.0	100.0	5
2011	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	89.0	83.3	161
2012	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	90.9	75.0	80.0	62.1	229
2013	63.3	0.0	0.0	0.0	0.0	0.0	0.0	91.4	97.3	100.0	87.5	44.0	320
Total	225	35	42	106	–	–	–	177	213	2 022	6 425	2 651	11 896

Table B7: Number of female gemfish that were staged, by month for each fishing year, 1990–2013, for SKI 3 (Chatham and South) and SKI 7.

    (a) SKI 3 Chatham

Fishing year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total no.
1990	0	0	0	0	0	0	0	13	1	–	–	0	14
1991	61	0	22	25	0	0	0	0	0	–	–	0	108
1992	0	0	0	0	0	0	2	0	0	–	–	0	2
1993	0	0	0	0	0	0	12	0	0	–	–	0	12
1994	0	0	0	0	0	0	1	13	0	–	–	0	14
1995	–	–	–	–	–	–	–	–	–	–	–	–	0
1996	–	–	–	–	–	–	–	–	–	–	–	–	0
1997	–	–	–	–	–	–	–	–	–	–	–	–	0
1998	0	0	0	2	0	0	1	0	0	–	–	0	3
1999	0	0	1	0	0	0	0	1	0	–	–	0	2
2000	0	0	0	0	0	0	0	1	0	–	–	0	1
2001	0	0	0	0	3	34	0	0	0	–	–	1	38
2002	0	0	0	0	0	0	4	14	0	–	–	0	18
2003	0	0	0	0	0	0	5	18	0	–	–	0	23
2004	0	0	0	0	0	0	1	0	0	–	–	0	1
2005	0	0	0	0	0	0	0	2	0	–	–	0	2
2006	0	0	0	0	0	2	0	0	0	–	–	0	2
2007	0	1	1	0	0	0	0	0	0	–	–	0	2
2008	–	–	–	–	–	–	–	–	–	–	–	–	0
2009	–	–	–	–	–	–	–	–	–	–	–	–	0
2010	0	0	0	0	1	17	0	0	0	–	–	0	18
2011	–	–	–	–	–	–	–	–	–	–	–	–	0
2012	–	–	–	–	–	–	–	–	–	–	–	–	0
2013	0	0	0	0	2	7	0	0	0	–	–	0	9
Total	61	1	24	27	6	60	26	62	1	0	0	1	269

(b) SKI 3 South

Fishing year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total no.
1990	0	33	0	0	0	0	0	5	0	0	9	0	47
1991	0	0	0	0	73	11	1	11	0	0	0	0	96
1992	4	0	0	88	132	57	135	0	0	6	0	0	422
1993	29	0	0	0	19	139	85	0	0	0	0	0	272
1994	0	0	0	0	11	128	243	0	0	0	0	1	383
1995	0	0	0	24	229	89	1	0	0	0	0	0	343
1996	0	0	0	8	54	3	6	0	0	0	0	0	71
1997	0	0	0	1	0	47	3	0	0	0	0	0	51
1998	0	0	85	2	10	12	2	0	0	0	0	0	111
1999	0	0	7	6	11	8	6	0	0	0	0	0	38
2000	0	153	0	0	4	133	5	0	0	0	0	0	295
2001	10	0	0	3	9	3	0	0	0	0	0	0	25
2002	0	0	0	1	33	331	65	0	0	0	0	0	430
2003	0	0	0	56	584	60	159	105	18	0	0	2	984
2004	0	0	0	26	41	16	5	0	0	0	4	0	92
2005	0	0	0	6	14	7	84	51	53	0	0	0	215
2006	0	1	8	0	5	31	62	97	0	0	0	0	204
2007	0	0	0	2	6	3	4	0	0	0	0	0	15
2008	0	0	0	3	0	0	0	0	0	0	0	0	3
2009	0	0	0	0	1	0	0	0	0	0	0	0	1
2010	0	0	0	0	4	3	0	0	0	0	0	0	7
2011	0	0	0	1	1	0	92	0	0	0	0	0	94
2012	2	0	0	0	0	0	0	0	0	0	0	0	2
2013	0	0	0	0	0	0	9	0	0	0	0	0	9
Total	45	187	100	227	1 241	1 081	967	269	71	6	13	3	4 210

(c) SKI 7

Fishing year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total no.
1990	0	0	0	0	–	–	–	0	4	9	29	0	42
1991	0	0	0	0	–	–	–	0	0	9	231	56	296
1992	0	0	0	0	–	–	–	0	0	80	324	92	496
1993	12	0	0	0	–	–	–	0	0	8	99	15	134
1994	46	0	0	0	–	–	–	0	0	271	1301	83	1 701
1995	0	0	3	34	–	–	–	0	0	13	32	49	131
1996	0	0	0	0	–	–	–	0	0	1	68	200	269
1997	0	0	0	0	–	–	–	0	0	0	52	21	73
1998	0	10	7	0	–	–	–	0	0	2	3	4	26
1999	0	0	0	0	–	–	–	0	0	8	23	279	310
2000	1	0	0	0	–	–	–	0	3	7	141	289	441
2001	9	0	0	0	–	–	–	0	1	23	66	11	110
2002	0	0	0	0	–	–	–	4	4	69	184	0	261
2003	7	0	0	0	–	–	–	0	0	161	253	60	481
2004	0	0	0	0	–	–	–	0	0	103	473	13	589
2005	0	0	0	0	–	–	–	0	0	99	186	98	383
2006	0	0	3	0	–	–	–	0	25	17	67	20	132
2007	0	0	1	0	–	–	–	0	3	7	42	7	60
2008	0	1	2	0	–	–	–	0	0	0	1	0	4
2009	6	1	5	0	–	–	–	0	16	52	17	0	97
2010	0	0	0	0	–	–	–	0	0	0	3	1	4
2011	0	0	0	0	–	–	–	0	1	0	89	50	140
2012	0	0	0	0	–	–	–	20	50	3	8	87	168
2013	38	0	0	0	–	–	–	138	72	2	7	11	268
Total	119	12	21	34	0	0	0	162	179	944	3 699	1 446	6 616
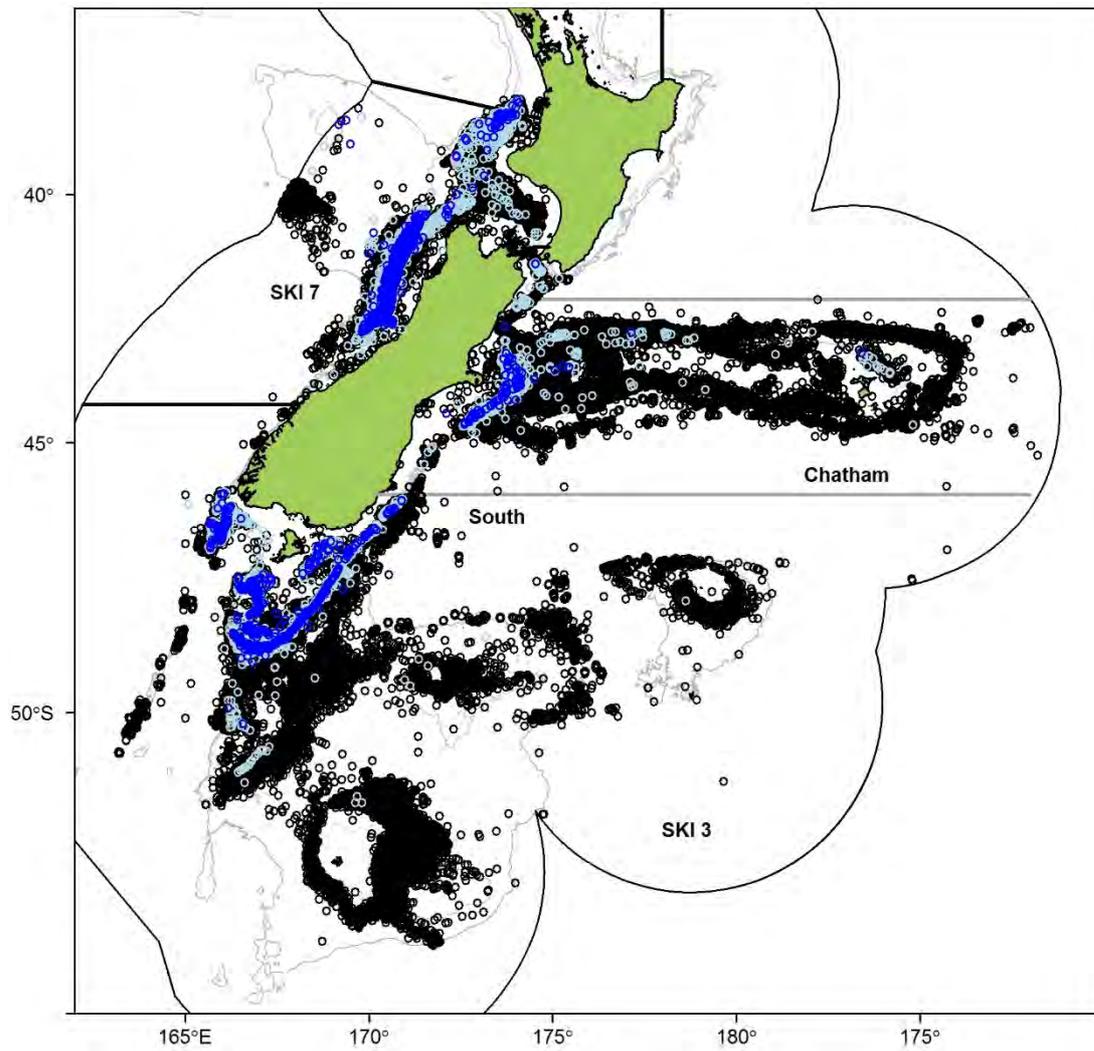
Figure B1: Distribution of observed tows, where black is observed tows in SKI 3 (Chatham and South) and SKI 7, light blue is observed tows with gemfish catch, blue is observed tows with gemfish catch which has been sampled for length and sex data, 1990–2013.

a.   SKI 3 Chatham
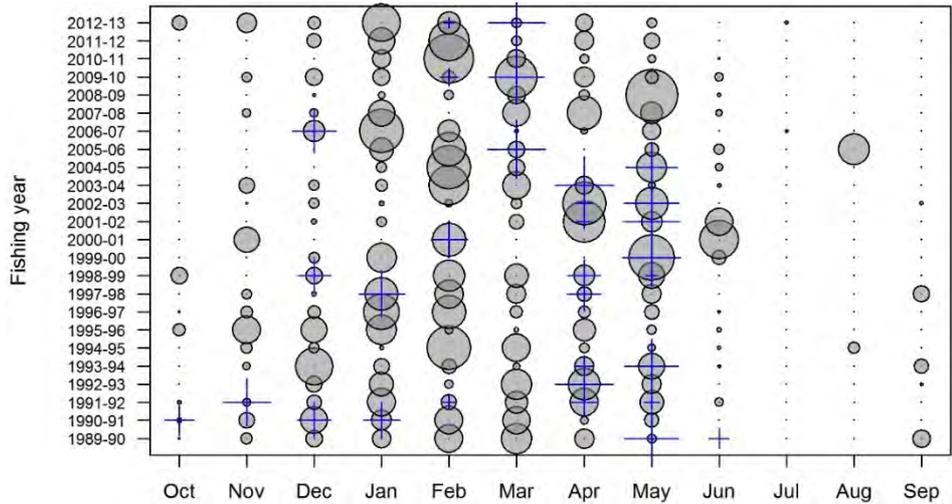
b.   SKI 3 South
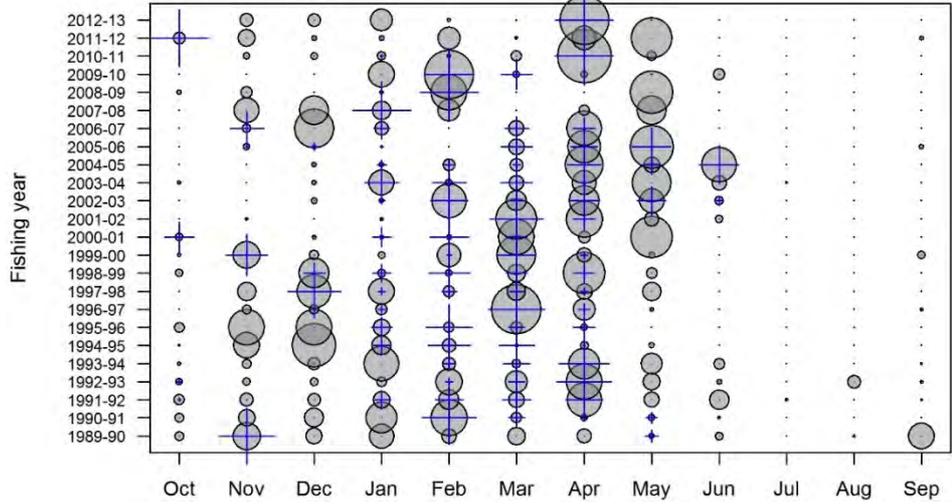
c.   SKI 7
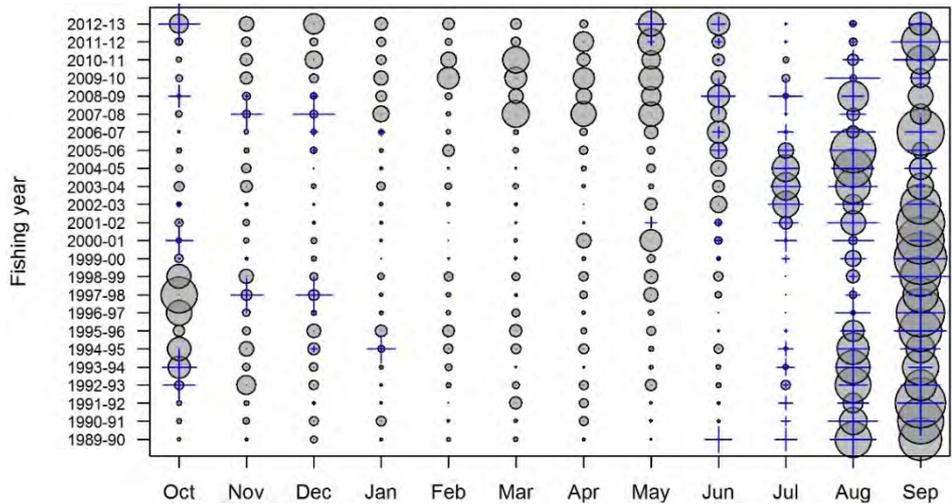
Figure B2: Proportion of the annual commercial gemfish catch (◎) and the observed gemfish catch (+) in each month, for the Chatham and South areas (SKI 3) and SKI 7.
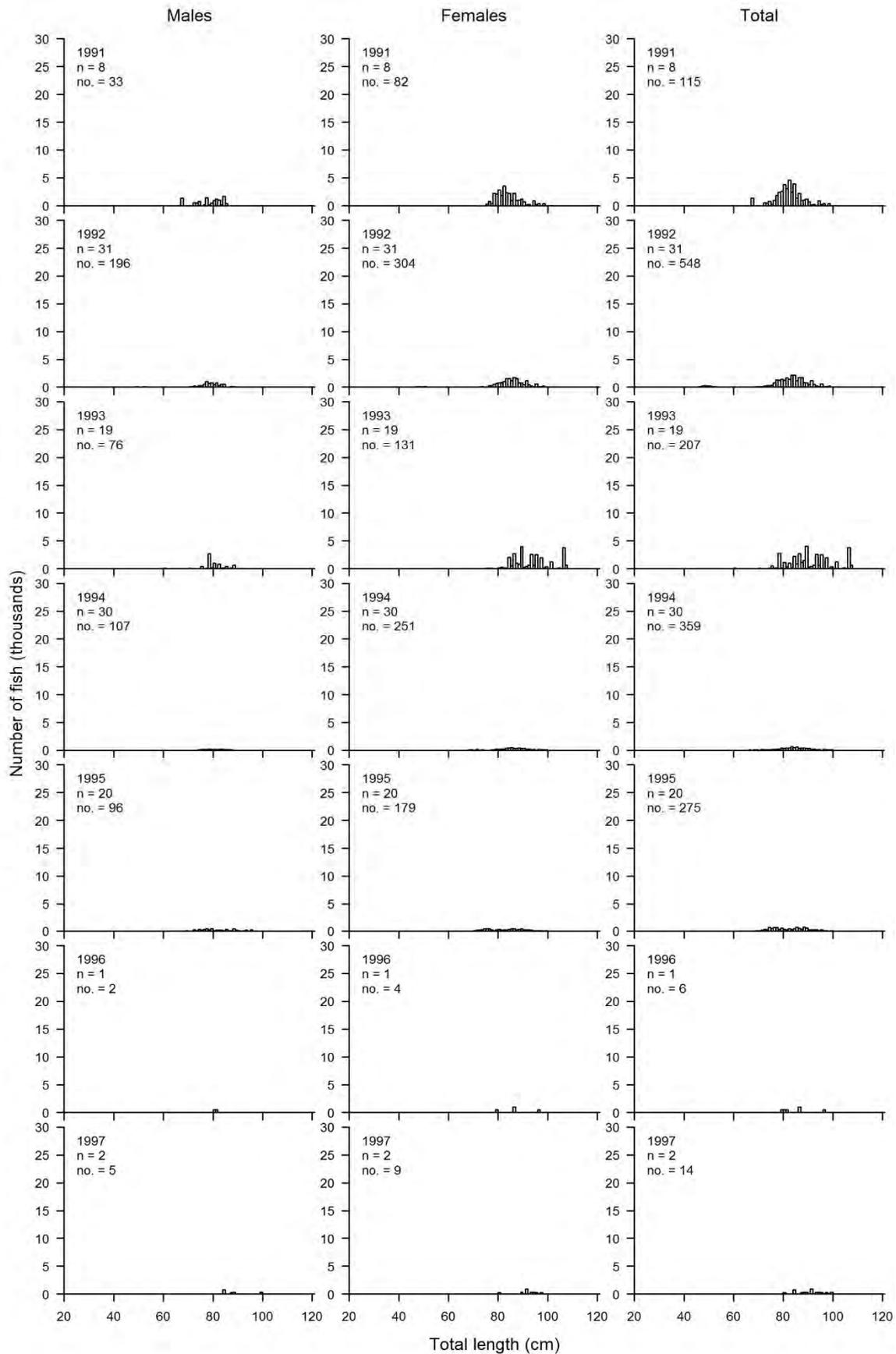
Figure B3: Scaled length frequency distributions for gemfish based on observer data from the South area of SKI 3, for 1991–2006.
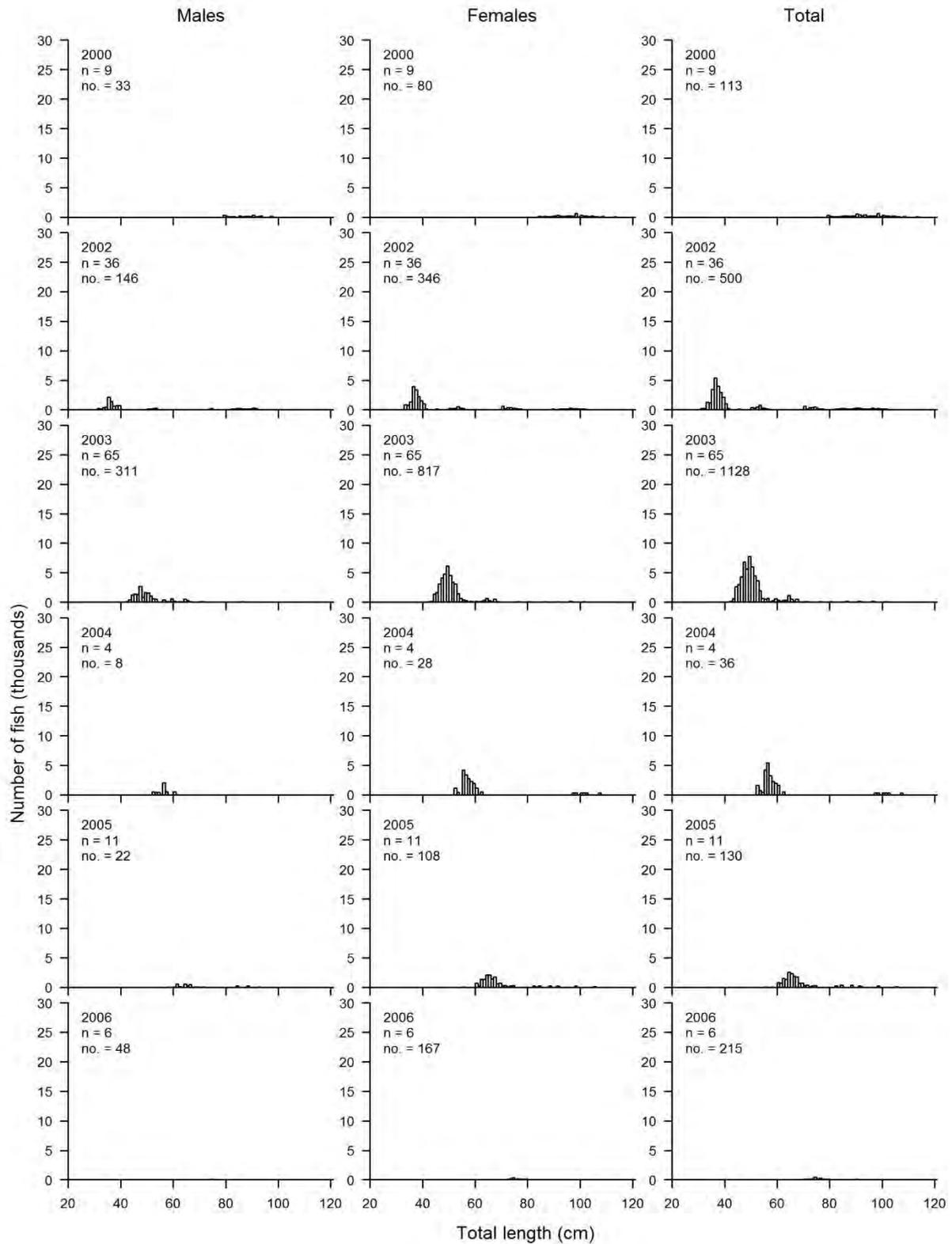
Figure B3 – *continued.*
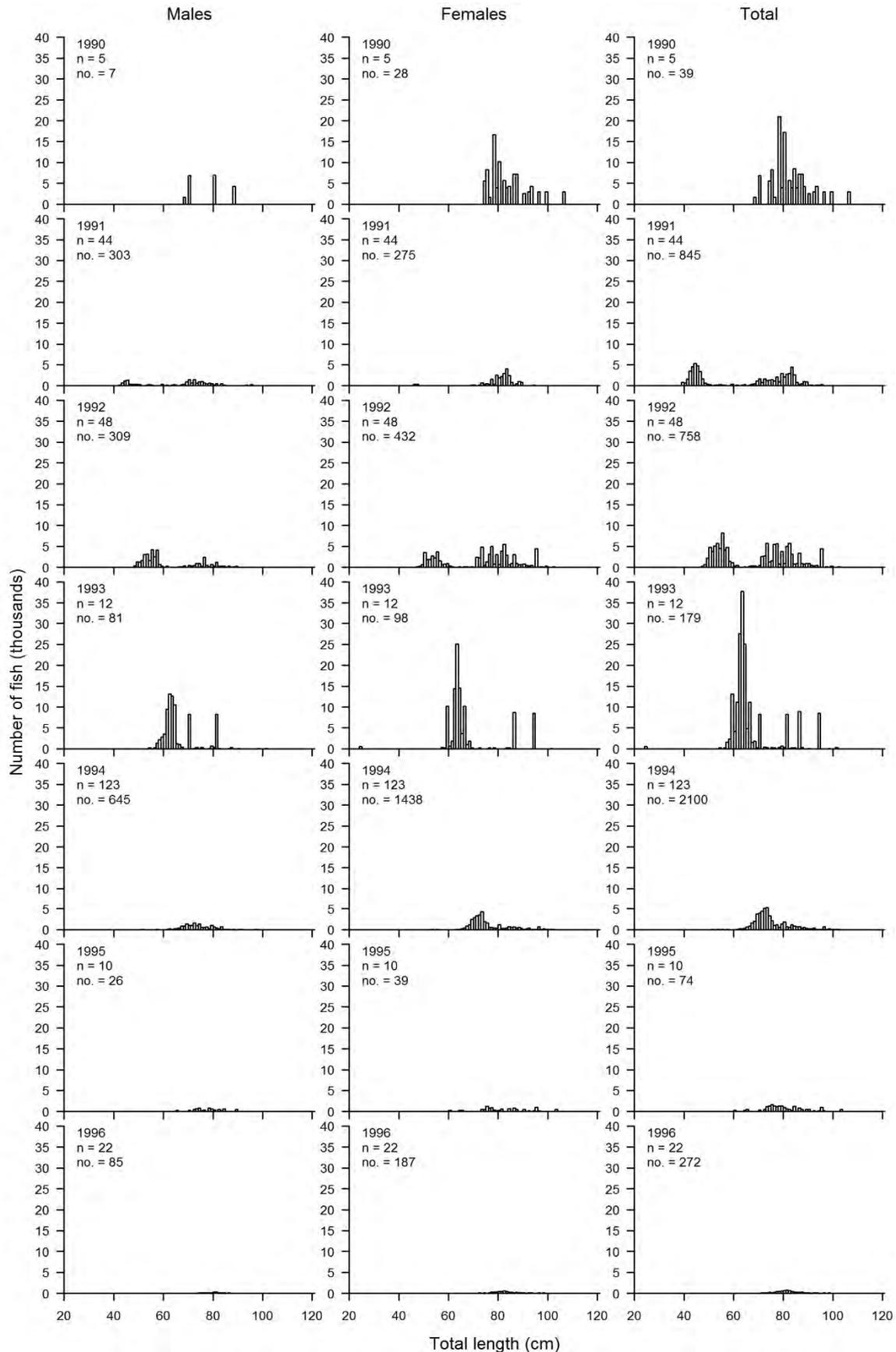
Figure B4: Scaled length frequency distributions for gemfish observed during commercial effort off the west coast South Island, for June-September of 1990–96, 2001–07, 2009, 2011–13. Note the change of scale for the number of fish after 1996.
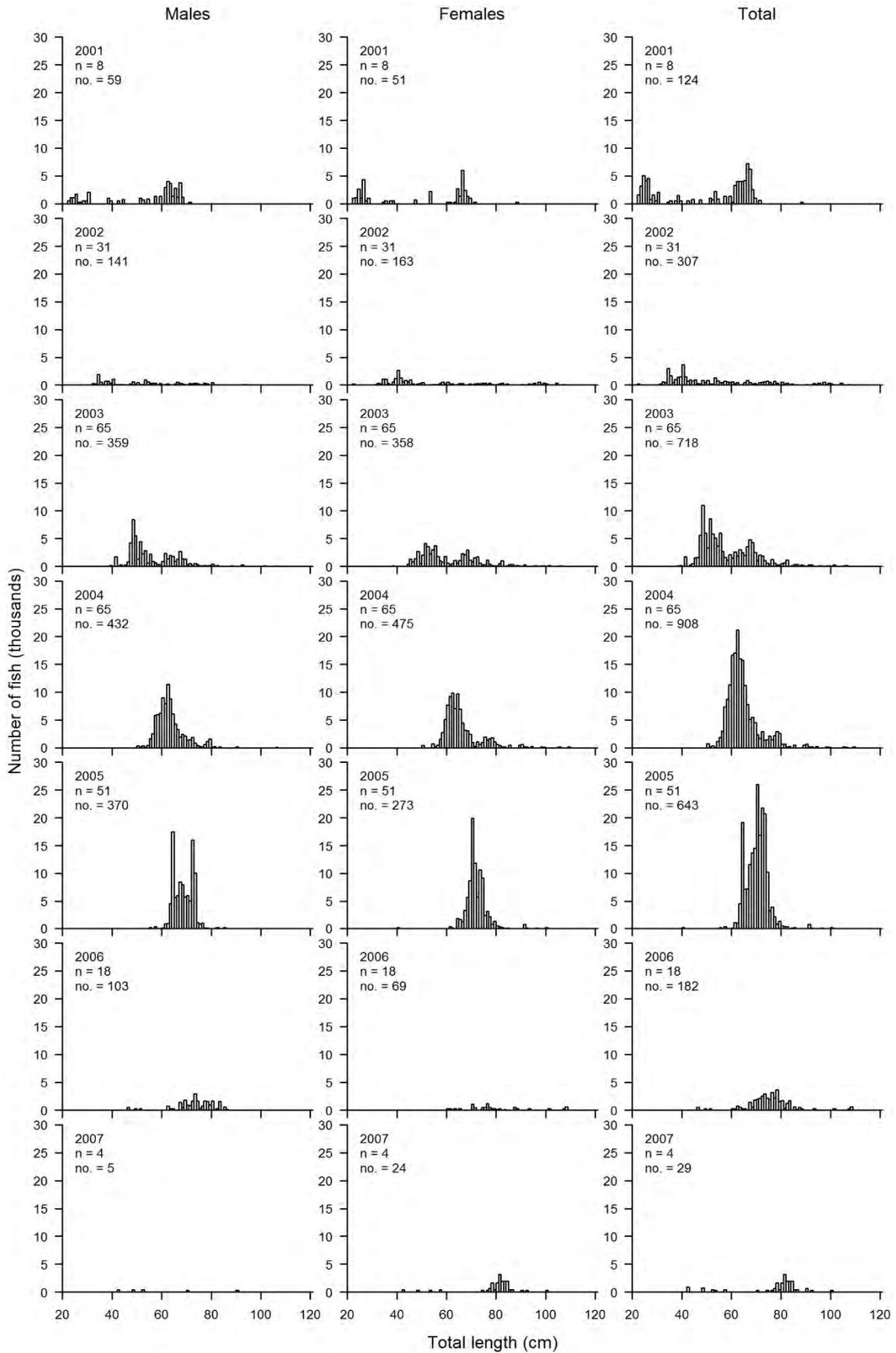
Figure B4 – *continued.*
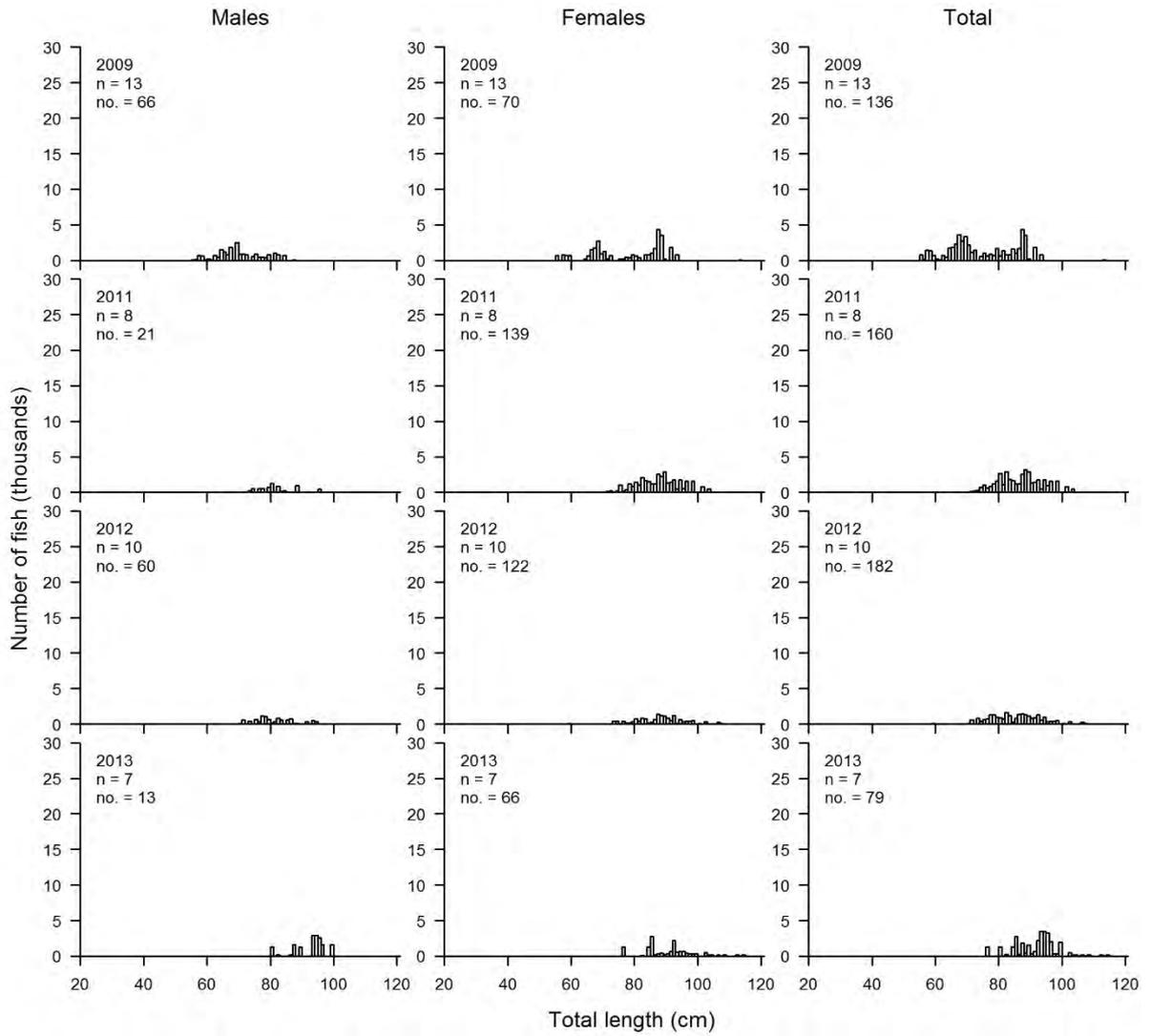
Figure B4 – *continued.*
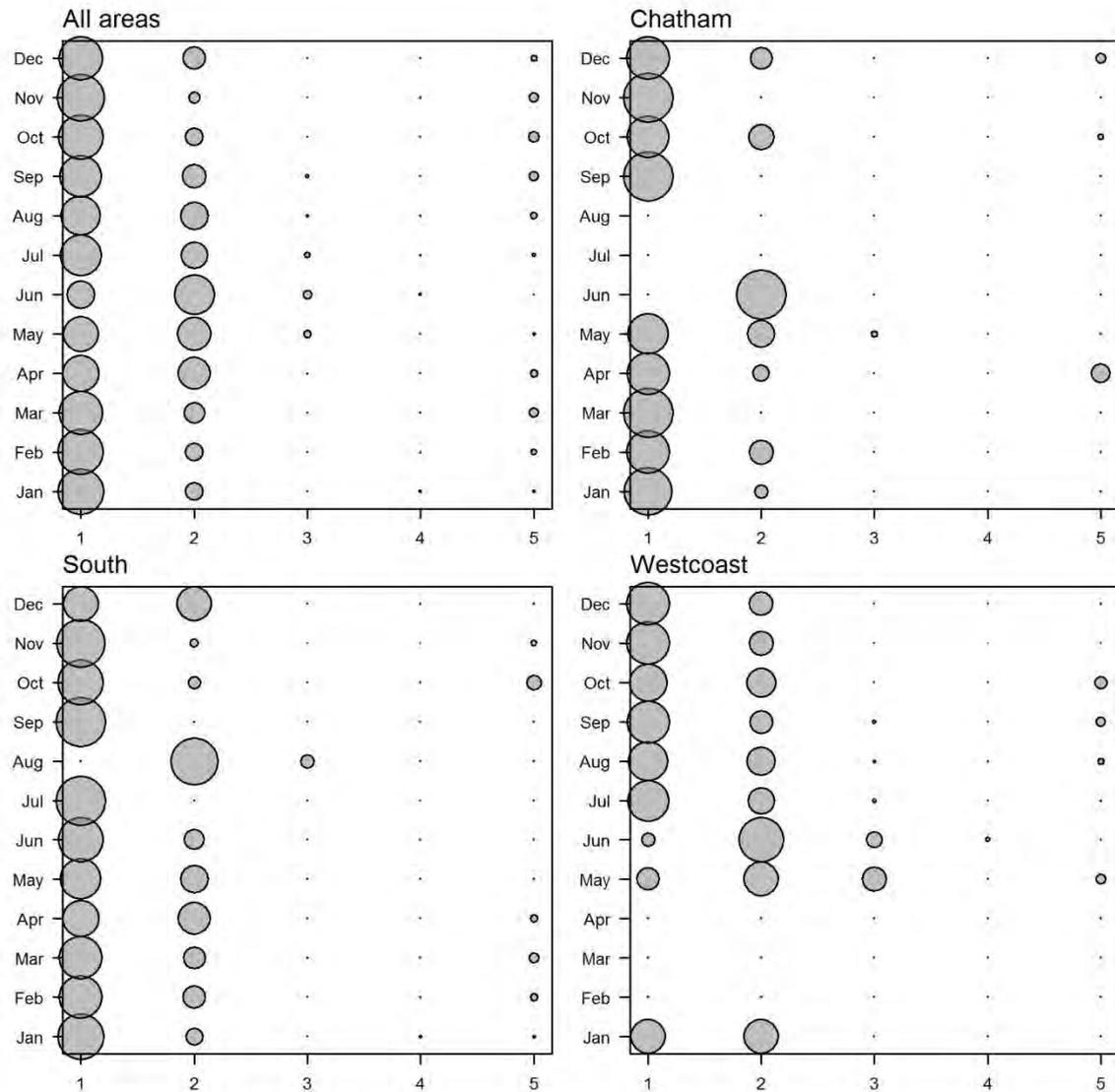
Figure B5: Percentage of females at each gonad stage by month, for SKI 3 and SKI 7 combined, and for separate SKI 3 areas and SKI 7. Female gonad stage 1 is immature/resting, gonad stage 2 is ripening, gonad stage 3 is ripe, gonad stage 4 is running ripe, and gonad stage 5 is spent.
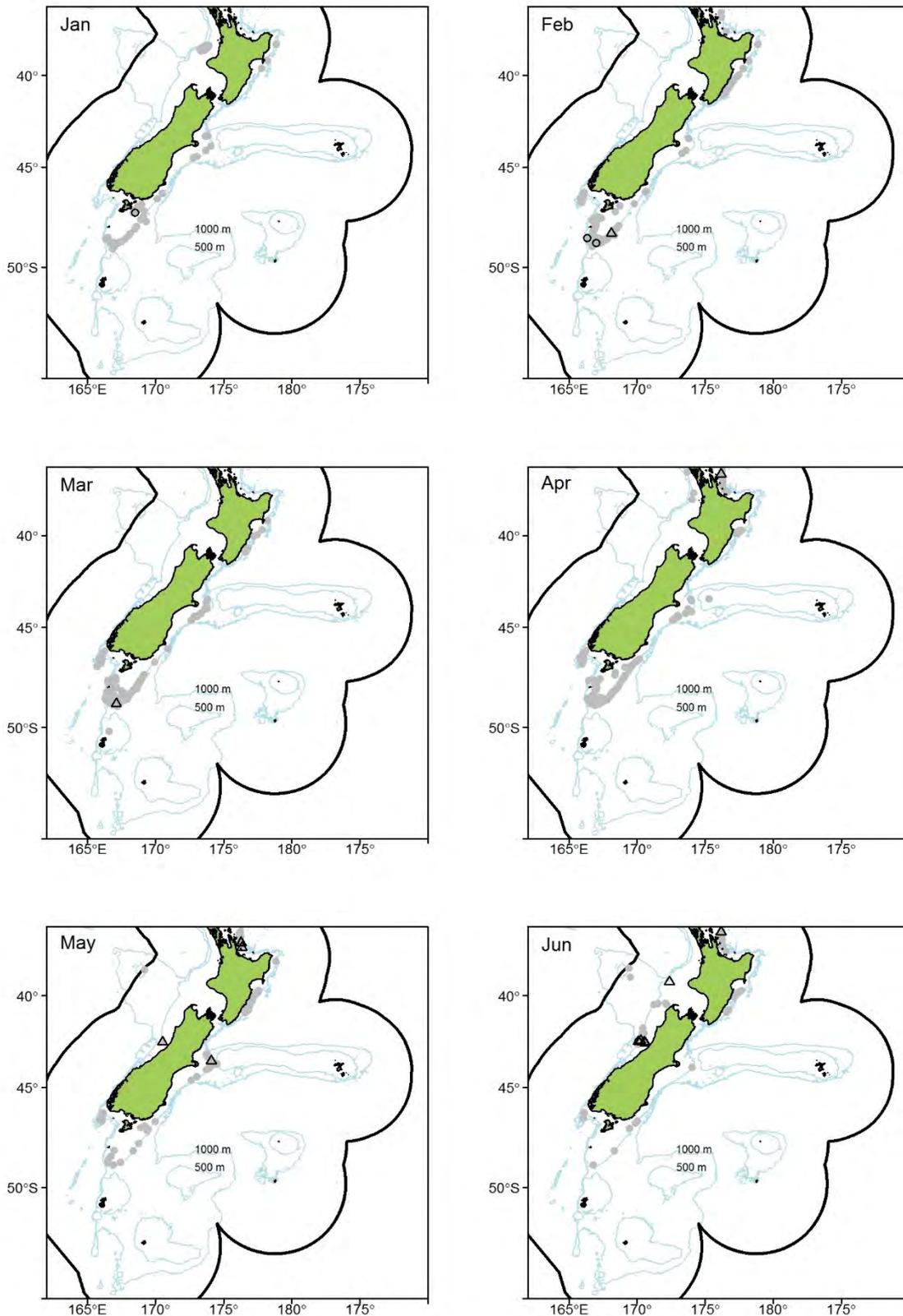
Figure B6: Distribution of female gemfish reproductive stage data from observer data, by month, where grey circles represent immature females, Δ are ripe, and O are running ripe.
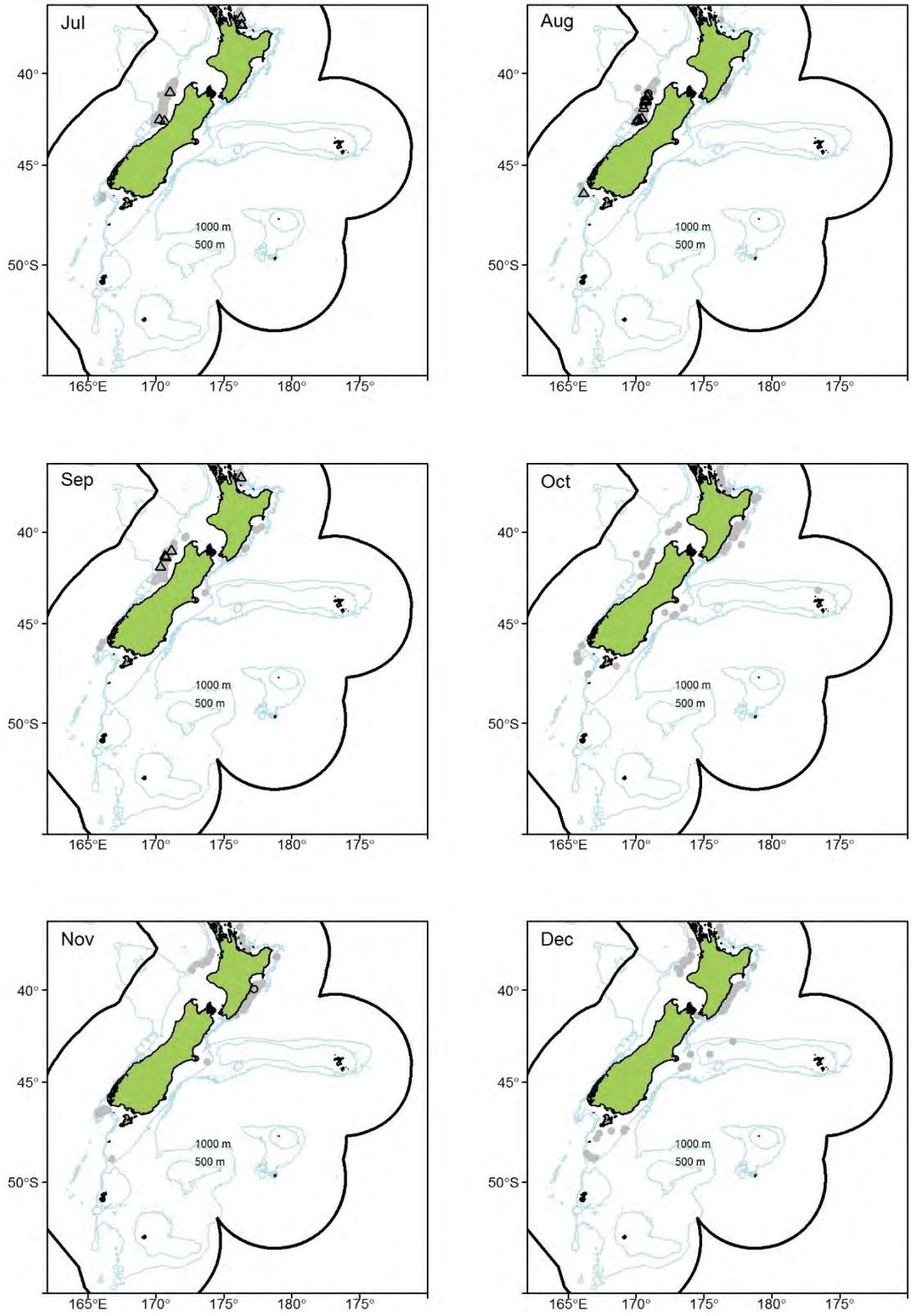
Figure B6 – *continued.*
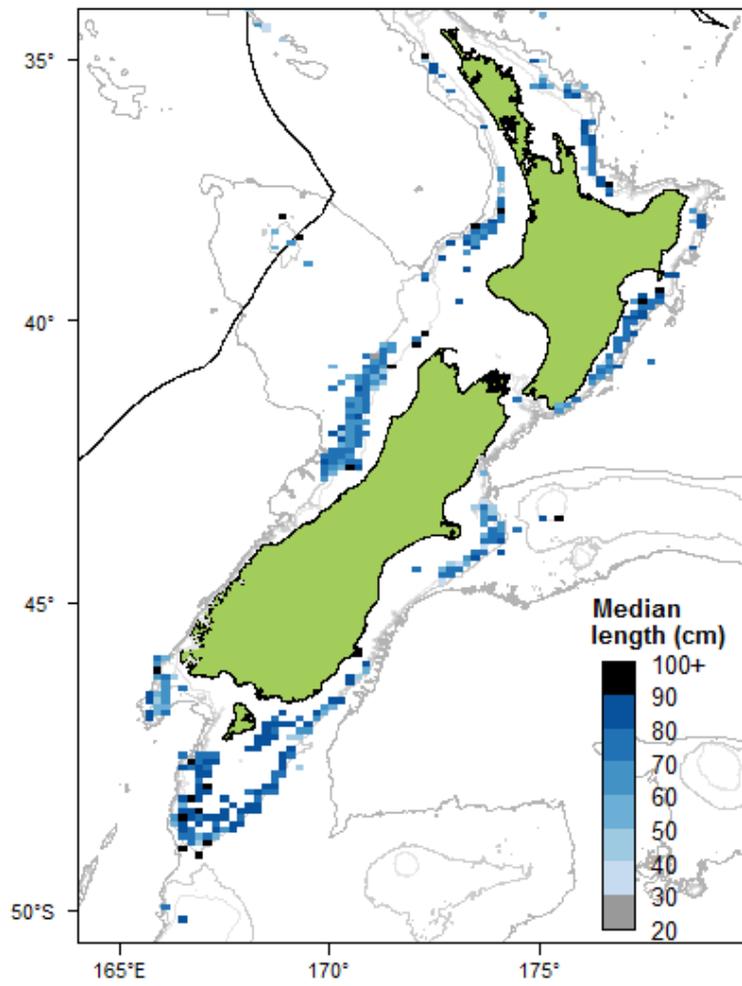
Figure B7: Distribution of median lengths of all gemfish measured by observers (*n* = 24 863 fish), 1990–2013.

APPENDIX C: CHARACTERISATION

Table C1: List of tables and fields requested in the Ministry for Primary Industries extract 9384.

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	Trip
Effort_depth	accuracy)	Literal_yn
Effort_height	End_latitude (full accuracy)	Interp_yn
Effort_num	End_longitude (full accuracy)	Resrch_yn
Effort_num_2	Pair_trawl_yn	
Effort_seqno	Bottom_depth	

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	Processed_weight	Resrch_yn
stocks)	Processed_weight_type	
State_code	Form_type	

Estimated subcatch table

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

Table C2: Number of landing events by major destination code and form type for SKI stocks for fishing years 1989–90 (1990) to 2012–13 (2013). CELR is Catch Effort Landing Return; NCELR is Netting Catch Effort Landing Return; CLR is Catch Landing Return. Destination codes are defined in Table C3. Note: the last Total column includes counts of all reported destination codes.

SKI 3

Fish year	CELR/NCELR			CLR				All				
	L	F	Total	L	T	R	Total	L	T	R	O	Total
1990	921	–	921	320	78	24	422	1 241	78	24	3	1 346
1991	1 010	–	1 010	299	64	36	399	1 309	64	36	5	1 414
1992	911	–	911	336	54	36	426	1 247	54	36	6	1 343
1993	561	–	561	303	51	51	405	864	51	51	2	968
1994	531	–	531	195	28	39	262	726	28	39	1	794
1995	315	–	315	135	35	24	194	450	35	24	1	510
1996	179	–	179	110	27	20	157	289	27	21	1	338
1997	134	–	134	121	16	13	150	255	16	13	–	284
1998	100	–	100	103	2	6	111	203	2	6	–	211
1999	66	–	66	110	–	13	123	176	–	13	–	189
2000	39	–	39	96	–	6	102	135	–	6	–	141
2001	43	–	43	170	–	5	175	213	–	5	2	220
2002	97	–	97	214	–	11	225	311	–	11	–	322
2003	186	–	186	282	–	16	298	468	–	16	1	485
2004	147	–	147	265	–	24	289	412	–	24	2	438
2005	120	1	121	194	–	11	205	314	–	11	–	325
2006	88	–	88	153	–	15	168	241	–	15	–	256
2007	107	1	108	143	–	4	147	250	–	4	–	254
2008	10	–	10	151	–	2	153	161	–	2	–	163
2009	20	1	21	128	–	8	136	148	–	8	–	156
2010	16	–	16	200	–	4	204	216	–	4	–	220
2011	30	–	30	247	–	7	254	277	–	7	–	284
2012	35	–	35	153	–	3	156	188	–	3	–	191
2013	35	1	36	184	–	11	195	219	–	11	–	230
Total	5 701	4	5 705	4 612	355	389	5 356	10 313	355	390	24	11 082

Table C2: *continued.*

SKI 7

Fish year	CELR/NCELR				CLR				All				
	L	F	T	Total	L	T	R	Total	L	T	R	O	Total
1990	203	–	–	203	77	60	66	203	280	60	66	19	425
1991	246	–	1	247	54	33	47	134	300	34	47	20	401
1992	225	–	3	228	30	44	51	125	255	47	51	9	362
1993	239	–	–	239	107	47	59	213	346	47	59	5	457
1994	253	–	–	253	95	38	68	201	348	38	68	2	456
1995	222	–	1	223	81	32	34	147	303	33	34	5	375
1996	269	–	–	269	57	17	20	94	326	17	20	1	364
1997	238	–	–	238	66	17	15	98	304	17	15	2	338
1998	132	–	–	132	53	7	6	66	185	7	6	–	198
1999	216	–	–	216	70	2	8	80	286	2	8	–	296
2000	152	–	–	152	87	2	30	119	239	2	30	1	272
2001	158	–	1	159	187	3	18	208	345	4	18	–	367
2002	172	1	–	173	277	2	17	296	449	2	17	–	468
2003	247	13	–	260	225	–	25	250	472	–	26	–	498
2004	446	4	5	455	279	–	16	295	725	5	19	1	750
2005	276	4	2	282	190	–	19	209	466	2	19	–	487
2006	275	1	5	281	153	–	15	168	428	5	15	–	448
2007	286	7	1	294	145	–	12	157	431	1	14	–	446
2008	15	–	2	17	398	–	11	409	413	2	11	–	426
2009	19	–	5	24	422	–	5	427	441	5	5	–	451
2010	20	2	6	28	478	–	9	487	498	6	9	–	513
2011	20	–	3	23	660	–	9	669	680	3	9	–	692
2012	22	2	5	29	569	–	17	586	591	5	18	–	614
2013	25	–	6	31	639	–	6	645	664	6	6	–	676
Total	4 376	34	46	4 456	5 399	304	583	6 286	9 775	350	590	65	10 780

Table C3: Destination codes, total landing weight, number of landings, and whether the records were kept or dropped, for all gemfish catch reported for 1990–2013, by SKI stock.

SKI 3

Destination code	Greenweight (t)	No. records	Description	Action
L	2 233.42	10 313	Landed in New Zealand to a Licensed Fish Receiver	Keep
T	1 003.80	355	Transferred to another vessel	Keep
E	33.05	1 093	Eaten	Keep
O	16.21	24	Conveyed outside New Zealand	Keep
A	15.28	71	Accidental loss	Keep
C	11.58	29	Disposed to the Crown	Keep
F	0.02	4	Recreational catch	Keep
S	< 0.00	2	Seized by the Crown	Keep
R	294.96	390	Retained on board	Drop
D	0.73	16	Discarded	Drop
Q	0.40	57	Holding receptacle on land	Drop
Null	0.09	7	Missing destination type code	Drop

SKI 7

Destination code	Greenweight (t)	No. records	Description	Action
L	4 857.66	9 775	Landed in New Zealand to a Licensed Fish Receiver	Keep
T	1 331.17	350	Transferred to another vessel	Keep
O	530.79	65	Conveyed outside New Zealand	Keep
E	30.84	833	Eaten	Keep
A	1.17	50	Accidental loss	Keep
F	0.46	42	Recreational catch	Keep
C	0.08	3	Disposed to the Crown	Keep
U	0.05	5	Used as bait	Keep
S	0.04	2	Seized by the Crown	Keep
W	< 0.00	1	Sold at wharf	Keep
R	1 232.25	590	Retained on board	Drop
D	3.32	32	Discarded	Drop
Null	1.14	3	Missing destination type code	Drop
B	0.17	3	Stored as bait	Drop

Table C4: Details of data corrections by imputation and invalid record removal during the grooming process for each QMA. 'Records' is the number of unique records; 'Trips' is the number of unique trips; and 'Catch' is the total greenweight (t) of gemfish remaining in the effort and landings datasets after each step in the grooming process.

SKI 3

	Effort			Landings		
	Records	Trips	Catch	Records	Trips	Catch
Original extract	244 919	10 910	3 117	12 361	10 991	3 610
Remove missing keys	244 919	10 910	3 117	12 361	10 991	3 610
Remove unmatched trips	244 919	10 910	3 117	12 215	10 854	3 338
Remove duplicate trip form	244 042	10 840	3 112	12 129	10 784	3 334
Remove invalid start date	244 070	10 746	3 112	12 129	10 746	3 334
Remove invalid primary method	244 056	10 745	3 112	12 128	10 745	3 334
Remove invalid target method	244 056	10 745	3 112	12 128	10 745	3 334
Remove invalid statistical area	240 719	10 678	3 074	12 036	10 678	3 288
Re-stratify effort	39 128	10 678	3 074	12 036	10 678	3 288
Remove BDRQ destination type	38 155	10 504	3 014	11 600	10 496	3 063
Remove multiple state code	38 155	10 504	3 014	11 600	10 496	3 063
Remove invalid green weight	38 117	10 501	3 012	11 594	10 493	3 061
Fix extreme/NA green weight	38 117	10 501	3 012	11 594	10 493	3 061
DQSS	38 081	10 499	2 773	11 589	10 491	2 867

SKI 7

	Effort			Landings		
	Records	Trips	Catch	Records	Trips	Catch
Original extract	218 455	9 949	5 430	11 754	9 994	7 989
Remove missing keys	218 455	9 949	5 430	11 754	9 994	7 989
Remove unmatched trips	218 455	9 949	5 430	11 646	9 898	7 915
Remove duplicate trip form	215 701	9 949	5 417	11 463	9 720	7 898
Remove invalid start date	215 767	9 601	5 417	11 463	9 601	7 898
Remove invalid primary method	215 767	9 601	5 417	11 463	9 601	7 898
Remove invalid target method	215 767	9 601	5 417	11 463	9 601	7 898
Remove invalid statistical area	211 501	9 529	5 270	11 348	9 529	7 692
Re-stratify effort	39 389	9 529	5 270	11 348	9 529	7 692
Remove BDRQ destination type	38 471	9 355	5 091	10 749	9 351	6 487
Remove multiple state code	38 471	9 355	5 091	10 749	9 351	6 487
Remove invalid green weight	38 471	9 355	5 091	10 749	9 351	6 487
Fix extreme/NA green weight	38 471	9 355	5 091	10 749	9 351	6 487
DQSS	38 471	9 355	5 091	10 749	9 351	6 487

Table C5: The reported Quota Management Report (QMR) or Monthly Harvest Return (MHR) catch, annual retained landings in the groomed and unmerged dataset, and retained landings in the groomed and merged dataset, and estimated catches in the groomed and merged dataset for SKI stocks from 1989–90 (1990) to 2012–13 (2013). All catch and landings data are in tonnes.

SKI 3

Fishing	Landings			Merged estimated	
	MHR	Unmerged	Merged	Catch	% of MHR
1990	1 164	729	704	613	53
1991	616	509	494	382	62
1992	287	296	292	197	69
1993	371	319	318	263	71
1994	75	82	82	51	68
1995	160	160	159	91	57
1996	49	51	51	31	63
1997	58	58	58	30	52
1998	27	25	25	13	48
1999	17	24	24	6	35
2000	62	60	60	40	65
2001	47	48	48	36	77
2002	72	72	72	40	56
2003	115	113	113	60	52
2004	78	89	89	43	55
2005	72	64	64	40	56
2006	27	26	26	9	33
2007	26	26	26	7	27
2008	18	19	18	8	44
2009	11	11	11	5	45
2010	20	20	20	5	25
2011	33	32	32	13	39
2012	11	11	11	4	36
2013	23	23	23	6	26

Table C5 *continued.*

SKI 7

Fishing year	MHR	Landings Unmerged	Merged	Merged estimated Catch	% of MHR
1990	932	721	622	583	63
1991	325	334	316	186	57
1992	584	432	398	344	59
1993	469	742	676	500	107
1994	321	336	335	202	63
1995	103	144	142	104	101
1996	81	81	65	44	54
1997	238	100	97	67	28
1998	44	134	133	109	248
1999	59	56	56	33	56
2000	107	61	61	34	32
2001	87	122	120	87	100
2002	123	109	107	60	49
2003	268	285	275	170	63
2004	542	495	491	350	65
2005	635	600	593	474	75
2006	248	241	223	130	52
2007	209	128	128	72	34
2008	179	247	246	199	111
2009	213	222	222	166	78
2010	144	141	141	95	66
2011	301	282	280	205	68
2012	260	185	184	123	47
2013	234	289	289	185	79

Table C6: Total number of trips, number of trips with zero estimated catch, and proportion of trips with zero estimated catch, by form type for SKI 3 and SKI 7 from 1989–90 (1990) to 2012–13 (2013). Fish stock areas are shown in Figure 1. CELR is Catch Effort Landing Return; TCER is Trawl Catch Effort Return, and TCEPR is Trawl Catch Effort Processing Return.

SKI 3

Fishing year	CELR Total trips	Zero trips	Proportion	TCEPR Total trips	Zero trips	Proportion	TCER Total trips	Zero trips	Proportion
1990	918	482	0.53	282	103	0.37	–	–	–
1991	983	555	0.56	289	128	0.44	–	–	–
1992	898	565	0.63	359	234	0.65	–	–	–
1993	543	349	0.64	305	206	0.68	–	–	–
1994	526	303	0.58	209	158	0.76	–	–	–
1995	310	205	0.66	159	115	0.72	–	–	–
1996	175	119	0.68	127	95	0.75	–	–	–
1997	134	80	0.60	132	97	0.73	–	–	–
1998	95	57	0.60	107	79	0.74	–	–	–
1999	65	50	0.77	118	93	0.79	–	–	–
2000	38	26	0.68	104	76	0.73	–	–	–
2001	42	39	0.93	190	152	0.80	–	–	–
2002	97	90	0.93	225	168	0.75	–	–	–
2003	184	175	0.95	271	195	0.72	–	–	–
2004	146	134	0.92	279	193	0.69	–	–	–
2005	120	112	0.93	206	146	0.71	–	–	–
2006	88	80	0.91	167	135	0.81	–	–	–
2007	76	67	0.88	164	134	0.82	–	–	–
2008	4	4	1.00	115	91	0.79	59	36	0.61
2009	7	5	0.71	118	103	0.87	39	34	0.87
2010	8	8	1.00	142	123	0.87	91	69	0.76
2011	13	11	0.85	167	127	0.76	91	59	0.65
2012	24	22	0.92	114	98	0.86	68	41	0.60
2013	22	21	0.95	136	118	0.87	54	33	0.61

Table C6 *continued.*

SKI 7

Fishing year	CELR Total trips	CELR Zero trips	CELR Proportion	TCEPR Total trips	TCEPR Zero trips	TCEPR Proportion	TCER Total trips	TCER Zero trips	TCER Proportion
1990	197	99	0.50	119	44	0.37	–	–	–
1991	242	118	0.49	86	43	0.50	–	–	–
1992	225	114	0.51	69	32	0.46	–	–	–
1993	230	135	0.59	119	45	0.38	–	–	–
1994	241	133	0.55	117	52	0.44	–	–	–
1995	211	132	0.63	108	49	0.45	–	–	–
1996	256	148	0.58	69	37	0.54	–	–	–
1997	226	127	0.56	80	43	0.54	–	–	–
1998	125	65	0.52	62	30	0.48	–	–	–
1999	200	112	0.56	76	42	0.55	–	–	–
2000	145	98	0.68	82	57	0.70	–	–	–
2001	158	119	0.75	163	109	0.67	–	–	–
2002	171	119	0.70	233	137	0.59	–	–	–
2003	246	165	0.67	180	90	0.50	–	–	–
2004	429	211	0.49	224	90	0.40	–	–	–
2005	277	144	0.52	143	44	0.31	–	–	–
2006	276	147	0.53	138	62	0.45	–	–	–
2007	272	180	0.66	142	82	0.58	–	–	–
2008	12	7	0.58	100	62	0.62	208	71	0.34
2009	15	8	0.53	90	43	0.48	223	73	0.33
2010	17	5	0.29	98	56	0.57	301	101	0.34
2011	16	4	0.25	101	44	0.44	394	123	0.31
2012	25	7	0.28	97	62	0.64	354	134	0.38
2013	26	10	0.38	115	72	0.63	400	134	0.34

Table C7: Total estimated catch (t) for SKI 3 (for both subareas and all SKI 3) and SKI 7 from the groomed and merged data, 1989–90 (1990) to 2012–13 (2013).

Fishing year	Chatham	South	SKI 3 All	SKI 7 All	Total
1990	485.2	218.5	703.7	622.3	1 326.1
1991	307.8	185.9	493.7	315.6	809.2
1992	144.8	147.4	292.2	398.4	690.7
1993	86.9	231.5	318.4	675.7	994.1
1994	29.4	53.0	82.4	335.2	417.5
1995	78.2	81.1	159.3	142.4	301.7
1996	25.1	25.8	50.9	64.8	115.7
1997	8.0	50.2	58.2	96.5	154.7
1998	4.1	20.7	24.8	133.4	158.2
1999	2.7	21.5	24.2	55.9	80.1
2000	2.1	58.0	60.1	61.0	121.1
2001	2.3	45.7	48.0	120.1	168.1
2002	10.4	61.5	71.9	106.7	178.5
2003	30.7	82.3	113.0	275.2	388.2
2004	17.6	71.3	88.9	491.4	580.2
2005	8.0	56.0	64.0	592.7	656.8
2006	3.0	22.8	25.8	222.6	248.3
2007	4.6	21.3	25.9	128.3	154.3
2008	2.9	15.3	18.2	245.7	263.9
2009	4.2	7.0	11.2	221.8	233.0
2010	4.7	14.8	19.5	140.8	160.3
2011	7.9	24.2	32.1	280.3	312.3
2012	2.3	8.2	10.5	184.3	194.9
2013	6.7	16.1	22.8	289.2	312.0
Total	1 279.7	1 540.1	2 819.8	6 200.2	9 020.0

Table C8: Total catch (t) by vessel nationality from groomed and merged data for SKI 3 and SKI 7 combined, for 1989–90 (1990) to 2012–13 (2013).

Fishing year	KOR	NZL	JAP	RUS	UKR	POL	NOR	Other	UNK	Total
1990	308.9	389.6	509.9	22.4	2.8	0	4.8	2.6	84.9	1 326.1
1991	156.2	180.9	285.1	54.9	0.1	0	21.6	0	110.3	809.2
1992	197.3	99.7	338.2	4.3	0	0	0.1	0	51	690.7
1993	443.6	136.1	337.5	30.6	9.9	0.1	4.7	1.2	30.2	994.1
1994	176.4	53.8	156.9	14	1.7	0.1	0.6	0.5	13.5	417.5
1995	127.4	109.5	45.1	13.1	0.2	2.7	0.1	0.3	3.2	301.7
1996	54.5	49.2	4.7	2.1	1.9	0.3	0	0	3.1	115.7
1997	52.3	54.4	37.6	2.7	4.3	0.2	0	0	3.3	154.7
1998	136.1	14.2	4.4	0.1	0.3	0	0	0	3.1	158.2
1999	36.6	26.8	7	8.6	0.3	0	0	0	0.6	80.1
2000	39.2	25.9	41.7	1.5	10.9	0.2	0.2	1.2	0.5	121.1
2001	117.4	29.3	6.1	1.5	1.6	8.4	1.3	1.9	0.5	168.1
2002	122.7	42.8	5.8	0.2	3	1.9	0.8	0.4	1	178.5
2003	256.9	85.1	9.5	1.8	5.8	9.1	4.1	1.8	13.9	388.2
2004	270.2	198.3	14.3	5.8	13.9	20.2	6.6	0	50.9	580.2
2005	380.1	161.2	28.9	1.8	4.5	11.1	5.4	0	63.8	656.8
2006	100.2	95.5	14.1	0.7	2.8	1.2	0	0	33.7	248.3
2007	58.1	75.5	3.1	0.7	1.5	1.1	0	0	14.3	154.3
2008	91.5	157.2	2.9	0.2	1.4	0.2	0	0	10.5	263.9
2009	119.1	100.1	0.8	3	4.9	0	0	0	5.2	233.0
2010	30.1	100.5	1.3	9.6	6.1	0	0	0	12.6	160.3
2011	73.2	215.2	1.1	4.1	7	0	0	0	11.6	312.3
2012	33.3	138	0.7	1.4	1.5	0	0	0	20.1	194.9
2013	142.7	138.6	3.3	8.1	7.8	0	0	0	11.6	312.0
Total	3 524.0	2 677.5	1 860.3	193.1	94.2	56.8	50.4	10.1	553.3	9 020.0

Table C9a: Total gemfish catch and percentage of gemfish catch reported from the Chatham area of SKI 3, by month, for 1989–90 (1990) to 2012–13 (2013).

Fishing year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total catch (t)
1990	0.2	7.1	8.3	12.6	36.1	21.0	5.3	4.0	0.6	0.0	0.0	4.9	485
1991	6.8	8.6	23.0	10.2	23.1	16.9	4.3	5.0	0.1	0.0	0.0	2.0	308
1992	10.5	3.6	9.0	19.6	7.0	24.3	14.1	9.9	0.3	0.1	0.1	1.8	145
1993	1.8	1.5	11.8	24.1	8.3	18.3	14.8	17.7	1.0	0.0	–	0.5	87
1994	0.6	3.3	34.5	10.6	6.8	2.9	14.7	23.9	1.7	0.0	0.0	1.0	29
1995	0.7	2.8	3.4	1.3	46.7	34.8	3.2	2.5	0.4	0.0	2.7	1.5	78
1996	5.6	24.5	20.2	25.7	1.8	4.9	11.4	5.2	0.2	–	0.1	0.4	25
1997	3.8	13.9	7.2	21.4	21.1	11.0	11.6	7.7	0.5	0.1	0.0	1.6	8
1998	1.4	8.1	7.5	15.3	13.4	16.0	7.6	4.0	0.5	–	0.1	26.1	4
1999	3.5	18.1	8.8	17.0	14.0	7.7	15.5	10.0	1.9	0.2	0.2	3.2	3
2000	2.6	7.1	23.7	9.3	13.7	16.6	13.3	9.6	1.8	0.0	–	2.4	2
2001	2.2	18.2	17.5	11.8	21.7	8.1	6.3	5.6	2.4	–	–	6.2	2
2002	1.3	0.2	1.0	9.0	5.7	12.3	35.0	23.7	10.9	0.4	0.0	0.2	10
2003	0.9	0.7	2.8	6.9	9.4	15.2	47.0	14.4	0.7	0.9	0.1	0.9	31
2004	2.5	7.4	3.8	4.7	2.8	10.2	13.9	3.6	0.6	0.3	0.3	50.0	18
2005	3.5	0.2	3.2	8.7	6.7	14.3	10.4	24.1	4.1	0.2	0.5	23.9	8
2006	0.8	10.3	4.6	23.2	15.2	21.3	13.2	7.1	3.1	0.1	0.5	0.6	3
2007	3.4	10.2	12.8	41.6	11.7	2.1	8.8	8.3	0.5	–	0.5	0.1	5
2008	2.8	3.5	3.2	14.8	19.9	9.4	24.7	18.4	1.9	0.1	0.2	1.0	3
2009	3.1	4.5	1.5	4.2	2.0	7.4	7.8	66.5	1.9	0.0	0.0	1.1	4
2010	1.5	4.6	22.5	5.3	9.6	25.7	9.4	4.2	2.2	0.7	12.3	2.0	5
2011	1.8	9.6	14.5	2.2	46.5	14.2	4.3	5.0	1.2	0.4	–	0.3	8
2012	6.3	5.0	8.8	11.2	25.5	13.0	16.4	5.8	7.4	–	–	0.5	2
2013	4.7	12.2	5.2	19.6	12.1	7.8	14.0	1.6	21.5	0.4	–	0.8	7
Total catch (t)	44	84	159	166	318	250	109	91	9	0.7	3	47	1 280
% total	3.4	6.5	12.5	13.0	24.8	19.5	8.5	7.1	0.7	0.1	0.2	3.7	100.0

Table C9b: Total gemfish catch and percentage reported from SKI 3 Chatham area, by Statistical Area*, for 1989–90 (1990) to 2012–13 (2013).

Fishing year	018	020	021	022	023	024	401	Other	Total catch (t)
1990	19.8	7.4	0.1	70.3	0.7	0.3	0.0	1.3	485
1991	13.5	4.9	2.6	71.2	1.9	1.0	2.5	2.4	308
1992	38.2	6.5	0.3	42.3	1.3	2.5	7.5	1.3	145
1993	61.4	4.4	1.0	26.9	0.1	2.4	1.9	2.0	87
1994	60.5	3.6	0.1	23.7	0.2	8.2	0.6	2.9	29
1995	85.9	6.5	0.3	3.6	0.0	1.7	0.0	2.0	78
1996	77.5	7.0	1.7	4.3	0.1	3.2	1.1	5.1	25
1997	51.6	5.1	1.6	17.9	0.2	10.7	7.0	5.9	8
1998	30.1	28.6	1.3	16.1	0.5	17.4	3.2	2.7	4
1999	23.5	9.9	2.7	37.1	1.4	1.8	4.2	19.5	3
2000	18.8	8.8	1.4	29.0	4.4	2.6	11.4	23.6	2
2001	8.1	16.4	2.6	40.5	5.2	5.0	2.8	19.3	2
2002	6.7	53.0	1.5	31.7	0.2	4.2	1.2	1.6	10
2003	4.3	23.7	1.5	63.1	0.6	4.1	0.7	2.0	31
2004	9.6	28.1	8.4	34.5	6.6	2.8	2.4	7.7	18
2005	7.5	26.1	1.0	38.7	1.2	1.8	1.7	22.0	8
2006	23.4	18.0	3.0	42.0	5.2	4.0	0.4	3.9	3
2007	6.3	13.8	0.4	55.8	3.8	7.3	5.8	6.9	5
2008	8.0	29.9	4.6	24.0	6.6	4.7	12.9	9.3	3
2009	5.3	68.9	0.2	17.3	2.2	2.8	0.3	3.1	4
2010	5.9	29.2	0.5	49.8	3.5	2.7	2.3	6.1	5
2011	4.9	11.1	0.4	66.1	3.0	5.0	2.4	7.1	8
2012	6.8	19.0	0.5	49.5	1.7	2.6	10.0	9.9	2
2013	6.8	13.2	3.6	42.1	20.0	0.5	3.9	9.9	7
Catch (t)	365	103	14	709	16	20	24	29	1 280
% total	28.5	8.0	1.1	55.4	1.2	1.6	1.9	2.3	100.0

* The estimated catch for each of the Statistical Areas 019, 402–412, and 049–052, that comprise "Other", was less than 7 t over the whole dataset.

Table C9c: Total gemfish catch and percentage reported from SKI 3 Chatham area, by primary method, for 1989–90 (1990) to 2012–13 (2013).

Fishing year	BLL	BT	MB	MW	SN	Other	Total catch (t)
1990	0.04	96.1	–	–	3.85	0.01	485
1991	0.01	94.5	0.01	0.00	5.39	0.10	308
1992	0.01	84.4	0.02	0.02	15.50	0.03	145
1993	0.35	88.3	0.12	0.09	11.10	0.04	87
1994	0.00	57.9	3.57	0.14	38.36	0.02	29
1995	0.05	95.3	0.11	0.01	4.38	0.11	78
1996	0.13	93.0	0.13	0.12	6.57	0.02	25
1997	0.48	76.8	1.51	1.51	16.54	0.19	8
1998	0.09	69.6	1.08	0.94	28.28	0.00	4
1999	–	77.8	10.71	3.02	8.46	–	3
2000	2.22	69.1	6.79	12.22	9.66	–	2
2001	–	89.9	3.30	2.91	3.83	–	2
2002	–	96.1	1.51	0.67	1.68	–	10
2003	–	97.3	1.90	0.44	0.37	–	31
2004	0.11	96.8	1.53	1.03	0.51	–	18
2005	–	97.1	1.11	1.43	0.31	–	8
2006	3.94	85.2	8.24	0.88	1.35	0.38	3
2007	1.79	90.4	0.86	0.24	3.40	3.27	5
2008	12.03	80.5	2.21	0.41	2.77	2.05	3
2009	–	94.9	0.82	0.23	3.65	0.40	4
2010	–	80.9	11.13	1.75	1.06	5.11	5
2011	0.25	83.0	10.00	1.41	3.02	2.33	8
2012	–	75.2	4.34	1.40	3.22	15.79	2
2013	–	72.6	9.19	3.72	0.85	13.61	7
Total (t)	1	1 181	6	2	88	3	1 280
% total	0.1	92.3	0.4	0.1	6.9	0.2	100.0

Table C9d: Total gemfish catch and percentage reported from SKI 3 Chatham area, by target species, for 1989–90 (1990) to 2012–13 (2013). Annual totals are given in Table C9a. Target species codes are given in Table C12.

Fishing year	BAR	HAK	HOK	HPB	JMA	LIN	OEO	RCO	SKI	SQU	SWA	TAR	WAR	Other
1990	23.4	0.0	1.2	0.1	3.3	1.5	0.0	13.2	42.2	5.6	2.1	4.6	0.1	2.6
1991	45.2	0.0	5.7	0.8	1.9	2.8	0.0	7.4	25.1	4.7	1.6	3.6	0.2	0.9
1992	10.9	0.2	2.4	2.4	0.1	8.1	3.5	10.6	24.0	22.5	1.2	10.7	0.8	2.4
1993	9.3	1.6	2.5	0.6	0.0	2.5	0.0	8.0	48.8	13.7	1.0	8.9	0.7	2.5
1994	5.4	1.4	1.0	11.9	0.0	9.6	0.0	5.5	23.8	16.4	0.6	8.3	1.8	14.4
1995	2.5	2.6	13.0	1.8	0.0	1.1	0.0	2.8	70.9	2.6	0.1	0.9	0.6	1.1
1996	7.6	3.6	6.1	2.2	0.0	1.7	0.0	1.6	69.1	2.2	0.5	1.7	1.2	2.4
1997	2.4	2.0	9.7	6.9	0.5	6.0	0.0	8.4	32.0	12.0	0.8	6.0	2.0	11.3
1998	4.5	1.4	8.6	2.1	0.6	17.6	0.0	32.8	7.0	9.4	0.1	3.2	4.0	8.6
1999	5.4	10.1	17.7	4.8	8.9	4.1	0.1	9.7	–	19.5	2.3	2.4	0.2	14.8
2000	3.4	4.9	29.3	10.0	7.2	10.3	–	5.4	–	18.3	0.0	0.2	0.5	10.4
2001	14.0	6.4	32.9	0.5	0.3	4.9	–	4.7	–	33.4	0.2	0.6	0.2	2.0
2002	6.7	0.4	6.8	0.3	1.4	1.3	0.0	10.9	–	62.6	3.6	0.7	0.1	5.2
2003	7.4	0.2	6.1	0.1	1.1	0.1	0.3	13.2	–	61.4	3.5	0.7	4.1	1.9
2004	4.0	0.9	59.3	0.2	0.0	0.1	0.0	21.8	–	10.9	0.0	1.2	0.0	1.5
2005	2.0	3.2	18.8	0.1	0.0	0.2	0.2	13.7	–	37.5	0.6	6.7	1.0	16.1
2006	2.2	0.8	31.1	0.8	2.7	0.5	0.0	13.7	–	30.4	2.1	4.9	1.7	9.2
2007	7.0	1.5	9.7	3.2	0.5	1.5	0.0	11.5	–	42.5	3.6	8.0	0.7	10.3
2008	18.2	1.7	13.1	1.4	2.3	0.8	–	5.5	–	16.4	17.6	7.0	0.1	15.9
2009	7.5	0.5	8.4	1.3	0.0	0.5	–	7.0	–	63.9	5.3	4.3	0.1	1.2
2010	12.4	0.3	32.9	0.3	1.0	1.5	–	24.8	–	3.7	8.6	8.6	0.4	5.7
2011	15.3	0.0	12.2	0.9	0.3	1.2	–	15.2	–	28.2	13.5	9.3	0.8	3.1
2012	15.3	–	18.0	0.3	2.1	0.1	–	21.0	–	6.2	10.7	18.4	0.5	7.5
2013	7.5	0.0	43.0	0.2	5.4	0.3	–	19.8	–	0.6	6.8	11.6	0.2	4.5
Catch (t)	239	44	389	53	40	78	4	288	343	524	86	133	22	156
% total	18.7	3.4	30.4	4.1	3.1	6.1	0.3	22.5	26.8	41.0	6.7	10.4	1.7	12.2

Table C10a: Total gemfish catch (t) and percentage of gemfish catch reported from the South area of SKI 3, by month, for 1989–90 (1990) to 2012–13 (2013).

Fishing year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total catch (t)
1990	0.5	7.3	11.5	24.2	10.4	31.0	6.8	5.5	1.2	0.0	0.3	1.3	219
1991	2.0	11.9	21.2	27.2	25.2	5.0	5.4	1.7	0.2	0.0	0.0	0.0	186
1992	2.6	6.5	6.2	8.2	14.0	13.6	28.0	5.2	10.9	0.0	0.5	4.4	147
1993	1.7	2.5	3.6	6.0	31.0	13.5	30.2	8.9	2.1	0.0	0.1	0.4	231
1994	2.1	6.7	9.6	27.7	8.4	4.1	8.9	2.1	7.3	0.0	22.9	0.2	53
1995	0.5	28.7	40.3	13.8	9.6	1.8	3.6	0.9	0.0	–	0.0	0.6	81
1996	2.0	33.1	30.7	5.9	8.9	8.7	2.2	0.8	–	–	–	7.6	26
1997	1.5	8.8	2.1	3.3	0.3	58.7	23.4	1.6	0.0	–	–	0.3	50
1998	0.6	18.4	35.9	11.2	2.9	17.7	5.7	7.0	0.4	–	–	0.0	21
1999	1.3	2.6	18.0	5.2	3.2	44.3	22.9	2.0	0.2	0.0	0.1	0.2	22
2000	2.5	22.2	6.2	0.8	44.3	17.3	6.6	0.1	0.1	0.0	–	0.0	58
2001	4.2	0.7	4.4	0.8	0.6	36.0	1.2	47.2	0.0	0.0	0.1	4.7	46
2002	1.0	1.1	1.2	0.7	2.6	56.3	28.0	7.7	1.3	0.0	0.1	0.1	61
2003	0.2	0.5	1.6	2.0	30.0	33.1	18.5	11.0	2.6	0.0	0.5	0.0	82
2004	1.2	0.4	4.6	13.7	1.9	13.2	18.4	38.9	4.6	0.1	0.1	3.0	71
2005	0.7	0.6	3.5	3.2	8.7	8.9	32.2	24.4	17.4	0.1	0.2	0.1	56
2006	1.2	9.1	3.5	1.1	7.2	16.3	41.8	18.6	0.8	0.2	0.0	0.1	23
2007	1.7	11.6	33.1	6.5	2.6	5.8	32.7	2.9	2.7	–	–	0.6	21
2008	4.1	21.4	31.7	5.1	10.9	3.5	22.9	0.2	–	–	–	0.0	15
2009	3.0	14.8	11.7	2.9	22.9	4.2	10.6	25.3	4.2	0.2	0.1	0.2	7
2010	5.7	2.8	11.5	31.6	37.4	3.0	1.4	6.1	0.4	0.1	0.0	0.0	15
2011	1.9	6.6	2.8	15.6	7.3	6.0	56.0	3.4	0.2	0.0	–	0.1	24
2012	18.2	5.1	2.2	6.1	18.4	5.0	14.0	30.1	0.2	0.0	0.0	0.7	8
2013	4.6	13.1	16.1	19.0	7.1	5.9	31.0	2.6	0.4	–	–	0.2	16
Total catch (t)	26	126	172	191	252	289	271	136	45	0.3	15	18	1 540
% total	1.7	8.2	11.2	12.4	16.3	18.7	17.6	8.8	2.9	0.0	0.9	1.2	100.0

Table C10b: Total gemfish catch and percentage reported from SKI 3 South area, by Statistical Area*, for 1989–90 (1990) to 2012–13 (2013).

Fishing year	025	026	027	028	029	030	504	602	Other	Total catch (t)
1990	0.9	6.0	14.0	36.6	17.2	15.9	5.7	2.4	1.4	219
1991	0.3	6.1	19.0	50.6	3.1	10.7	6.0	3.8	0.4	186
1992	1.8	6.0	12.9	22.1	11.4	40.8	2.7	1.0	1.3	147
1993	0.9	5.1	8.6	26.1	22.1	30.0	3.4	2.2	1.5	232
1994	4.3	16.0	22.8	12.3	1.3	32.8	6.2	3.2	0.5	53
1995	18.1	8.1	37.4	9.0	4.1	19.7	2.8	0.6	0.1	81
1996	5.4	6.2	26.0	7.8	1.6	48.1	1.2	3.1	1.2	26
1997	0.4	4.6	2.2	15.9	0.6	73.7	1.6	1.0	0.3	50
1998	1.9	4.3	7.7	24.2	11.1	47.8	2.4	1.0	0.2	21
1999	0.9	2.3	7.4	36.7	0.0	40.5	4.2	6.5	1.3	22
2000	0.2	0.5	0.9	9.8	1.9	84.0	0.3	0.3	1.9	58
2001	0.0	0.4	0.7	3.1	0.0	93.7	0.2	0.2	1.6	46
2002	0.0	2.9	1.0	7.0	0.5	83.6	2.8	1.6	0.6	62
2003	0.1	6.0	5.5	10.4	0.5	71.7	1.6	3.6	0.7	82
2004	0.0	14.0	3.8	9.3	5.2	59.2	2.7	4.9	0.8	71
2005	0.0	2.1	5.2	8.0	0.9	79.5	1.1	2.5	0.8	56
2006	0.0	1.3	3.1	12.3	2.2	72.4	2.2	5.7	0.6	23
2007	1.9	3.3	8.5	21.1	27.7	29.6	3.3	3.8	1.0	21
2008	0.7	1.3	5.2	32.7	4.6	37.9	4.6	8.5	4.5	15
2009	1.4	1.4	7.1	15.7	18.6	40.0	1.4	14.3	0.6	7
2010	0.7	2.7	6.1	31.1	31.1	12.8	4.1	5.4	6.0	15
2011	0.8	4.1	5.0	19.4	2.9	57.0	3.7	5.0	2.1	24
2012	1.2	3.7	3.7	17.1	8.5	51.2	2.4	8.5	3.4	8
2013	1.9	3.7	12.4	26.7	0.6	42.2	3.7	8.7	1.0	16
Catch (t)	28	87	178	363	139	633	54	42	35	1 540
% total	1.8	5.7	11.6	23.6	9.0	41.1	3.5	2.7	1.1	100.0

* The estimated catch for each of the Statistical Areas 031, 032, 302, 303,501–503, 601, 603–614, 617–621, and 623–625 that comprise "Other" was less than 7 t over the whole dataset. The data for these areas are included in the annual total catch.

Table C10c: Total gemfish catch and percentage reported from SKI 3 South area, by primary method, for 1989–90 (1990) to 2012–13 (2013).

Fishing year	BLL	BT	MB	MW	SN	Other	Total catch (t)
1990	0.0	91.8	8.0	0.2	–	–	219
1991	–	84.0	14.5	1.5	0.0	–	186
1992	0.1	99.1	0.7	0.1	–	–	147
1993	0.1	87.9	11.5	0.6	–	0.0	232
1994	0.2	98.1	1.6	0.2	–	0.0	53
1995	0.0	97.3	0.6	1.1	0.9	0.0	81
1996	0.8	94.4	4.6	0.2	–	–	26
1997	0.0	98.0	1.8	0.1	0.0	0.0	50
1998	0.0	98.8	0.9	0.2	0.0	–	21
1999	0.9	59.1	32.6	7.4	–	–	22
2000	0.7	92.3	3.6	3.4	–	–	58
2001	0.2	97.2	1.3	1.3	–	–	46
2002	0.0	98.7	1.1	0.2	0.0	0.0	62
2003	0.1	95.3	4.2	0.4	–	0.0	82
2004	–	91.5	8.4	0.2	–	–	71
2005	0.0	98.5	1.2	0.3	0.0	–	56
2006	–	94.5	5.4	0.1	–	–	23
2007	0.0	95.3	4.3	0.3	–	–	21
2008	1.3	94.6	3.4	0.5	–	–	15
2009	0.0	71.0	28.5	0.4	0.0	–	7
2010	0.7	59.1	37.5	2.5	–	–	15
2011	0.4	88.4	8.7	1.7	–	0.8	24
2012	0.0	79.3	18.2	2.1	–	0.0	8
2013	0.6	89.4	9.6	0.5	–	–	16
Total catch (t)	2	1 414	111	12	1	0	1 540
% total	0.1	91.8	7.2	0.8	0.1	0.0	100.0

Table C10d: Total gemfish catch and percentage reported from SKI 3 South area, by target species, for 1989–90 (1990) to 2012–13 (2013). Annual totals are given in Table C10a. Target species codes are given in Table C12.

Fishing year	BAR	HOK	JMA	LIN	RCO	SKI	SQU	SWA	WAR	WWA	Other
1990	42.3	4.4	2.5	9.1	0.0	4.2	21.7	8.6	0.0	3.2	3.9
1991	17.5	5.8	0.0	10.6	0.2	0.2	54.6	10.4	0.0	0.0	0.7
1992	18.6	5.9	3.8	5.9	0.4	3.0	43.1	15.6	2.8	0.0	0.9
1993	36.2	1.4	0.4	1.8	0.4	11.3	34.6	13.3	0.0	–	0.5
1994	18.3	1.7	0.0	4.5	1.7	23.5	21.3	25.2	3.1	–	0.8
1995	48.2	2.4	0.1	1.0	6.9	–	15.9	13.1	10.1	0.4	1.9
1996	22.0	7.6	1.7	2.1	27.2	0.0	11.1	10.3	12.6	–	5.5
1997	1.0	4.6	0.3	0.9	4.7	–	78.7	9.1	0.1	–	0.7
1998	13.0	7.8	6.7	0.2	16.2	7.1	38.8	10.1	0.0	–	0.1
1999	0.4	4.5	21.3	2.1	0.7	0.0	52.7	16.6	0.1	0.1	1.4
2000	0.7	7.4	5.8	0.4	0.0	0.0	23.7	39.8	0.0	21.4	0.9
2001	0.1	4.9	0.1	1.1	3.3	0.0	82.4	1.1	0.0	4.1	2.9
2002	0.4	0.7	0.4	0.3	0.0	0.0	92.5	4.0	0.0	0.6	1.0
2003	0.3	1.6	0.5	0.4	0.1	0.0	95.6	0.9	0.0	0.4	0.4
2004	0.5	4.1	3.6	0.4	0.0	–	87.6	0.5	0.0	2.9	0.6
2005	0.3	0.7	0.0	0.4	–	–	92.8	0.2	0.1	5.0	0.5
2006	2.6	0.3	0.2	4.6	0.0	–	77.7	5.0	0.1	8.5	0.8
2007	16.8	4.7	0.1	9.4	0.0	–	29.2	29.3	3.0	6.9	0.5
2008	2.8	1.6	0.1	22.1	1.8	–	49.9	3.8	0.4	16.2	1.3
2009	19.7	1.1	0.5	16.2	–	–	44.9	5.2	1.4	7.6	3.3
2010	32.6	1.3	0.7	5.1	–	–	43.1	4.5	0.2	6.4	6.2
2011	2.4	2.8	0.4	5.3	–	–	83.0	2.5	0.6	0.5	2.4
2012	9.1	2.9	0.5	13.5	0.0	–	59.5	3.6	1.5	4.7	4.6
2013	3.3	3.5	1.0	8.5	0.5	–	58.2	12.0	1.7	3.6	7.6
Catch (t)	308	57	26	71	23	54	755	168	19	36	24
% total	20.0	3.7	1.7	4.6	1.5	3.5	49.1	10.9	1.2	2.3	1.6

Table C11a: Percentage of gemfish catch reported from SKI 7, by month, for 1989–90 (1990) to 2012–13 (2013).

Fishing year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total catch (t)
1990	0.2	3.5	1.5	0.9	1.0	1.3	0.4	0.3	2.0	4.1	55.3	29.6	622
1991	0.6	1.5	3.0	3.6	0.7	0.9	2.6	0.4	0.7	9.4	33.6	43.0	316
1992	1.6	1.7	0.7	0.5	0.1	6.3	3.4	0.7	0.5	0.8	20.1	63.6	398
1993	1.0	7.5	1.5	0.3	0.6	2.3	1.9	2.0	0.9	7.8	23.5	50.7	676
1994	10.3	1.7	2.9	0.7	0.8	0.3	0.4	3.3	1.3	21.2	49.0	8.1	335
1995	5.4	6.3	6.4	1.8	2.8	2.5	2.9	0.6	1.7	7.0	17.0	45.6	142
1996	3.4	4.3	6.2	6.8	7.6	5.6	3.4	3.5	0.9	2.2	20.1	35.8	65
1997	12.4	6.5	1.7	5.0	3.3	6.6	1.6	5.2	0.2	0.8	24.0	32.6	97
1998	11.2	1.9	1.7	0.5	0.4	0.3	1.9	2.2	0.9	0.1	1.9	77.2	133
1999	13.1	12.2	3.9	6.1	5.7	3.9	5.0	4.3	3.2	0.7	8.2	33.6	56
2000	3.3	1.0	2.5	0.8	0.7	1.5	1.8	3.0	2.0	3.1	62.6	17.9	61
2001	1.4	1.3	0.7	0.4	0.2	0.6	4.2	8.9	2.3	3.4	28.3	48.2	120
2002	2.6	1.8	0.7	0.6	0.3	0.5	0.7	0.3	4.0	16.1	38.3	34.2	107
2003	0.7	0.8	0.7	0.8	1.1	0.5	0.1	5.9	10.7	22.9	17.2	38.7	275
2004	2.7	4.9	0.7	1.9	1.7	1.1	0.9	0.8	10.9	32.3	26.5	15.7	491
2005	1.8	3.8	0.1	0.4	0.3	0.3	1.9	6.3	4.7	37.9	29.4	12.9	593
2006	1.3	1.6	1.4	1.0	3.4	1.2	3.1	2.7	13.7	22.3	44.5	3.7	223
2007	1.4	3.0	3.1	3.4	2.7	2.7	7.2	10.6	22.4	2.5	18.9	22.2	128
2008	1.3	1.7	1.3	4.9	0.7	14.6	11.6	11.9	4.2	3.4	13.6	30.7	246
2009	0.9	2.0	1.4	3.8	2.0	6.5	8.2	11.8	12.5	11.4	31.2	8.5	222
2010	1.6	4.8	3.1	5.5	13.3	13.9	11.6	17.1	5.1	6.6	8.5	8.9	141
2011	1.7	5.5	10.2	3.7	8.1	14.9	7.1	8.9	6.6	2.8	14.3	16.2	280
2012	2.3	4.1	2.3	3.7	2.6	3.3	14.8	25.9	5.9	2.0	8.9	24.3	184
2013	0.9	4.8	6.2	3.1	2.7	2.8	1.4	14.5	8.1	1.3	8.0	46.3	289
Total catch (t)	150	230	139	116	116	211	205	328	310	776	1 703	1 917	6 200
% total	2.4	3.7	2.2	1.9	1.9	3.4	3.3	5.3	5.0	12.5	27.5	30.9	100.0

Table C11b: Total gemfish catch and percentage reported from SKI 7, by Statistical Area, for 1989–90 (1990) to 2012–13 (2013).

Fishing year	017	033	034	035	036	037	038	039	040	041	702	703	Total catch (t)
1990	2.4	0.4	37.7	52.9	0.2	0.7	0.3	0.0	0.2	2.7	2.6	0.0	622
1991	9.4	1.2	33.0	53.8	0.9	0.0	0.6	0.3	0.0	0.0	0.0	0.5	316
1992	10.2	2.3	40.1	45.2	1.2	0.3	0.2	0.0	0.1	0.5	0.0	0.0	398
1993	4.5	1.7	41.7	45.7	4.2	0.3	0.0	0.1	1.2	0.2	0.0	0.1	676
1994	3.7	1.8	28.6	61.9	1.3	0.3	0.0	0.1	0.3	0.5	0.0	0.9	335
1995	7.9	2.5	18.9	61.5	4.3	1.3	0.1	0.1	1.5	1.8	0.0	0.0	142
1996	13.0	10.3	26.2	42.3	2.3	1.5	0.2	0.3	0.3	3.2	0.0	0.0	65
1997	3.8	11.5	33.2	47.2	1.7	0.2	1.3	0.0	0.1	1.1	0.0	0.0	97
1998	0.4	1.9	13.3	75.9	6.7	0.1	0.1	0.1	0.1	1.0	0.0	0.1	133
1999	1.6	21.1	35.8	33.5	3.2	0.4	0.9	0.4	0.5	1.1	0.0	0.0	56
2000	0.7	4.9	39.8	53.0	0.5	0.0	0.0	0.2	0.3	0.5	0.0	0.0	61
2001	0.2	1.2	53.6	43.5	0.7	0.2	0.0	0.0	0.2	0.2	0.0	0.0	120
2002	1.4	1.7	37.4	51.6	7.0	0.1	0.1	0.0	0.1	0.3	0.0	0.2	107
2003	0.7	1.7	39.8	54.7	1.9	0.1	0.1	0.0	0.1	0.8	0.0	0.1	275
2004	1.4	4.5	46.9	43.6	2.6	0.0	0.3	0.1	0.1	0.4	0.0	0.1	491
2005	0.5	1.2	53.6	41.1	2.6	0.0	0.2	0.1	0.1	0.2	0.0	0.5	593
2006	1.3	5.6	42.9	21.3	27.6	0.1	0.2	0.1	0.3	0.4	0.0	0.0	223
2007	4.6	6.2	28.8	48.9	8.9	0.3	0.2	0.9	0.2	0.6	0.0	0.0	128
2008	0.8	18.7	28.9	46.9	3.3	0.2	0.0	0.3	0.4	0.2	0.0	0.0	246
2009	1.6	10.5	37.4	46.8	2.3	0.1	0.0	0.7	0.1	0.3	0.0	0.0	222
2010	2.5	20.0	55.5	13.3	4.5	0.1	0.1	3.0	0.1	0.9	0.0	0.0	141
2011	3.6	12.2	45.8	26.3	8.1	0.2	0.1	2.1	0.1	0.6	0.0	0.1	280
2012	3.9	9.7	52.0	27.0	4.0	0.2	0.1	2.0	0.2	0.5	0.1	0.1	184
2013	1.4	8.0	61.2	21.3	4.8	0.2	0.0	1.8	0.1	0.4	0.0	0.0	289
Total catch (t)	205	302	2 542	2 757	241	16	11	27	19	43	16	10	6 200
% total	3.3	4.9	41.0	44.5	3.9	0.3	0.2	0.4	0.3	0.7	0.3	0.2	100.0

* The estimated catch for each of the Statistical Areas 701, 704–705, and 801 was less than 8 t over the whole dataset. The data for these areas are included in the annual total catch.

Table C11c: Total gemfish catch and percentage reported from SKI 7 area, by primary method, for 1989–90 (1990) to 2012–13 (2013).

Fishing year	BLL	BT	MB	MW	SN	Other	Total catch (t)
1990	0.2	77.7	6.7	15.3	0.0	0.1	622
1991	1.0	78.8	11.2	9.0	0.0	0.1	316
1992	0.6	92.7	3.0	3.6	0.0	0.1	398
1993	1.0	79.9	13.6	5.5	0.0	0.0	676
1994	1.0	61.9	17.1	19.9	0.0	0.1	335
1995	2.8	69.5	13.3	14.0	0.1	0.4	142
1996	8.3	68.4	7.9	13.4	1.9	0.3	65
1997	3.8	60.2	19.6	14.7	1.6	0.1	97
1998	2.3	51.1	42.3	3.7	0.0	0.5	133
1999	5.9	72.3	10.6	10.7	0.2	0.4	56
2000	2.1	70.5	17.2	10.0	0.0	0.2	61
2001	1.0	80.5	14.1	4.2	0.0	0.2	120
2002	1.0	80.8	10.8	6.7	0.0	0.7	107
2003	0.8	79.4	14.5	4.8	0.2	0.2	275
2004	0.9	76.0	17.1	5.4	0.0	0.7	491
2005	0.6	89.7	6.5	2.8	0.0	0.4	593
2006	3.5	87.6	2.7	4.9	0.0	1.2	223
2007	4.5	92.0	1.6	1.7	0.1	0.2	128
2008	2.9	96.4	0.6	0.1	0.0	0.0	246
2009	2.1	94.5	2.3	0.9	0.0	0.2	222
2010	1.3	87.4	9.5	1.6	0.0	0.1	141
2011	1.9	90.2	4.4	3.3	0.0	0.1	280
2012	2.4	91.5	1.0	4.9	0.1	0.2	184
2013	1.5	81.8	7.7	8.7	0.0	0.1	289
Total catch (t)	1.5	81.4	9.8	7.0	0.1	0.2	100
% total	92	5 048	609	432	5	15	6 200

Table C11d: Total gemfish catch and percentage reported from SKI 7 area, by target species, for 1989–90 (1990) to 2012–13 (2013). Annual totals are given in Table C12a. Target species codes are given in Table C12.

Fishing year	BAR	BNS	GSH	HAK	HOK	JMA	LIN	RCO	SKI	SQU	STA	SWA	TAR	Other
1990	25.9	0.0	0.0	–	26.3	19.4	0.7	0.1	22.9	–	0.6	2.2	1.3	0.6
1991	18.8	0.6	4.4	0.0	55.3	2.8	1.5	0.4	12.8	0.0	0.3	0.4	1.6	1.1
1992	20.7	0.2	0.3	0.6	10.5	31.1	1.1	2.6	23.7	0.0	0.3	6.9	1.5	0.6
1993	22.6	0.0	0.0	2.2	32.9	4.6	1.9	1.2	27.7	0.0	0.0	2.4	3.3	1.2
1994	29.9	0.1	0.2	1.5	45.9	1.5	1.4	0.3	14.3	–	0.4	2.4	1.6	0.6
1995	17.4	2.1	0.1	0.9	35.6	11.9	0.8	6.1	15.7	0.2	0.3	4.4	2.7	1.7
1996	40.3	4.7	0.0	0.0	33.3	4.5	2.3	0.5	1.2	–	0.1	1.8	7.0	4.2
1997	44.4	1.8	–	2.4	30.3	13.8	1.6	0.3	0.0	0.1	0.0	0.0	1.5	3.8
1998	9.7	1.4	–	0.3	39.5	1.5	0.7	0.5	44.1	0.0	1.2	–	0.1	1.1
1999	38.8	2.4	0.0	1.5	23.0	23.2	1.5	0.5	–	–	0.3	0.0	2.1	6.7
2000	8.1	1.3	0.3	0.0	78.1	6.1	2.3	–	–	–	0.1	1.9	0.4	1.4
2001	6.1	0.7	–	0.3	54.8	0.3	0.1	0.0	4.5	3.0	0.1	13.9	0.4	15.9
2002	8.8	0.5	0.0	0.1	73.4	4.8	0.5	0.1	–	0.0	0.1	5.3	1.5	5.0
2003	9.1	0.4	0.3	1.1	61.6	1.6	0.0	0.3	8.9	1.8	0.2	12.6	0.8	1.1
2004	10.7	0.7	0.0	0.5	74.0	0.1	1.0	0.3	1.6	1.5	1.6	1.7	4.8	1.3
2005	9.1	0.3	0.0	3.9	43.9	0.9	0.6	0.7	–	11.7	0.1	22.5	5.4	0.9
2006	2.6	2.3	0.4	4.0	68.2	0.2	5.6	1.6	0.0	3.8	0.5	5.3	3.3	2.2
2007	7.3	1.2	1.8	2.9	31.9	5.1	11.7	2.6	–	2.5	5.6	17.7	6.6	3.2
2008	2.3	0.6	0.1	1.9	10.3	0.6	32.1	0.5	1.6	–	6.2	34.2	6.7	2.9
2009	9.2	0.7	0.8	4.3	8.1	0.6	16.8	0.2	7.1	1.0	0.4	31.8	17.0	1.9
2010	2.1	0.3	1.4	6.0	20.8	0.3	24.3	0.5	6.5	1.7	1.4	3.5	28.8	2.4
2011	0.6	0.8	1.0	4.2	32.1	0.3	18.8	0.7	21.4	–	1.5	0.8	15.6	2.3
2012	5.7	0.7	2.0	5.4	28.0	0.2	14.5	0.7	24.1	0.0	1.5	1.3	12.4	3.6
2013	39.3	0.2	0.5	9.0	22.6	0.6	4.7	0.3	8.0	–	0.3	0.1	12.3	2.1
Total (t)	1 007	37	32	139	2 381	370	318	52	789	102	53	473	330	117
% total	16.2	0.6	0.5	2.2	38.4	6.0	5.1	0.8	12.7	1.6	0.8	7.6	5.3	1.9

Table C12: Species codes used in the report.

Code	Common name	Scientific name
BAR	Barracouta	*Thyrsites atun*
BNS	Bluenose	*Hyperoglyphe antarctica*
FRO	Frostfish	*Lepidopus caudatus*
GSH	Dark ghost shark	*Hydrolagus novaezealandiae*
HAK	Hake	*Merluccius australis*
HOK	Hoki	*Macruronus novaezelandiae*
HPB	Hapuku/bass	*Polyprion*
JMA	Jack mackerels	*Trachurus declivis*, *T. novaezelandiae*, *T. murphyi*
LDO	Lookdown dory	*Cyttus traversi*
LIN	Ling	*Genypterus blacodes*
RCO	Red cod	*Pseudophycis bachus*
SCH	School shark	*Galeorhinus galeus*
SKI	Gemfish	*Rexea solandri*
SQU	Arrow squid	*Nototodarus gouldi*, *N. sloanii*
STA	Stargazer	*Kathetostoma giganteum*
SWA	Silver warehou	*Seriolella punctata*
TAR	Tarakihi	*Nemadactylus macropterus*
WAR	Common warehou	*Seriolella brama*
WWA	White warehou	*Seriolella caerulea*
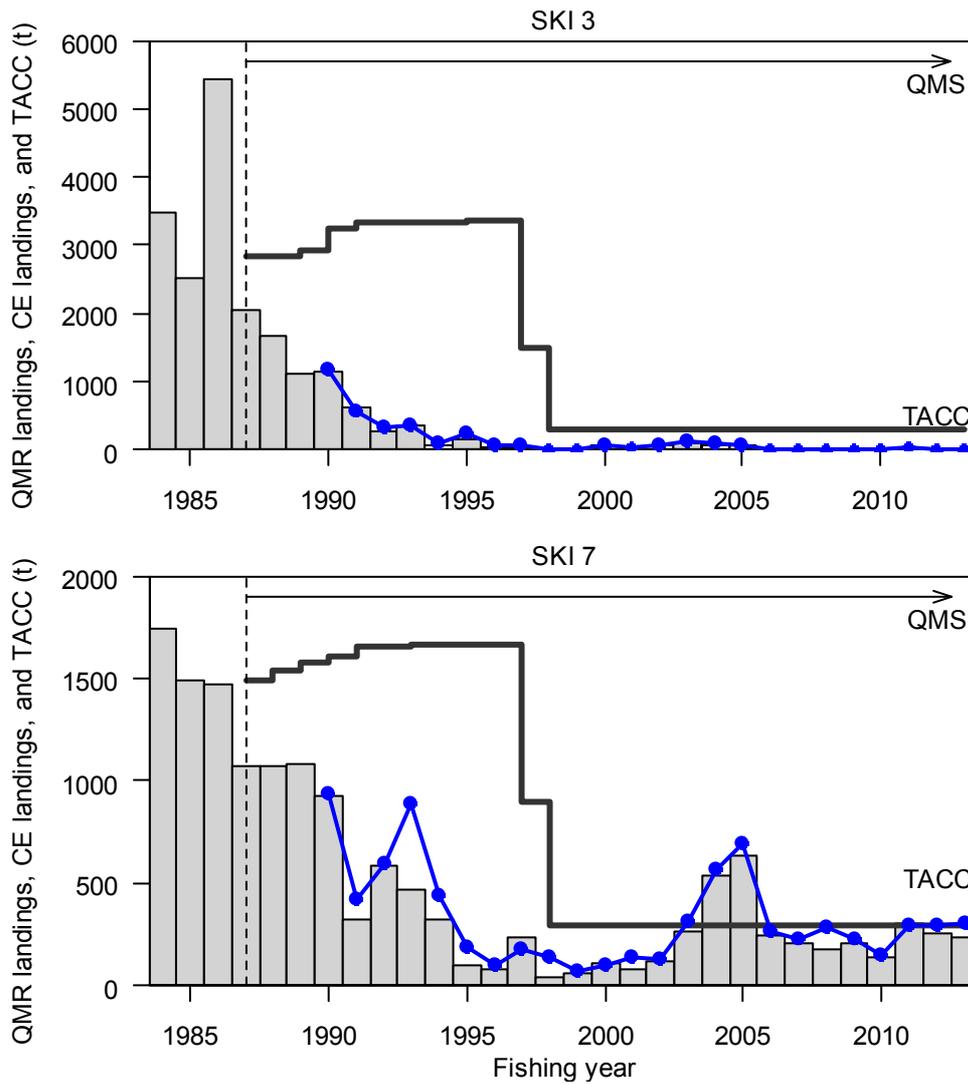
Figure C1: The QMR/MHR landings (grey bars), un-groomed catch effort landings (blue line), and TACC (black line) in tonnes for SKI 3 and SKI 7 stocks for the fishing years 1990 to 2013.
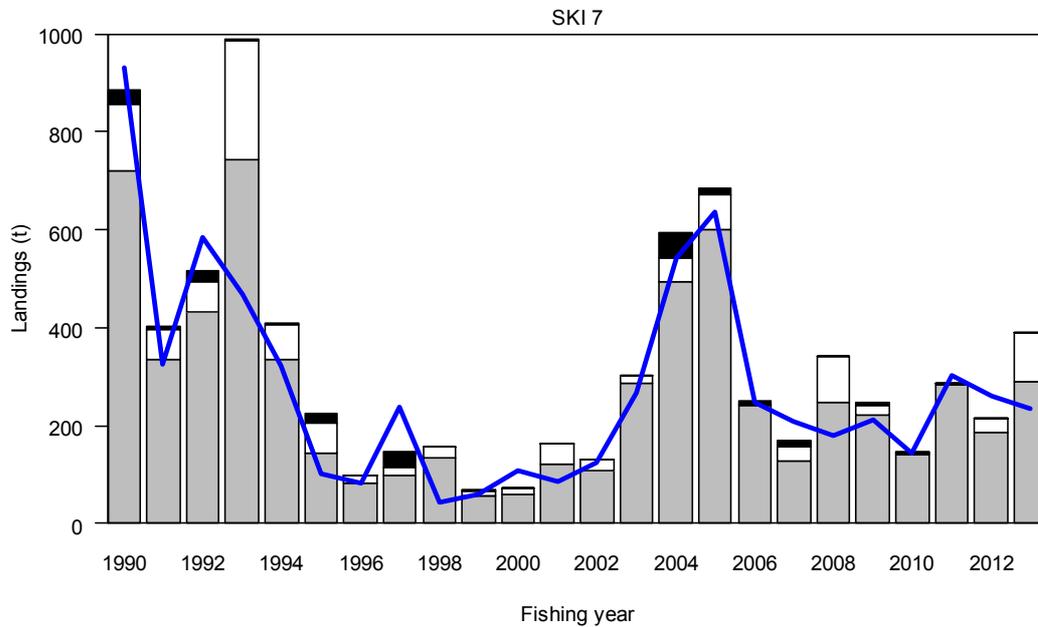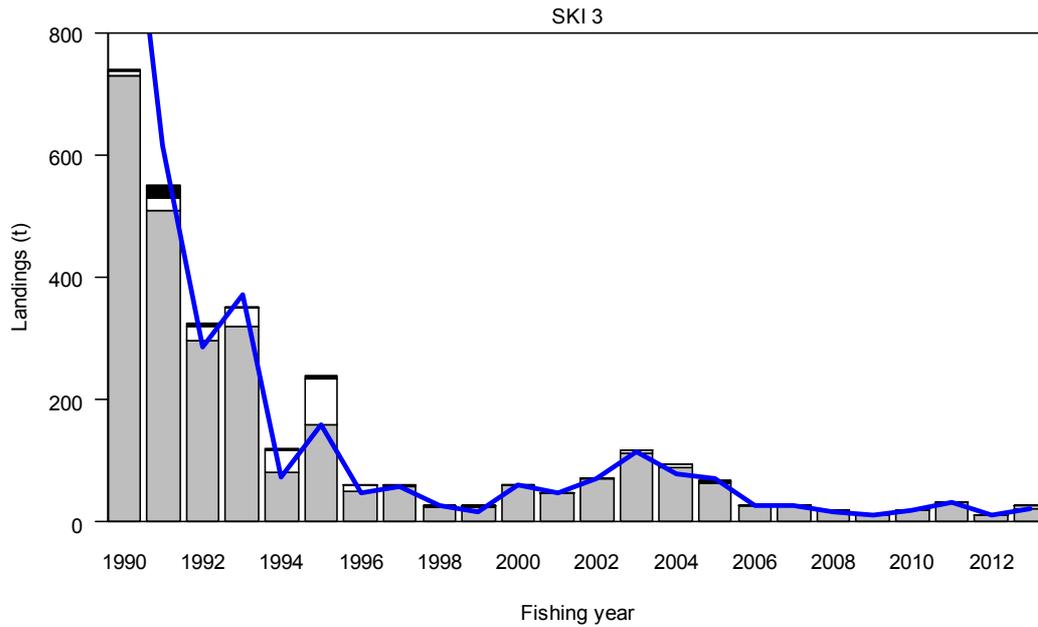
Figure C2: The retained landings (grey bars), interim landings (white bars), and landings dropped during data grooming (black bars), and MHR landings (blue line) in tonnes for SKI 3 and SKI 7 stocks for the fishing years 1990 to 2013.
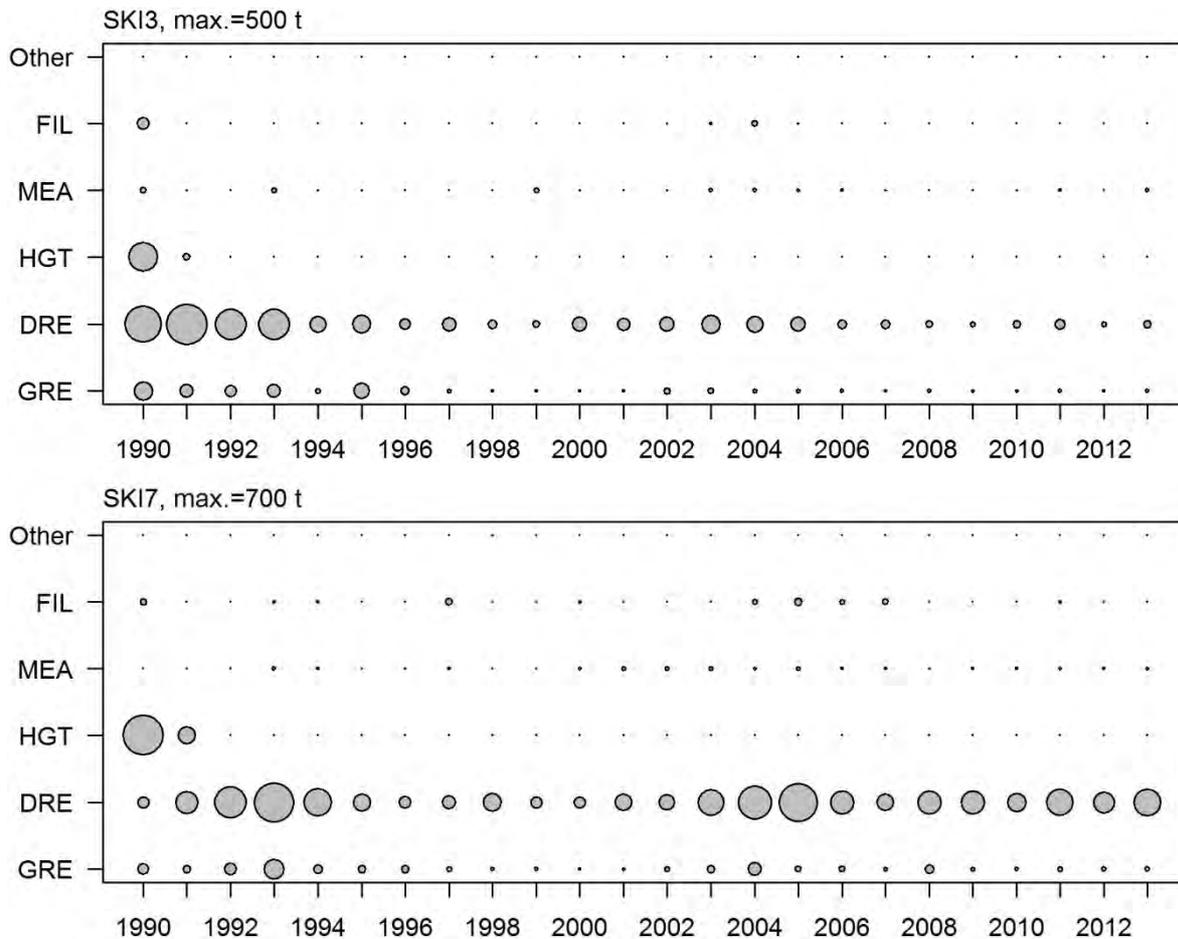
Figure C3: Retained landings (greenweight) by processed state for SKI 3 and SKI 7 stocks for fishing years 1990–2013. GRE is Green; DRE is dressed; HGT is headed, gutted, and tailed; MEA is mealed; and FIL is filleted or skin off filleted.
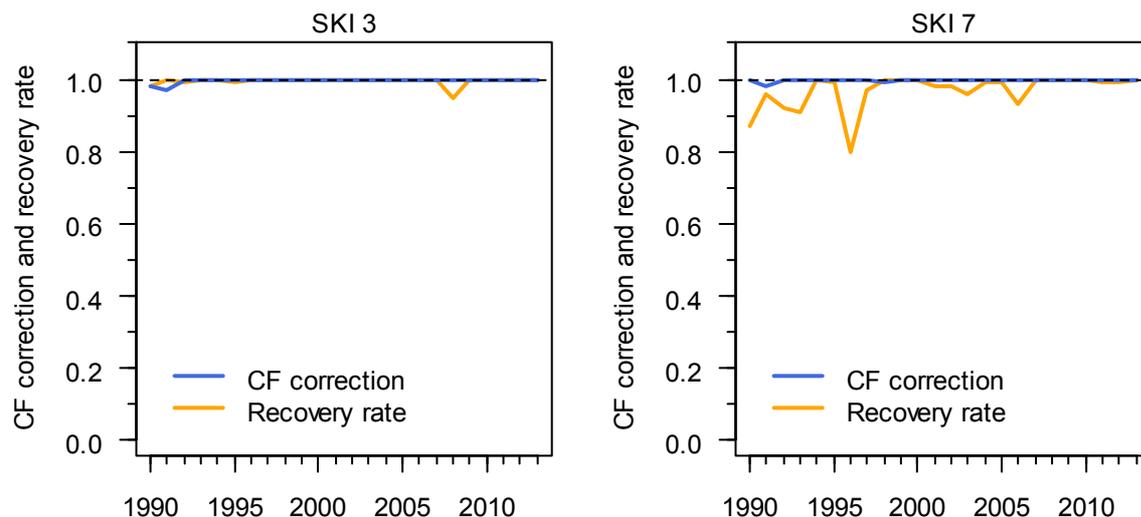
Figure C4: Conversion factor (CF) corrections (by the centroid method), defined as the ratio of annual green weight recalculated using the most recent correction factors for each processed state to the reported green weight, and the recovery rate, defined as the ratio of annual landings in the groomed and merged dataset to those in the groomed and unmerged dataset, for SKI 3 and SKI 7 stocks for the fishing years 1990–2013.
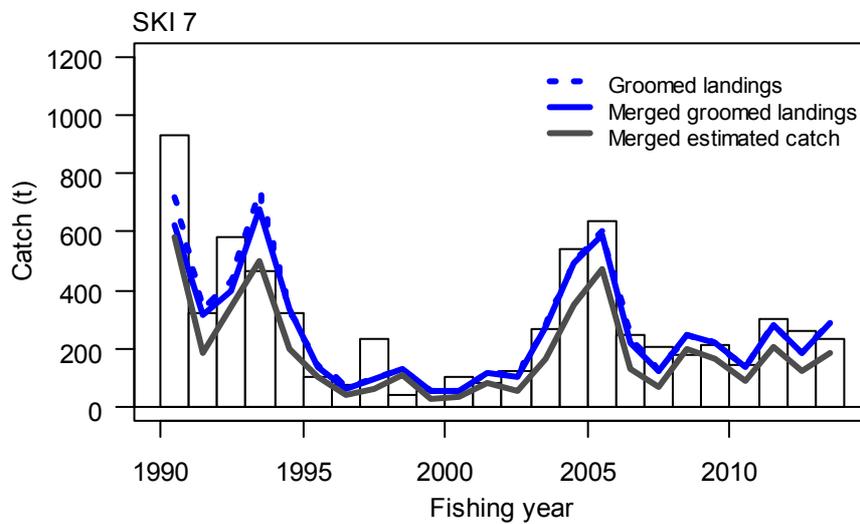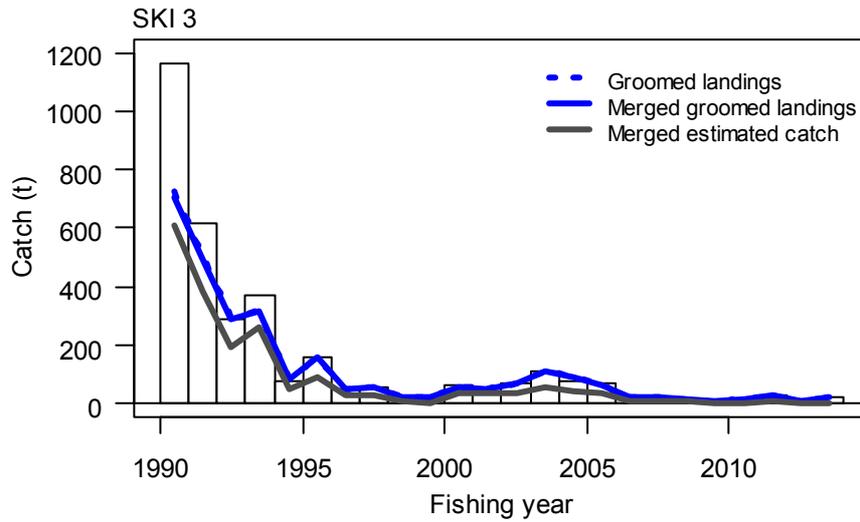
Figure C5: The QMR/MHR landings (white bars), retained landings in the groomed and unmerged dataset (blue dashed line), retained landings in groomed and merged dataset (blue solid line), and estimated catch in the groomed and merged dataset (grey solid line), using the centroid method, for SKI 3 and SKI 7 stocks for the fishing years 1990–2013.
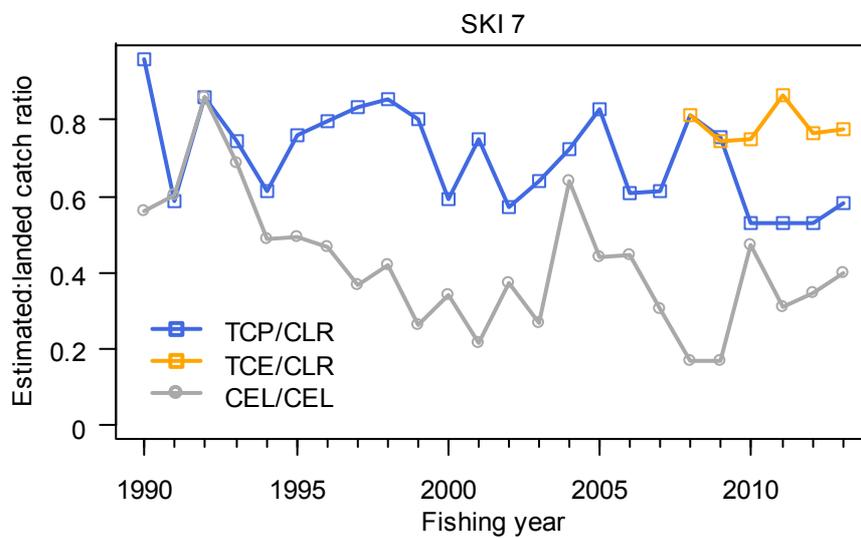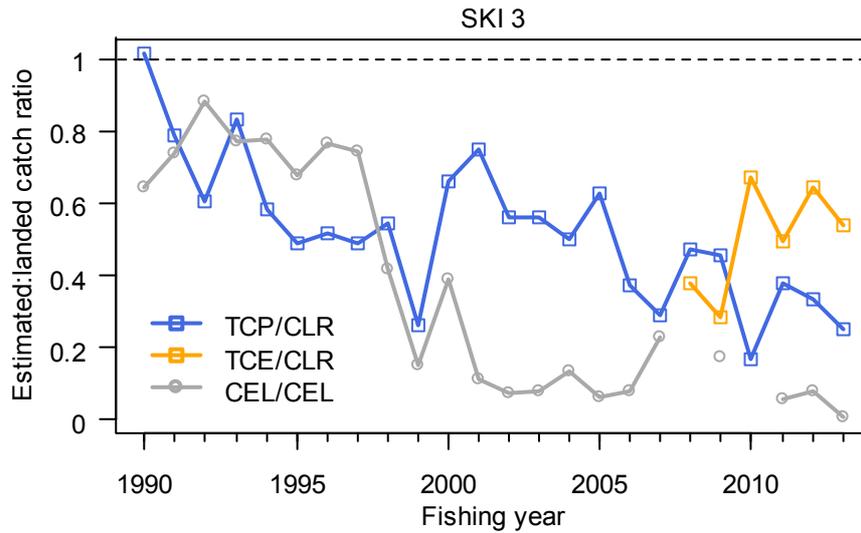
Figure C6: The reporting rate, defined as the ratio of the estimated catch as a proportion of retained landings in the groomed and merged dataset, for SKI 3 and SKI 7 stocks for the fishing years 1990–2013. The reporting rates for each stock were calculated by form type.
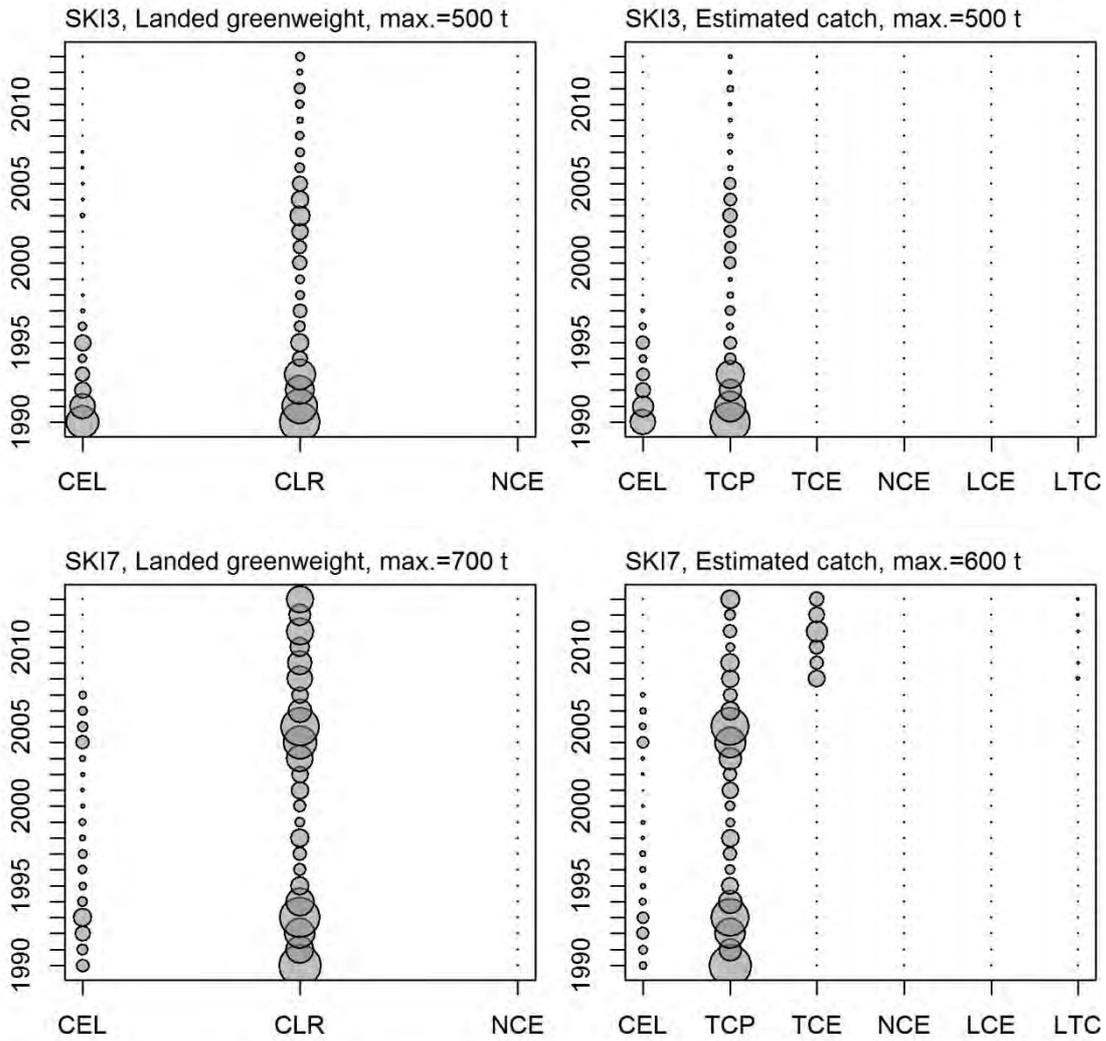
Figure C7: Proportion of landings by form type in the groomed and unmerged dataset, and proportion of estimated catches by form type in the groomed and unmerged dataset, for SKI 3 and SKI 7 stocks for the fishing years 1990–2013. The area of the circle is proportional to the annual catches (only comparable within each panel).

SKI 3
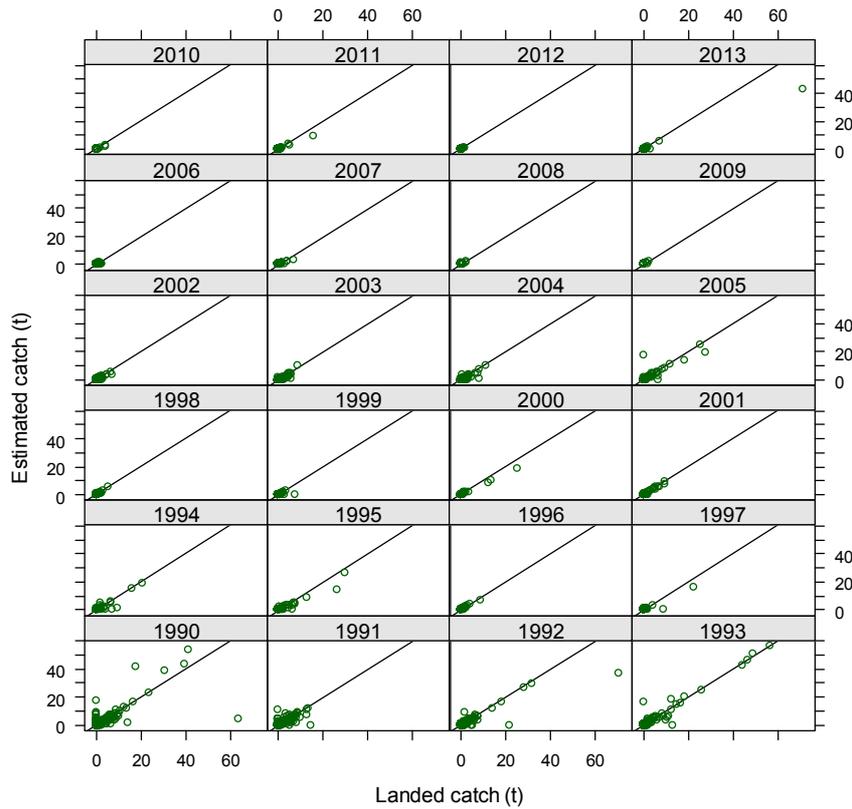
Figure C8: Estimated catch versus reported landings on a trip basis in the groomed and merged dataset for SKI 3 for 1989–90 to 2012–13, and by CELR, TCEPR, and TCER form types.

SKI 3: CELR
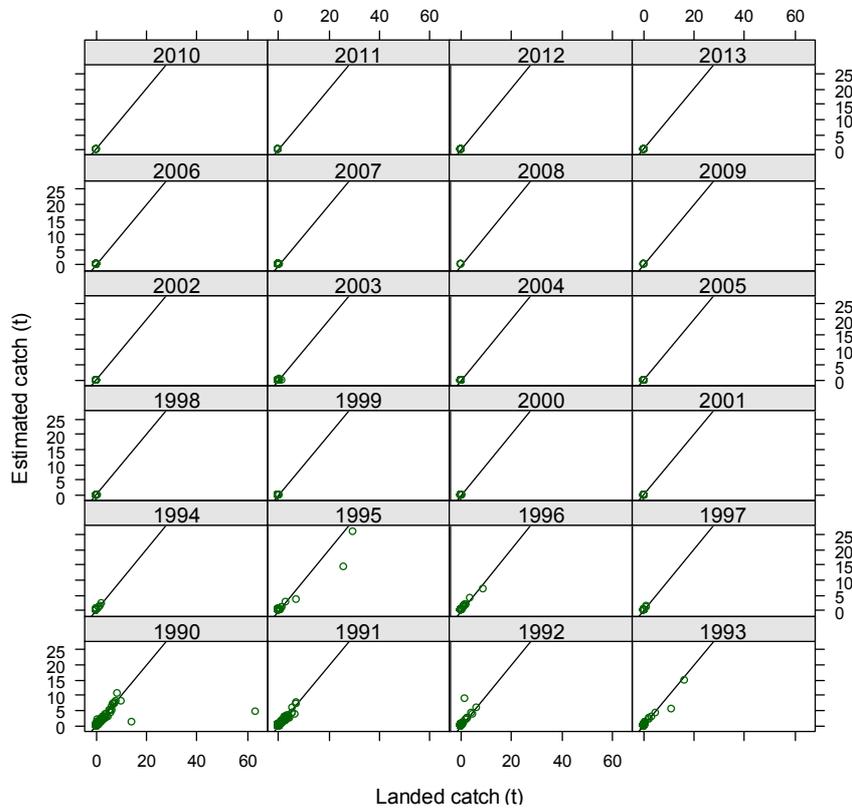
Figure C8 *continued.*

SKI 3: TCP/CLR
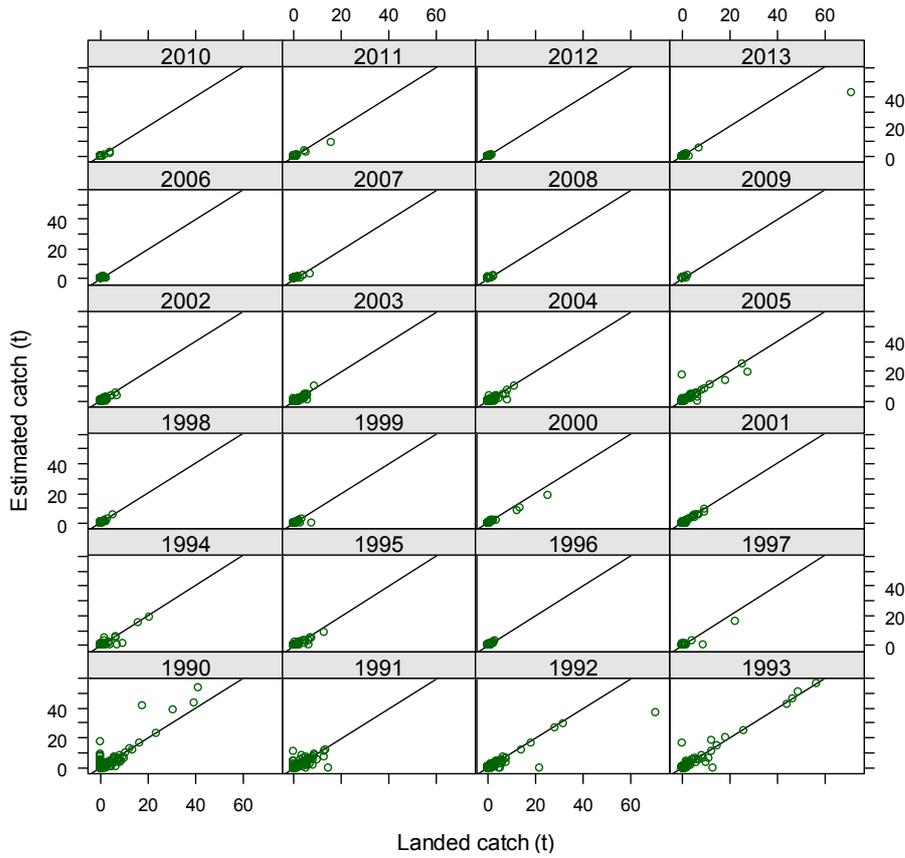
Figure C8 *continued.*

SKI 3: TCE/CLR
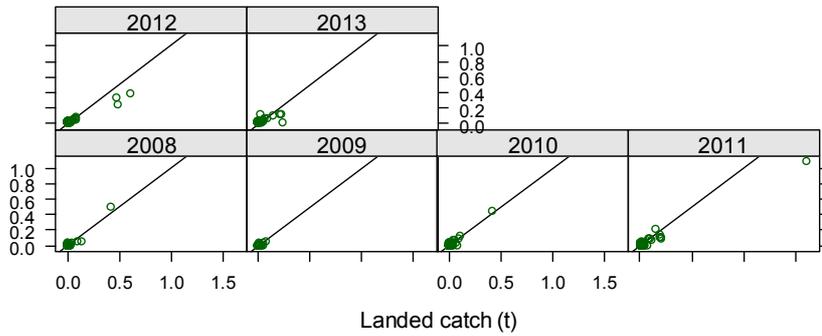
Figure C8 *continued.*
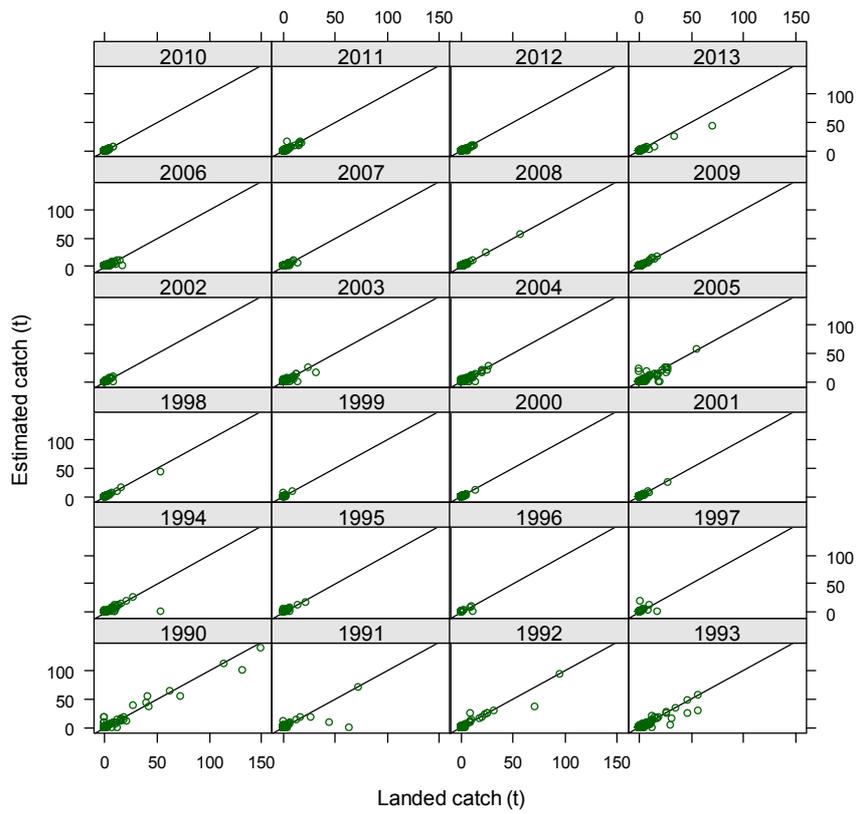
SKI 7

Figure C8 *continued.*

SKI 7: CELR
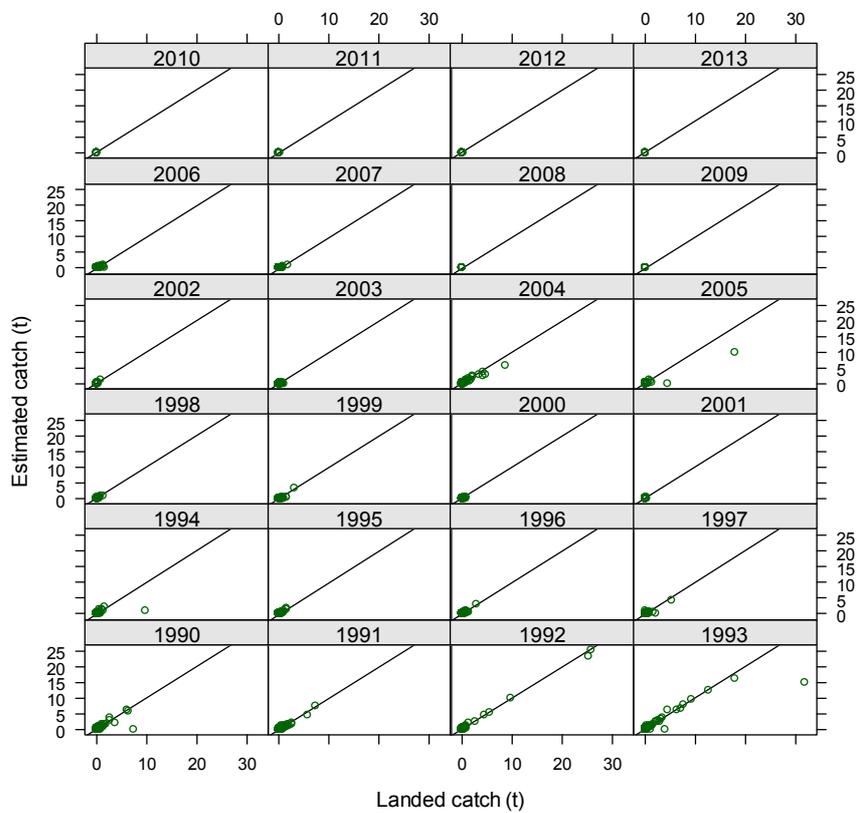
Figure C8 *continued.*

SKI 7: TCP/CLR
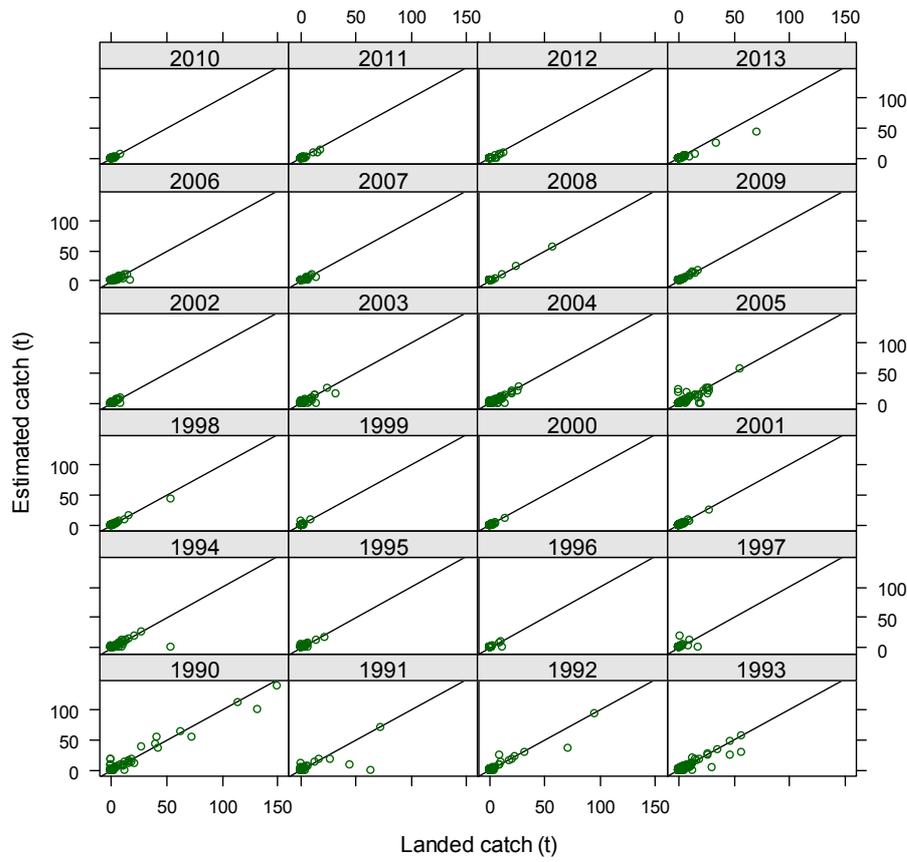
Figure C8 *continued.*

SKI 7: TCE/CLR
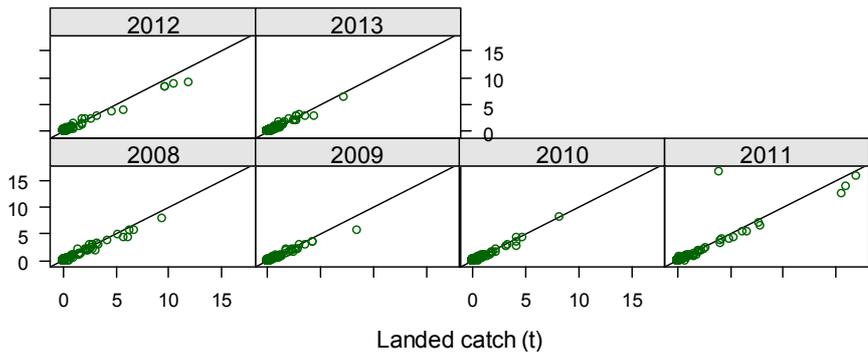
Figure C8 *continued.*
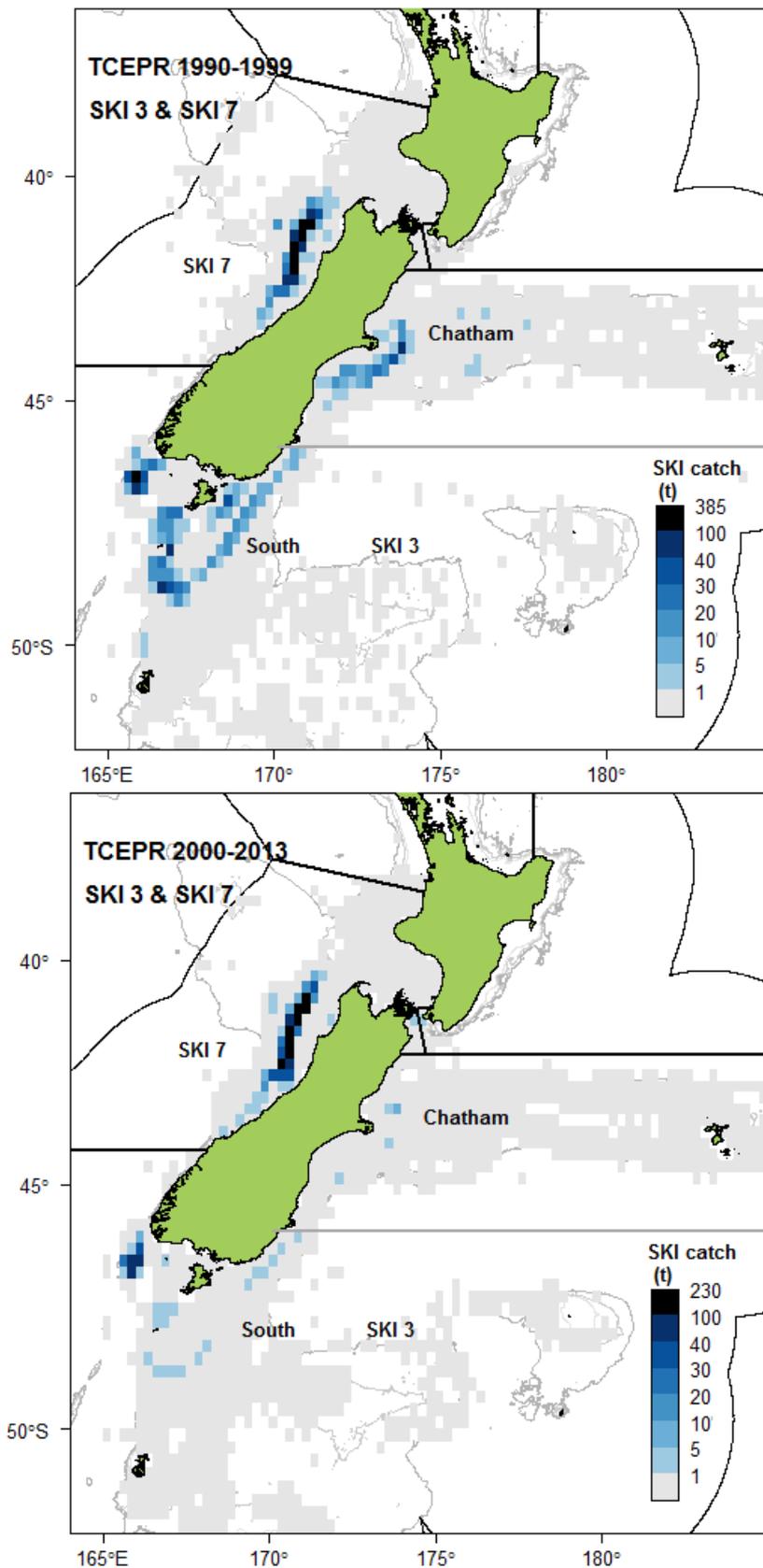
Figure C9a: Total estimated gemfish catch (t) from Trawl Catch Effort and Processing Return (TCEPR) records for fishing years 1990 to 1999 (upper) and for 2000 to 2013 (lower), for SKI 3 and SKI 7. The areas within SKI 3 are marked as Chatham and South.
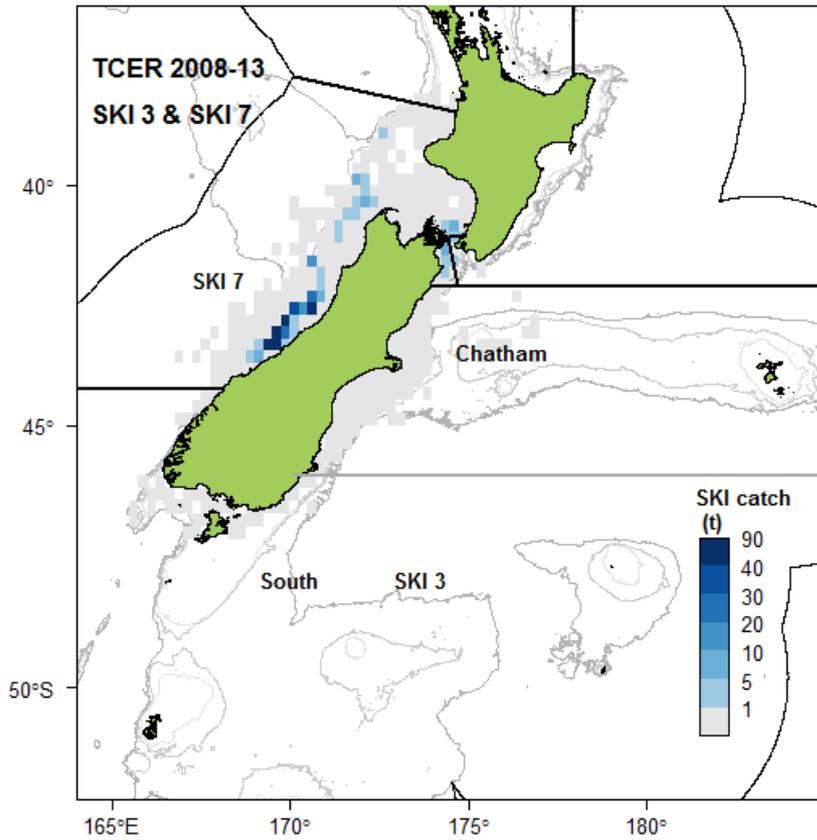
Figure C9b: Total estimated gemfish catch (t) from Trawl Catch Effort Return (TCER) records for 2007–08 to 2012–13, for SKI 3 and SKI 7. The areas within SKI 3 are marked as Chatham and South.
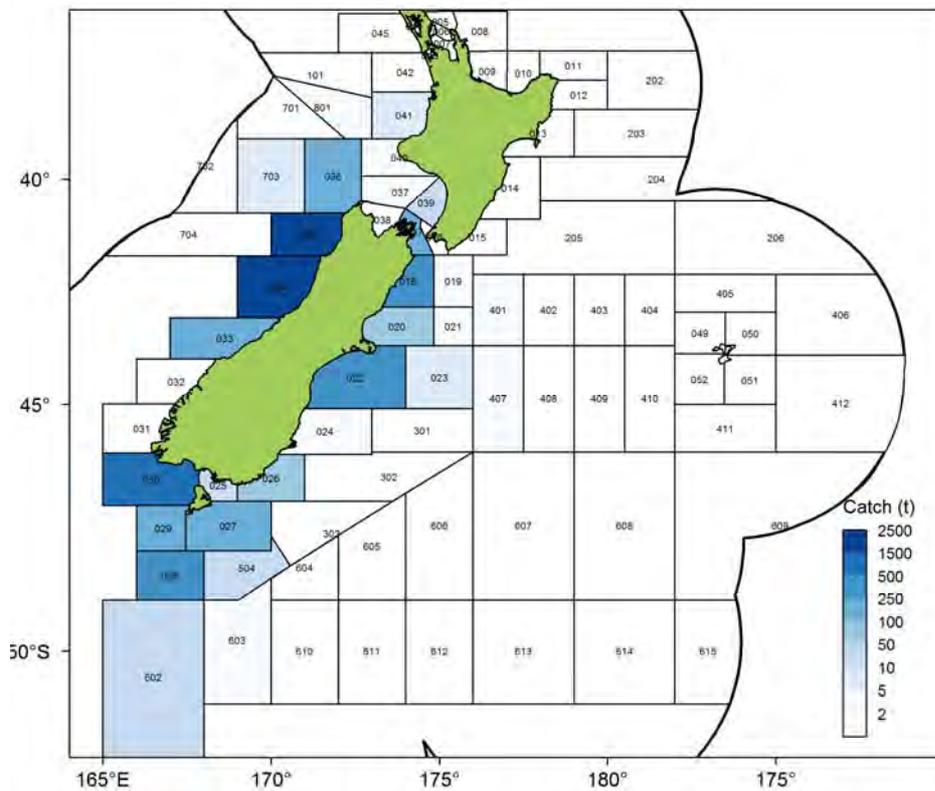
Figure C9c: Total gemfish catch (t) from SKI 3 and SKI 7 commercial gemfish records by Statistical Area for all forms and methods for 1989–90 to 2012–13. The maximum catch was 2241.5 t from Statistical Area 035.
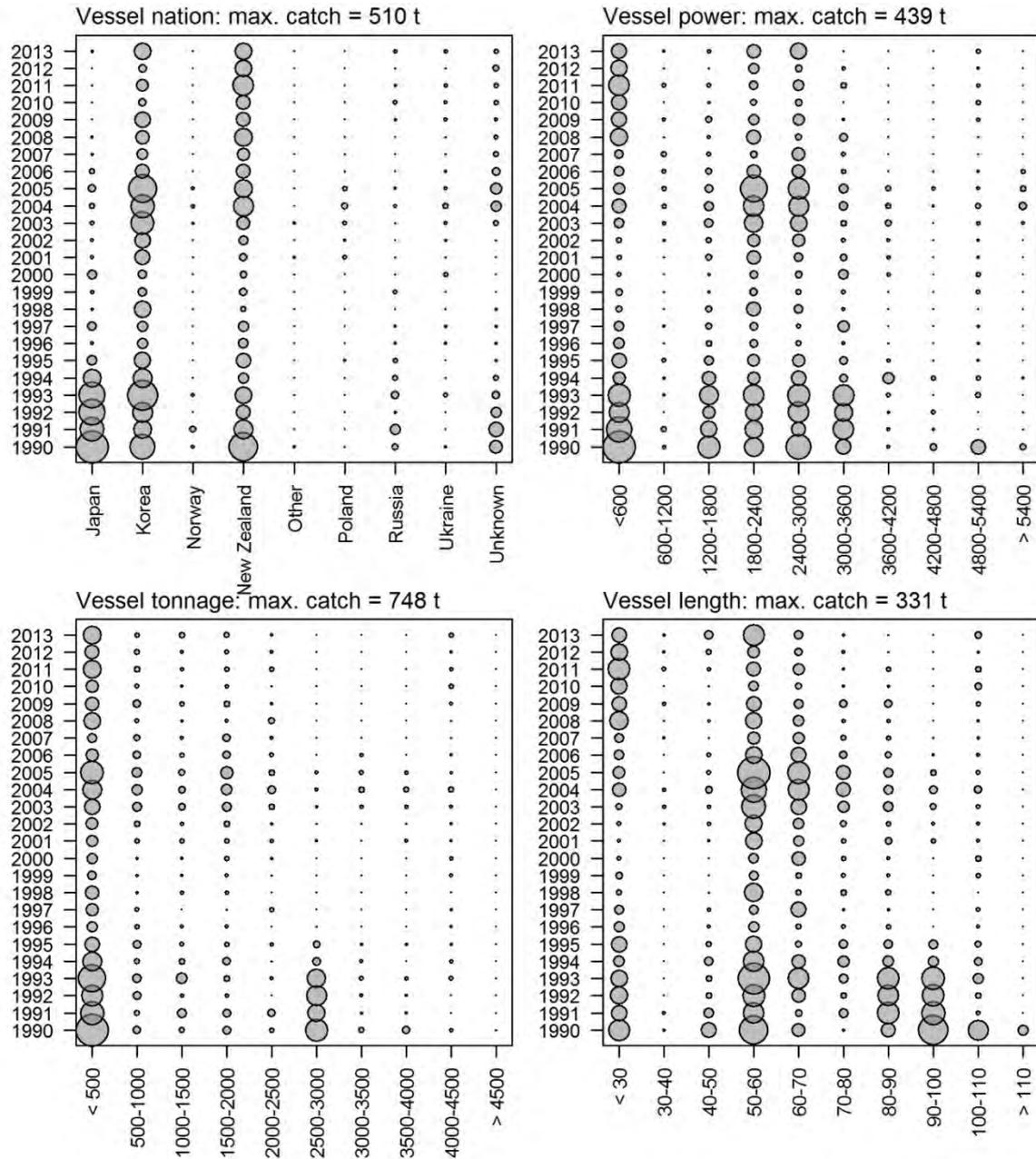
Figure C10: Distribution of annual gemfish catch (t) by vessel nationality, power, tonnage, and length for all merged data by fishing year from 1989–90 (1990) to 2012–13 (2013). Circle size is proportional to catch; maximum circle size is indicated on top left hand corner of each plot.
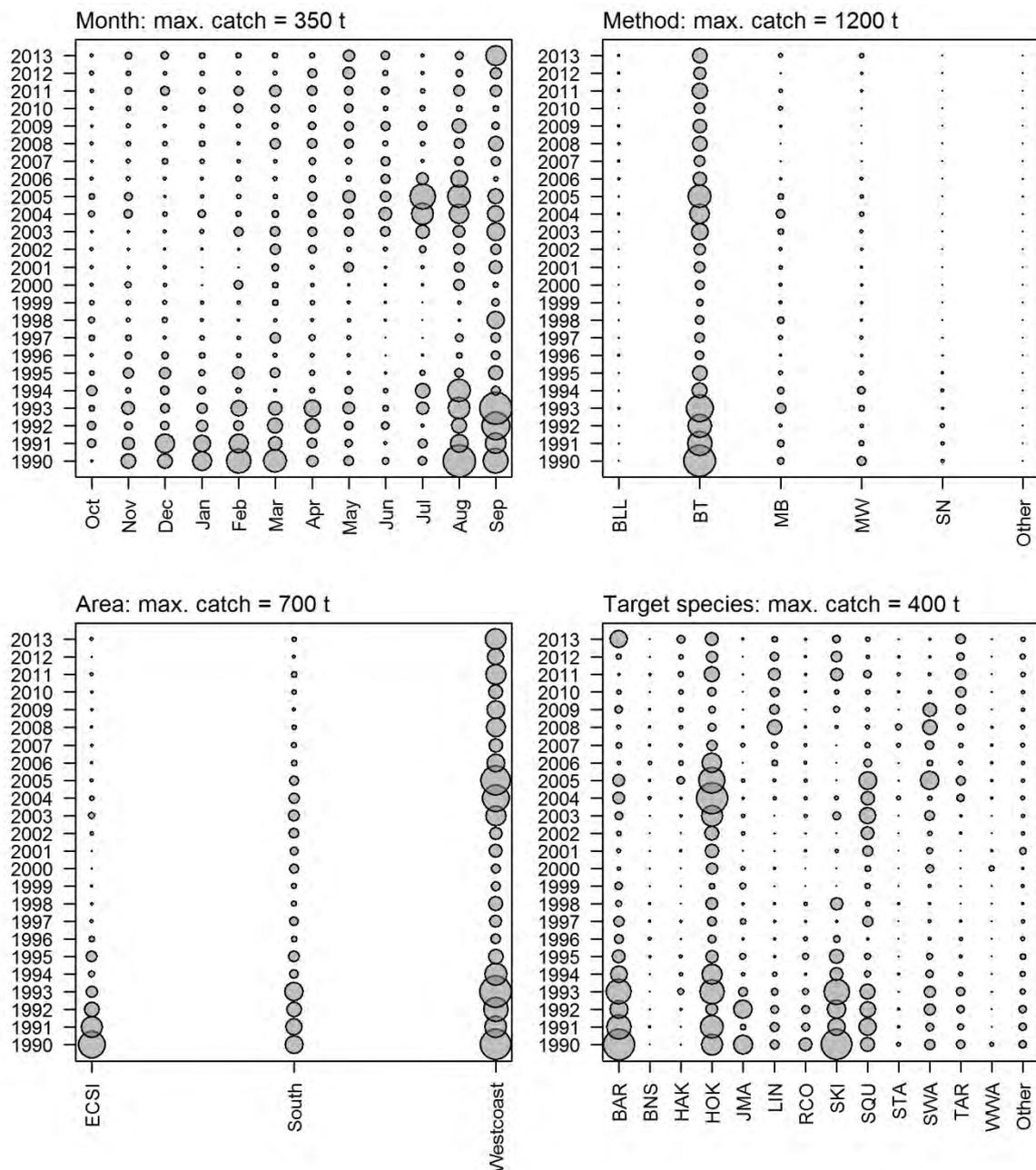
Figure C11: Distribution of SKI 3 and SKI 7 annual catch (t) by month, method, area, and target species for all merged data by fishing year from 1989–90 (1990) to 2012–13 (2013). Circle size is proportional to catch; maximum circle size is indicated on top left hand corner of each plot. BLL is bottom longline; BT is bottom trawl; MB is midwater trawl within 5 m of the seabed; MW is midwater trawl; and SN is setnet. Areas are shown in Figure 1. Target species codes are defined in Table C12.
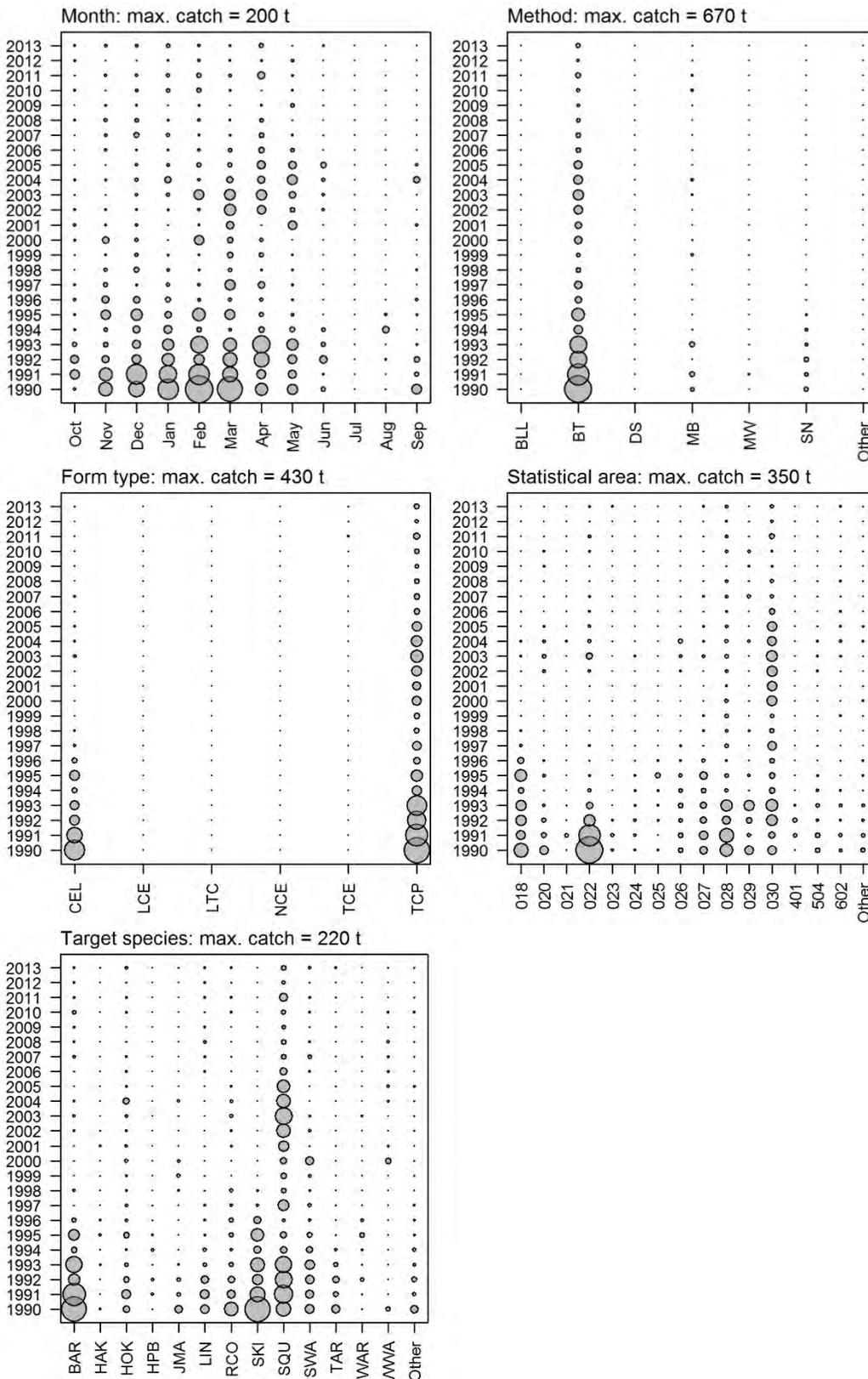
Figure C12a: Distribution of annual catch (t) by month, statistical area, method, and target species for SKI 3 merged data. Circle size is proportional to catch; maximum circle size is indicated on the top left hand corner of each plot. Statistical areas are shown in Figure 1. Form types are CEL for CELR, LCE for LCER, LTC for LTCER, NCE for NCER, TCE for TCER, and TCP for TCEPR as defined in Section 6.1. Fishing methods are defined in Figure C11. Target species codes are given in Table C12.
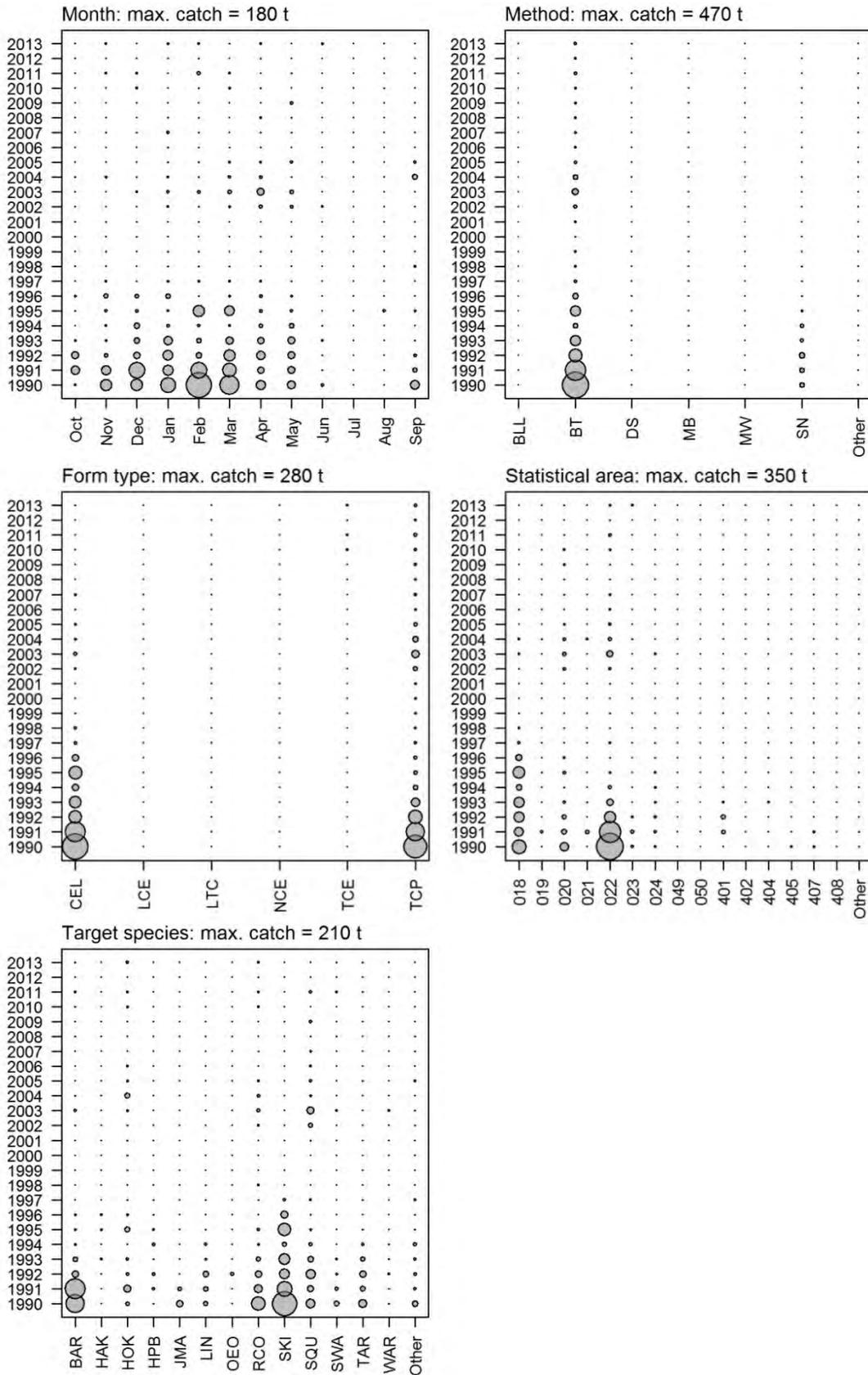
Figure C12b: Distribution of annual catch (t) by month, statistical area, method, and target species for SKI 3 merged data for the Chatham fishery area. Circle size is proportional to catch; maximum circle size is indicated on the top left hand corner of each plot. Form types are defined in Figure C12a. Fishing methods are defined in Figure C11. Target species codes are given in Table C12.
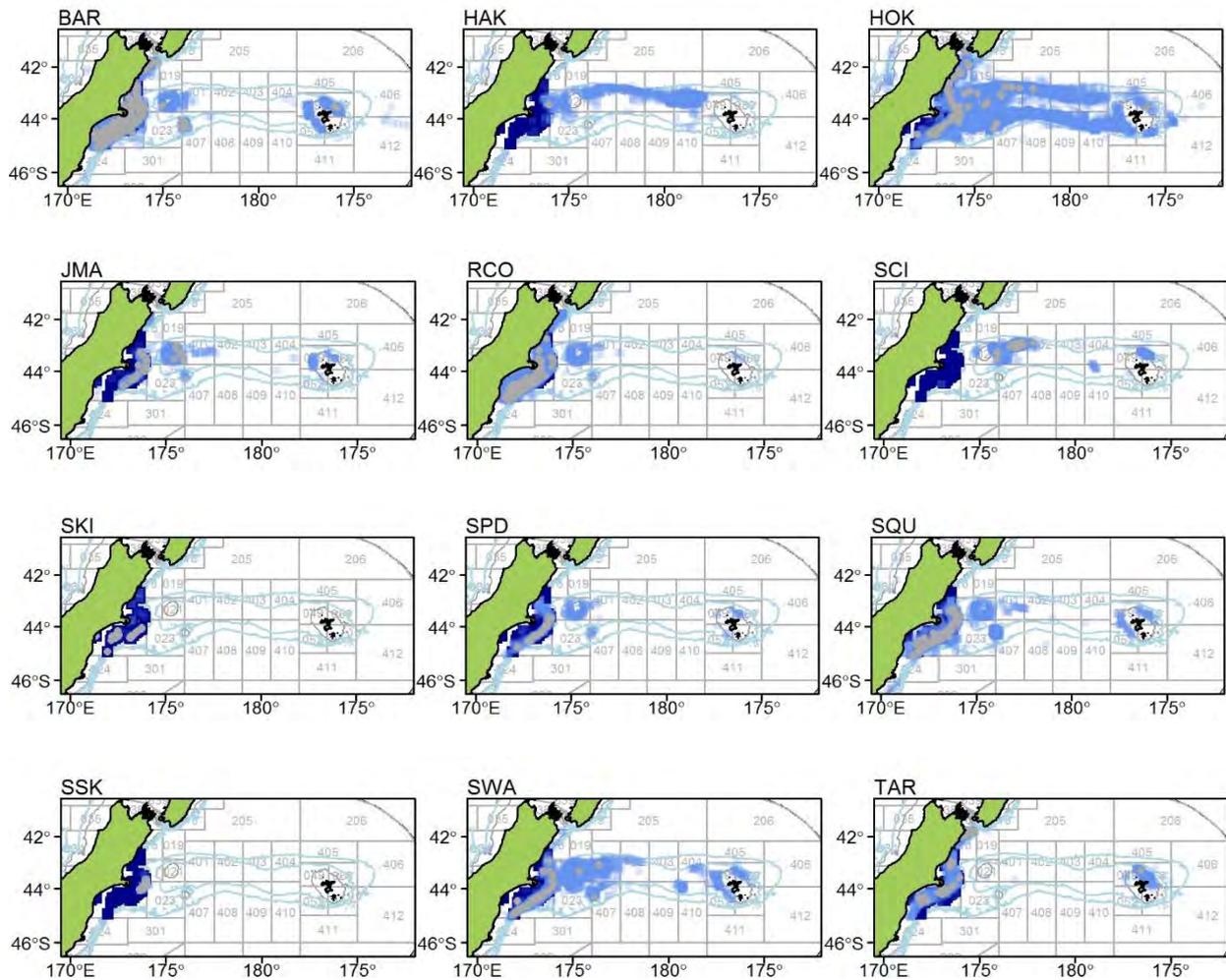
Figure C13a: Distribution of TCEPR effort for gemfish (■), for the main target species (■), and for the main target species where gemfish was caught (●), for the SKI 3 Chatham fishery, 1989–90 to 2012–13. Target species codes are defined in Table C12.
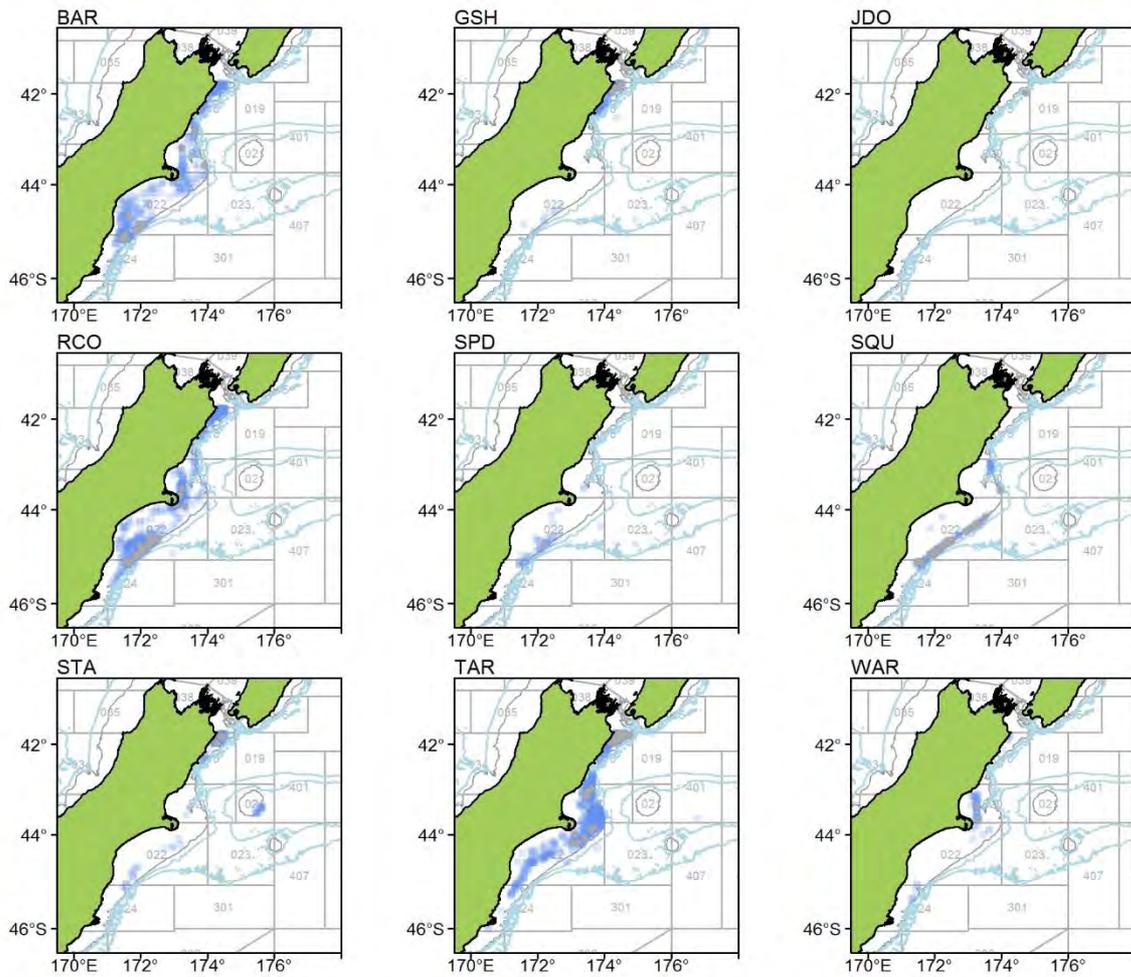
Figure C13b: Distribution of TCER effort for gemfish (■), for the main target species (■), and for the main target species where gemfish was caught (●), for the SKI 3 Chatham fishery area off the east coast of the South Island, 2007–08 to 2012–13 combined. Note all TCER effort was west of 178° E. Target species codes are defined in Table C12.
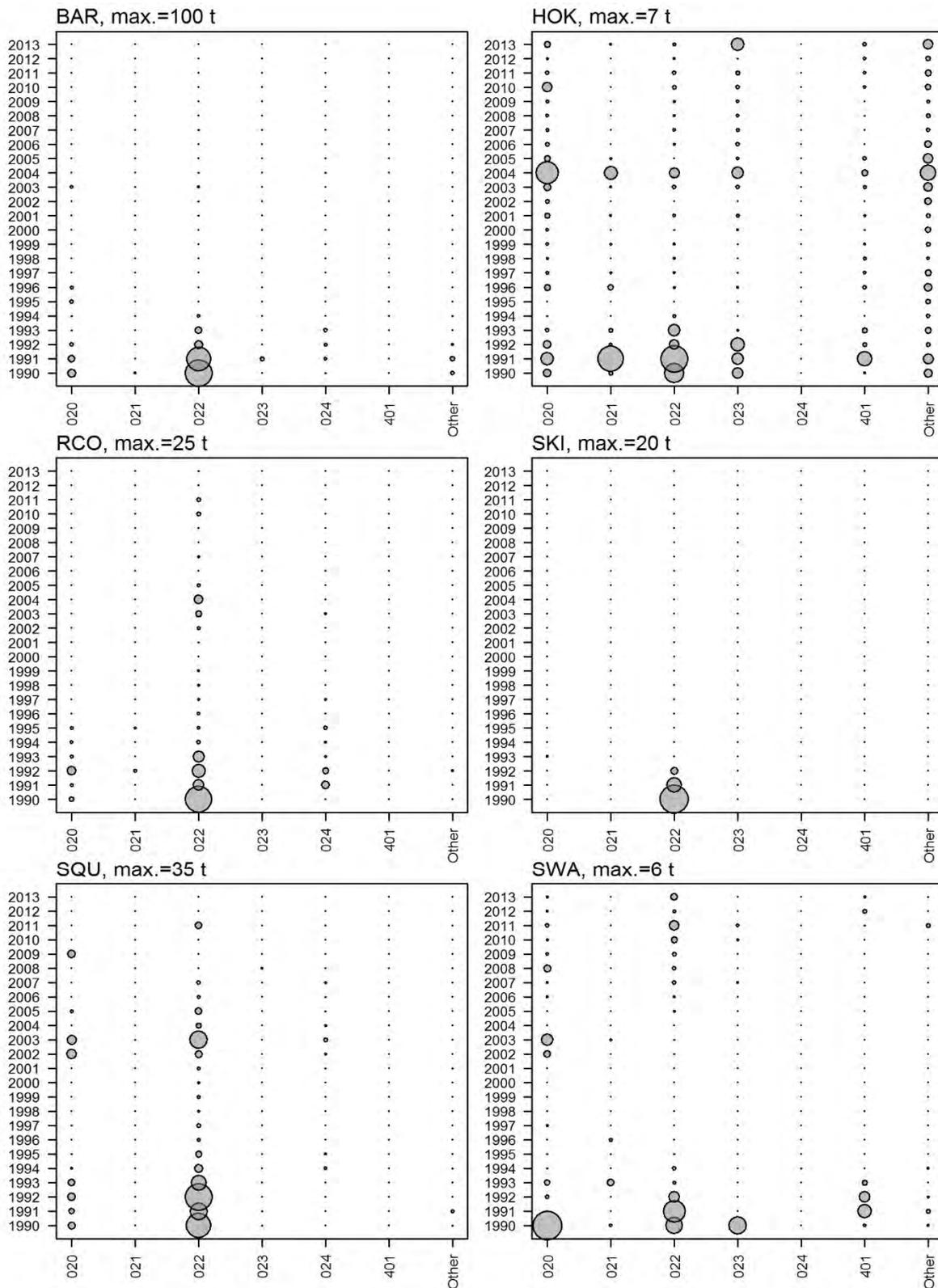
Figure C14a: Distribution of annual catch (t) from the Chatham fishery by Statistical Area and fishing year for the main bottom trawl target species reported on TCEPRs. Circle size is proportional to the catch for each species stratum; maximum circle size is indicated on the top left hand corner of each plot.
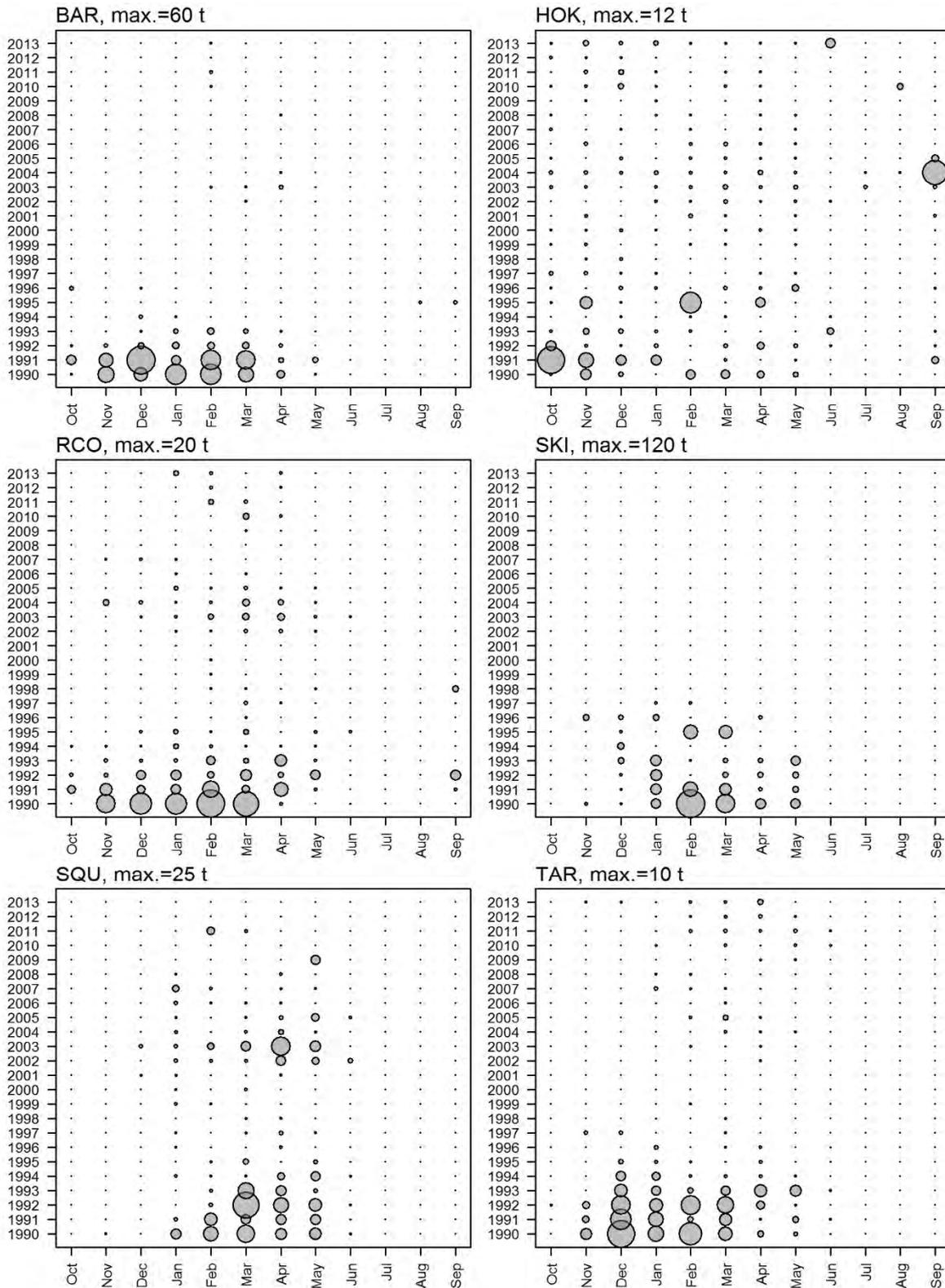
Figure C14b: Distribution of annual catch (t) from Chatham fishery by month and fishing year for the main bottom trawl target species reported on TCEPRs. Circle size is proportional to the catch for each species stratum; maximum circle size is indicated on the top left hand corner of each plot.
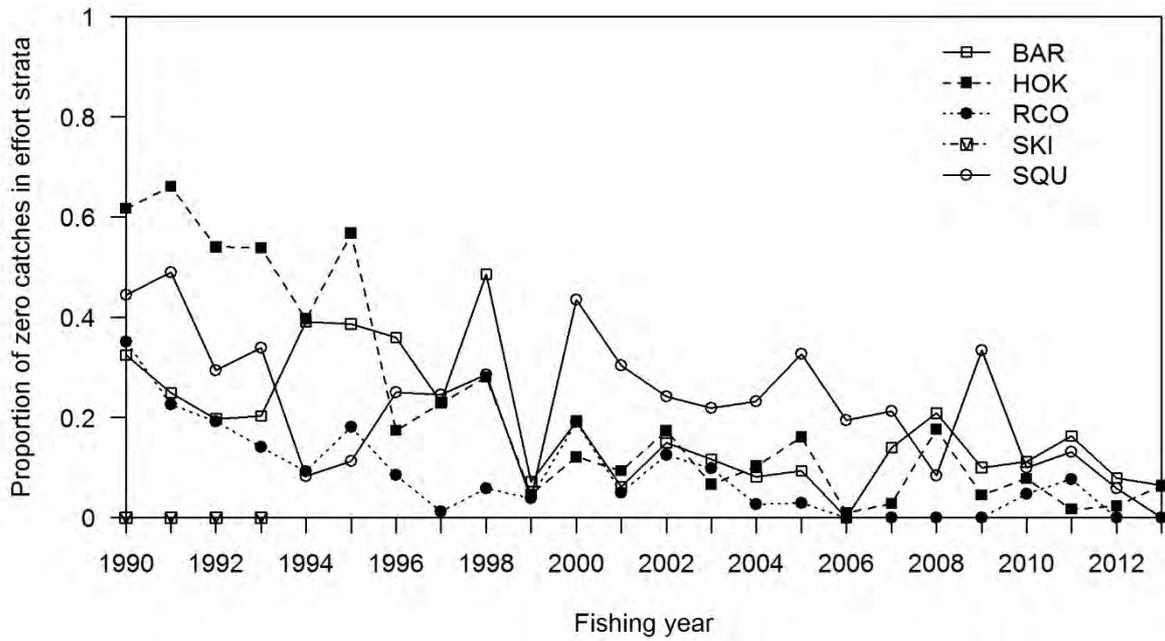
Figure C15: Proportion of zeros by main target species for the Chatham subarea of SKI 3 for TCEPR bottom trawl merged data.
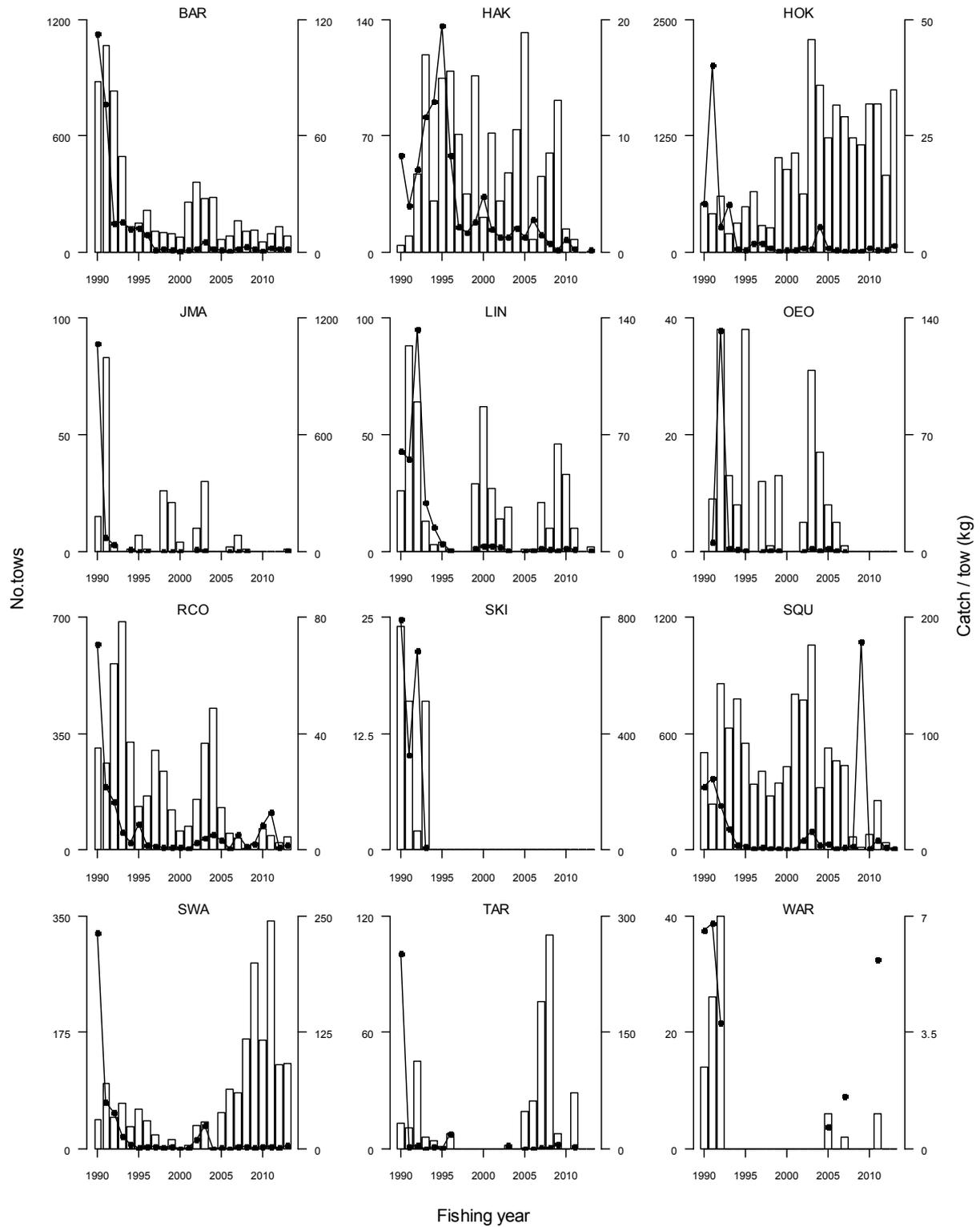
Figure C16: Unstandardised catch rate (kg.tow^{-1}) of gemfish taken by bottom trawl gear (points and lines) and the number of tows (bars) for the Chatham fishery where data were reported on TCEPRs, by target species for 1989–90 (1990) to 2012–13 (2013). Target species codes are given in Table C12.
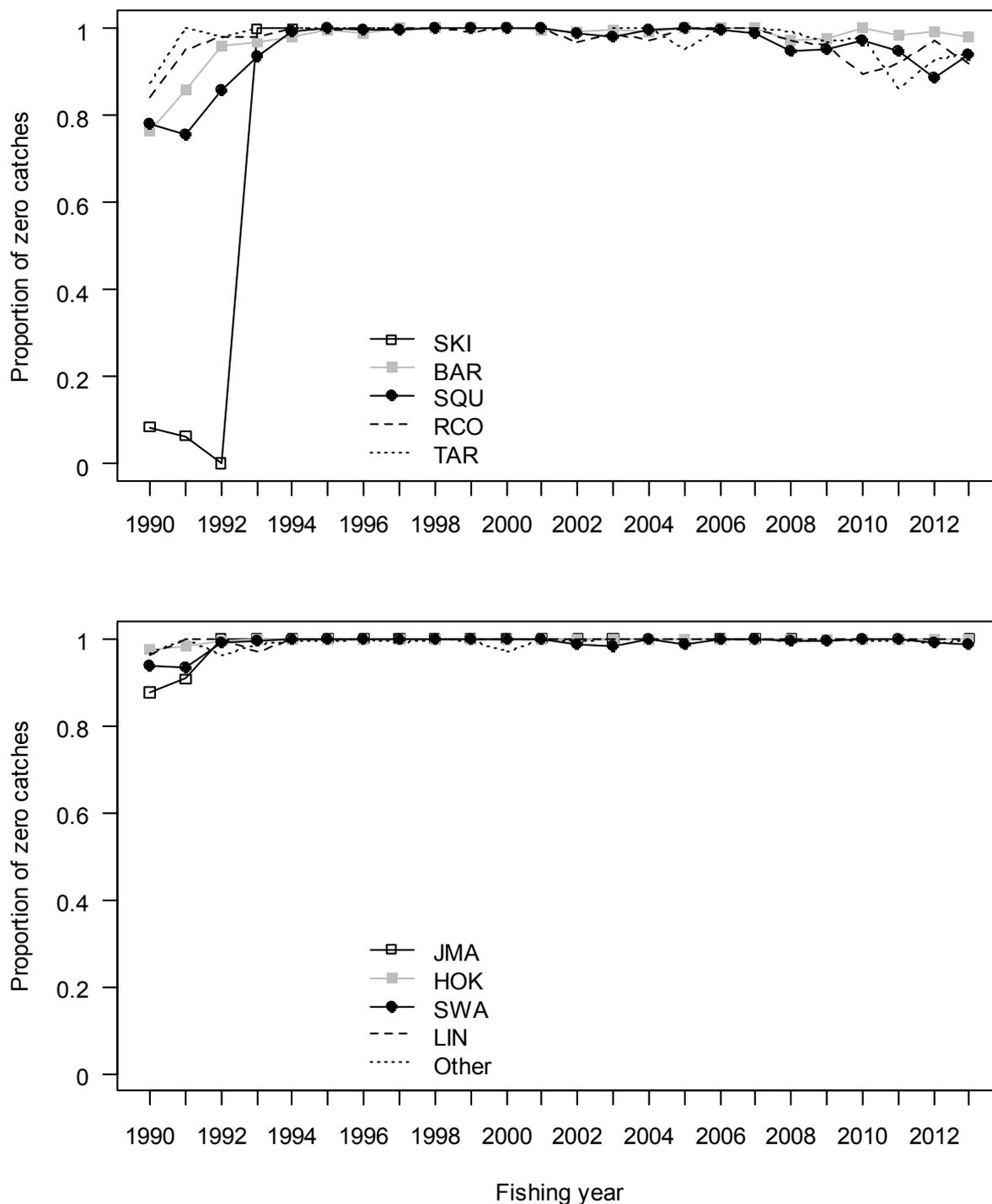
Figure C17: Proportion of zero tows for Chatham BT tows reported on TCERs and TCEPRs, 1989–90 (1990) to 2012–13 (2013), for the main target species. Target species codes are defined in Table C12.
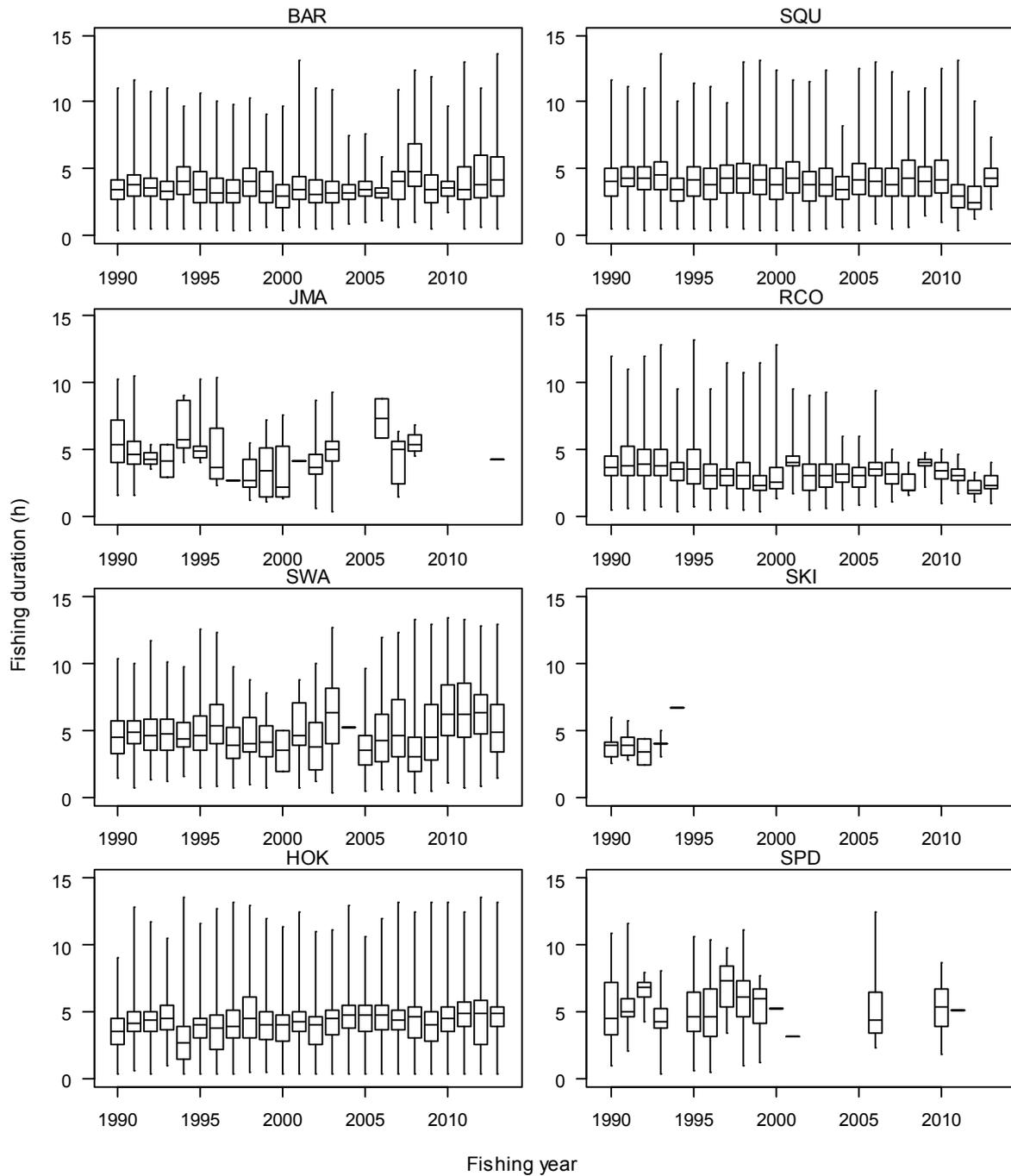
Figure C18a: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) of TCEPR bottom trawl tow durations reported for major target species fisheries catching gemfish in the Chatham fishery area, based on the groomed unmerged data. Target species codes are given in Table C12.
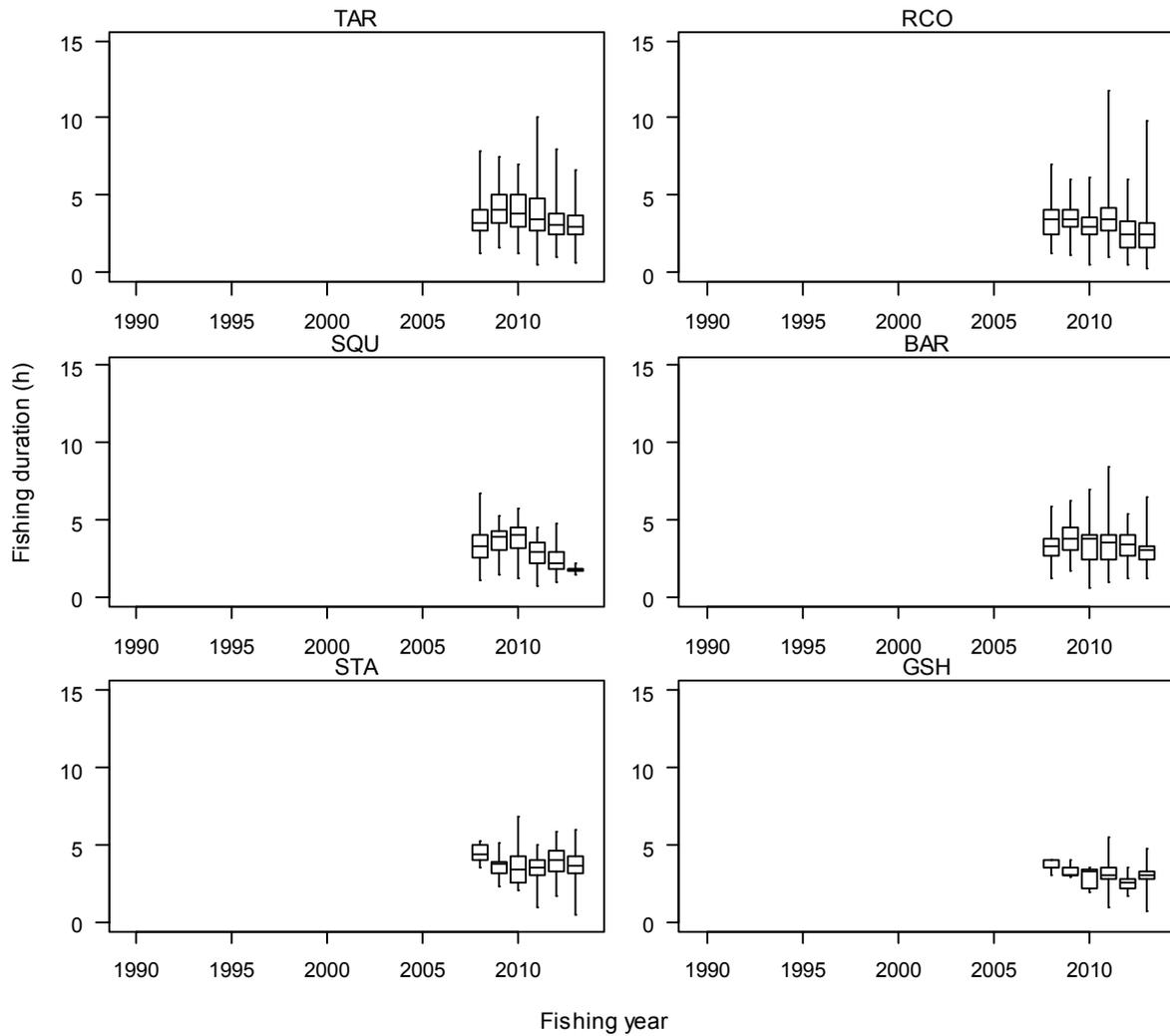
Figure C18b: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) of TCER bottom trawl tow durations reported for major target species fisheries catching gemfish in the Chatham fishery area, based on the groomed unmerged data. Target species codes are defined in Table C12.
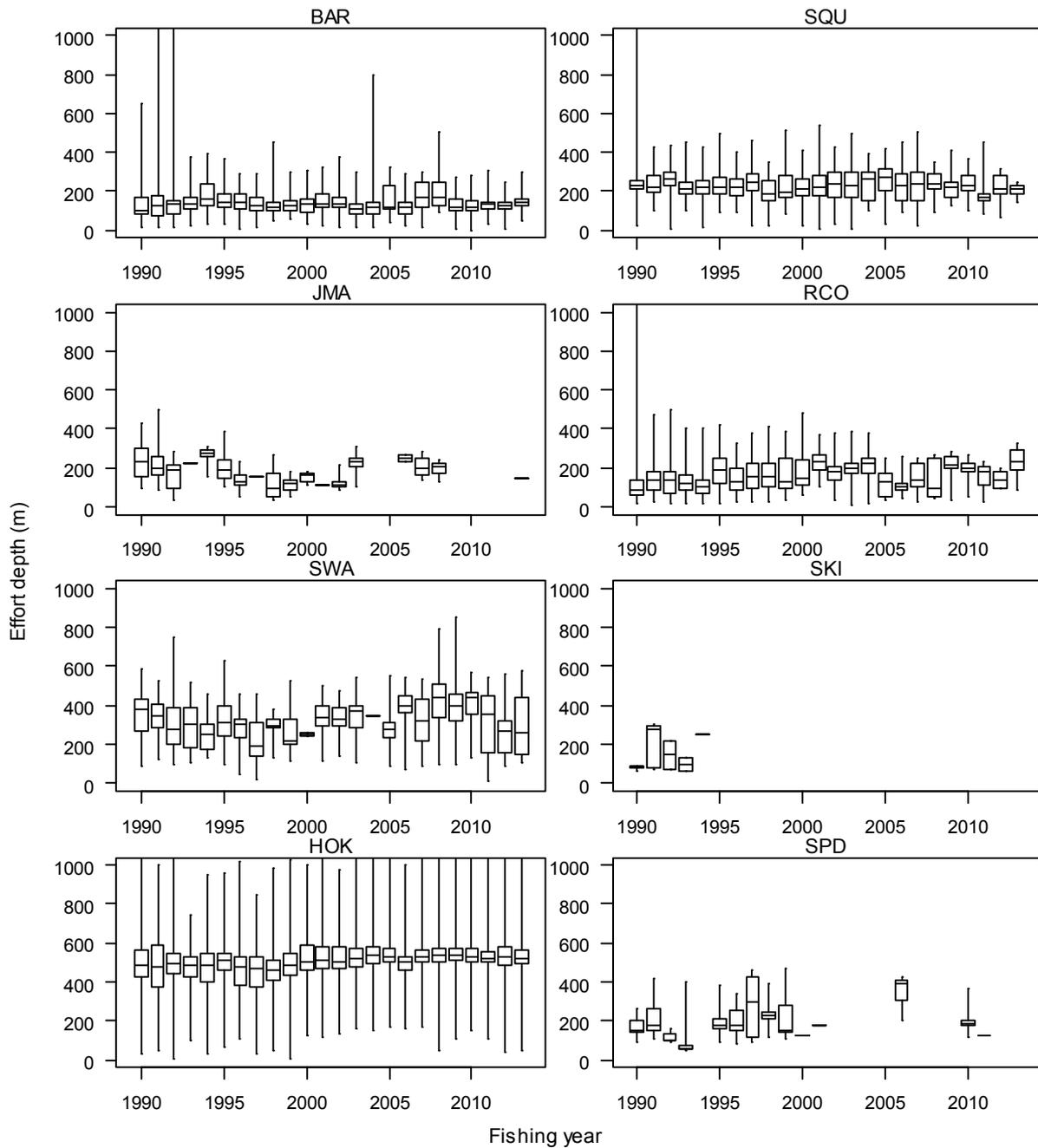
Figure C19a: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) of TCEPR bottom trawl effort depth data reported for major target species fisheries catching gemfish in the Chatham fishery area, based on the groomed unmerged data. Target species codes are defined in Table C12.
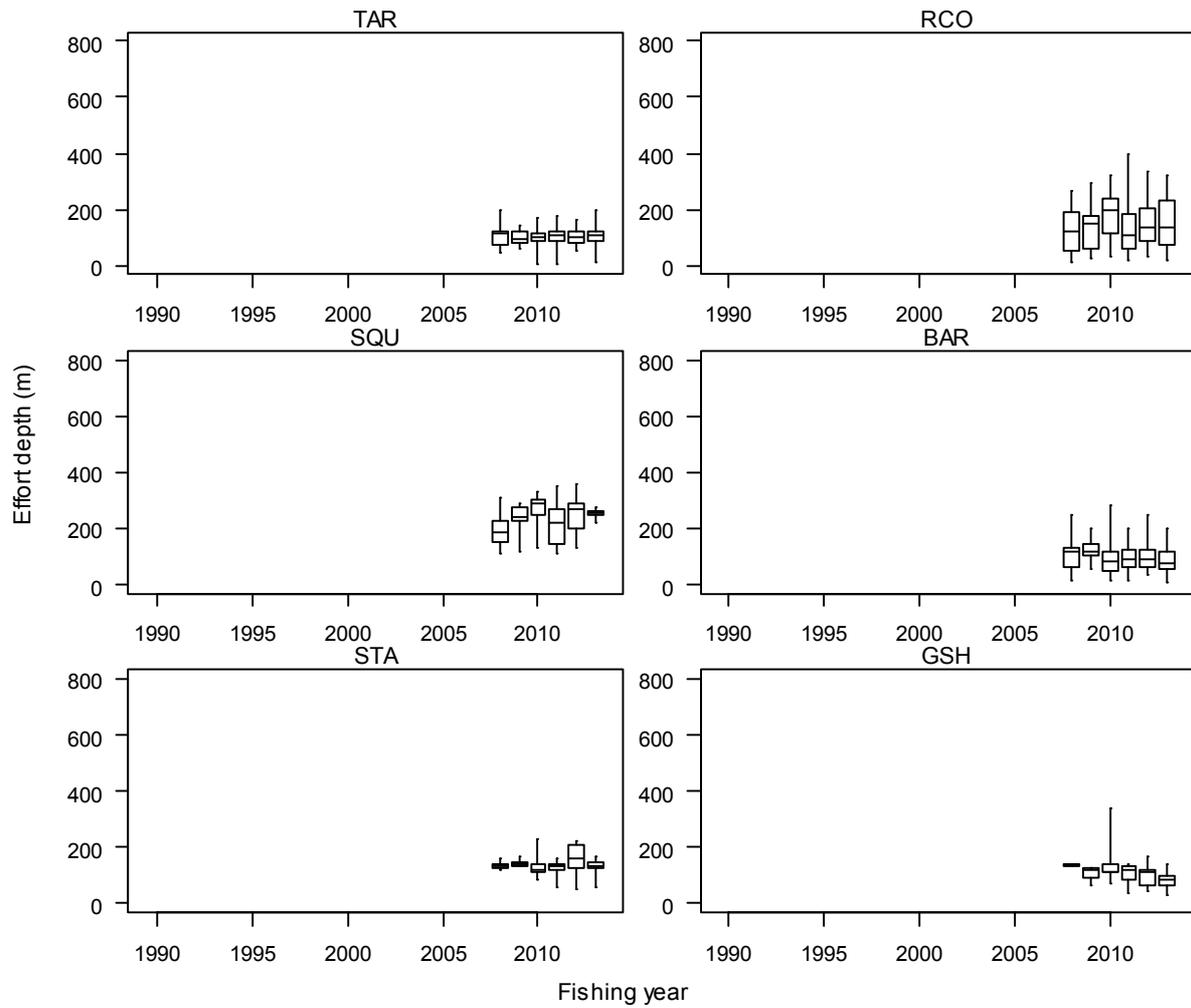
Figure C19b: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) of TCER bottom trawl effort depth data reported for major target species fisheries catching gemfish in the Chatham fishery area, based on the groomed unmerged data. Target species codes are defined in Table C12.
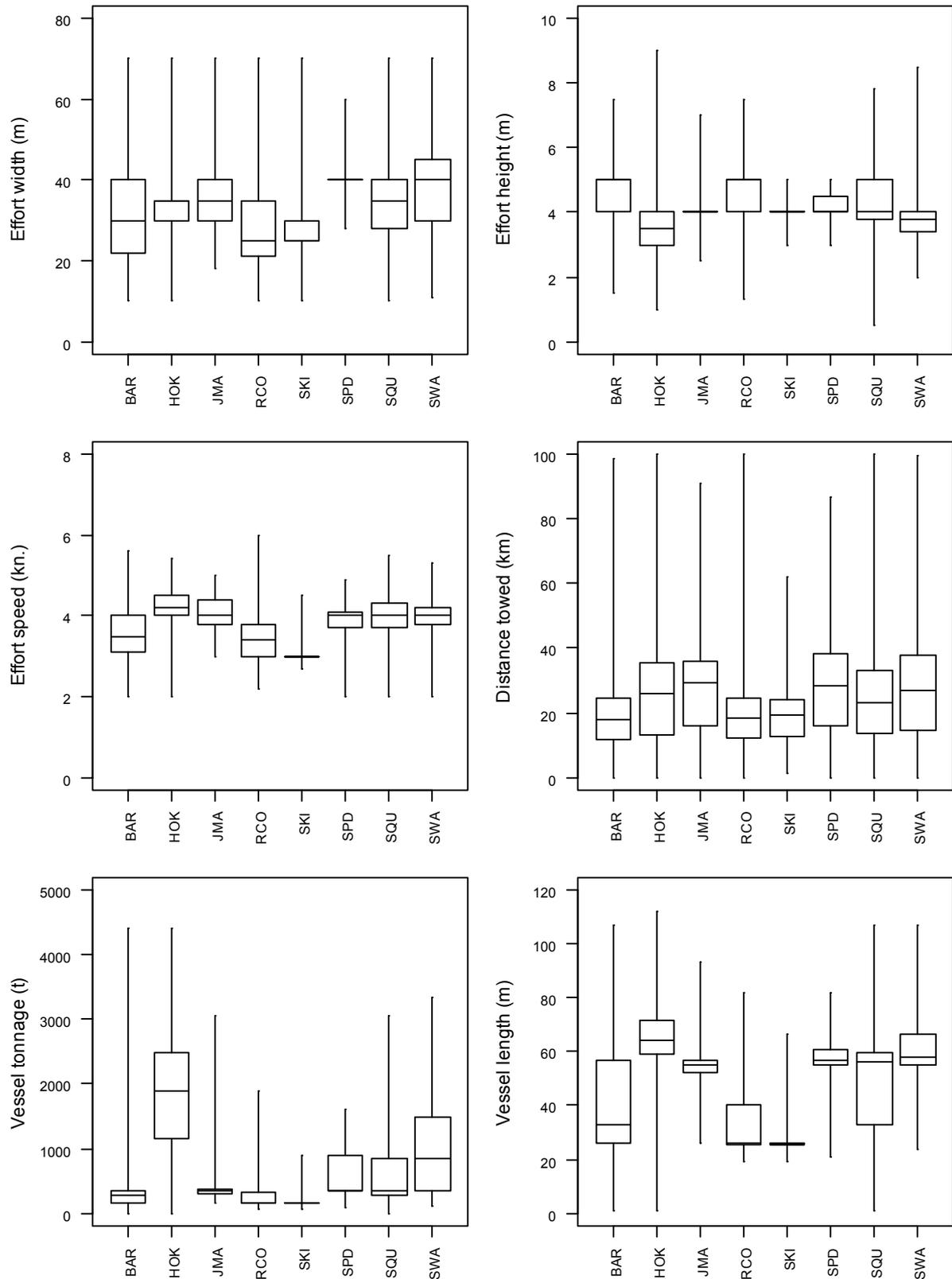
Figure C20a: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) for fishing effort variables and vessel characteristics for the main target species fisheries that caught gemfish and reported effort on TCEPRs in the Chatham fishery area, 1989–90 to 2012–13. Target species codes are defined in Table C12.
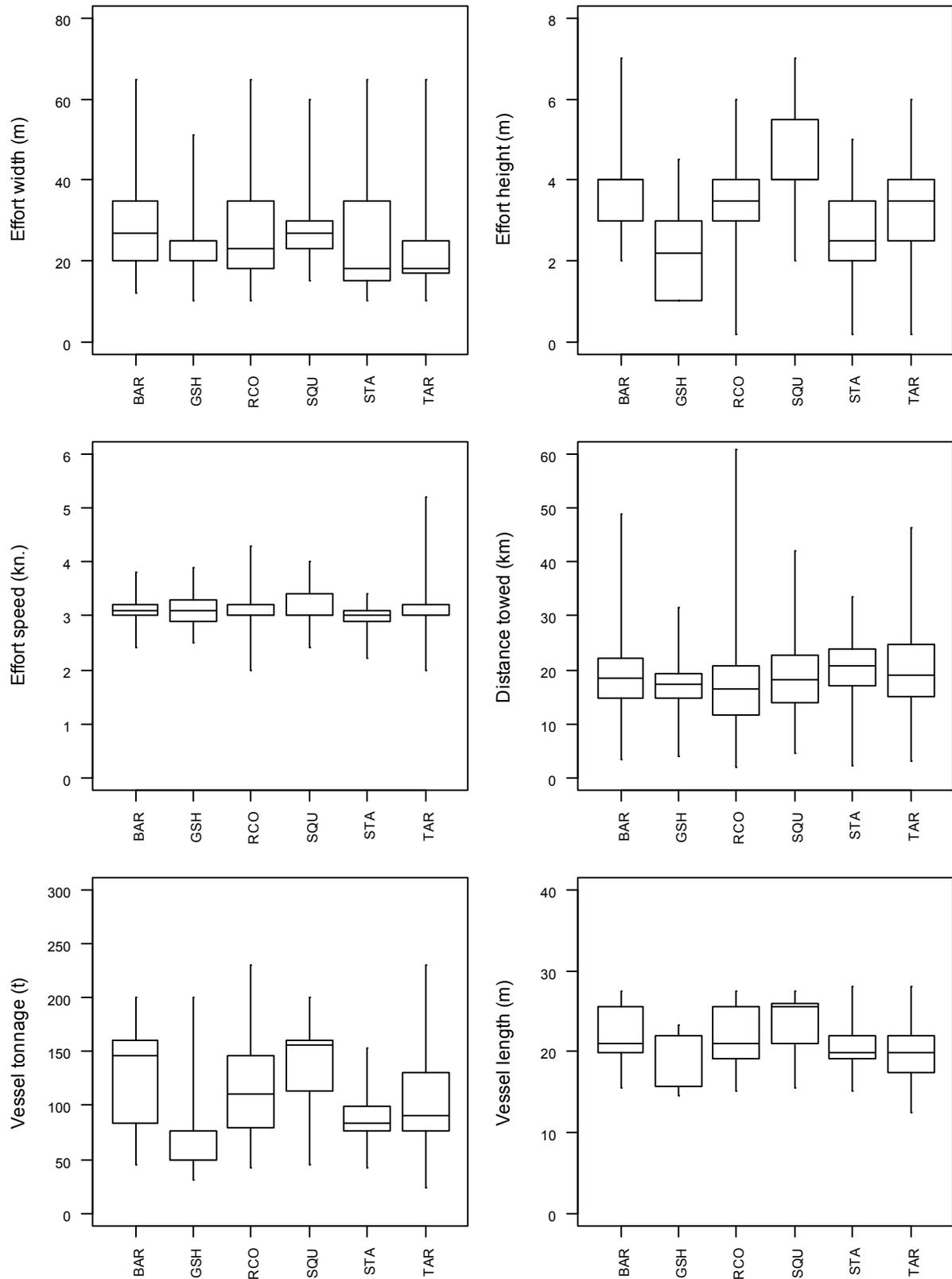
**Figure C20b: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) for fishing effort variables and vessel characteristics for the main target species fisheries that caught gemfish and reported effort on TCERs in the Chatham fishery area, 2007–08 to 2012–13. Target species codes are defined in Table C12.**
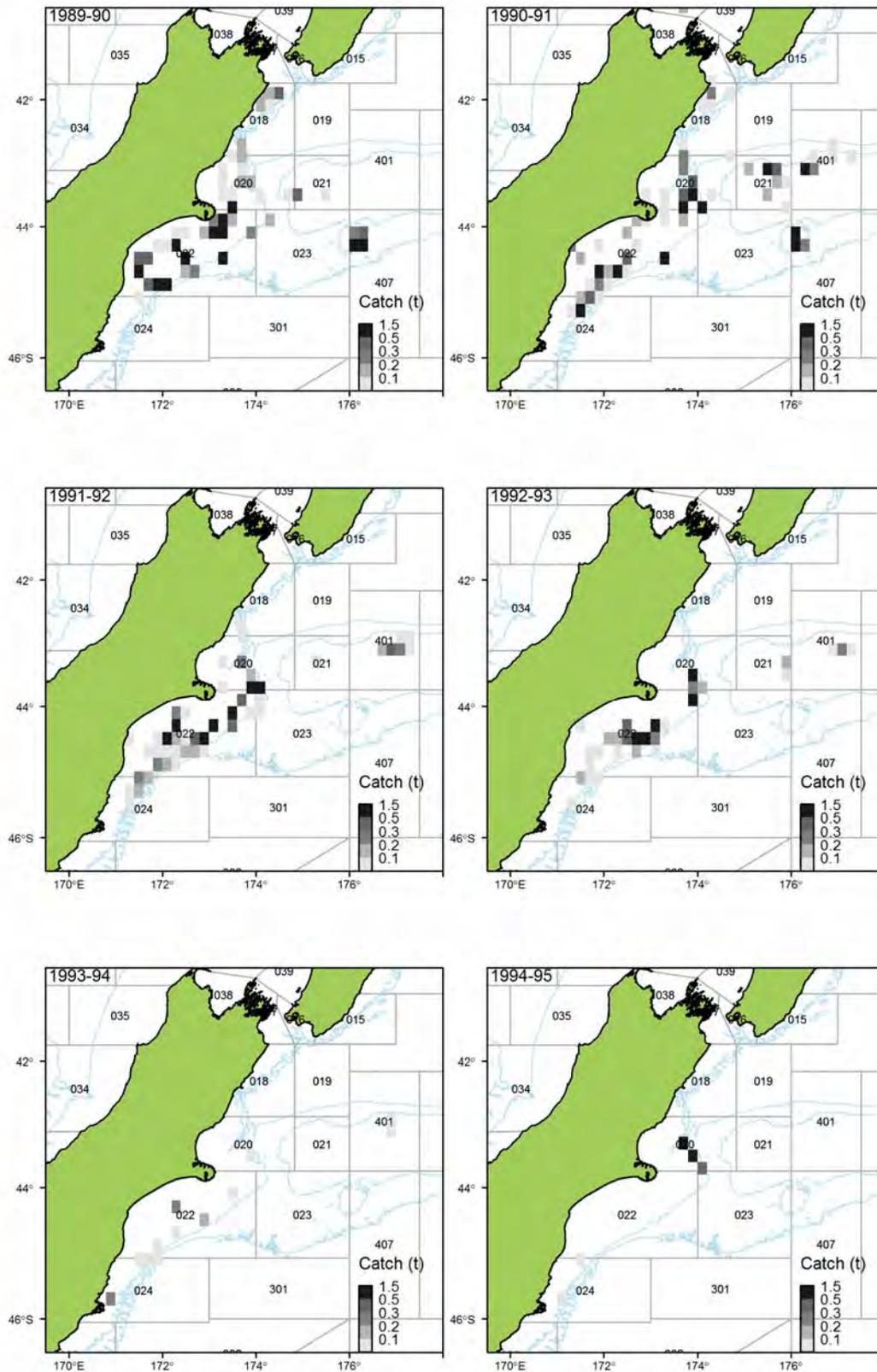
Figure C21: Distribution of TCEPR bottom trawl gemfish catch aggregated into 0.2° cells within the main Chatham fishery area, west of 178° E, 1989–90 to 1994–95. Blue lines show the 500 m and 1000 m depth contours.
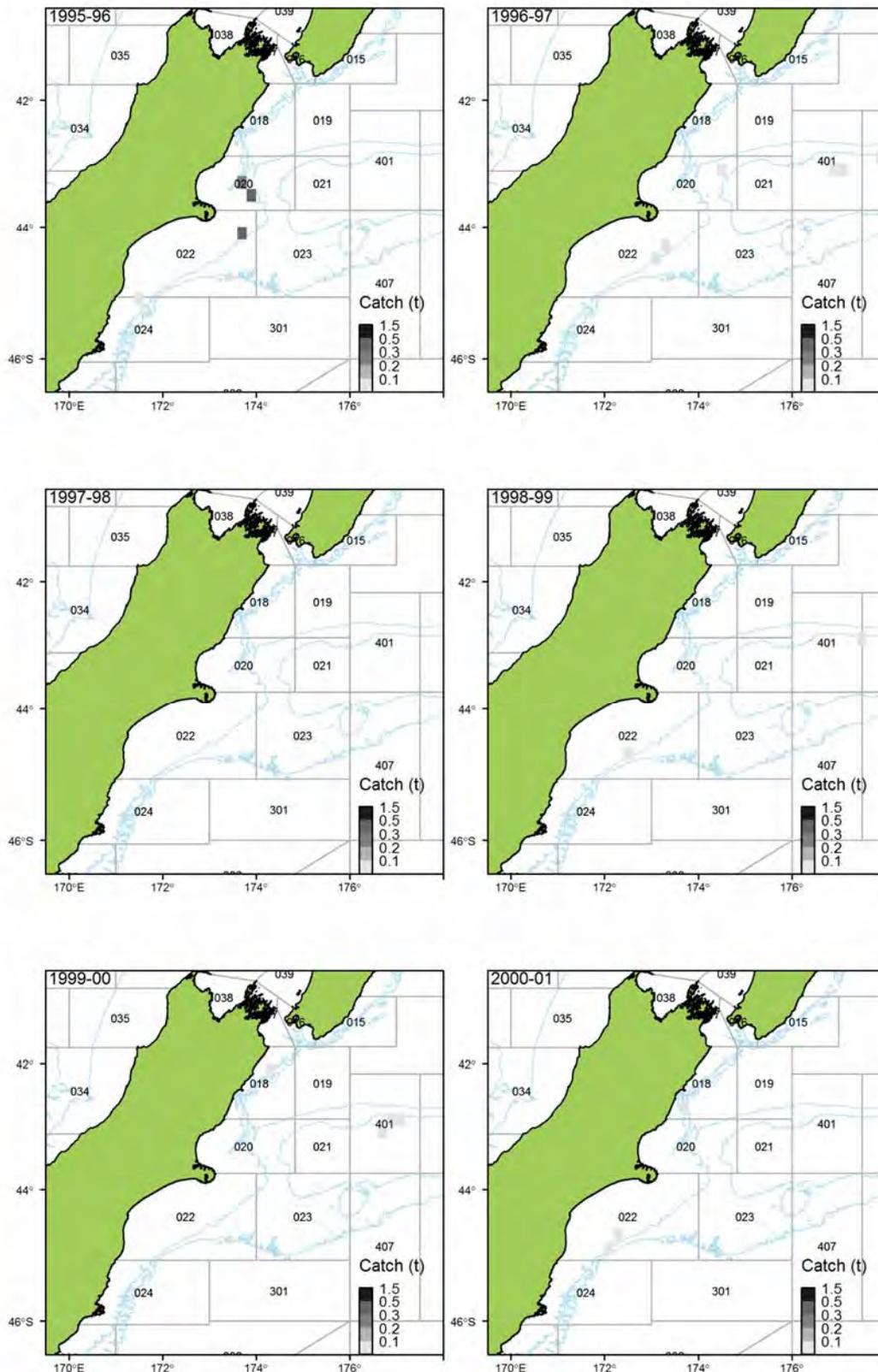
Figure C21 *continued*: **Distribution of TCEPR bottom trawl gemfish catch aggregated into 0.2° cells within the main Chatham fishery area, west of 178° E, 1995–96 to 2000–01. Blue lines show the 500 m and 1000 m depth contours.**
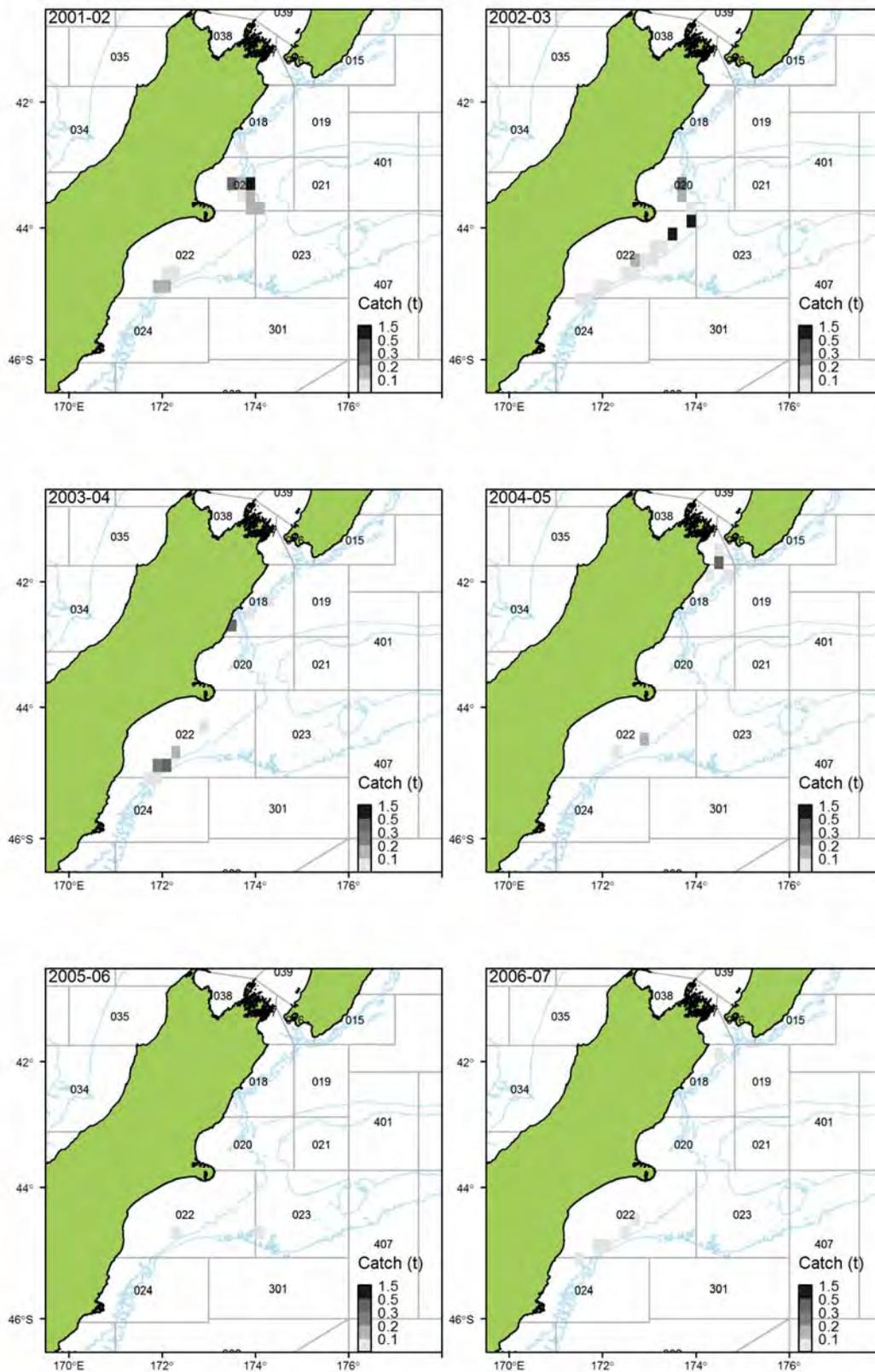
Figure C21 *continued*: **Distribution of TCEPR bottom trawl gemfish catch aggregated into 0.2° cells within the main Chatham fishery area, west of 178° E, 2001–02 to 2006–07. Blue lines show the 500 m and 1000 m depth contours.**
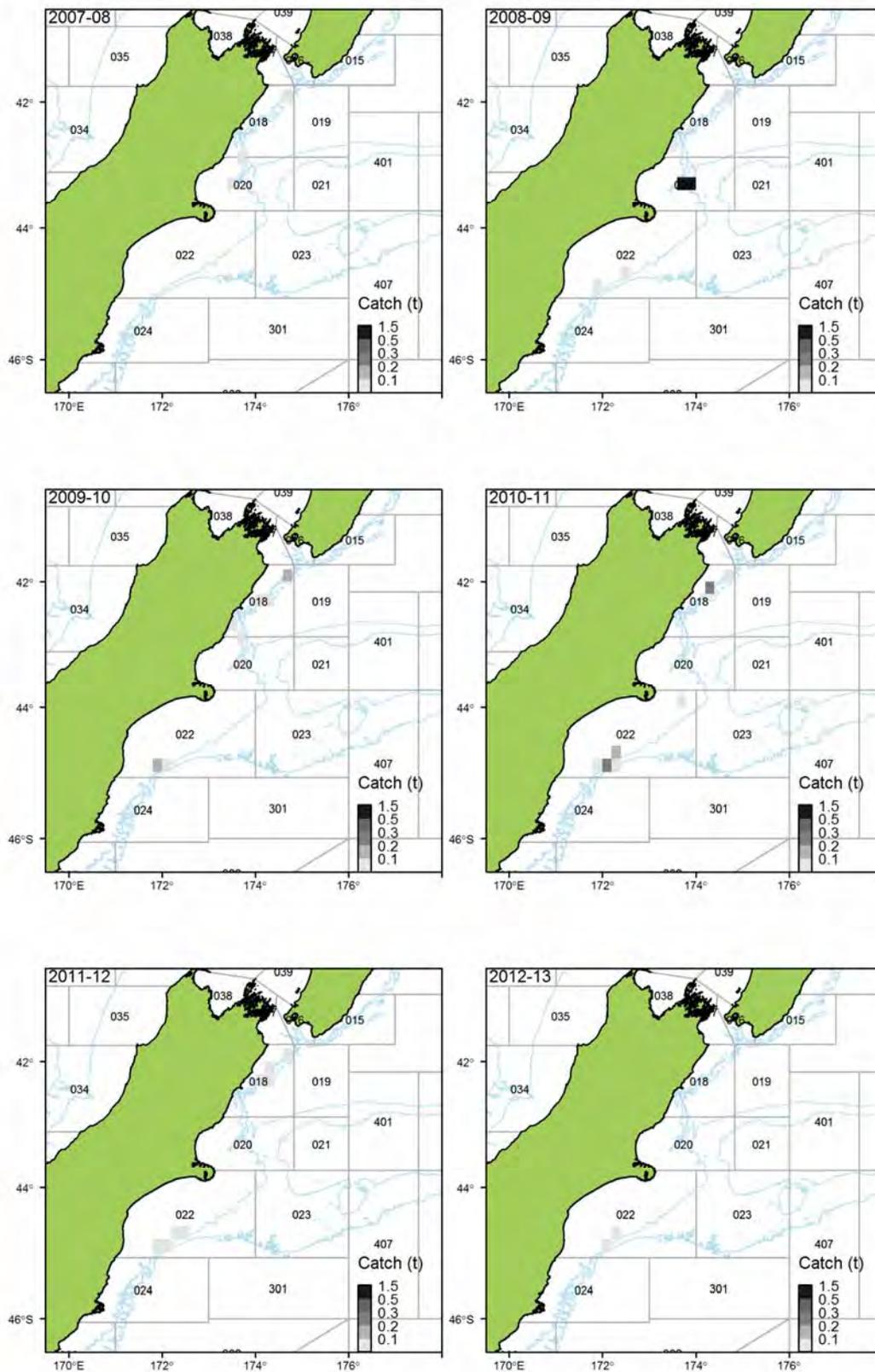
Figure C21 *continued*: **Distribution of TCEPR bottom trawl gemfish catch aggregated into 0.2° cells within the main Chatham fishery area, west of 178° E, 2007–08 to 2012–13. Blue lines show the 500 m and 1000 m depth contours.**
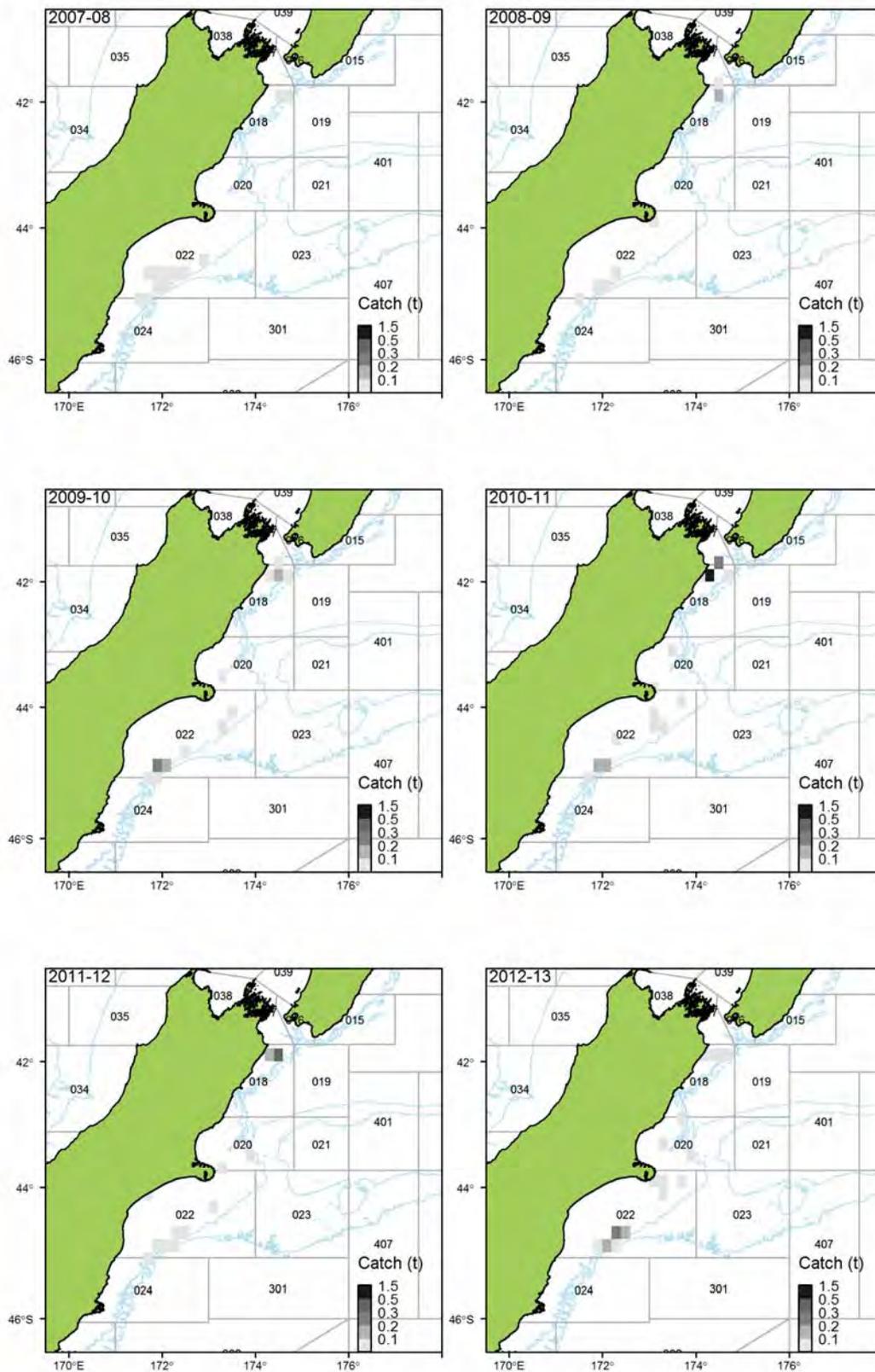
Figure C21 *continued*: **Distribution of TCER bottom trawl gemfish catch aggregated into 0.2° cells within the main Chatham fishery area, west of 178° E, 2007–08 to 2012–13. Blue lines show the 500 m and 1000 m depth contours.**
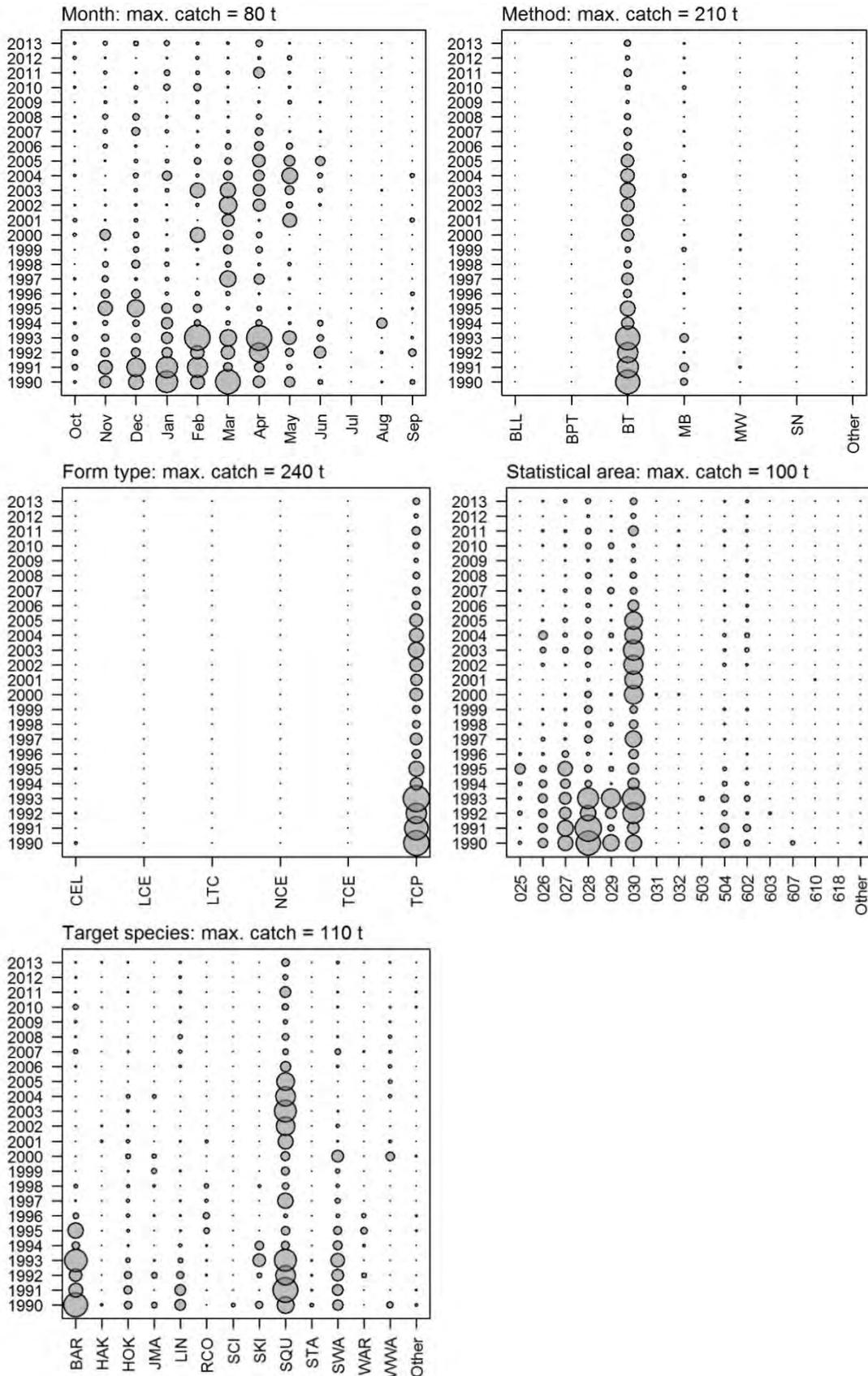
Figure C22: Distribution of annual catch (t) by month, statistical area, method, and target species for SKI 3 merged data for the South fishery area. Circle size is proportional to catch; maximum circle size is indicated on the top left hand corner of each plot. Form types are defined in Figure C12a. Fishing methods are defined in Figure C11. Target species codes are given in Table C12.
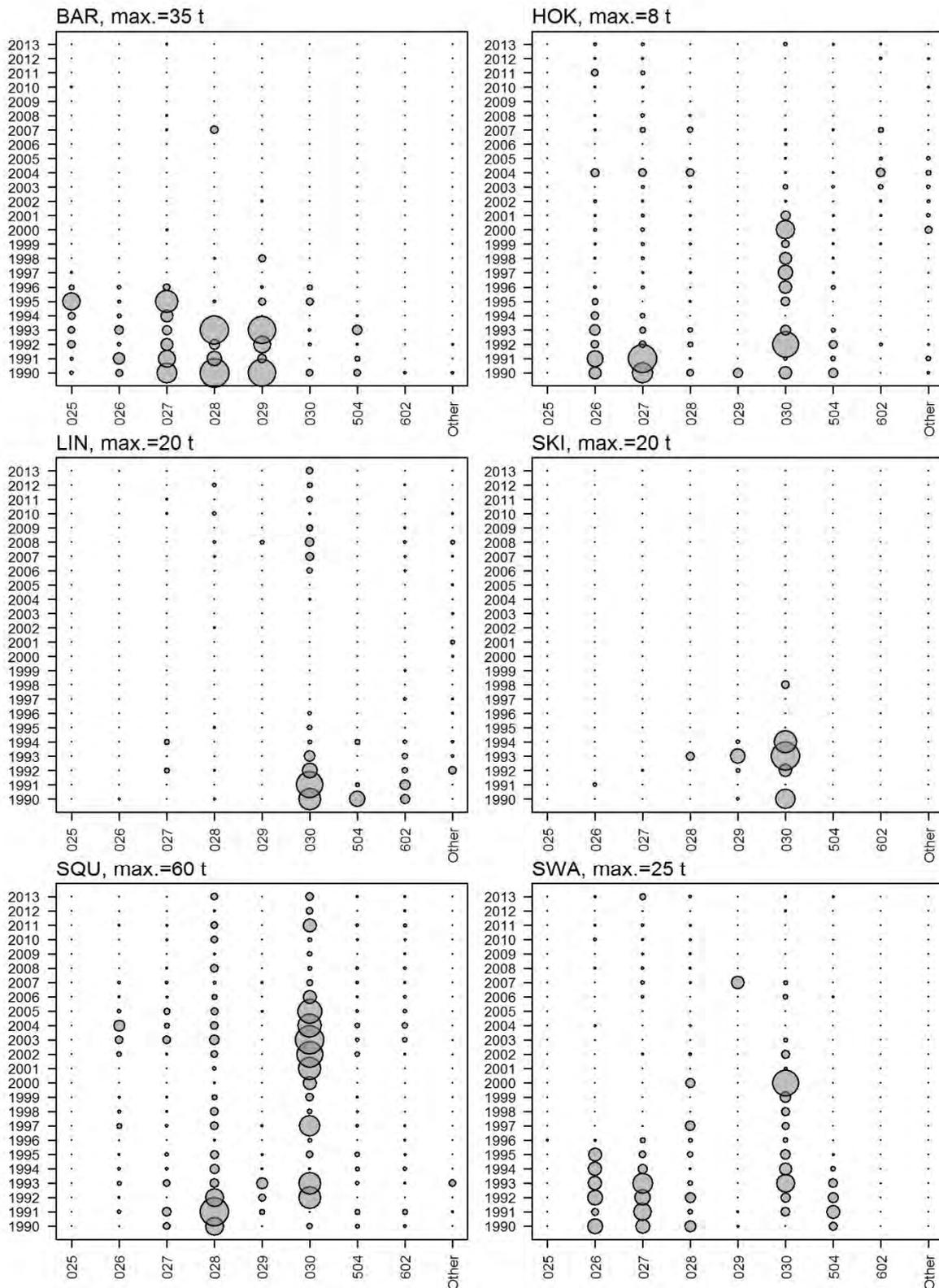
Figure C23a: Distribution of annual catch (t) from the SKI 3 South fishery by Statistical Area and fishing year for the main bottom trawl target species reported on TCEPRs and TCERs. Circle size is proportional to the catch for each species stratum; maximum circle size is indicated on the top left hand corner of each plot. Statistical Areas are shown on Figure 1.
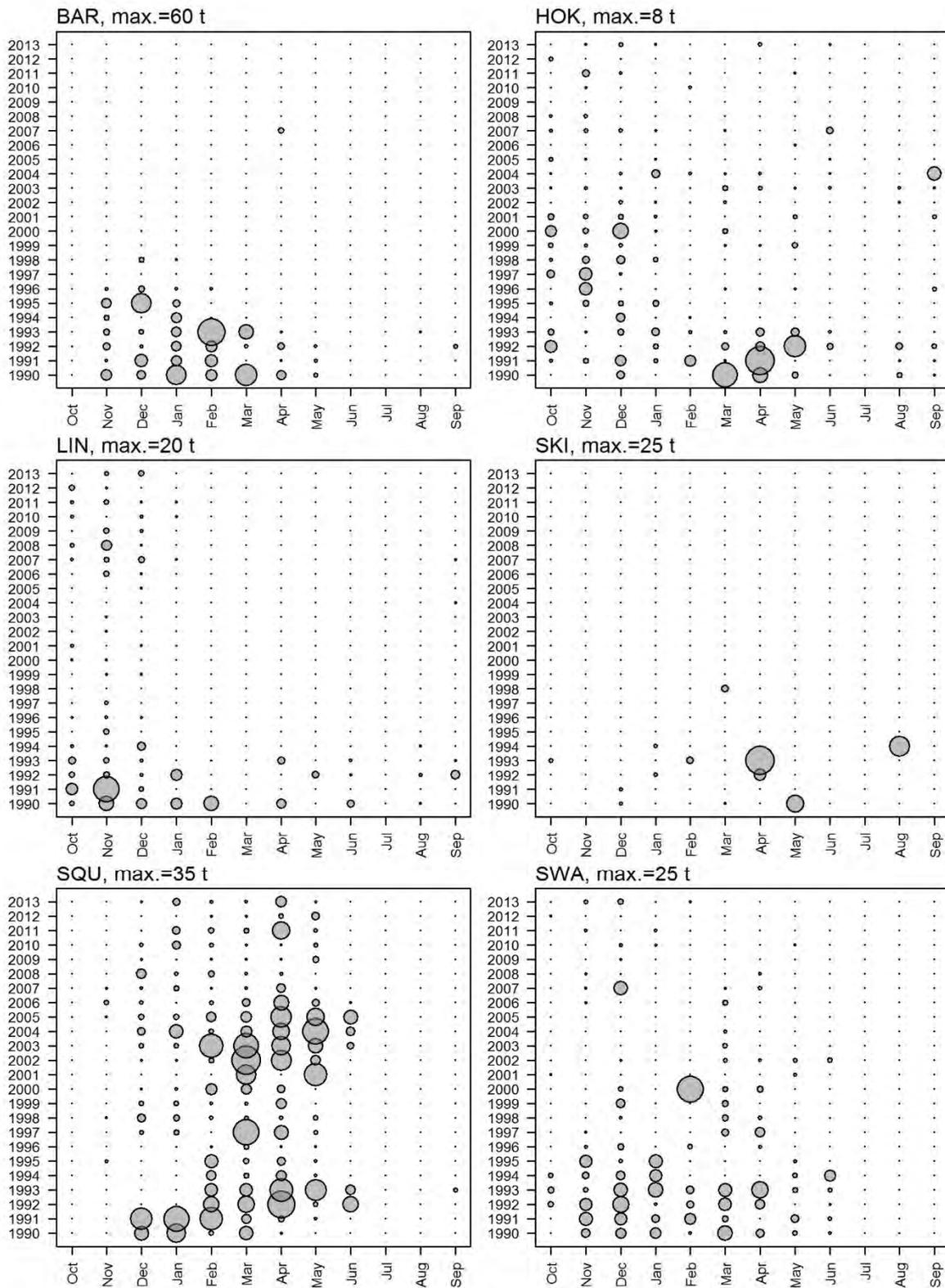
Figure C23b: Distribution of annual catch (t) from the SKI 3 South fishery by month and fishing year for the main bottom trawl target species reported on TCEPRs and TCERs. Circle size is proportional to the catch for each species stratum; maximum circle size is indicated on the top left hand corner of each plot.
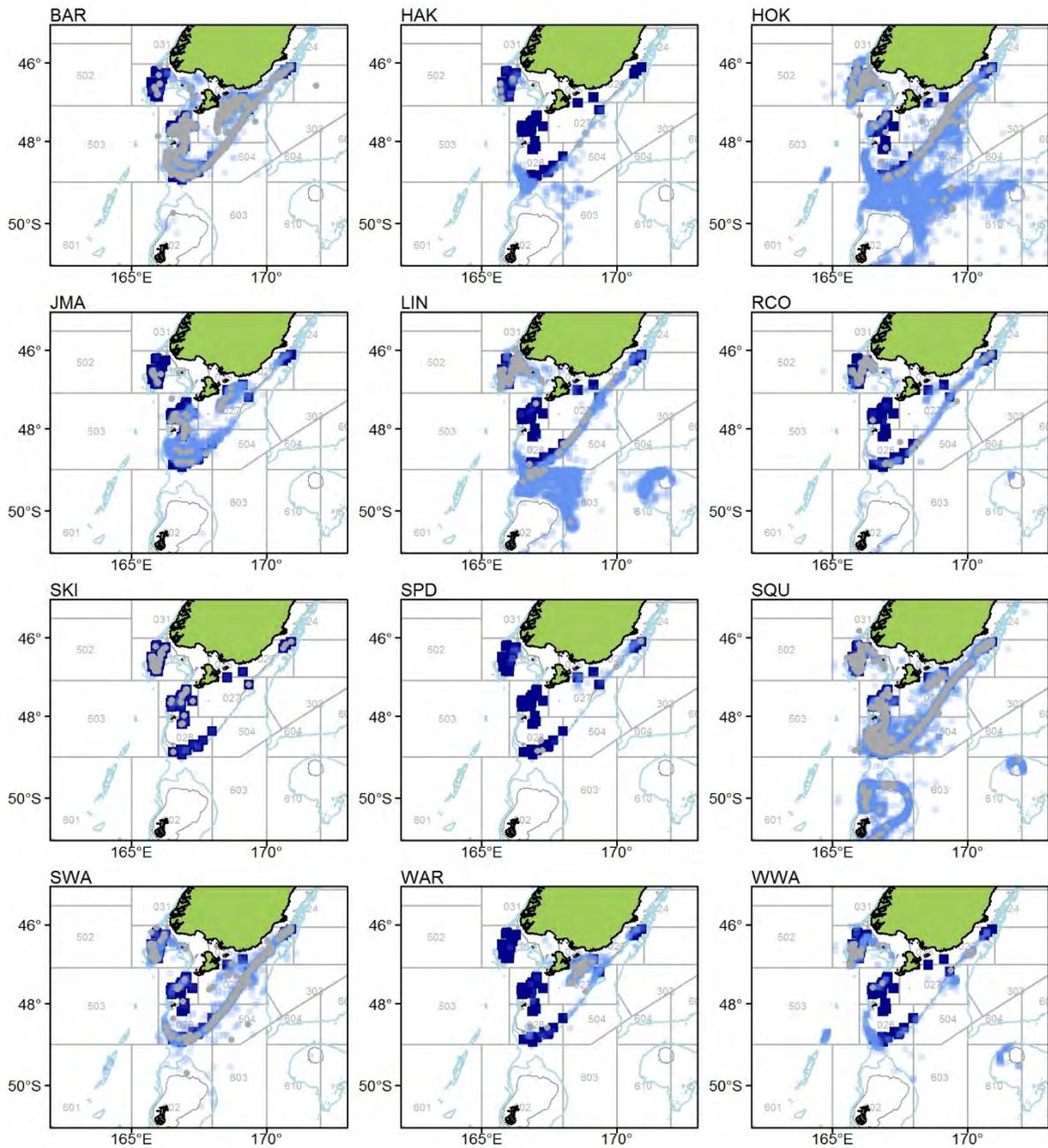
Figure C24: Distribution of TCEPR effort for gemfish (■), for the main target species (■), and for the main target species where gemfish was caught (●), within the main SKI 3 South fishery area off the southern South Island, 1989–90 to 2012–13.
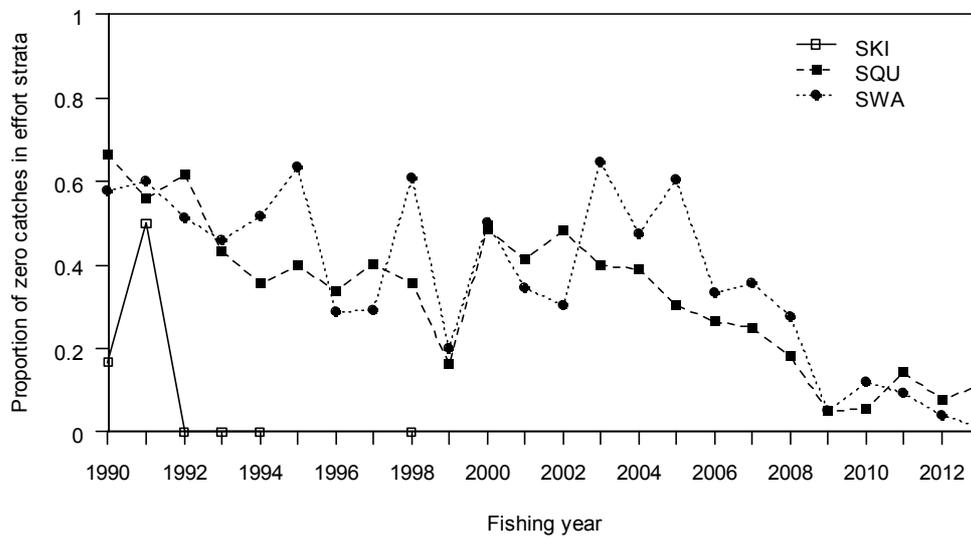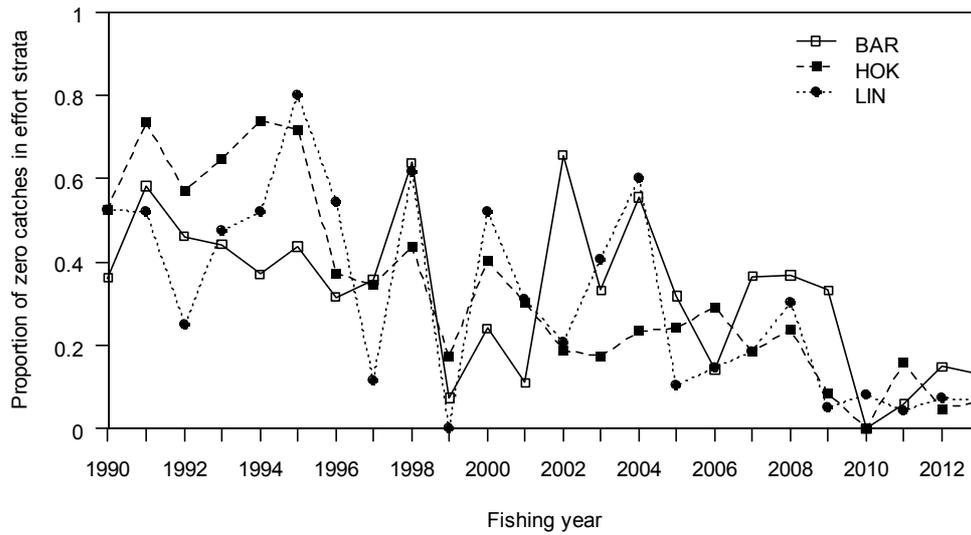
Figure C25: Proportion of zeros by main target species for the SKI 3 South for TCEPR bottom trawl merged data. Target species codes are defined in Table C12.
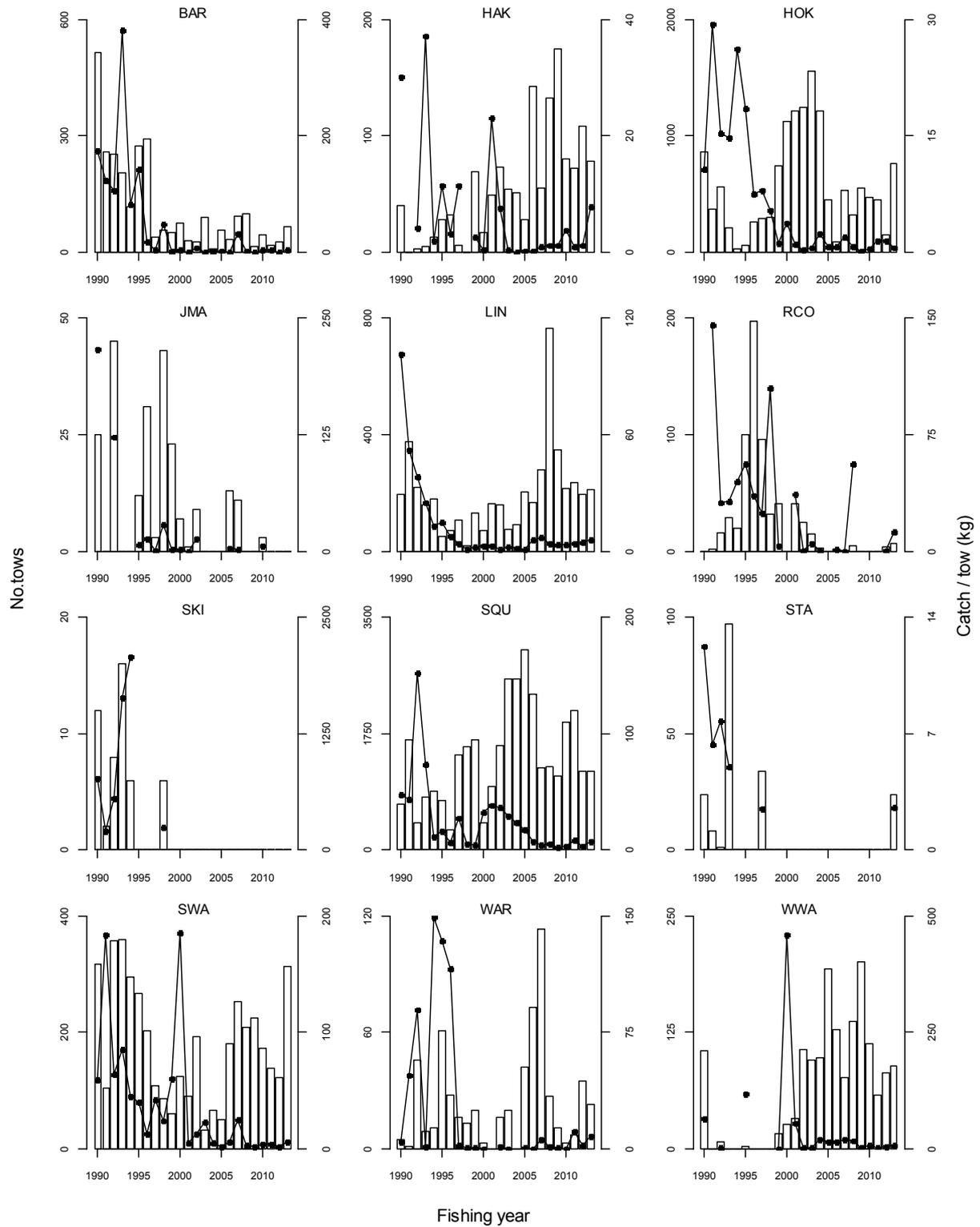
Figure C26: Unstandardised catch rate (kg.tow⁻¹) of gemfish taken by bottom trawl gear (points and lines) and the number of tows (bars) for the South fishery area of SKI 3 where data were reported on TCEPRs, by target species for 1989–90 (1990) to 2012–13 (2013). Target species codes are defined in Table C12.
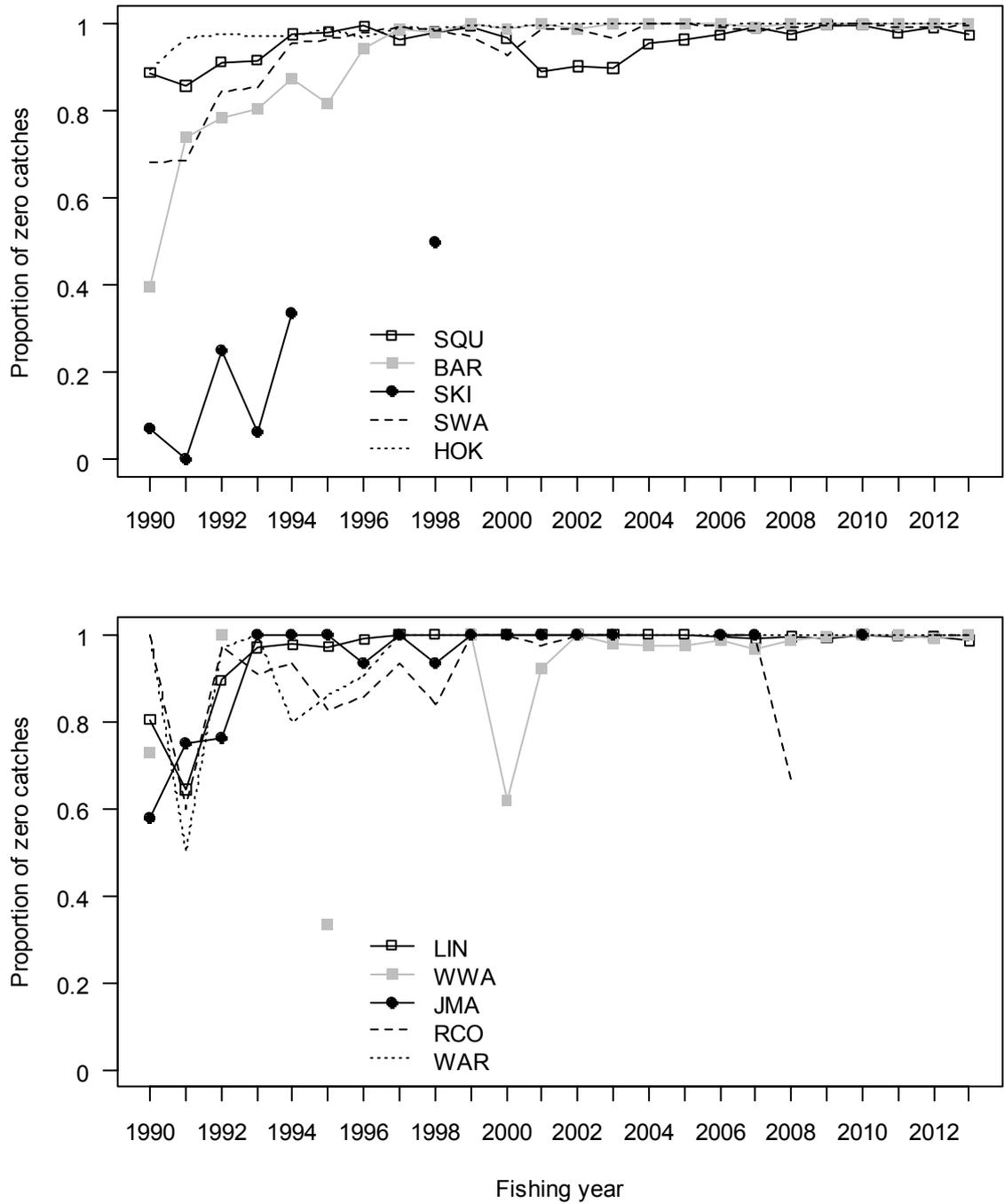
Figure C27: Proportion of zero catches in TCEPR bottom trawl tow-by-tow data reported from the South area of SKI 3, 1989–90 to 2012–13, for the main target species. Target species codes are defined in Table C12.
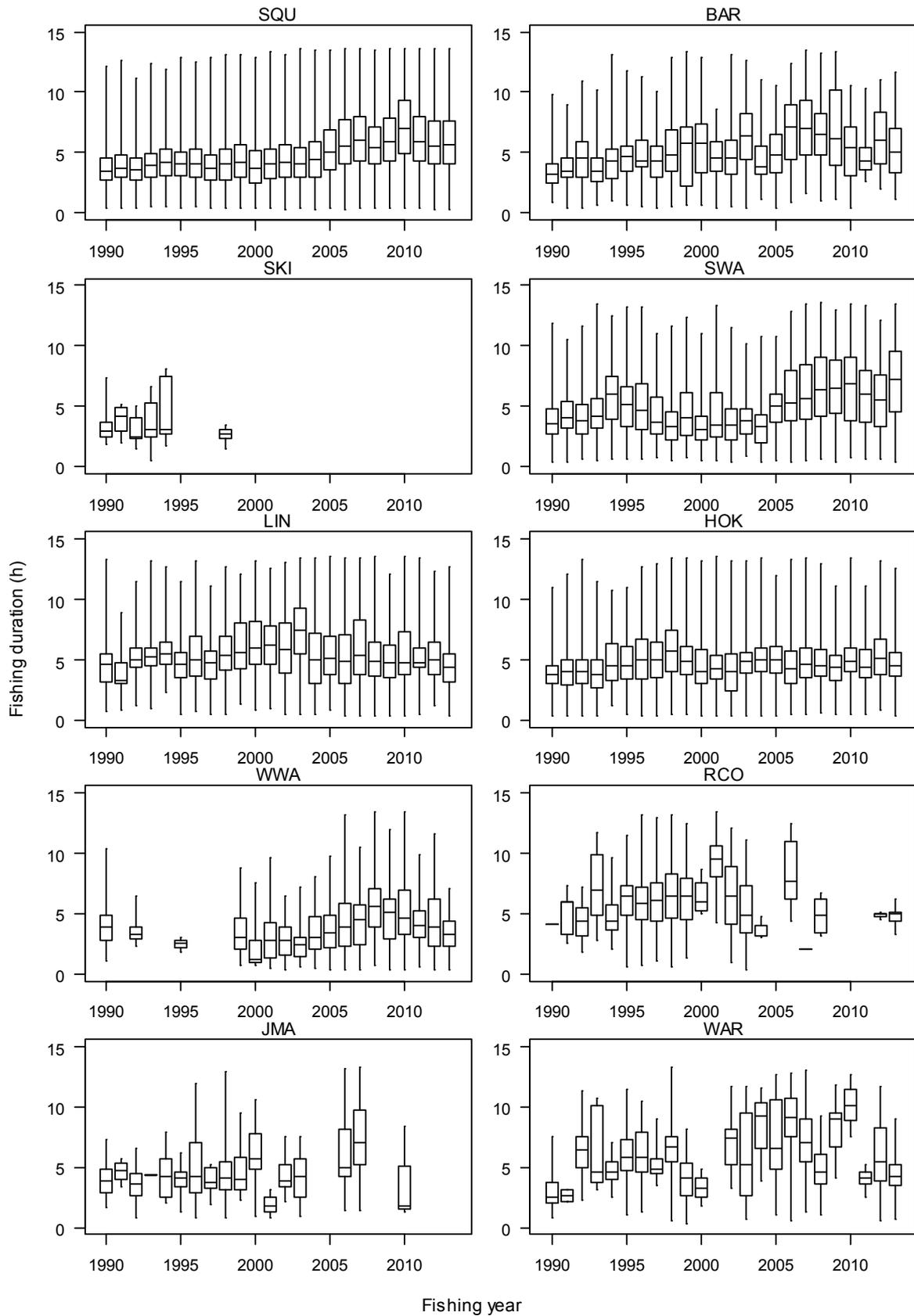
Figure C28a: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) of TCEPR bottom trawl tow durations reported for major target species fisheries catching gemfish in the SKI 3 South fishery area, based on the groomed unmerged data. Target species codes are defined in Table C12.
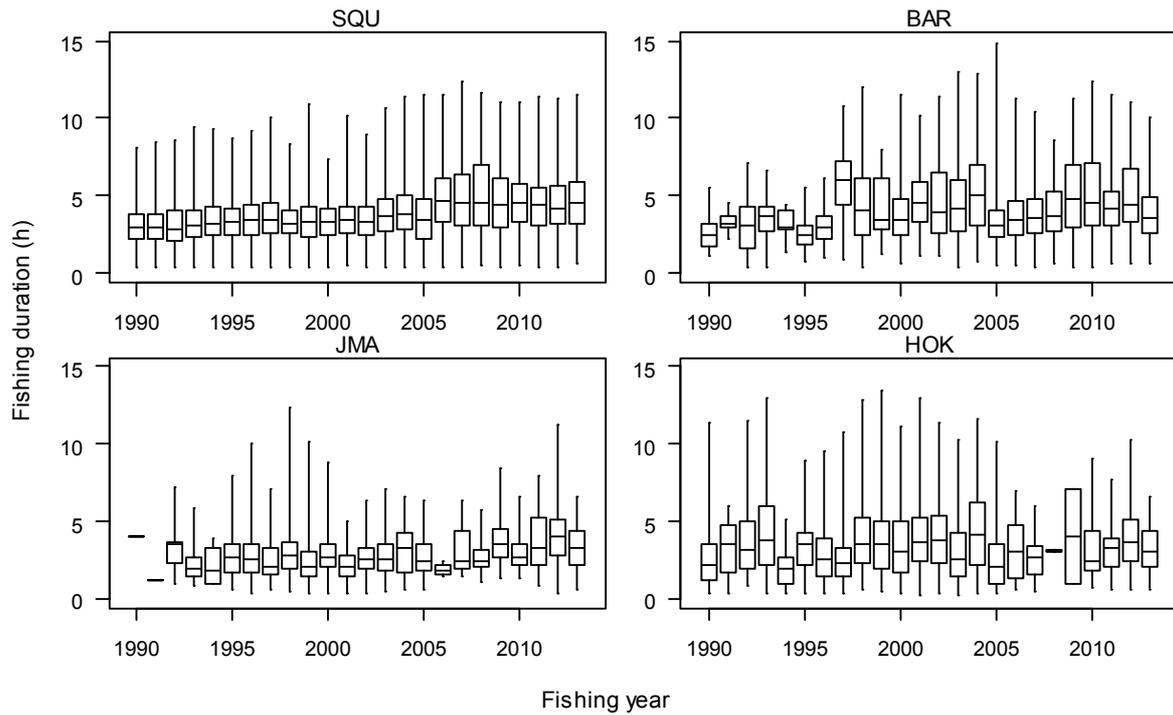
Figure C28b: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) of TCEPR midwater trawl tow durations reported for major target species fisheries catching gemfish in the SKI 3 South fishery area, based on the groomed unmerged data. Target species codes are defined in Table C12.
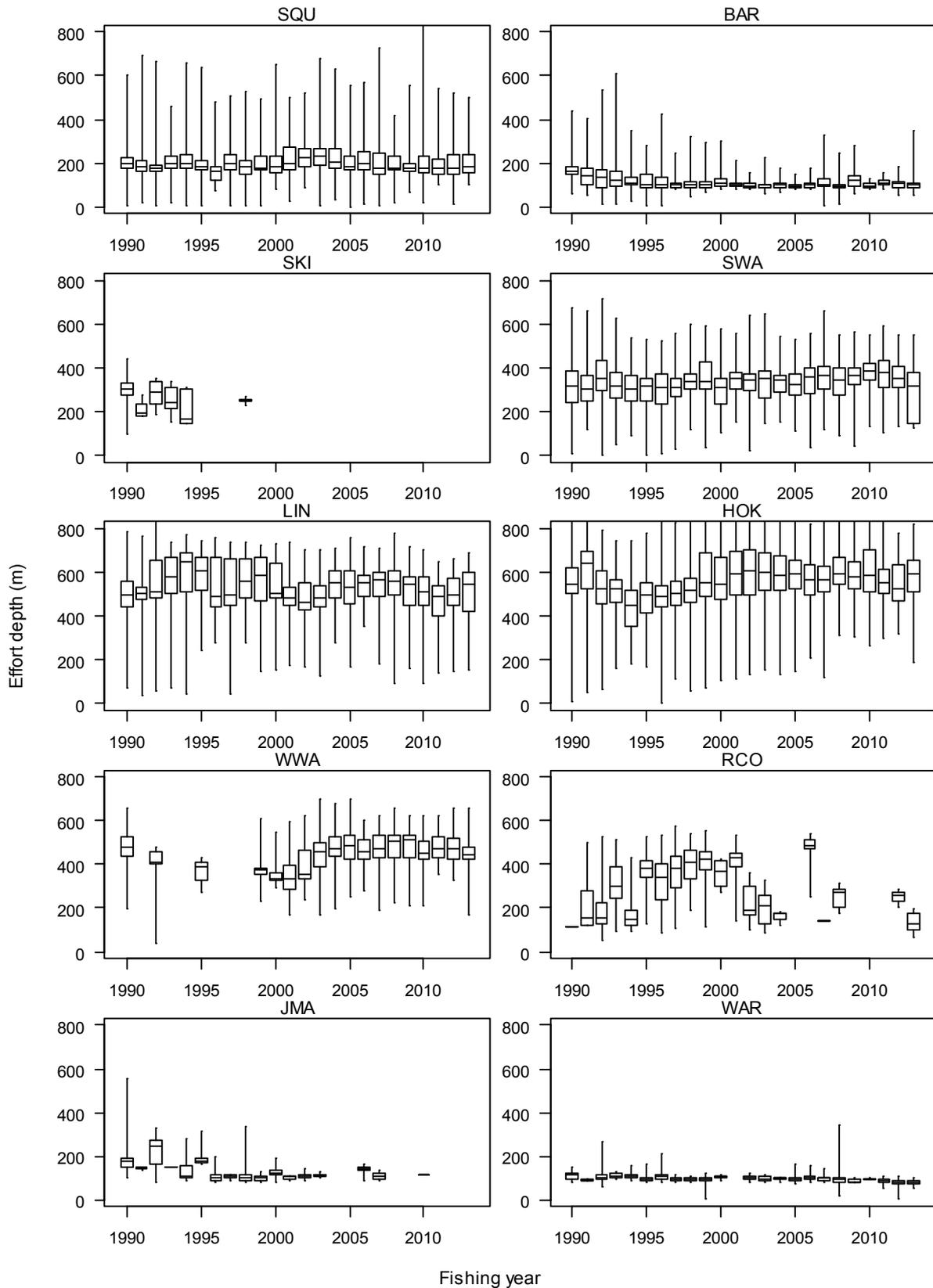
Figure C29a: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) for the effort depth during TCEPR bottom trawls that caught gemfish in the South fishery area of SKI 3, based on the groomed unmerged data. Target species codes are defined in Table C12.
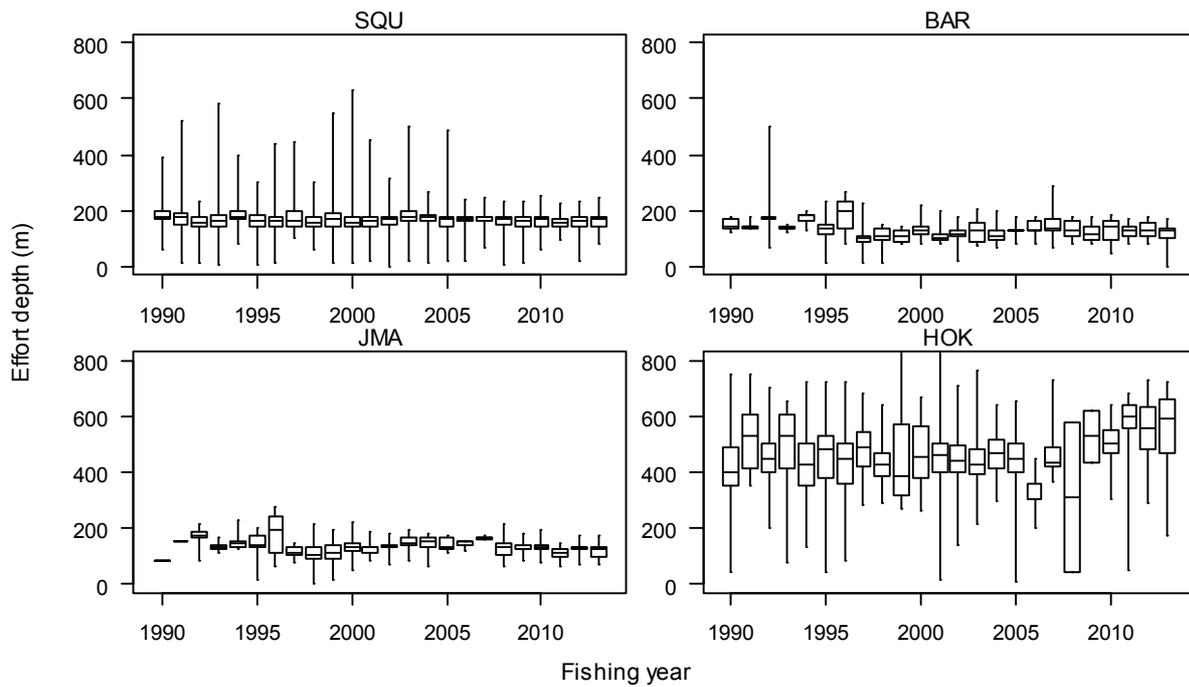
Figure C29b: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) for the effort depth during TCEPR midwater trawls that caught gemfish in the South fishery area, based on the groomed unmerged data. Target species codes are defined in Table C12.
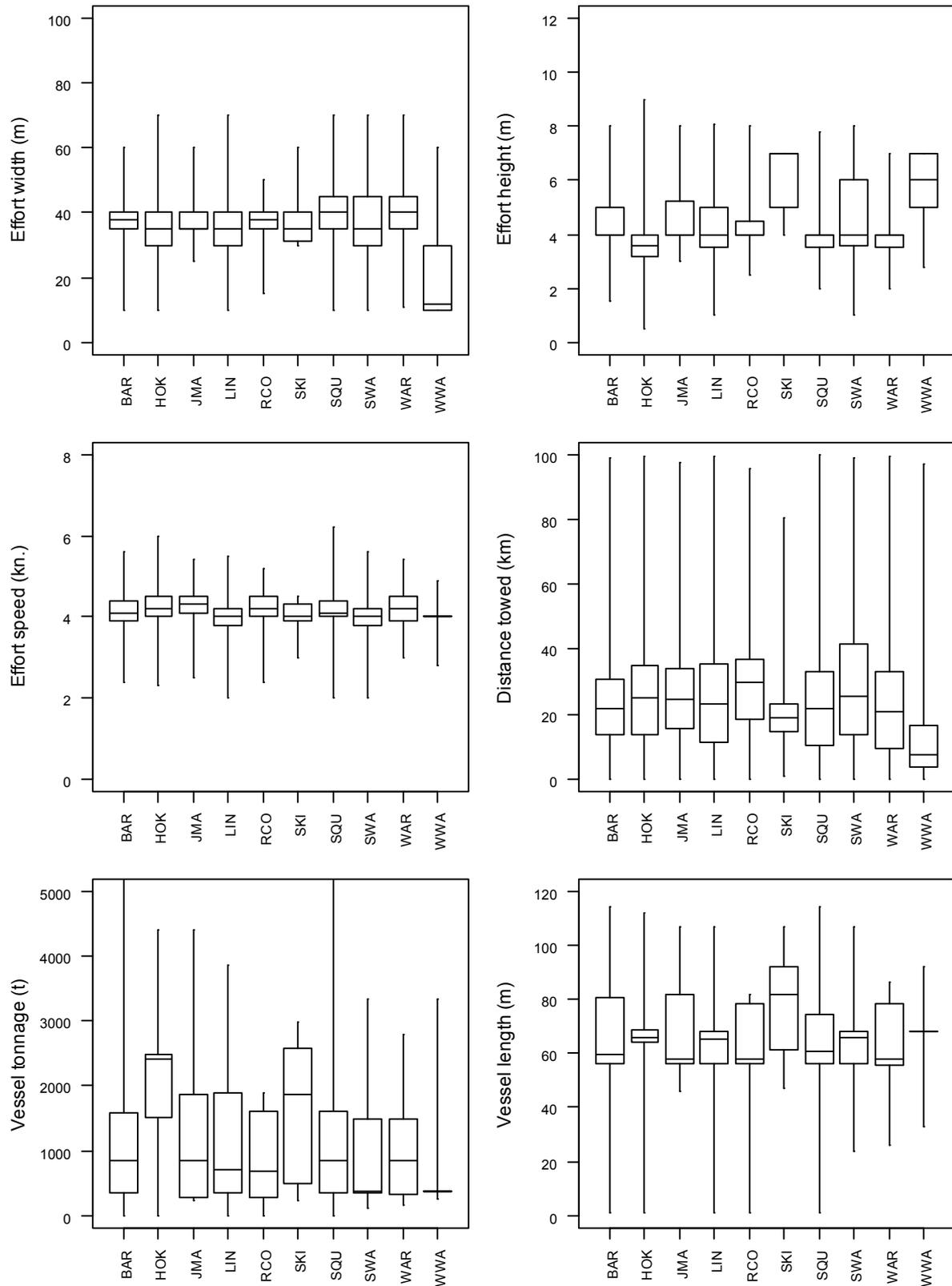
Figure C30a: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) for fishing effort variables and vessel characteristics for the main target species fisheries that caught gemfish and reported bottom trawl effort on TCEPRs in the SKI 3 South fishery area, 1989–90 to 2012–13. Target species codes are defined in Table C12.
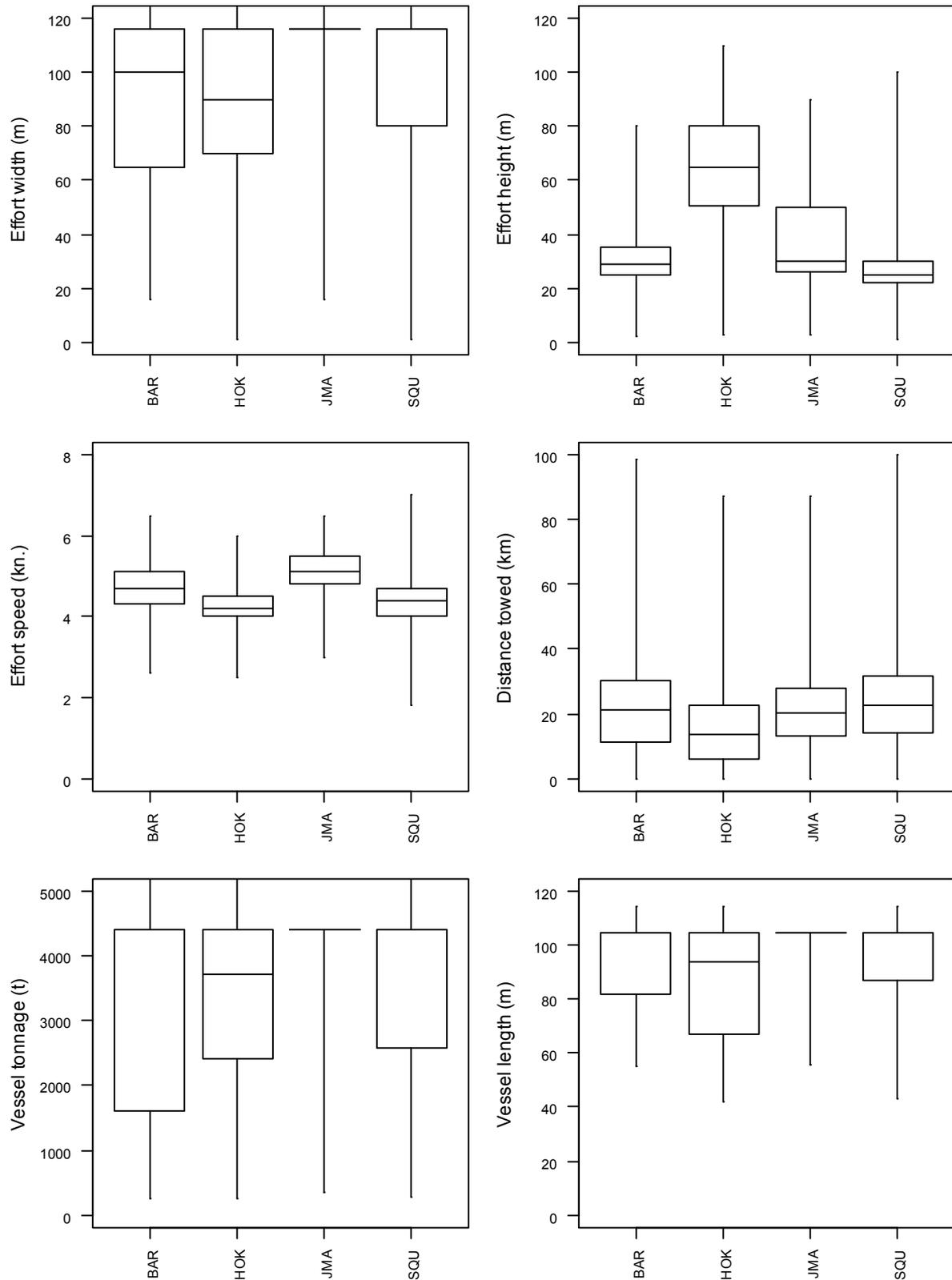
Figure C30b: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) for fishing effort variables and vessel characteristics for the main target species fisheries that caught gemfish and reported midwater trawl effort on TCEPRs in the SKI 3 South fishery area, 1989–90 to 2012–13. Target species codes are defined in Table C12.
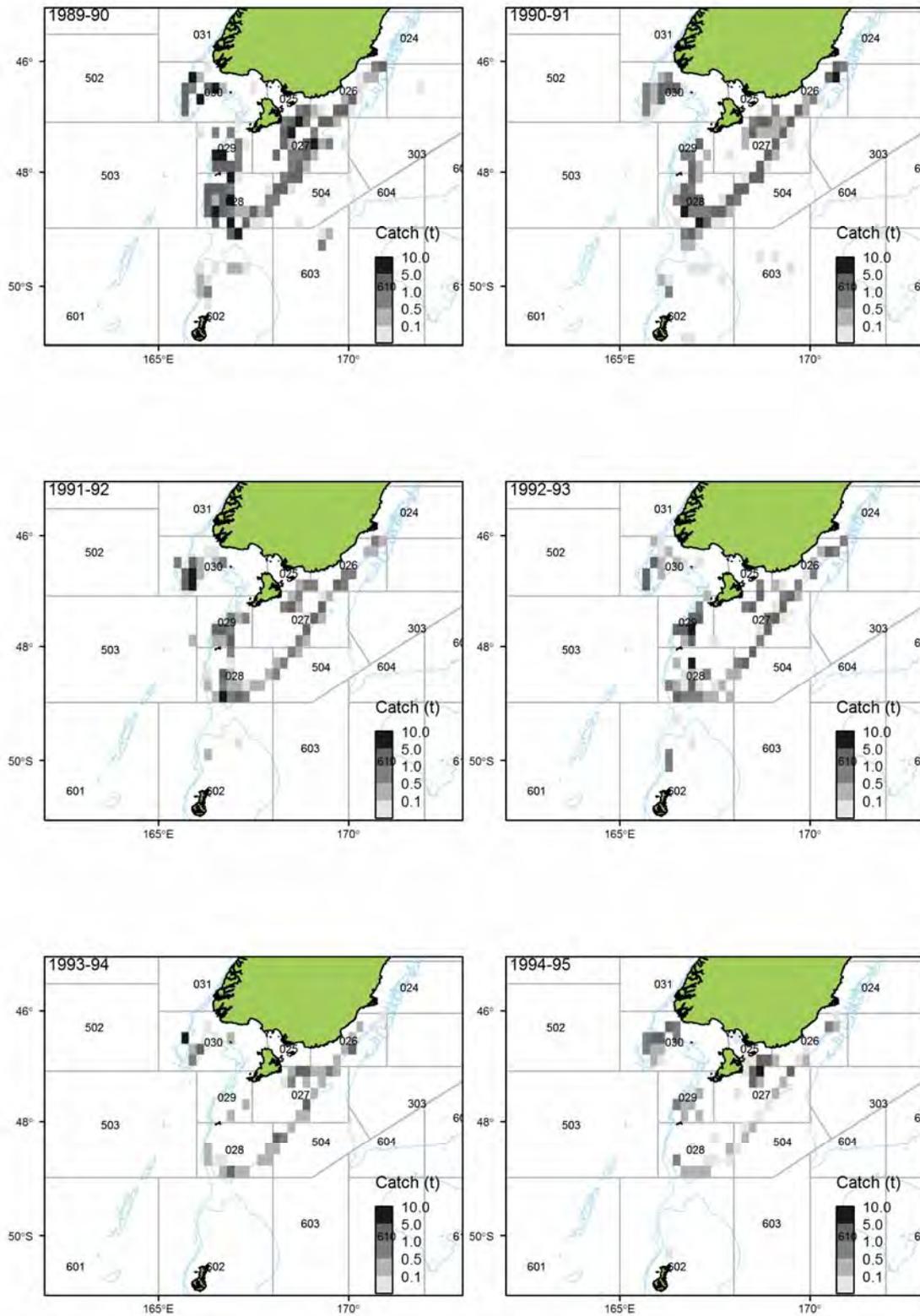
Figure C31: Distribution of TCEPR bottom trawl gemfish catch aggregated into 0.2° cells within the main SKI 3 South fishery area, 1989–90 to 1994–95.
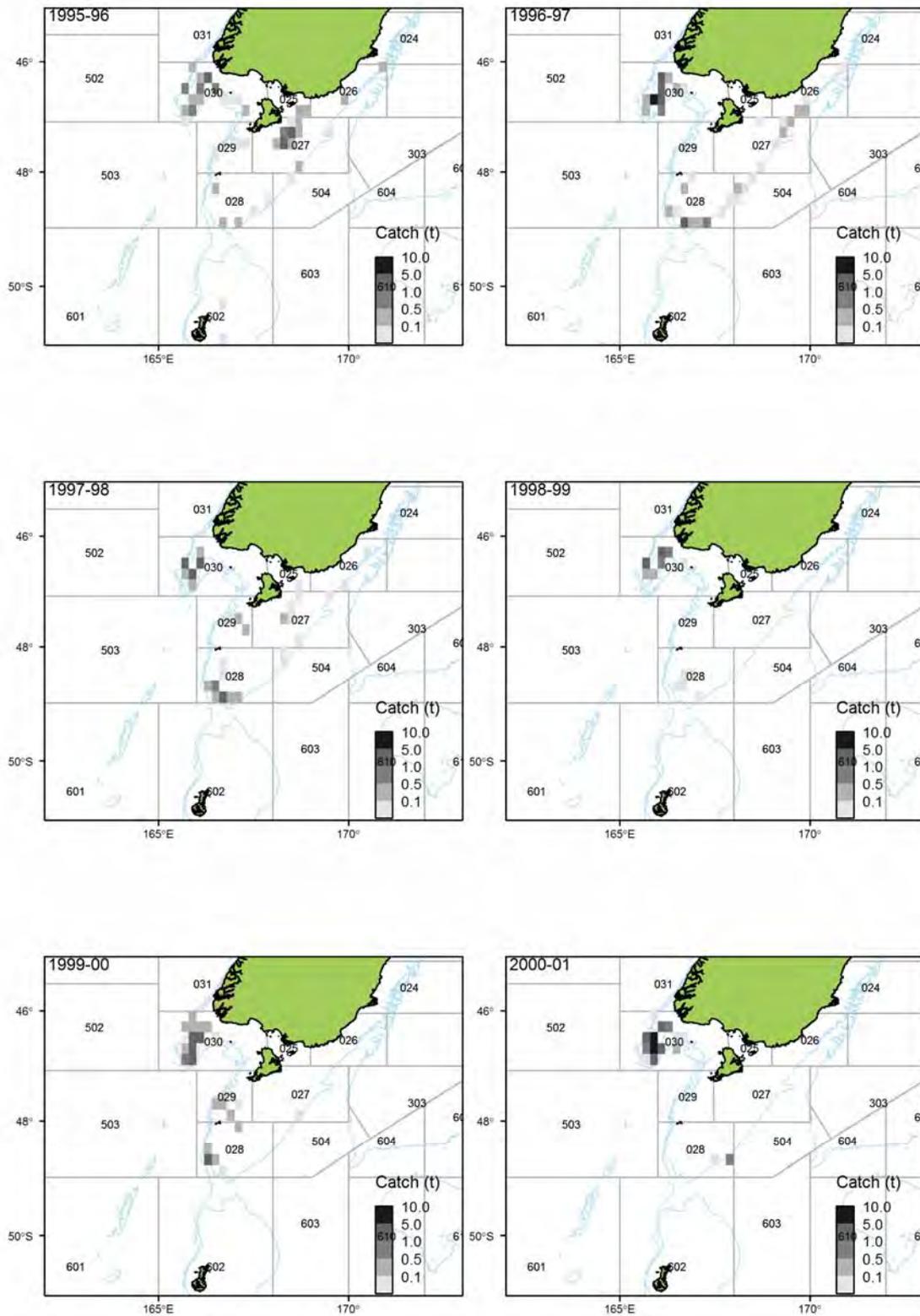
Figure C31 *continued***: Distribution of TCEPR bottom trawl gemfish catch aggregated into 0.2° cells within the main SKI 3 South fishery area, 1995–96 to 2000–01.**
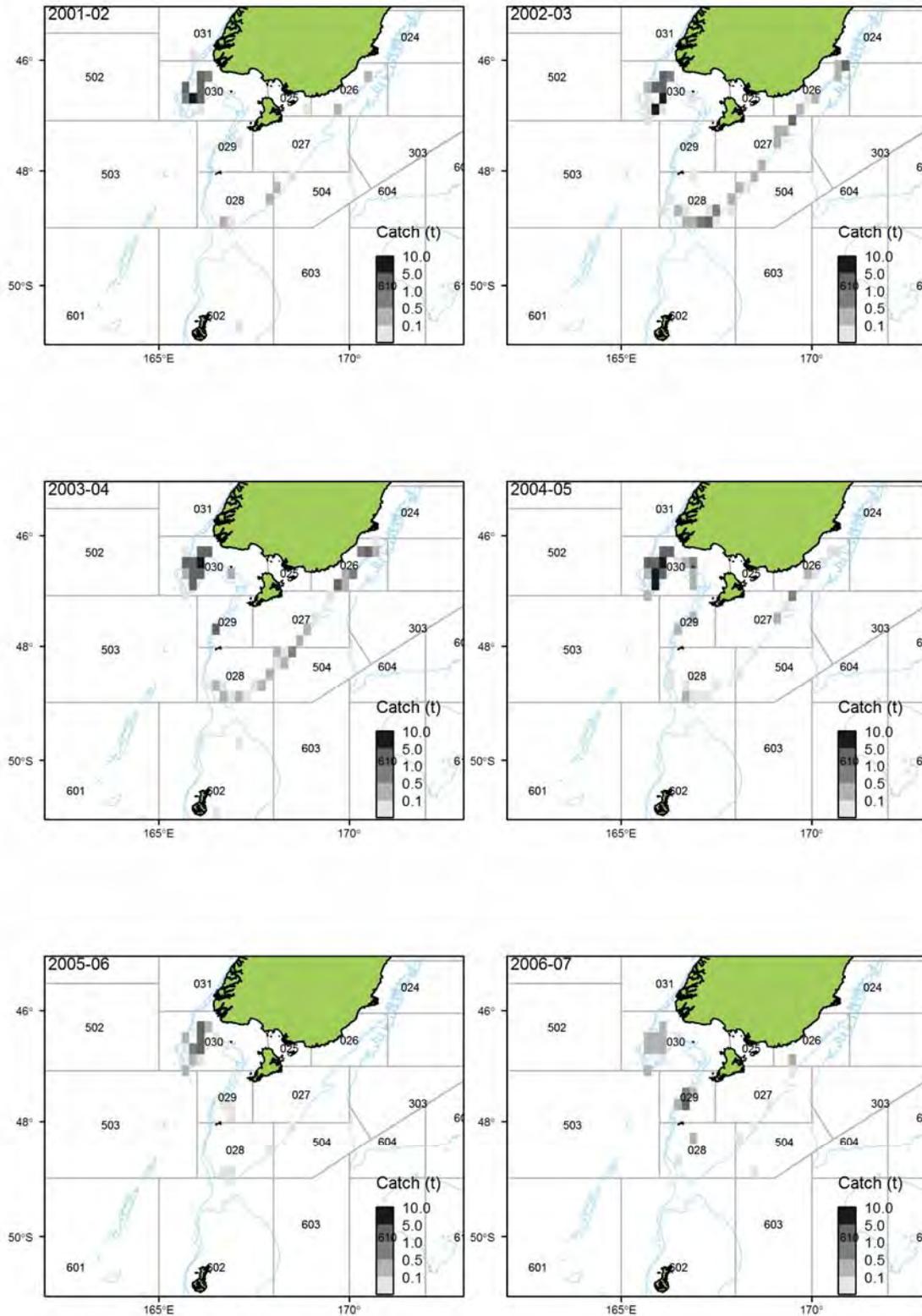
Figure C31 *continued*: **Distribution of TCEPR bottom trawl gemfish catch aggregated into 0.2° cells within the main SKI 3 South fishery area, 2001–02 to 2006–07.**
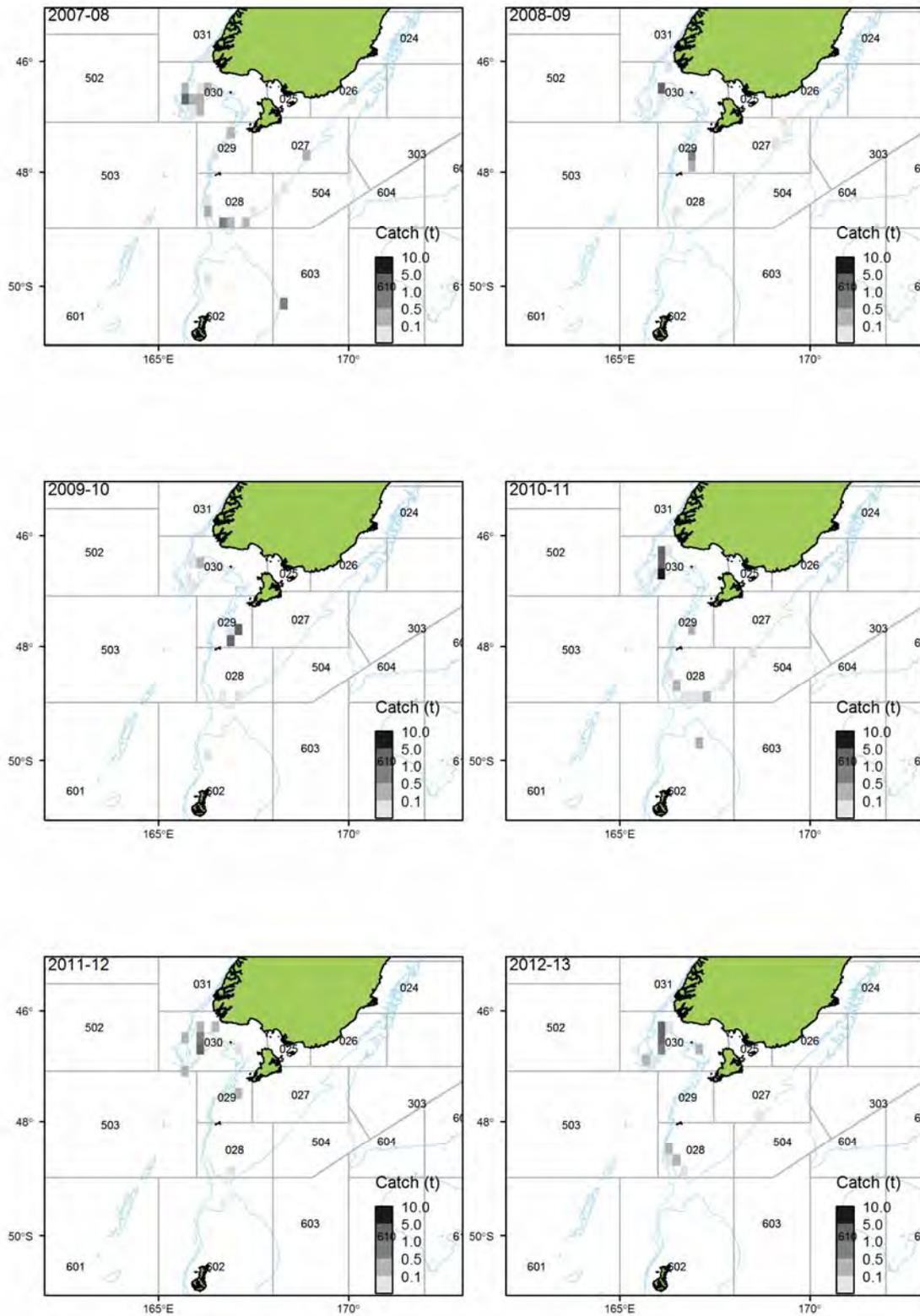
**Figure C31** *continued***: Distribution of TCEPR bottom trawl gemfish catch aggregated into 0.2° cells within the main SKI 3 South fishery area, 2007–08 to 2012–13.**
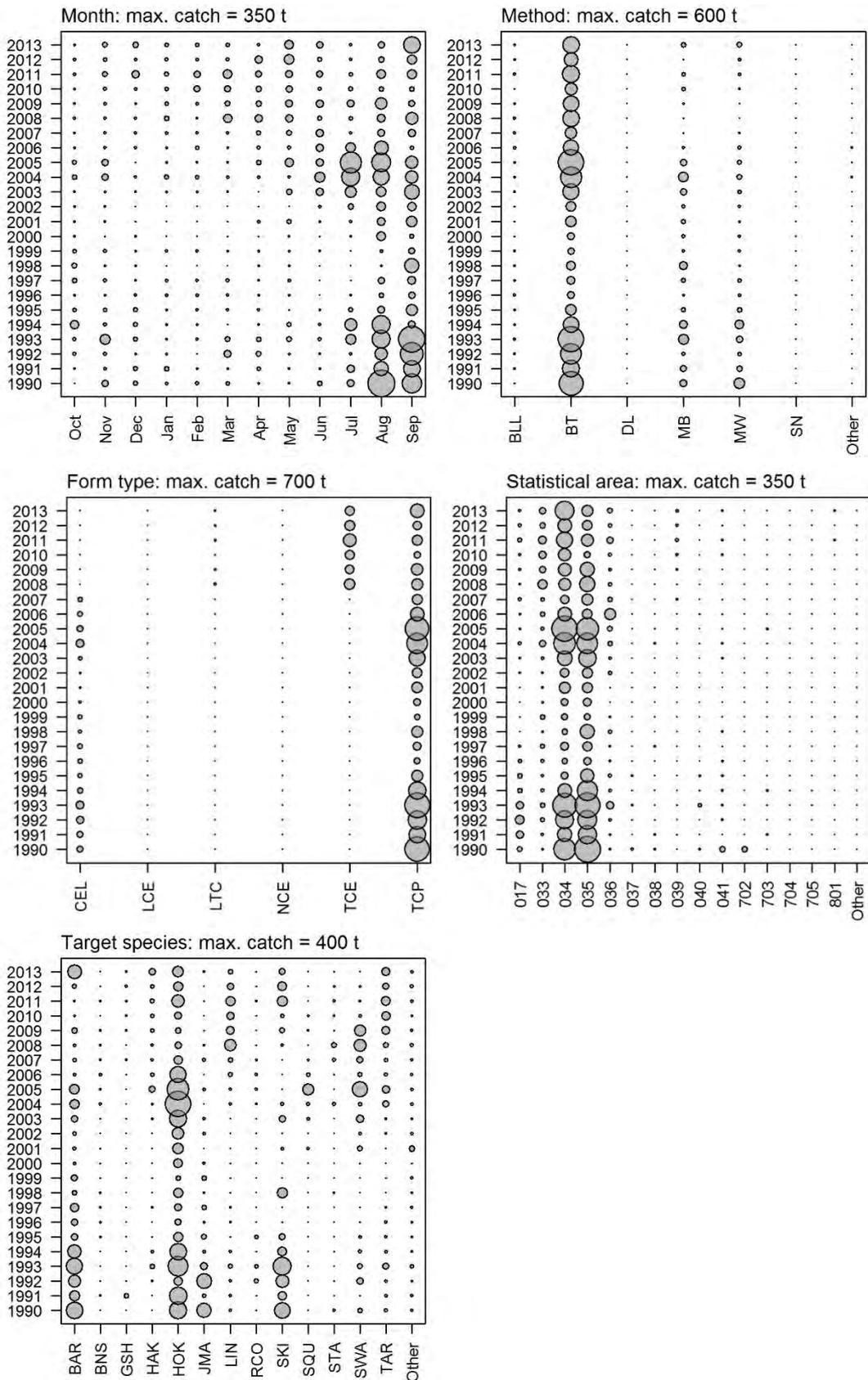
Figure C32: Distribution of annual catch (t) by month, statistical area, method, and target species for SKI 7 merged data. Circle size is proportional to catch; maximum circle size is indicated on the top left hand corner of each plot. Statistical areas are shown in Figure 1. Form types are defined in Figure C12a and fishing methods are defined in Figure C11. Target species codes are given in Table C12.
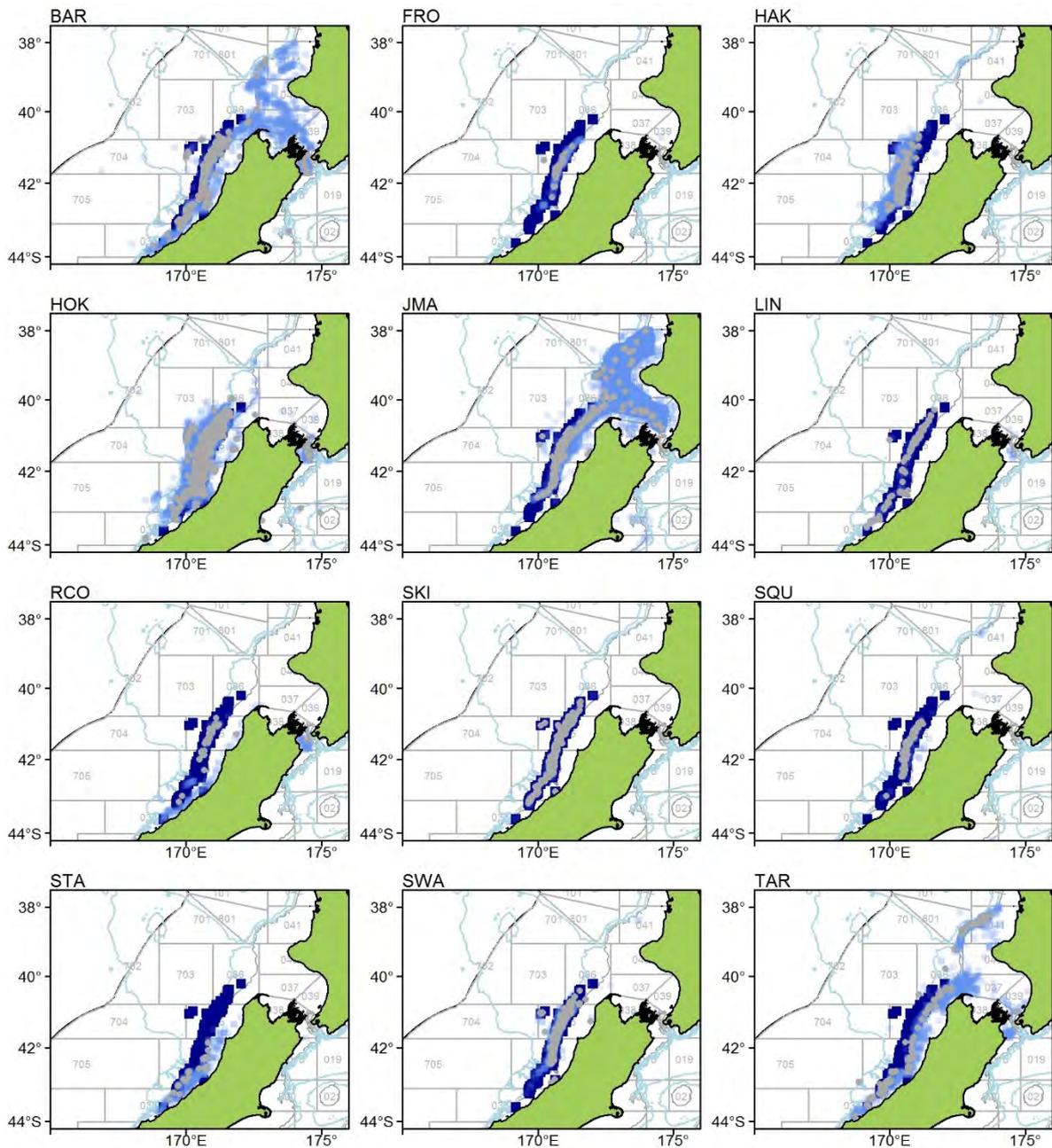
Figure C33a: Distribution of TCEPR effort for gemfish (■), for the main target species (■), and for the main target species where gemfish was caught (●), for the SKI 7 fishery off the west coast, 1989–90 to 2012–13.
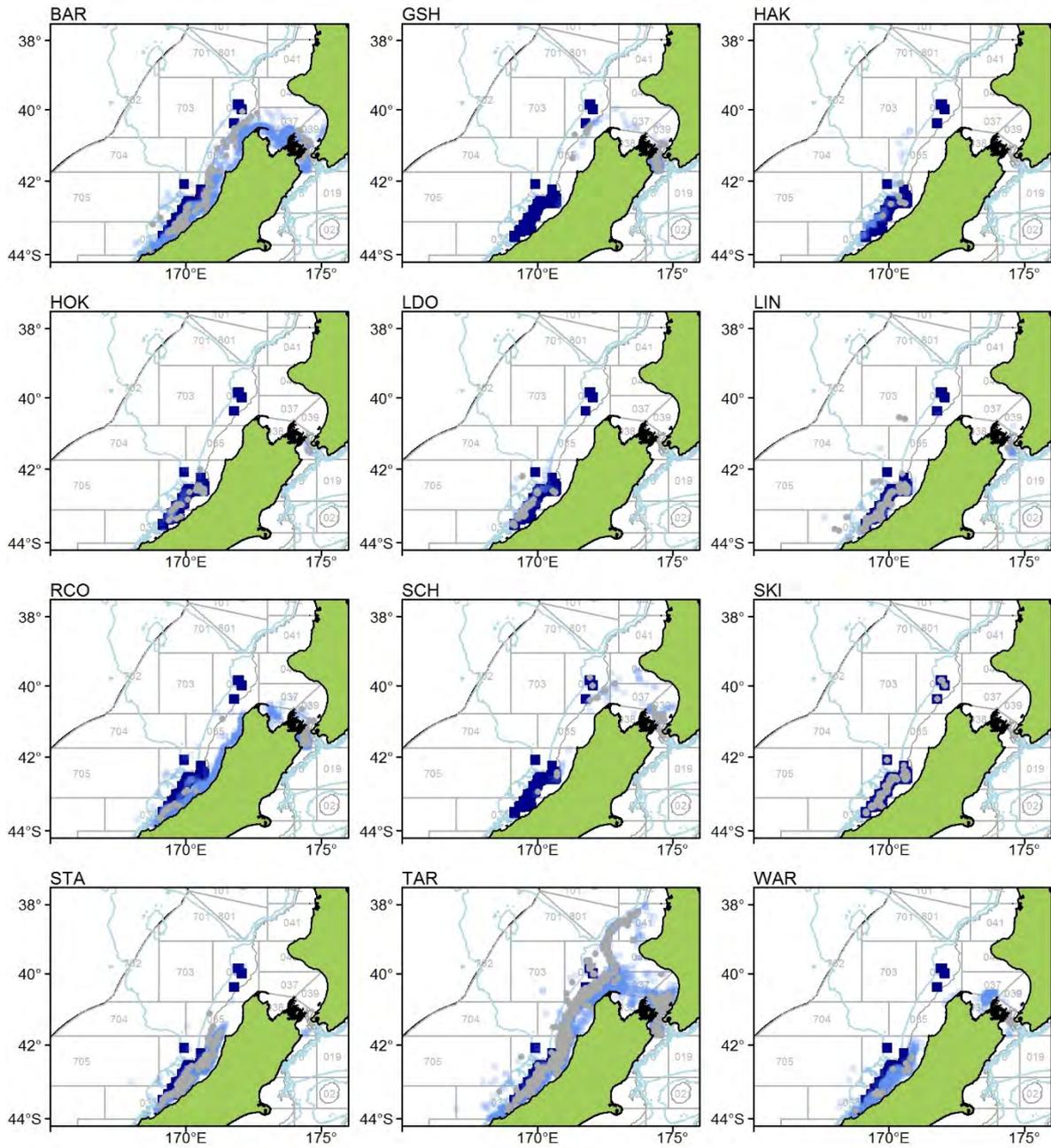
Figure C33b: Distribution of TCER effort for gemfish (■), for the main target species (■), and for the main target species where gemfish was caught (●), for the SKI 7 fishery off the west coast, 2007–08 to 2012–13 combined.
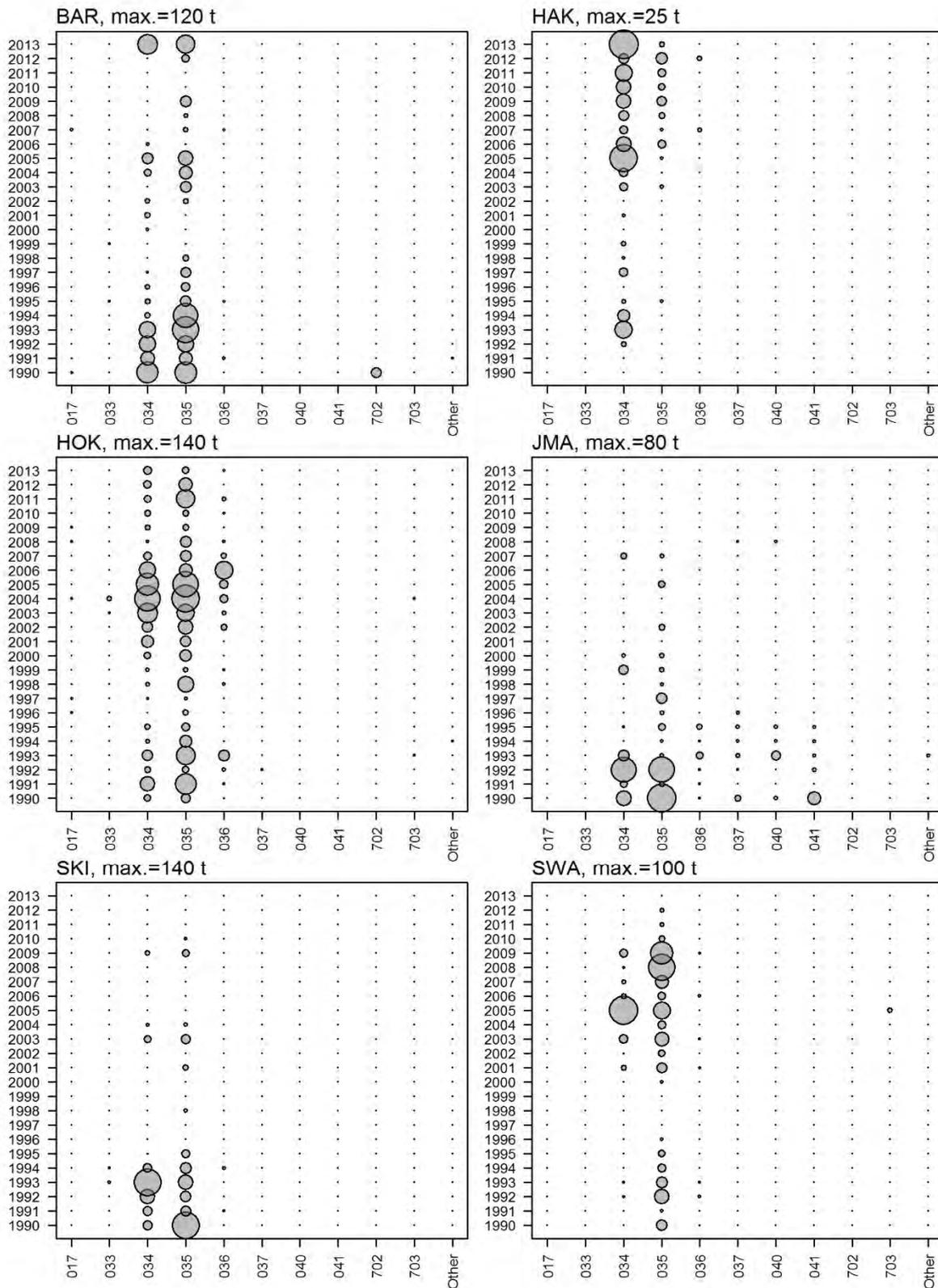
Figure C34a: Distribution of annual catch (t) from SKI 7 fishery by Statistical Area and fishing year for the main target species reported on TCEPRs. Circle size is proportional to the catch for each species stratum; maximum circle size is indicated on the top left hand corner of each plot.
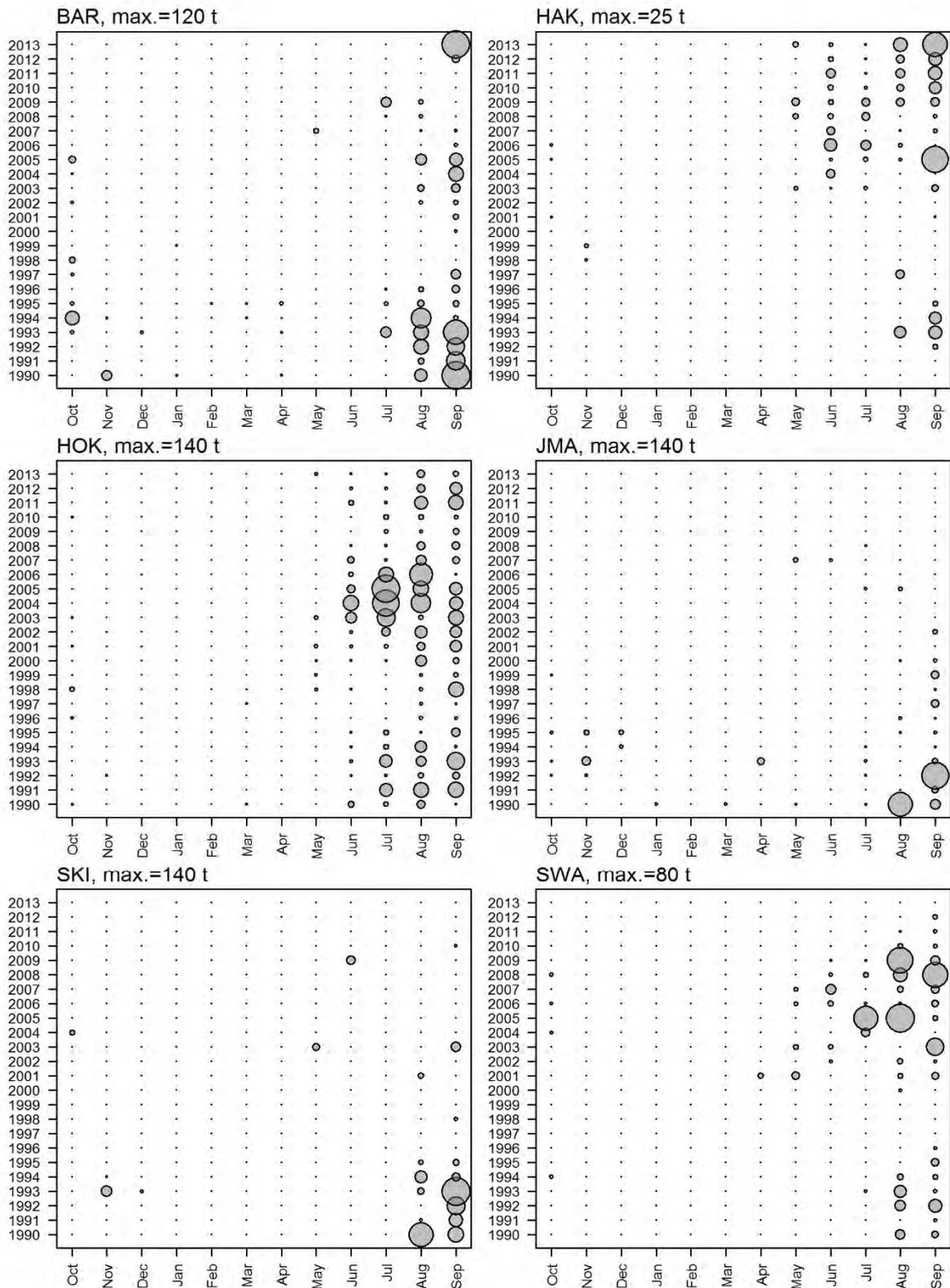
Figure C34b: Distribution of annual catch (t) from SKI 7 fishery by month and fishing year for the main target species reported on TCEPRs. Circle size is proportional to the catch for each species stratum; maximum circle size is indicated on the top left hand corner of each plot.

(a) Statistical Area
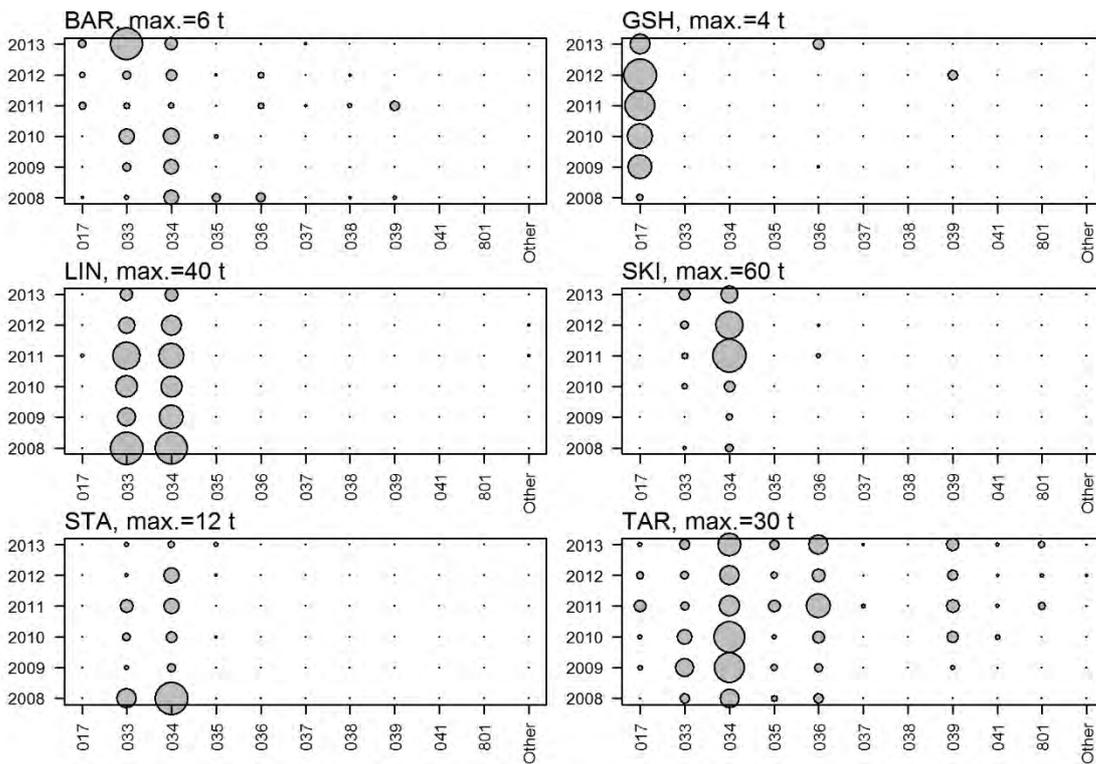
(b) Month
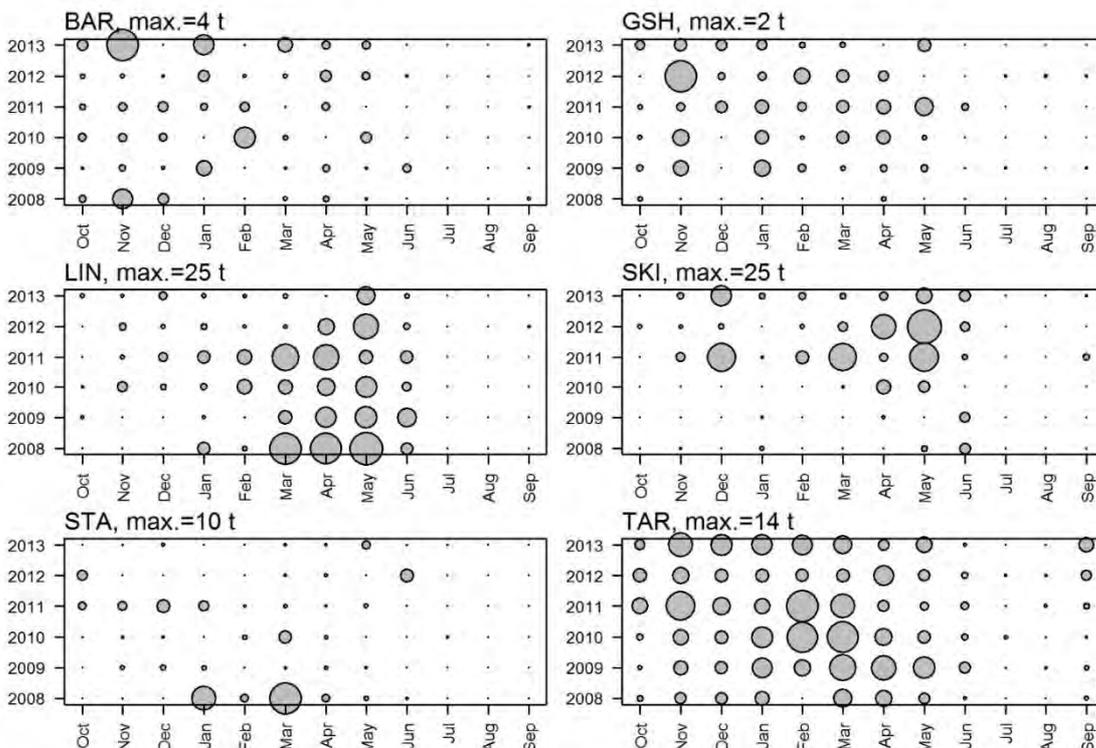
Figure C34c: Distribution of annual catch (t) from SKI 7 fishery by Statistical Area and month for each fishing year for the main bottom trawl target species reported on TCERs. Circle size is proportional to the catch for each species stratum; maximum circle size is indicated on the top left hand corner of each plot.
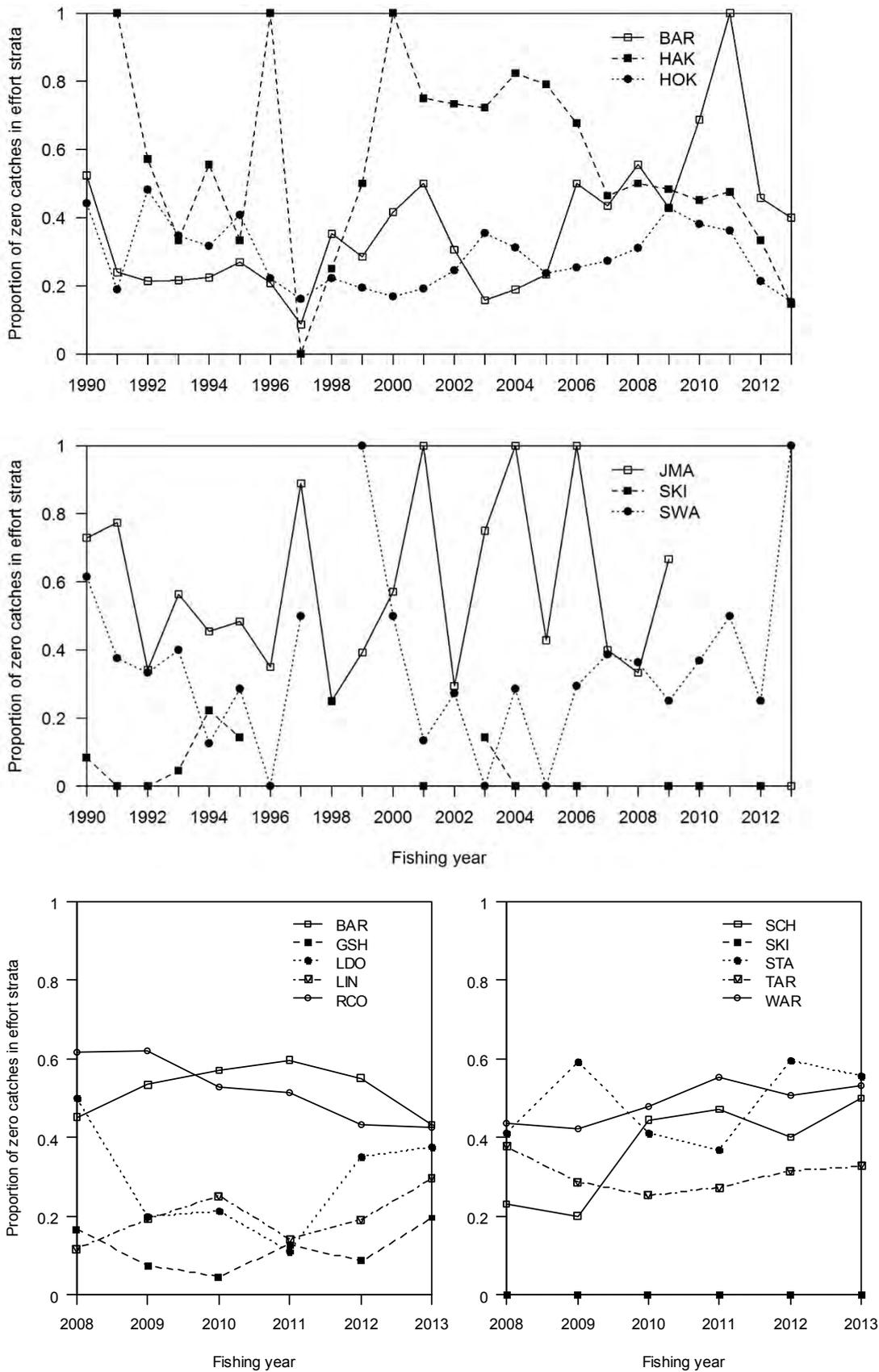
Figure C35: Proportion of zeros by main target species in SKI 7 for TCEPR (upper, 1990–2013) and TCER (lower, 2008–13) bottom trawl merged data – vessel-trip-area-target-method stratum.
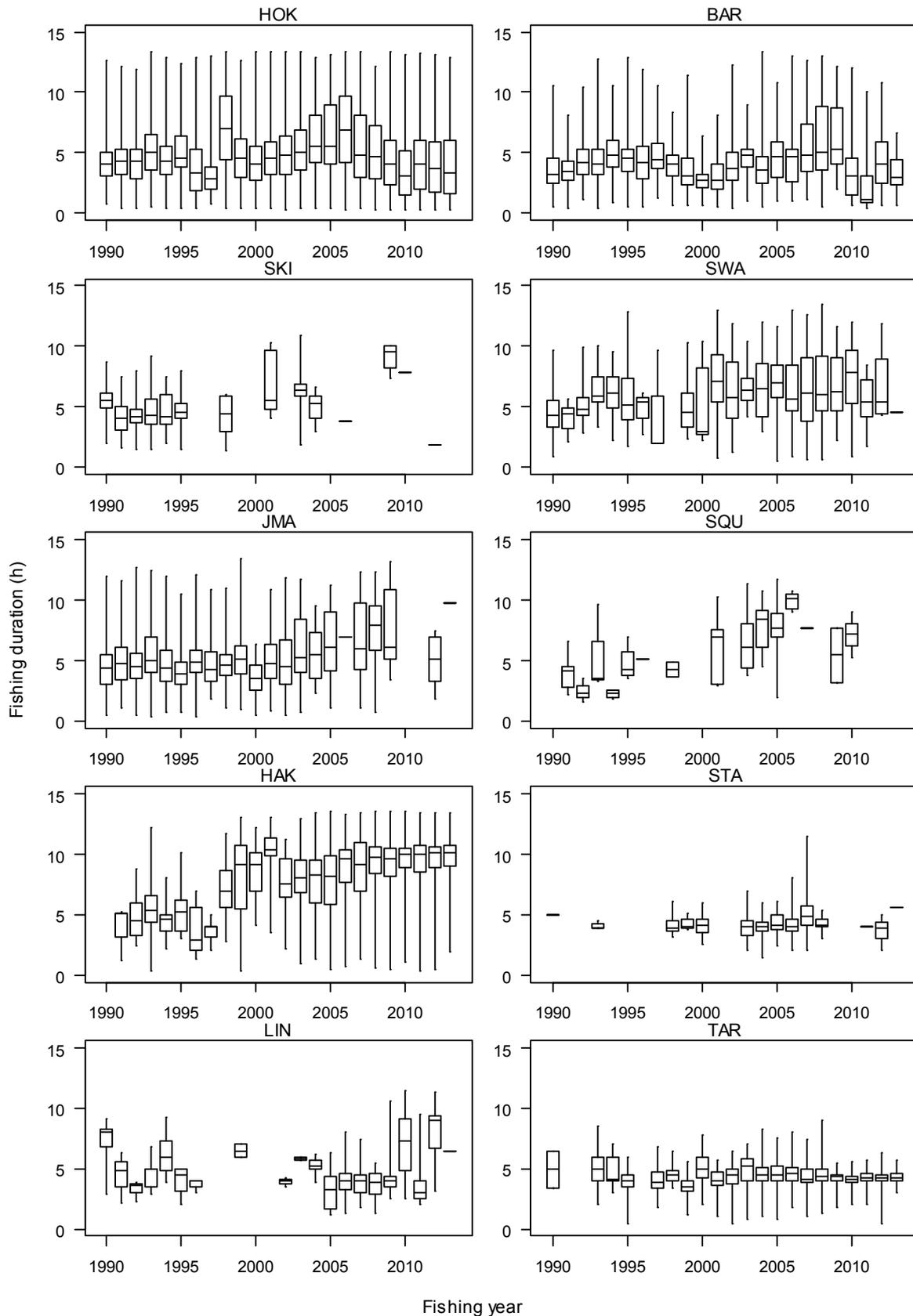
Figure C36a: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) for the fishing duration during TCEPR bottom trawls that caught gemfish in the SKI 7 fishery, based on the groomed unmerged data. Target species codes are defined in Table C12.
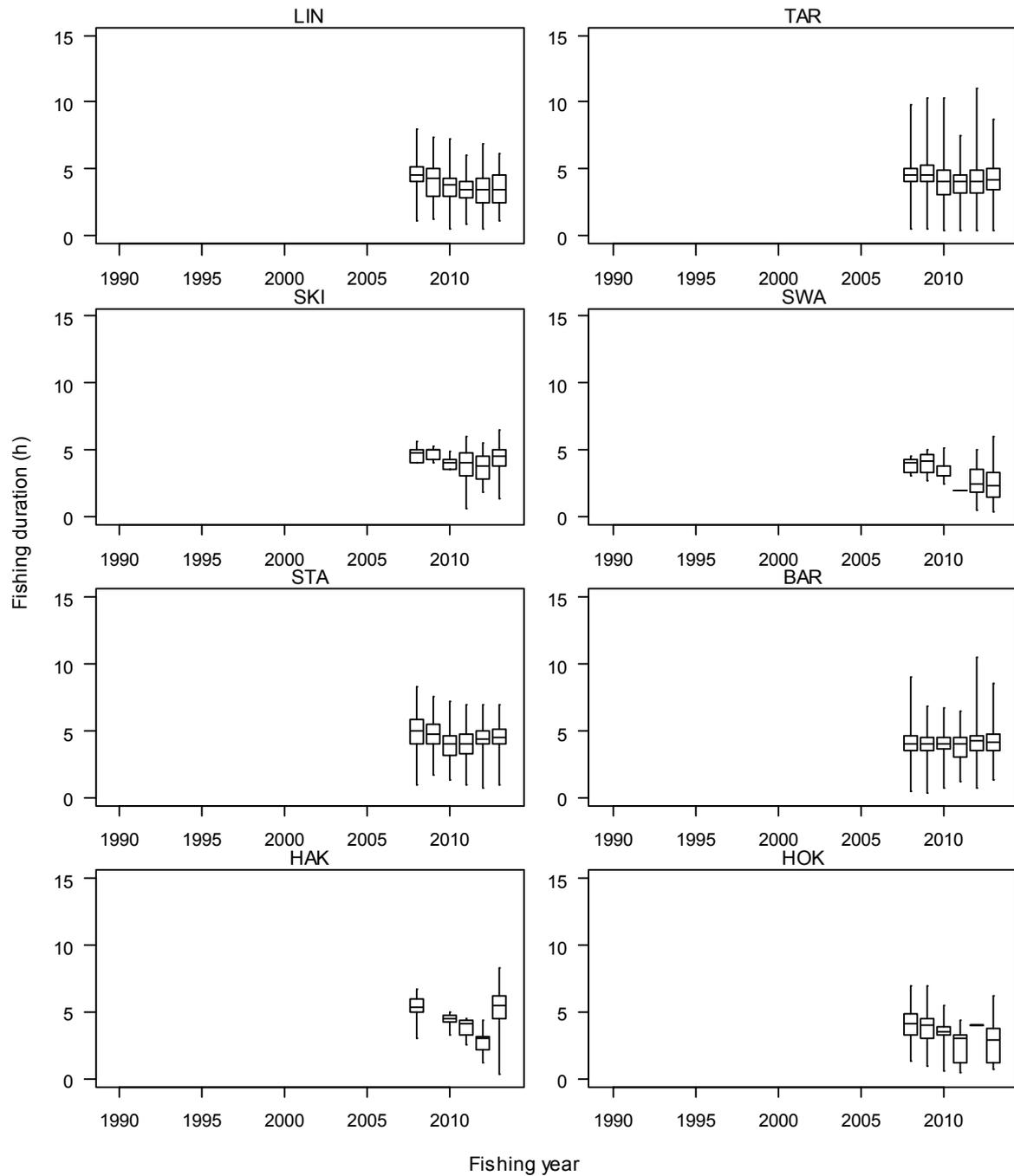
Figure C36b: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) for the fishing duration during TCER bottom trawls that caught gemfish in the SKI 7 fishery, based on the groomed unmerged data. Target species codes are defined in Table C12.
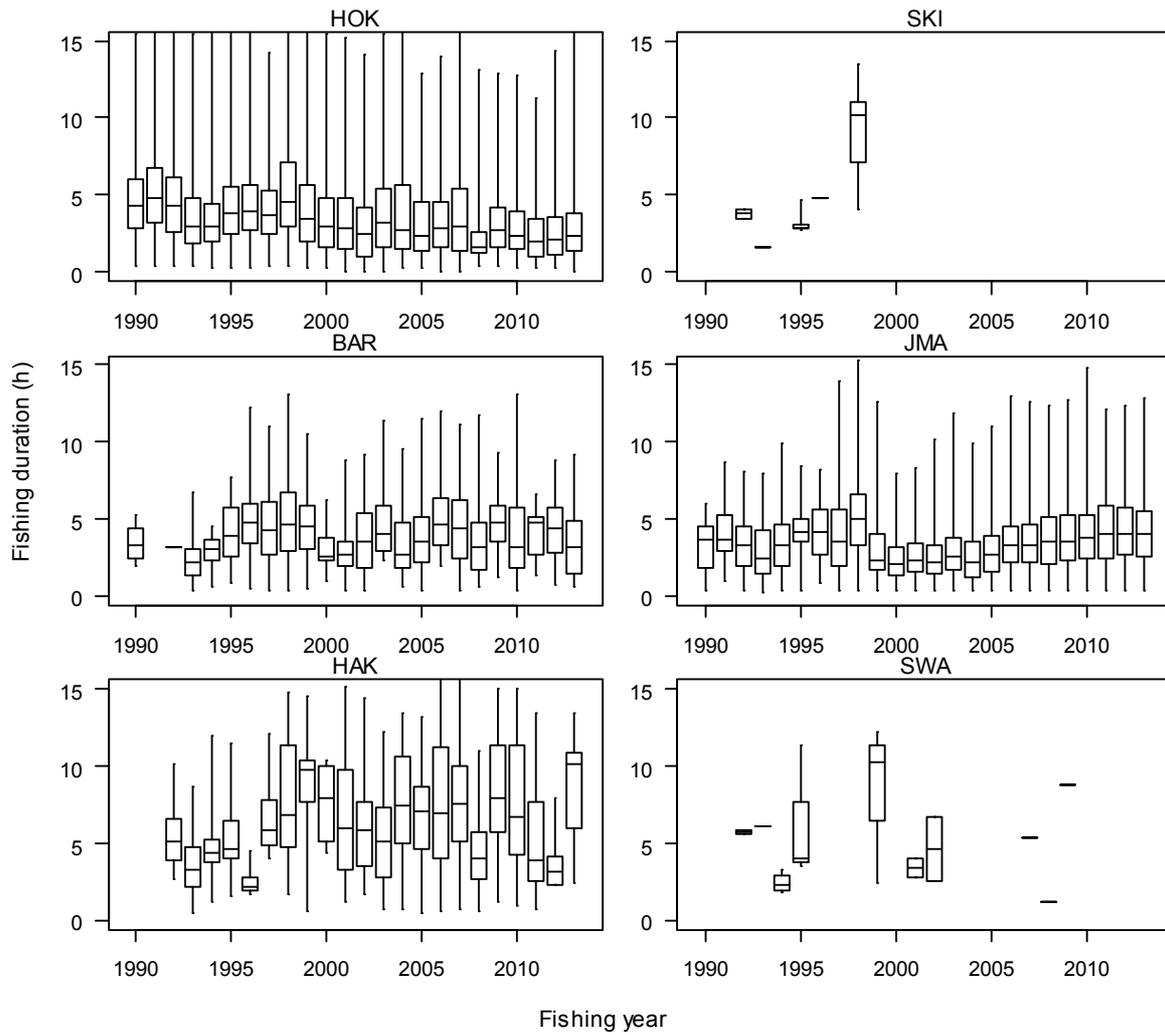
Figure C36c: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) for the fishing duration during TCEPR midwater trawls that caught gemfish in the SKI 7 fishery, based on the groomed unmerged data. Target species codes are defined in Table C12.
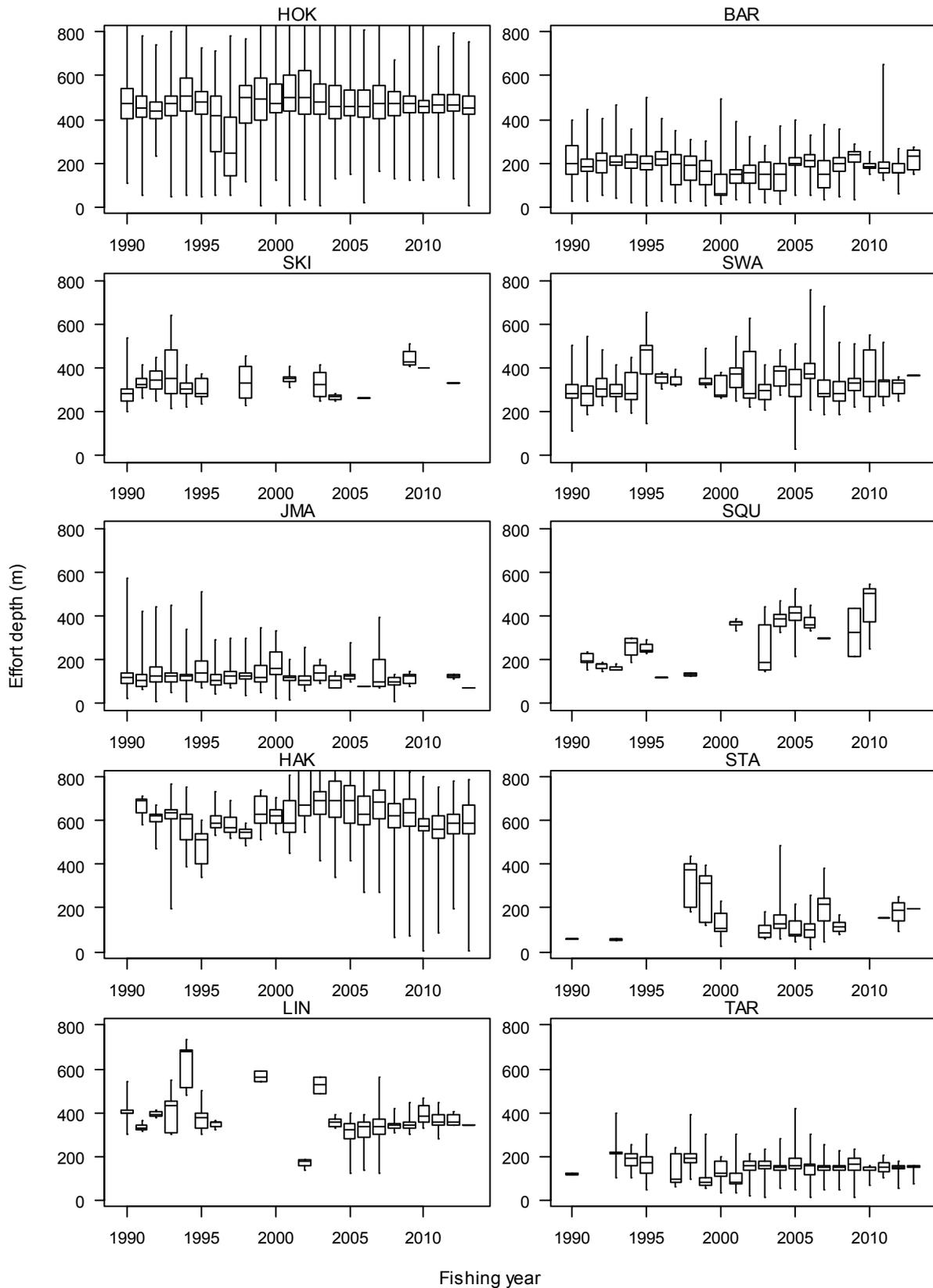
Figure C37a: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) for the effort depth during TCEPR bottom trawls that caught gemfish in the SKI 7 fishery, based on the groomed unmerged data. Target species codes are defined in Table C12.
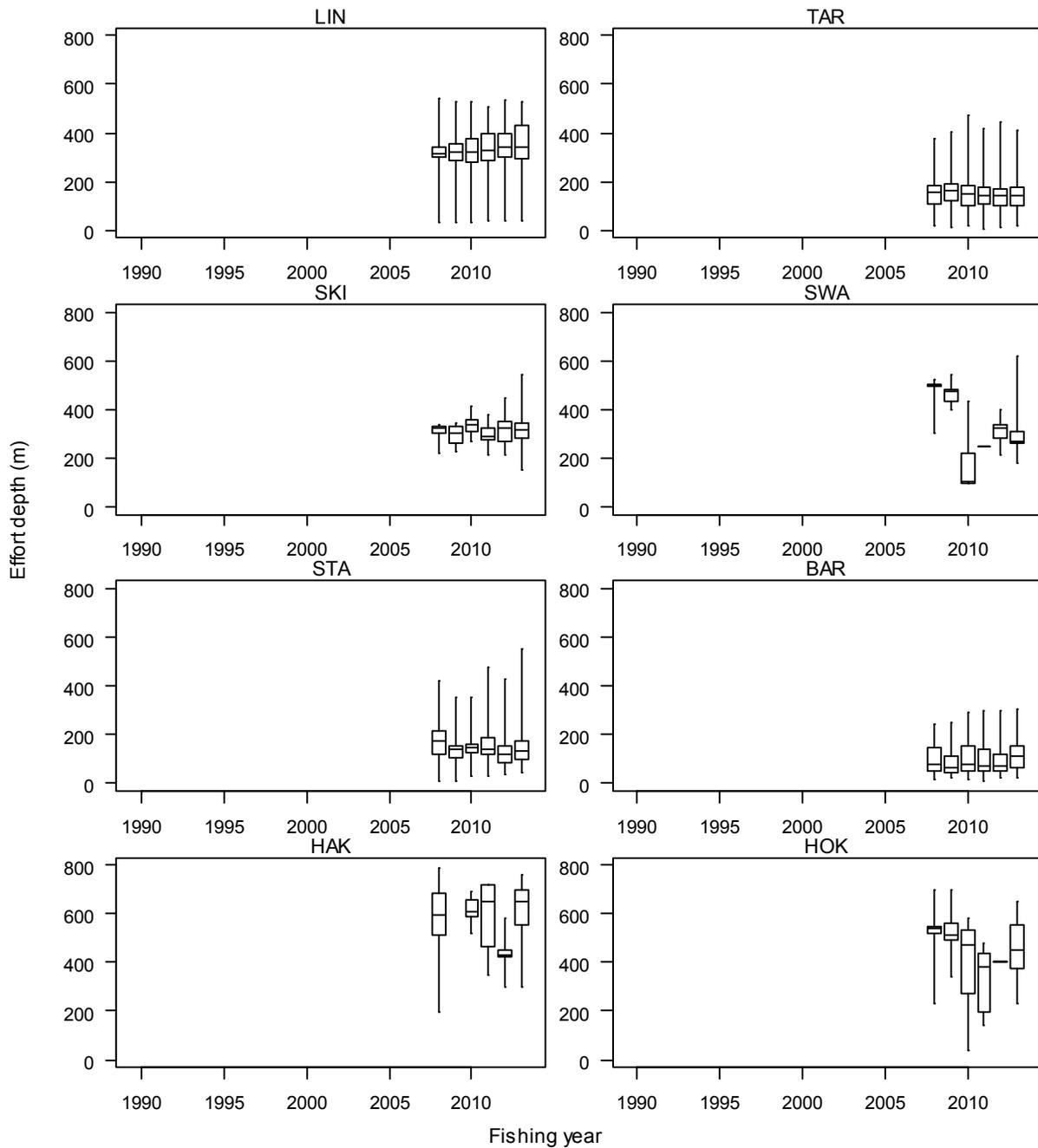
Figure C37b: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) for the effort depth during TCER bottom trawls that caught gemfish in the SKI 7 fishery, based on the groomed unmerged data. Target species codes are defined in Table C12.
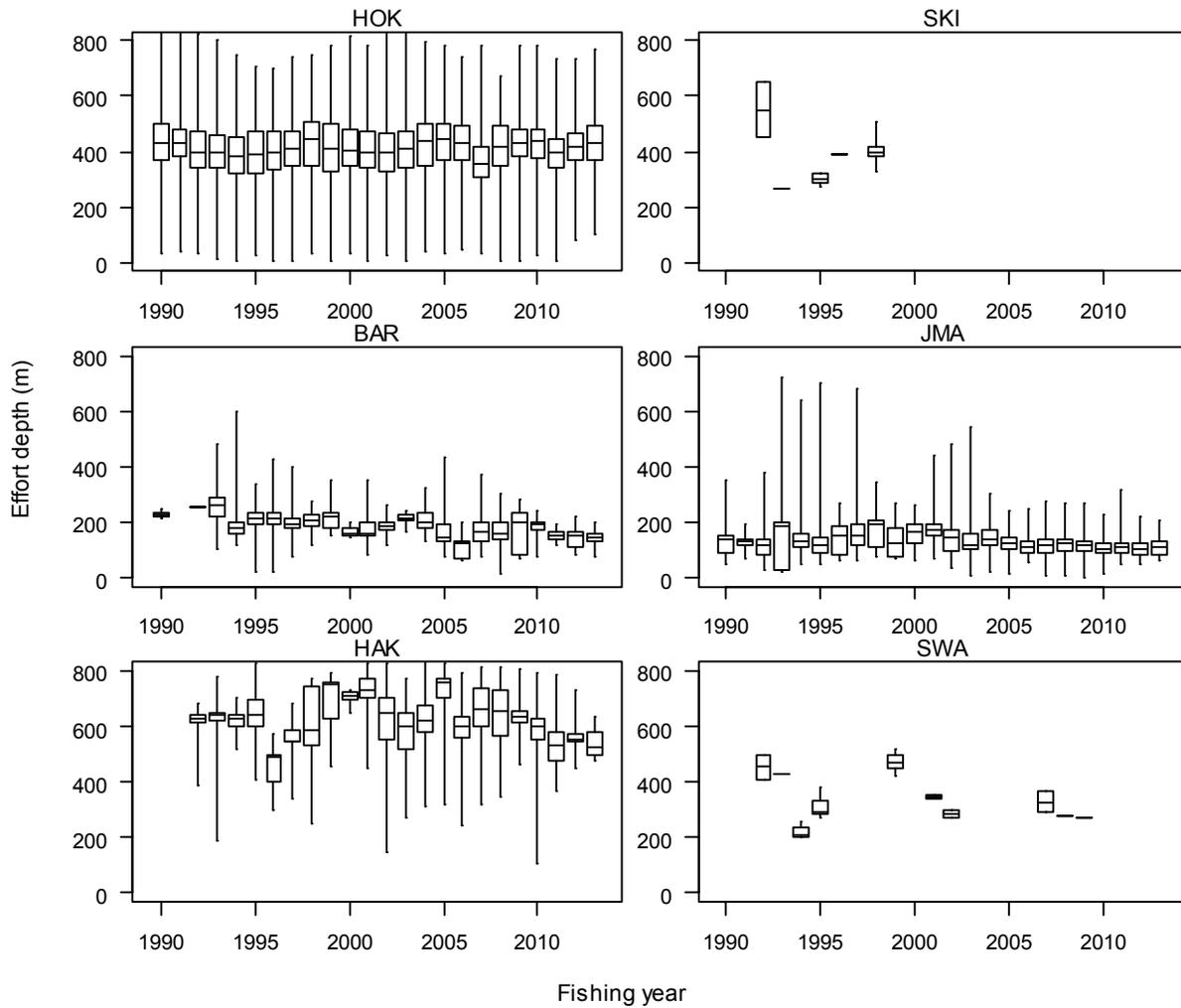
Figure C37c: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) for the fishing duration during TCEPR midwater trawls that caught gemfish in the SKI 7 fishery, based on the groomed unmerged data. Target species codes are defined in Table C12.
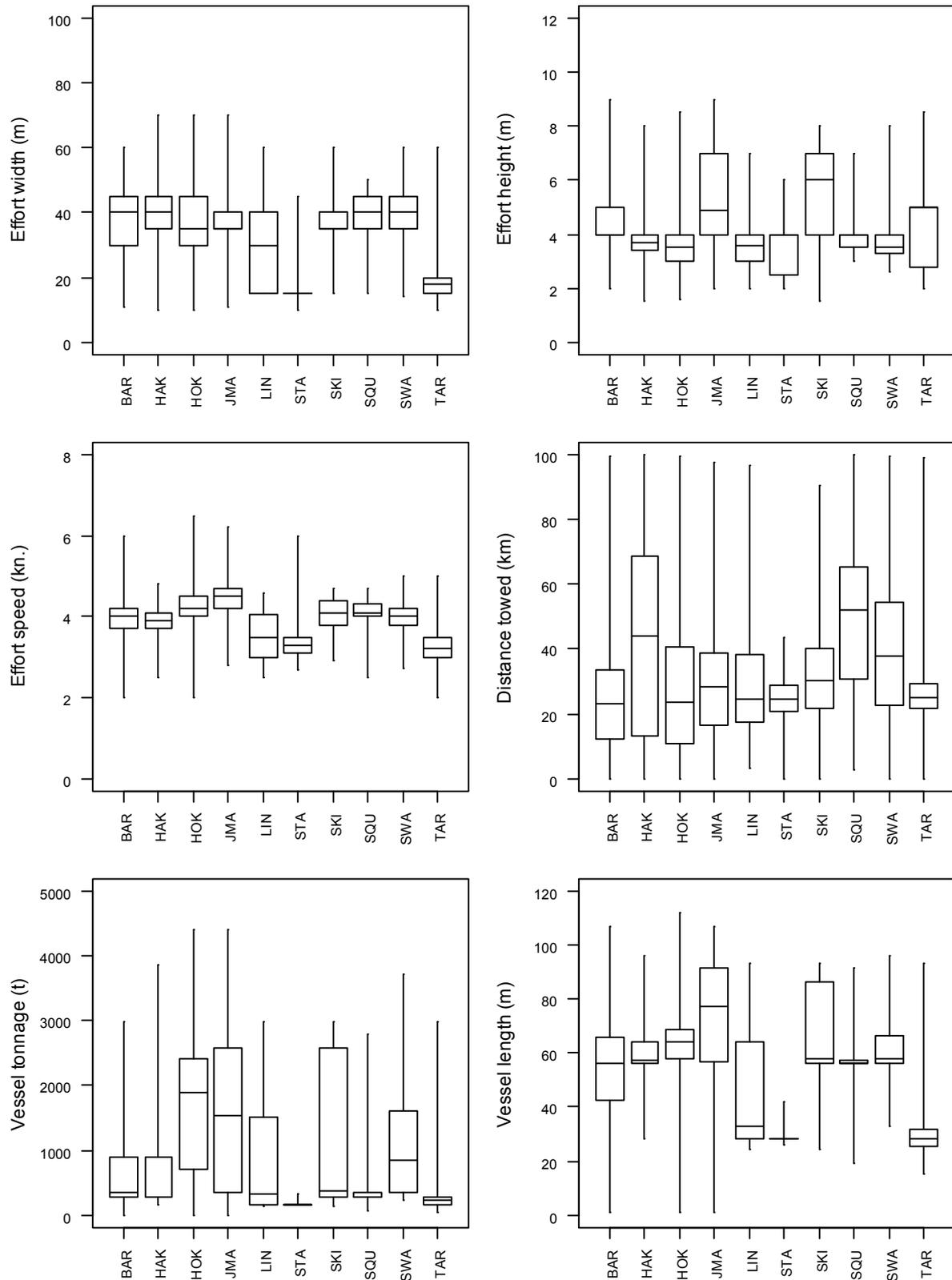
Figure C38a: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) for fishing effort variables and vessel characteristics for the main target species fisheries that caught gemfish and reported bottom trawl effort on TCEPRs in the SKI 7 fishery, 1989–90 to 2012–13. Target species codes are defined in Table C12.
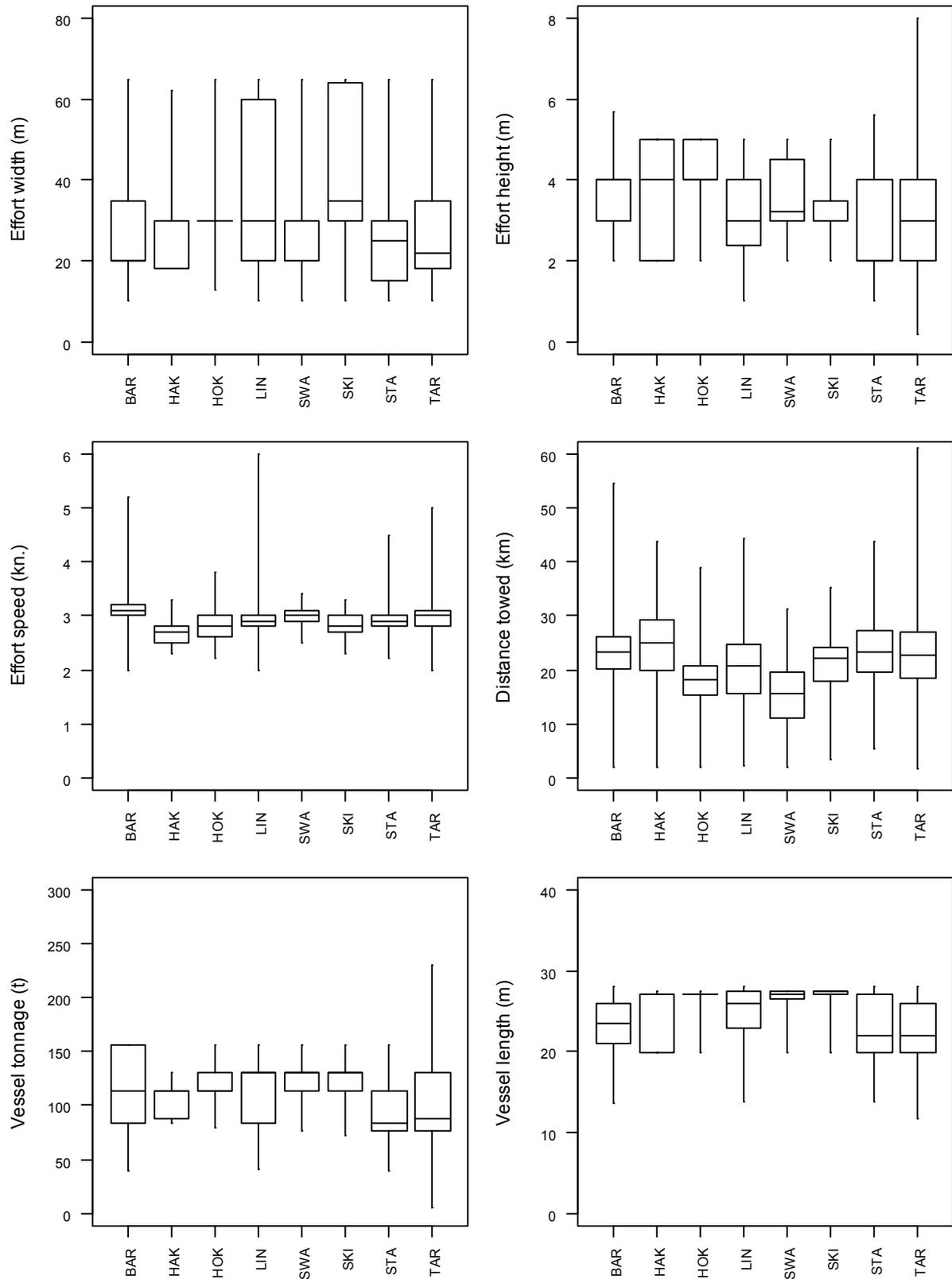
Figure C38b: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) for fishing effort variables and vessel characteristics for the main target species fisheries that caught gemfish and reported bottom trawl effort on TCERs in the SKI 7 fishery, 1989–90 to 2012–13. Target species codes are defined in Table C12.
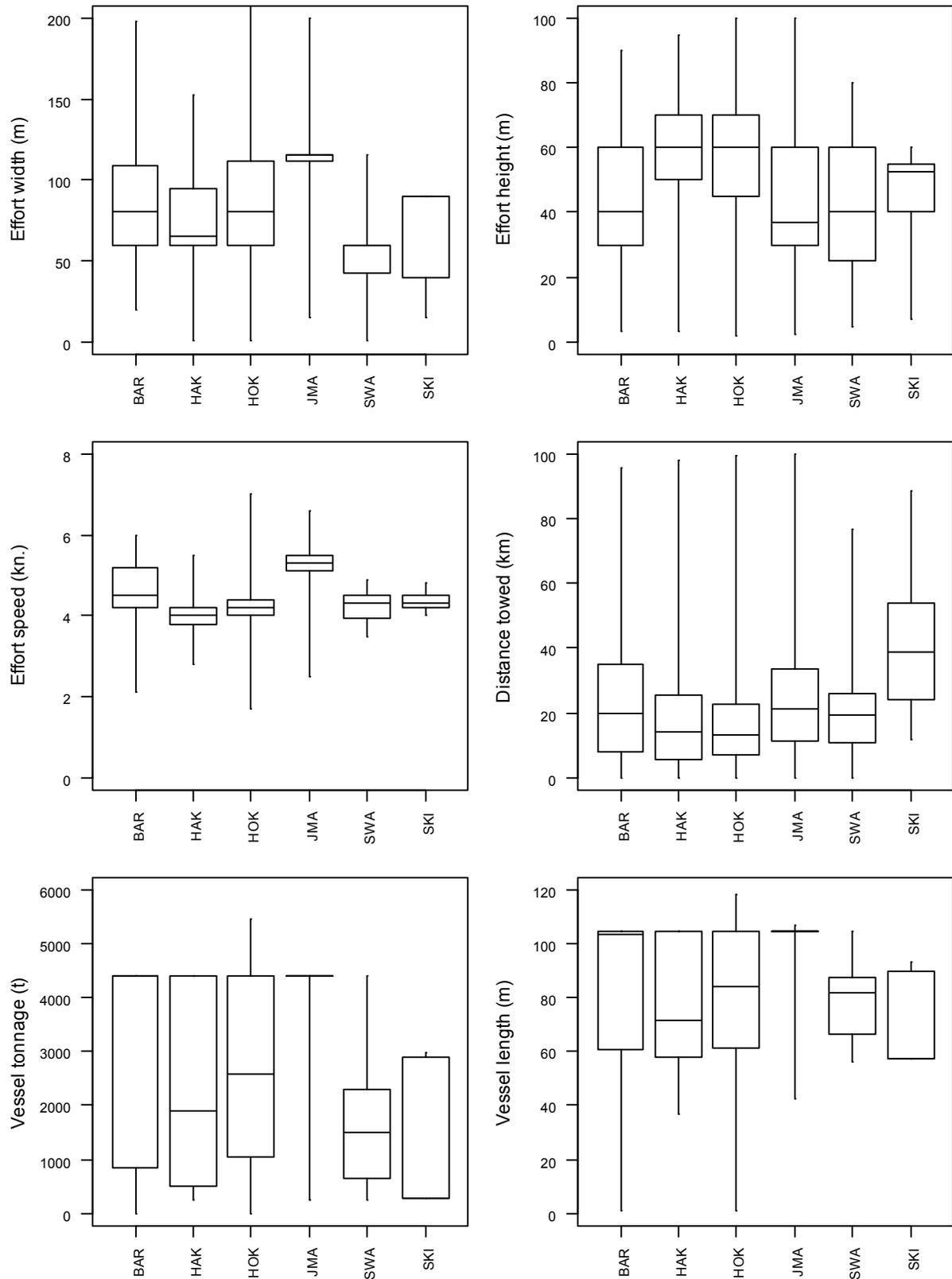
Figure C38c: Annual median (horizontal line), inter-quartile ranges (box), and range (vertical lines) for fishing effort variables and vessel characteristics for the main target species fisheries that caught gemfish and reported midwater trawl effort on TCEPRs in the SKI 7 fishery, 1989–90 to 2012–13. Target species codes are defined in Table C12.
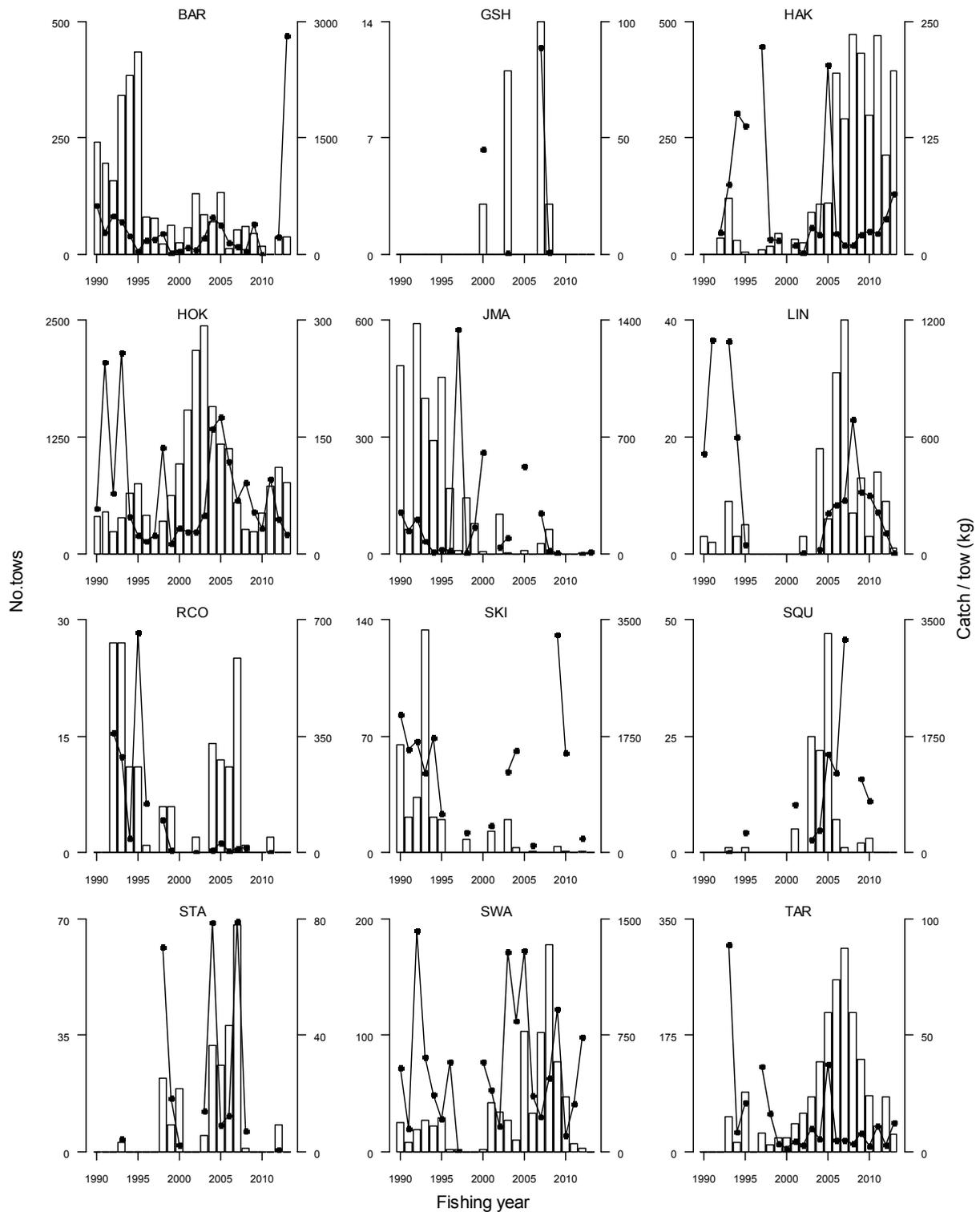
Figure C39a: Unstandardised catch rate (kg/tow) of gemfish taken by TCEPR bottom trawl gear (points and lines), and the number of tows (bars) for SKI 7, by target species for merged data. Target species codes are given in Table C12.
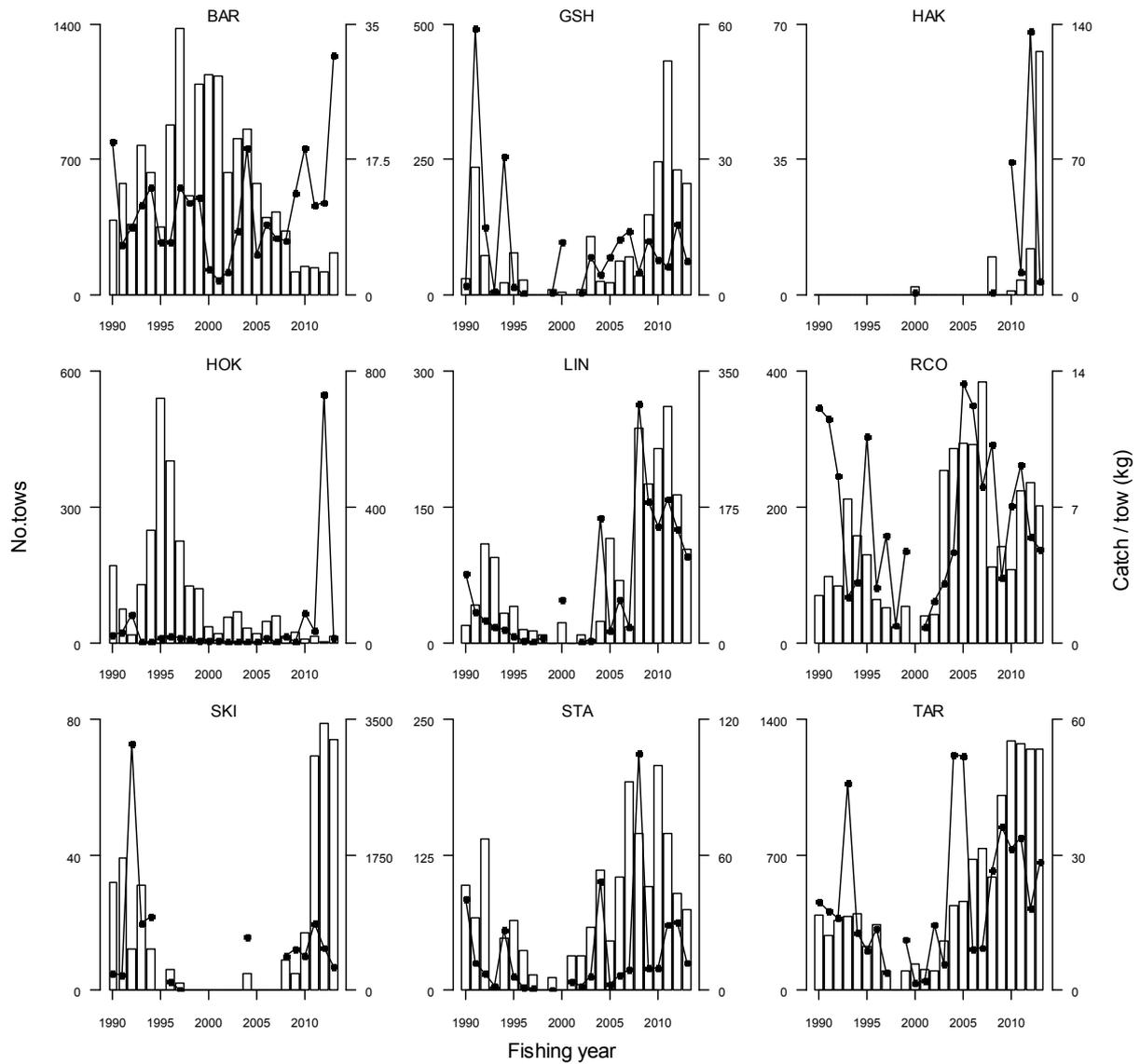
Figure C39b: Unstandardised catch rate (kg/tow) of gemfish taken by CELR and TCER bottom trawl gear (points and lines), and the number of tows (bars) for SKI 7, by target species for merged data. Target species codes are given in Table C12. Note that TCER forms replaced CELR forms for trawling from the 2008 fishing year.
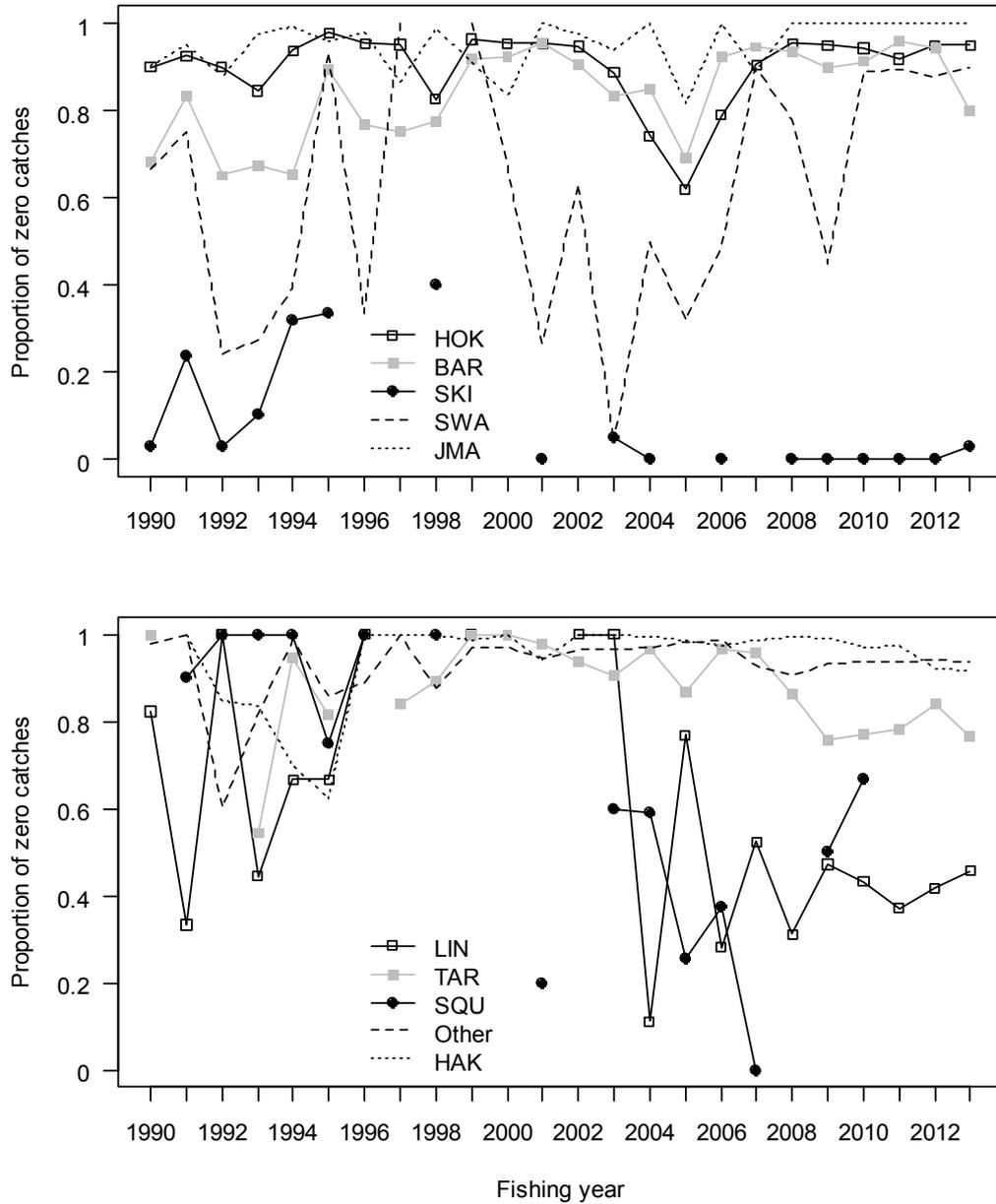
Figure C40: Proportion of zeros by main target species for SKI 7 for TCEPR and TCER bottom trawl unmerged data.
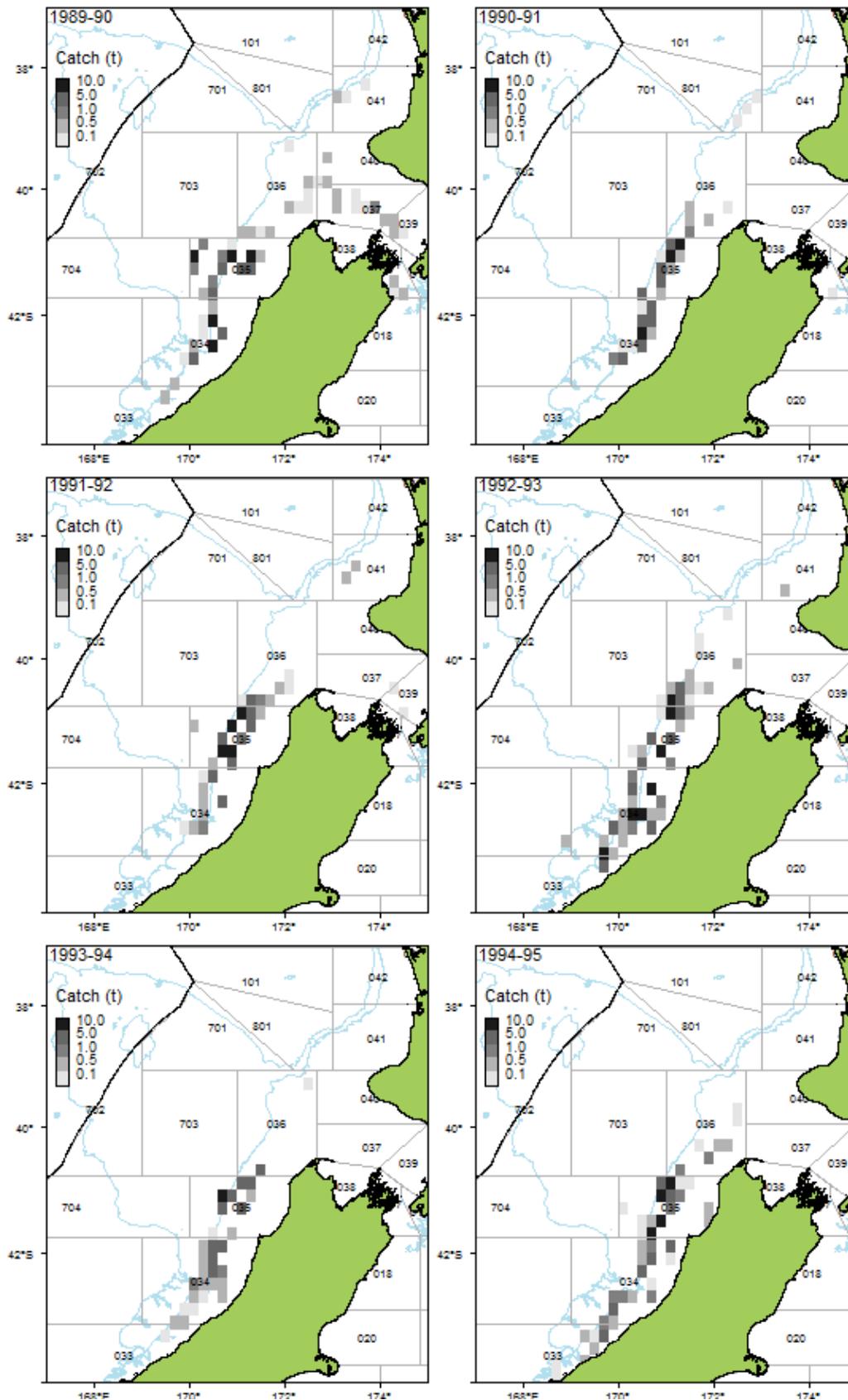
Figure C41: Distribution of TCEPR bottom trawl gemfish catch aggregated into 0.2° cells within the SKI 7 fishery, 1989–90 to 1994–95.
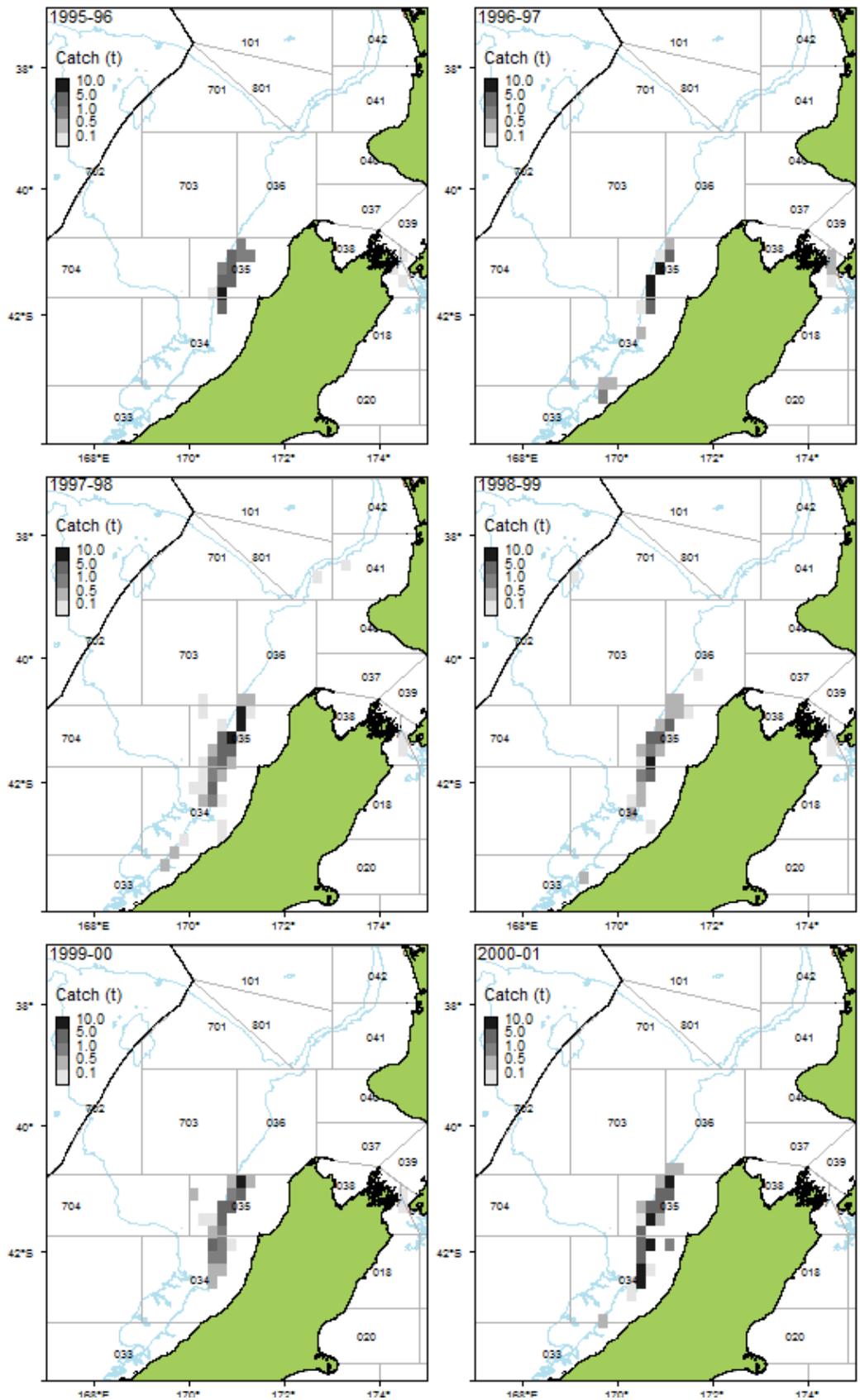
Figure C41 *continued***: Distribution of TCEPR bottom trawl gemfish catch aggregated into 0.2° cells within the SKI 7 fishery, 1995–96 to 2000–01.**
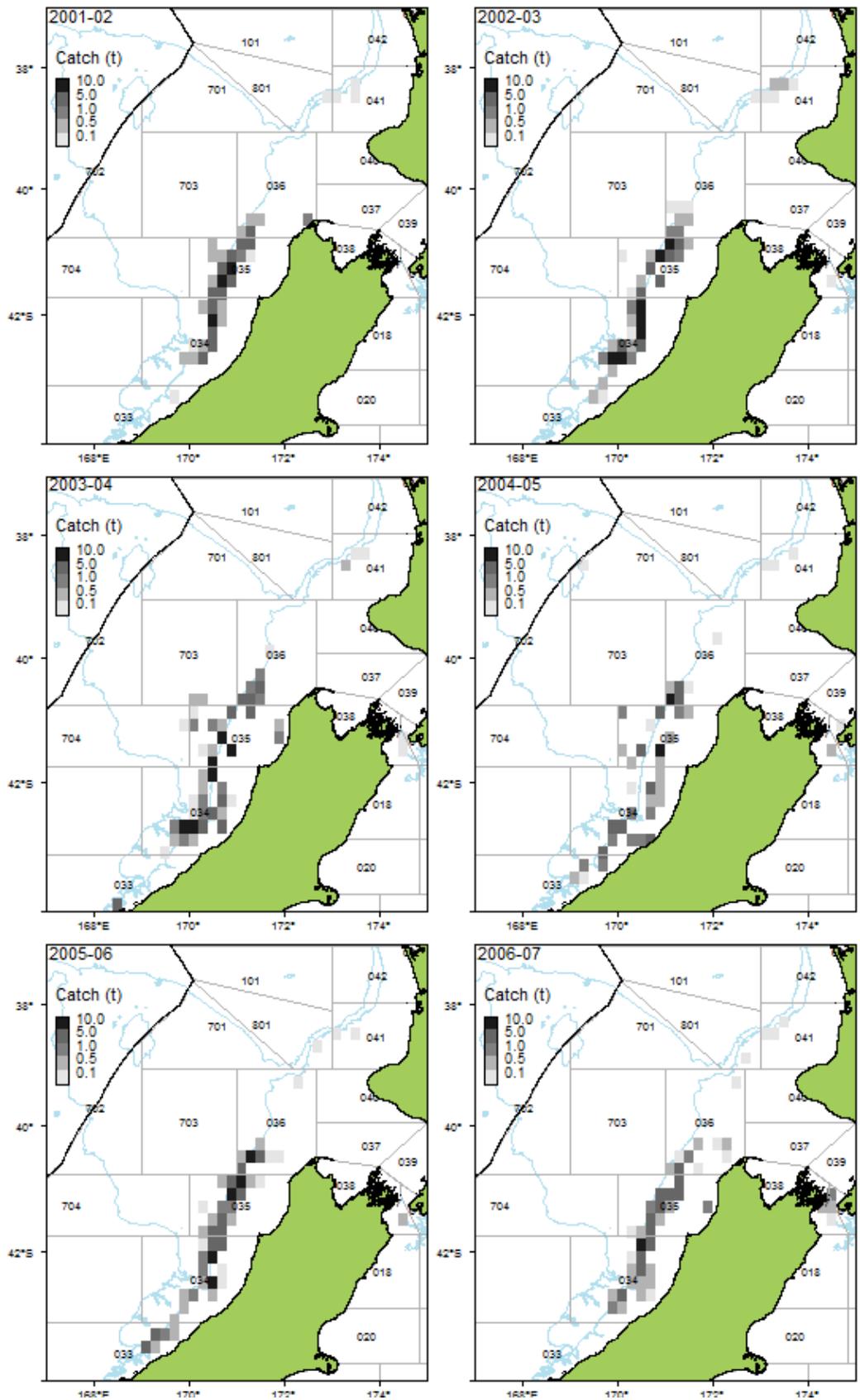
Figure C41 *continued*: **Distribution of TCEPR bottom trawl gemfish catch aggregated into 0.2° cells within the SKI 7 fishery, 2001–02 to 2006–07.**
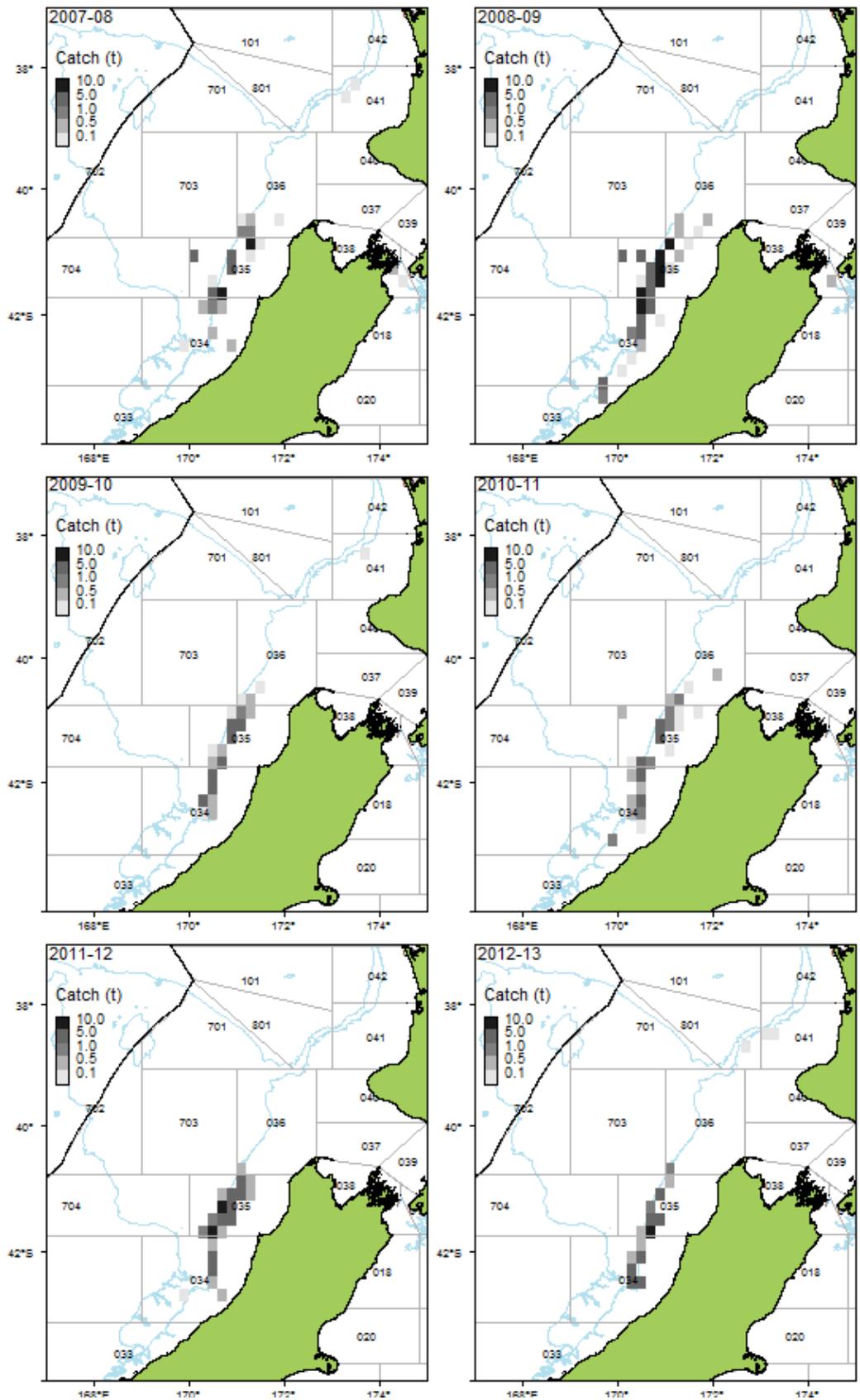
Figure C41 *continued*: **Distribution of TCEPR bottom trawl gemfish catch aggregated into 0.2° cells within the SKI 7 fishery, 2007–08 to 2012–13.**
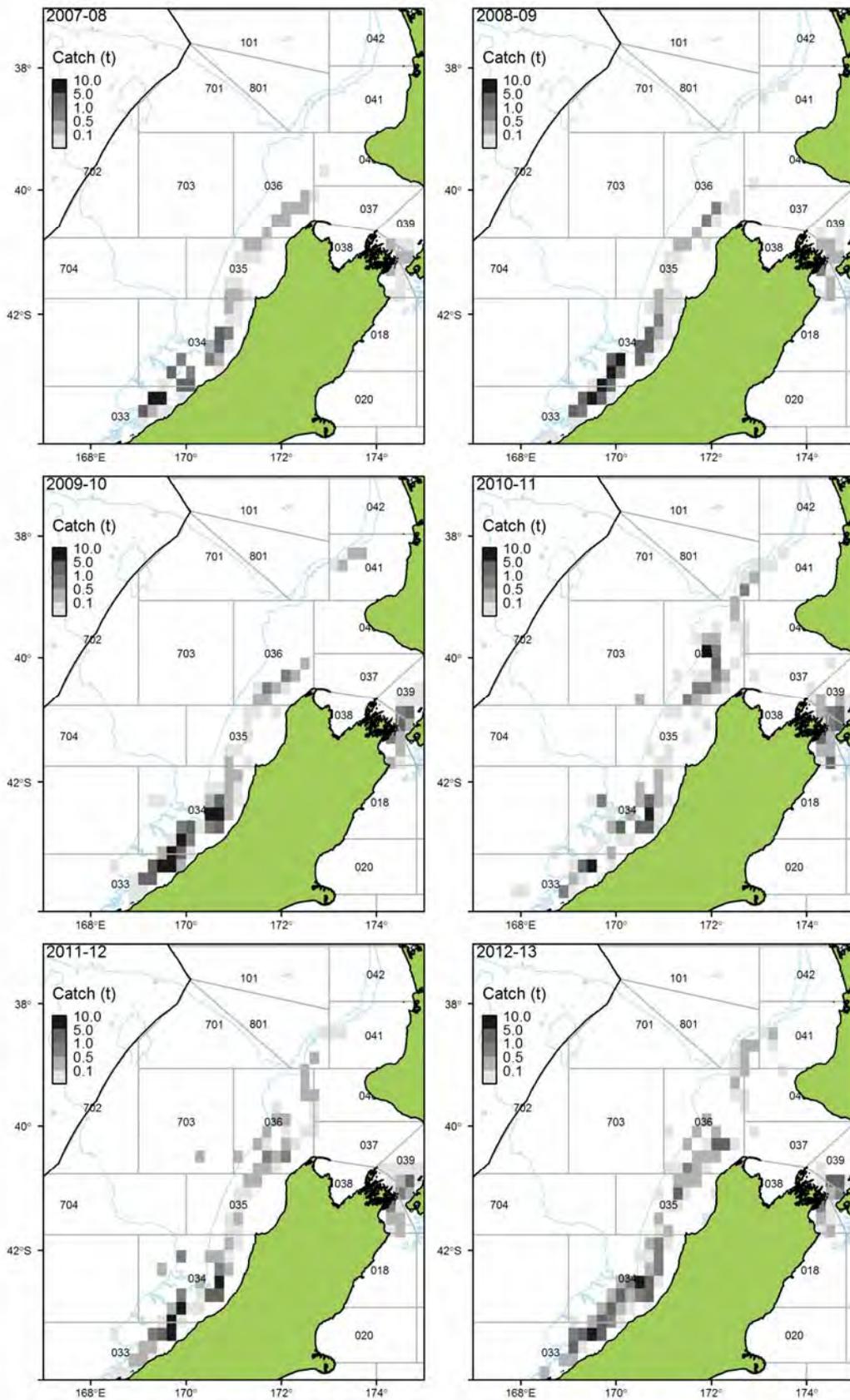
Figure C42: Distribution of TCER bottom trawl gemfish catch aggregated into 0.2° cells within the SKI 7 fishery, 2007–08 to 2012–13.
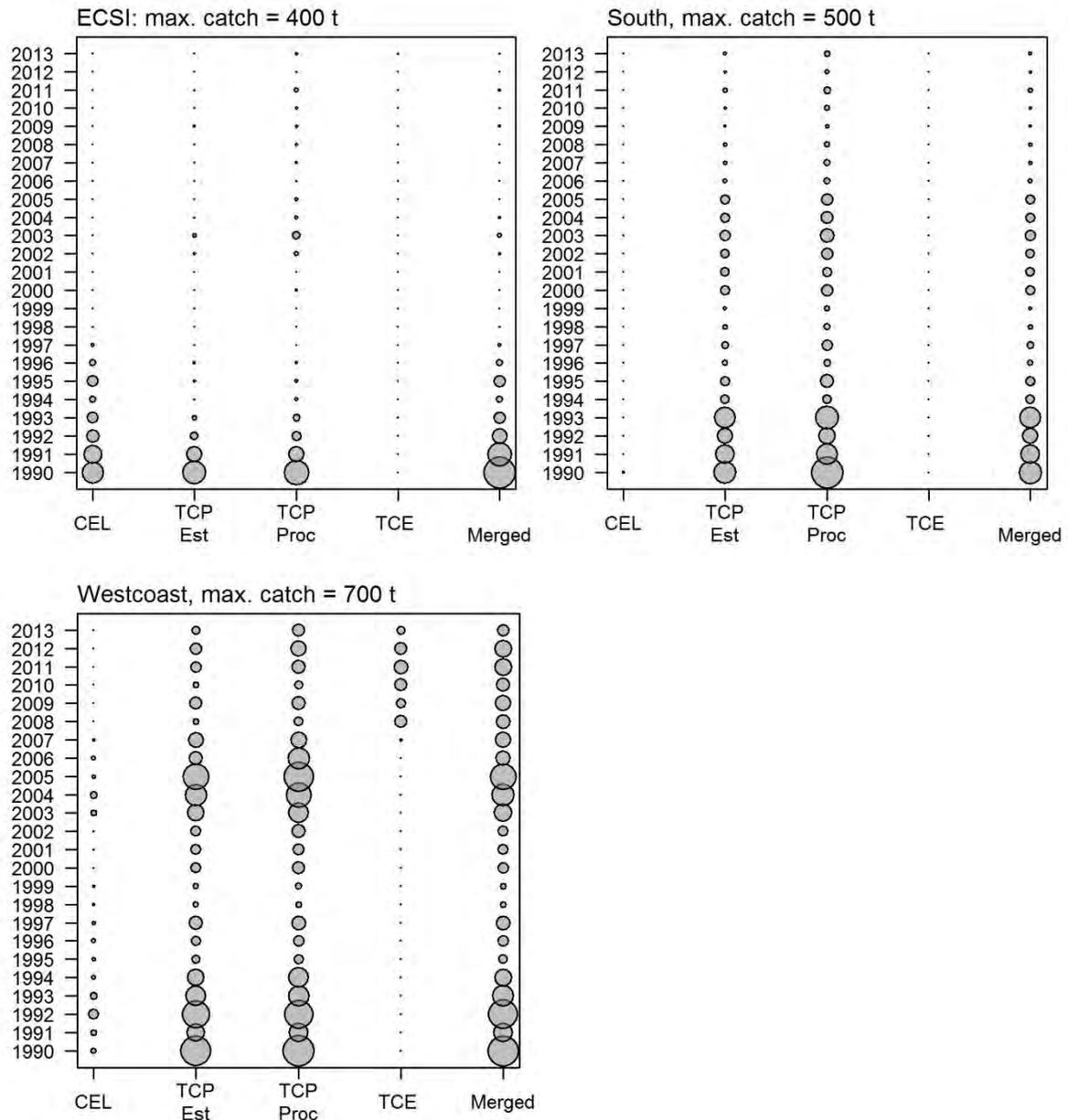
Figure C43: Annual catches (t) by form type for SKI 3 (Chatham and South) and SKI 7 by fishing years 1989–90 (1990) to 2012–13 (2013). CEL is the groomed estimated catch from CELR forms, TCP Est is the groomed estimated catch reported on the TCEPR forms, TCP Proc is the groomed greenweight from the processed part of the TCEPR forms, and TCE is the groomed estimated catch from TCER forms. Merged is the combined groomed estimated catch from all forms. The area of the circle is proportional to the annual catches (only comparable within each panel).

APPENDIX D: CATCH-PER-UNIT-EFFORT ANALYSIS

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

(a) SKI 7 TCEPR and TCER tow-by-tow data

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

Table D2: CPUE data constraints for core datasets in the SKI 7 fishery.

(1) SKI 7: TCEPR tow–by–tow data mixed target tows – estimated catch

Data source	TCEPR tow–by–tow
Year range	2000–2013
Season definition	May–September
Statistical areas	034, 035
Method	BT
Target species	BAR, HOK, HAK, SKI, SQU, SWA
Core vessel selection	> 80% of catch, ≥ 7 years vessel participation, all tows per vessel-year
Depth	100–800 m
Gemfish catch	All catches < 10 t per tow

(2) SKI 7: TCEPR tow–by–tow data hoki target tows – estimated catch

Data source	TCEPR tow–by–tow
Year range	2000–2013
Season definition	June–September
Statistical areas	034, 035
Method	BT, MW, MB (midwater gear towed near the bottom)
Target species	HOK
Core vessel selection	80% of catch, ≥ 6 years vessel participation, all tows per vessel-year
Depth	100–800 m

(3) SKI 7: TCER tow–by–tow data mixed target bottom tows – estimated catch

Data source	TCER tow–by–tow (top 8 catch species data)
Year range	2008–2013
Season definition	October–June
Statistical areas	033, 034
Method	BT
Target species	LIN, SKI, TAR
Core vessel selection	≥ 3 years vessel participation, for vessels that fished regularly from 2000 (based on CELR data)
Depth	50–500 m

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

(1) Estimated TCEPR mixed target bottom trawl catch data, May-September in 034 and 035, for each fishing year during 2000 to 2013

Fish year			All vessels						Core vessels			
	Vess	Tows	Prop. zero tows	Catch (t)	No. non-zero tows	CPUE	Vess	Tows	Prop. zero tows	Catch (t)	No. non-zero tows	CPUE
2000	27	1 059	0.95	21.1	54	0.39	8	318	0.88	18.3	39	0.47
2001	33	1 883	0.93	53.9	130	0.41	13	835	0.87	51.2	111	0.46
2002	36	2 514	0.94	38.9	152	0.26	13	1 405	0.92	36.5	118	0.31
2003	39	2 969	0.87	139.5	372	0.38	16	1 87	0.83	126.8	310	0.41
2004	36	1 898	0.76	212.7	448	0.47	16	1 294	0.73	174.5	348	0.50
2005	27	1 825	0.68	332.4	584	0.57	16	1 200	0.63	279.7	448	0.62
2006	25	1 807	0.89	62.3	202	0.31	14	1 293	0.87	52.3	167	0.31
2007	20	1 308	0.94	44.7	81	0.55	12	944	0.92	44.1	76	0.58
2008	15	1 455	0.96	59.6	61	0.98	10	1 101	0.95	58.3	59	0.99
2009	18	1 229	0.92	99.0	100	0.99	12	945	0.89	99.0	100	0.99
2010	19	1 166	0.96	14.6	49	0.30	13	935	0.95	14.6	49	0.30
2011	18	1 548	0.95	40.7	77	0.53	15	1 482	0.95	40.0	74	0.54
2012	20	1 502	0.95	34.4	78	0.44	11	940	0.93	24.4	65	0.38
2013	18	1 394	0.93	63.3	101	0.63	10	1 015	0.91	62.7	93	0.67
	56	23 557		1 216.9	2 489		17	15 747		1 082.4	2	

(2) Estimated TCEPR hoki all methods catch data, June-September in 034 and 035, for each fishing year during 2000 to 2013

Fish year			All vessels						Core vessels			
	Vess	Tows	Prop. zero tows	Catch (t)	No. non-zero tows	CPUE	Vess	Tows	Prop. zero tows	Catch (t)	No. non-zero tows	CPUE
2000	38	3 384	0.97	26.9	93	0.29	10	822	0.95	16.7	45	0.37
2001	53	5 391	0.97	37.5	150	0.25	13	1 607	0.93	32.7	108	0.30
2002	57	6 205	0.96	35.9	245	0.15	18	2 603	0.94	32	156	0.21
2003	46	6 139	0.92	90.3	488	0.19	21	3 329	0.88	75.7	400	0.19
2004	50	5 286	0.82	234.0	962	0.24	21	2 351	0.71	180.4	678	0.27
2005	37	3 269	0.77	200.5	764	0.26	22	1 461	0.60	160.2	580	0.28
2006	33	2 376	0.90	55.3	243	0.23	17	1 169	0.83	48.6	203	0.24
2007	31	1 612	0.94	19.7	93	0.21	13	779	0.89	19.4	83	0.23
2008	19	975	0.97	20.6	28	0.74	6	366	0.95	20.4	19	1.07
2009	20	1 016	0.97	6.7	27	0.25	6	302	0.93	6.2	22	0.28
2010	26	1 609	0.94	10.5	102	0.1	15	862	0.92	7.3	71	0.10
2011	27	2 358	0.92	48.2	195	0.25	20	1 655	0.9	44.8	171	0.26
2012	29	2 393	0.97	25.0	72	0.35	13	1 129	0.94	23.9	67	0.36
2013	24	2 591	0.94	22.9	153	0.15	12	1 164	0.91	16.5	109	0.15
Total	71	44 604		834.0	3 615		23	19 599		684.9	2 712	

(3) Estimated TCER main target bottom trawl catch data, October-June in 033–034, for each fishing year 2008 to 2013

			All vessels							Core vessels		
Fish year	No. vessels	No. tows	Prop. zero tows	Catch (t)	No. non-zero tows	CPUE	No. vessels	No. tows	Prop. zero tows	Catch (t)	No. non-zero tows	CPUE
2008	13	673	0.58	75.7	286	0.26	9	636	0.55	75.6	284	0.27
2009	11	910	0.62	50.9	348	0.15	9	878	0.61	50.7	339	0.15
2010	11	969	0.59	56.5	396	0.14	9	884	0.57	56.2	384	0.15
2011	16	925	0.62	102.2	353	0.29	9	834	0.59	101.8	339	0.30
2012	14	717	0.60	63.5	286	0.22	10	693	0.60	632.6	278	0.23
2013	12	747	0.62	42.3	284	0.15	9	700	0.61	40.0	274	0.15
Total	21	4 941		391.0	4 941		10	4 625		386.8	1 898	

Table D4: Variables retained in order of decreasing explanatory value by each SKI 7 lognormal model and the corresponding total r^2 value.

Dataset	Variable	r^2
TCEPR tow–by–tow estimated mixed target, bottom tows. Lognormal For 2000–13 fishing years	Year	6.6
	Vessel	31.5
	Day of fishing year	36.6
	Bottom depth	39.9
	Mid-time of tow	43.3
	Tow duration	45.6
	Target species	46.8
TCEPR tow–by–tow estimated hoki target, all methods. Lognormal For 2000–13 fishing years	Year	6.3
	Vessel	32.0
	Headline height	46.6
	Day of fishing year	49.7
	Wingspread	51.4
	Mid-time of tow	52.8
	Tow duration	54.5
TCER tow BT mixed target bottom tows. Lognormal For 2008–13 fishing years	Year	3.9
	Target species	26.6
	Vessel	35.9
	Bottom depth	41.1
	Mid-time of tow	44.5
	Tow duration	46.9
	Day of fishing year	48.5
	Start latitude	49.8

Table D5: SKI 7 lognormal CPUE core indices by fishing year, with 95% confidence intervals and CVs.

(a) TCEPR

Fishing year	Mixed BT target			Hoki target BTMW		
	Index	95% CI	CV	Index	95% CI	CV
2000	0.88	0.64–1.22	0.16	1.15	0.85-1.58	0.16
2001	0.86	0.70–1.05	0.10	1.00	0.82–1.24	0.10
2002	0.67	0.55–0..81	0.10	0.76	0.63–0.90	0.09
2003	0.84	0.73–0.96	0.07	0.92	0.81–1.04	0.06
2004	1.21	1.06–1.38	0.07	1.29	1.16–1.45	0.06
2005	1.58	1.39–1.78	0.06	1.28	1.14–1.45	0.06
2006	1.13	0.96–1.33	0.08	1.27	1.08–1.48	0.08
2007	0.87	0.69–1.10	0.12	0.83	0.66–1.03	0.11
2008	1.21	0.92–1.58	0.14	1.49	0.96–2.31	0.22
2009	1.56	1.22–1.94	0.11	1.27	0.84–1.93	0.21
2010	0.97	0.73–1.30	0.14	0.61	0.47–0.77	0.12
2011	0.92	0.73–1.16	0.12	0.78	0.66–0.92	0.08
2012	0.74	0.58–0.94	0.12	0.89	0.70–1.14	0.12
2013	1.01	0.81–1.27	0.11	0.89	0.72–1.11	0.11

(b) TCER

Fishing year	Mixed target core vessels		
	Index	95% CI	CV
2008	1.21	1.07–1.36	0.06
2009	0.89	0.79–0.99	0.06
2010	0.90	0.81–0.99	0.05
2011	1.09	0.98–1.22	0.06
2012	0.99	0.88–1.11	0.06
2013	0.97	0.86–1.09	0.05

(a) All vessels
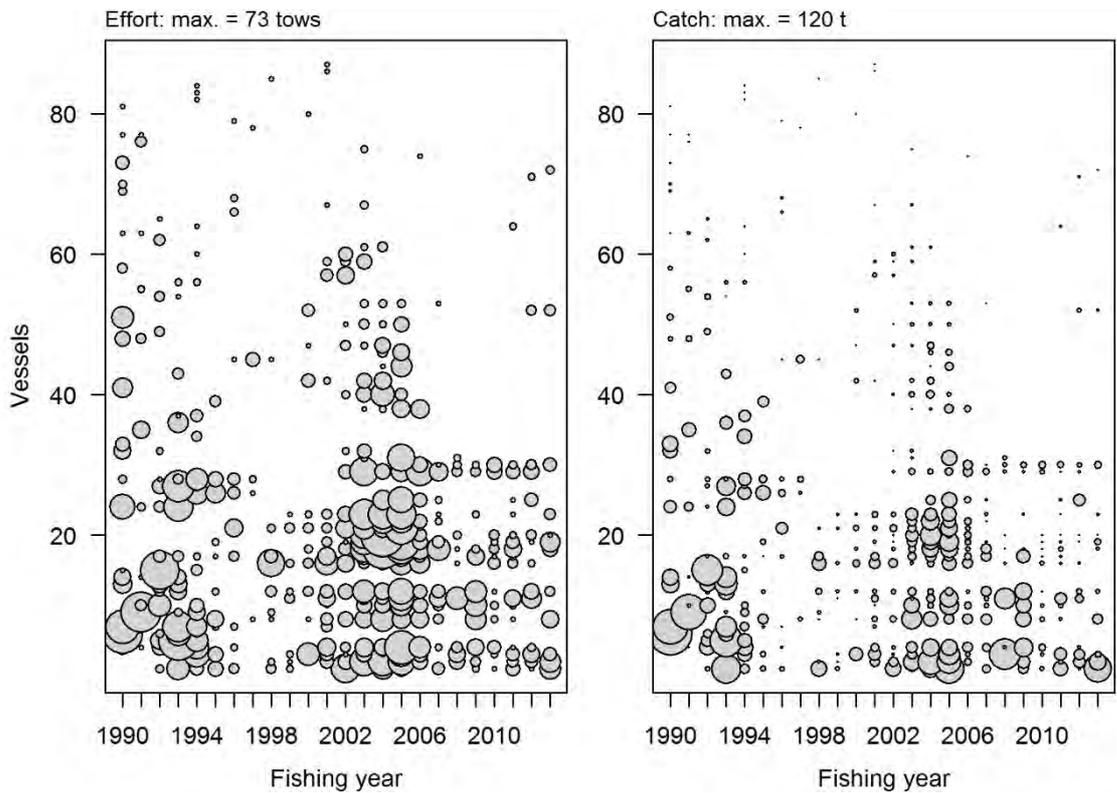
**(b) Core vessels (fished for at least 7 years)**
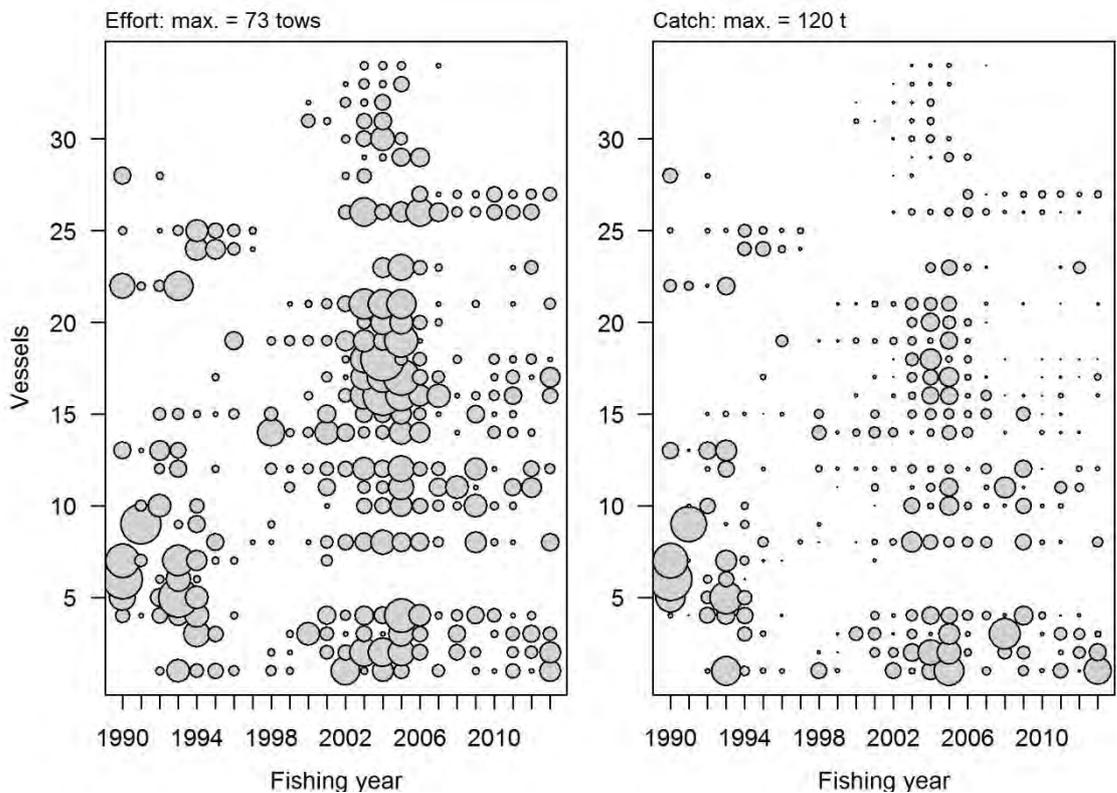
Figure D1: SKI 7 summary of effort (number of TCEPR tows) and estimated gemfish catch (t) by fishing year for 1990–2013 from (a) all vessels and (b) vessels with at least seven years of gemfish catch. The symbol area is proportional to either the number of tows or the annual catch, and the maximum circle size is shown in the label on the plot.

(a) All vessels
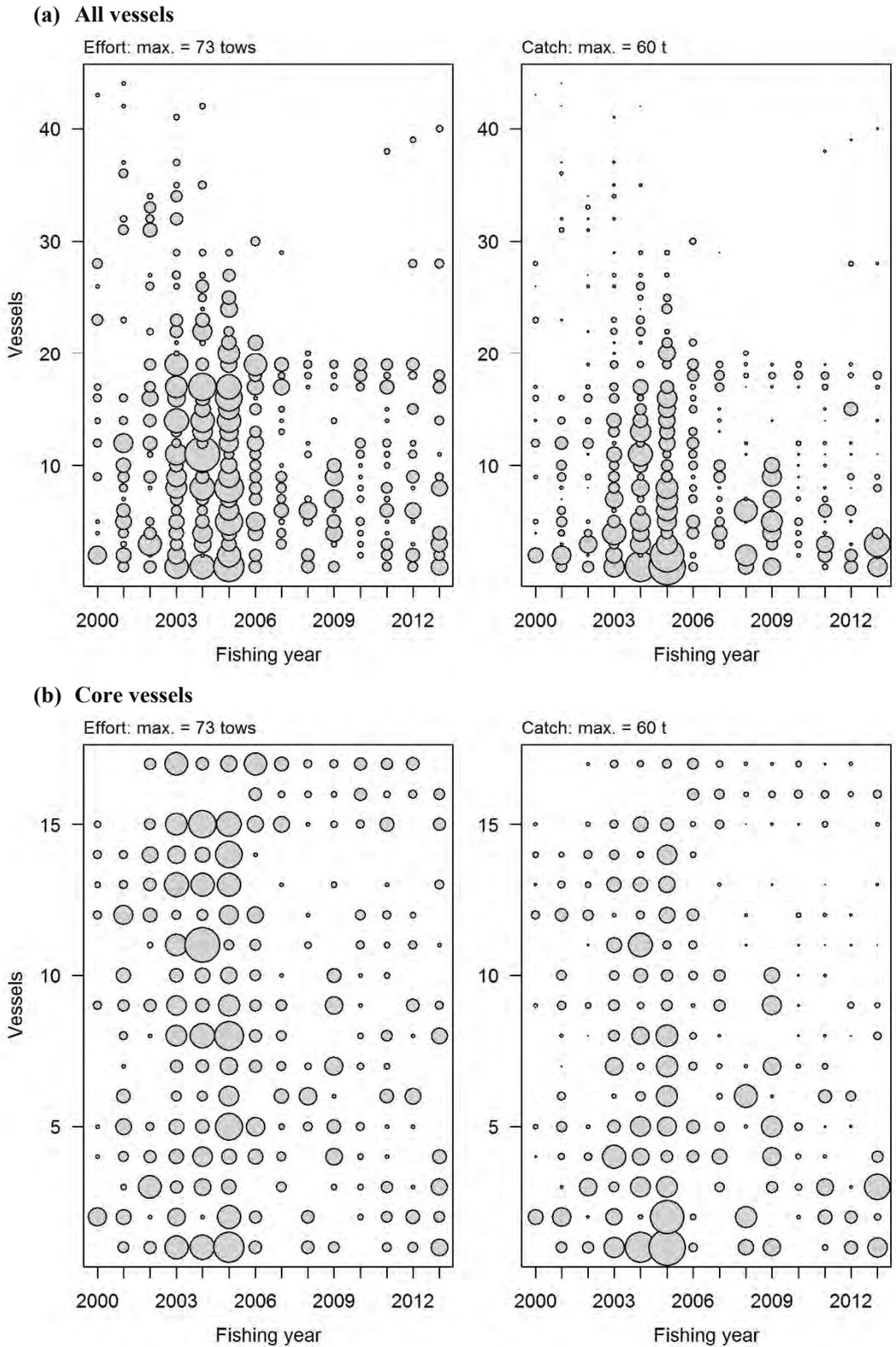
(b) Core vessels

Figure D2: SKI 7 summary of effort (number of TCEPR tows) and estimated gemfish catch (t) by fishing year for 2000–13 from (a) all vessels and (b) from core vessels for the mixed target bottom trawl dataset. The symbol area is proportional to either the number of tows or the annual catch, and the maximum circle size is shown in the label on the plot.
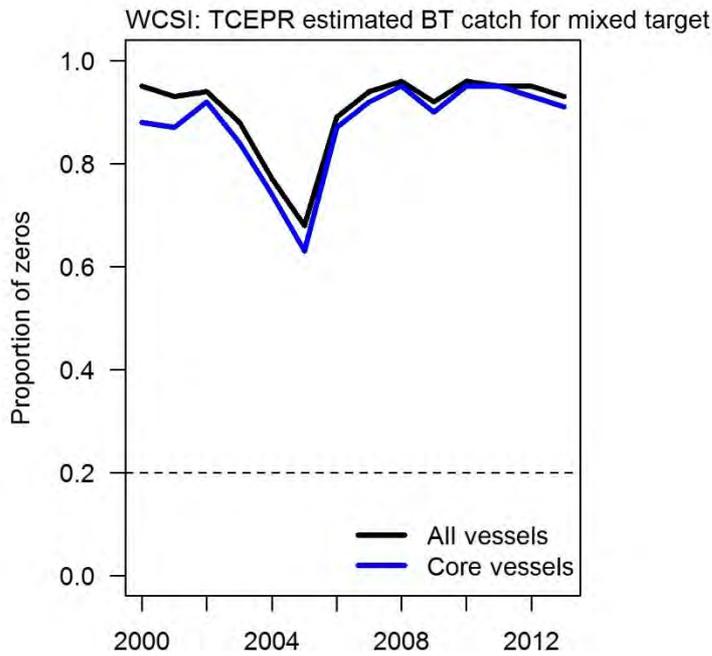
Figure D3: Proportion of zero gemfish catches in the SKI 7 TCEPR bottom trawl mixed target dataset, for all vessels and for core vessels, 2000–13.
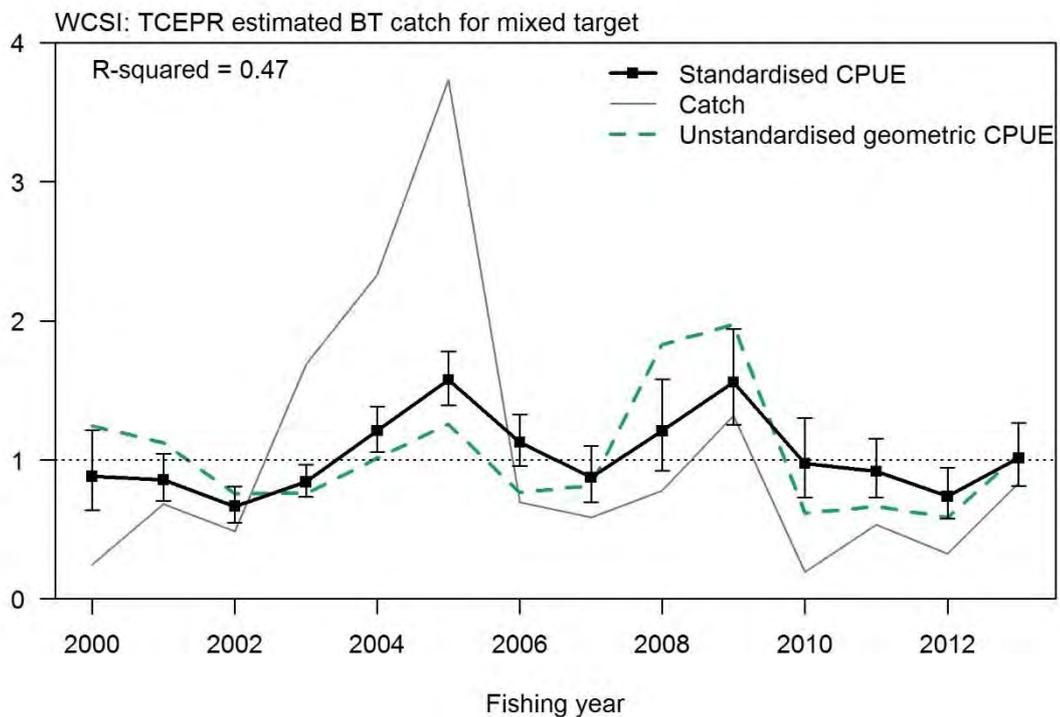
**Figure D4a: CPUE lognormal indices for SKI 7, based on the TCEPR bottom trawl mixed target dataset, showing catches (scaled to same mean as indices), and lognormal standardised and unstandardised indices. Bars indicate 95% confidence intervals.**
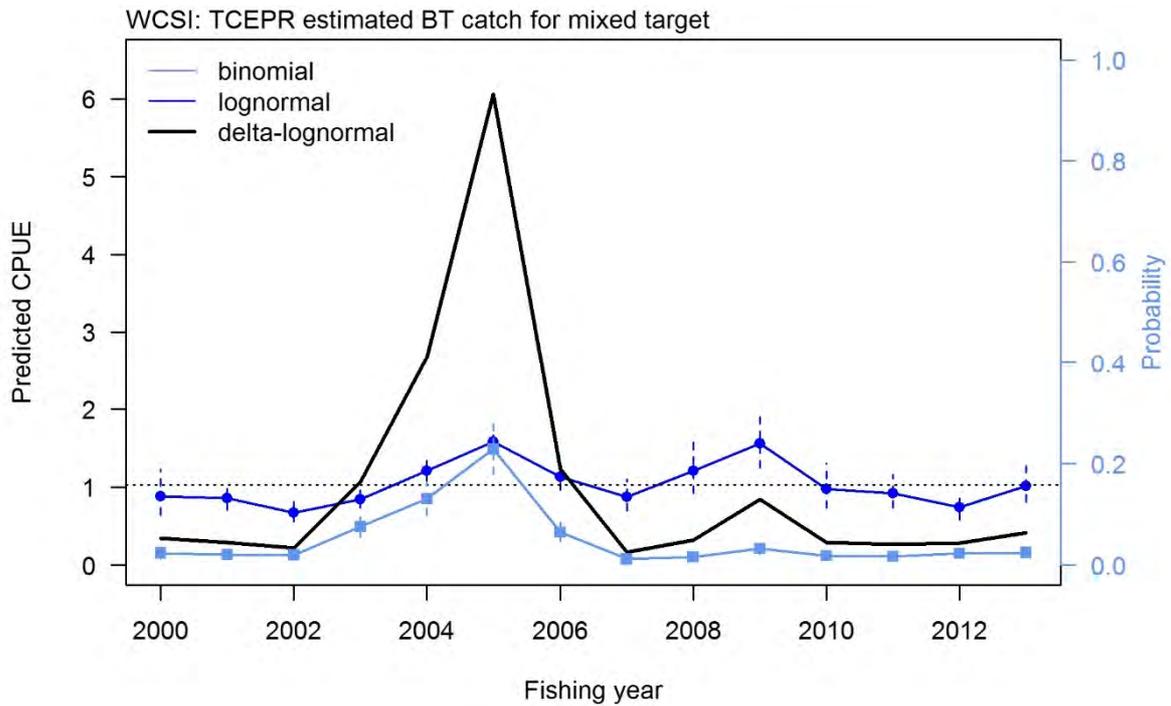
Figure D4b: SKI 7 CPUE from the lognormal, binomial, and delta–lognormal (combined) core vessel mixed target, bottom trawl estimated catch model, for May–September, 2000–2013. Bars indicate 95% confidence intervals.
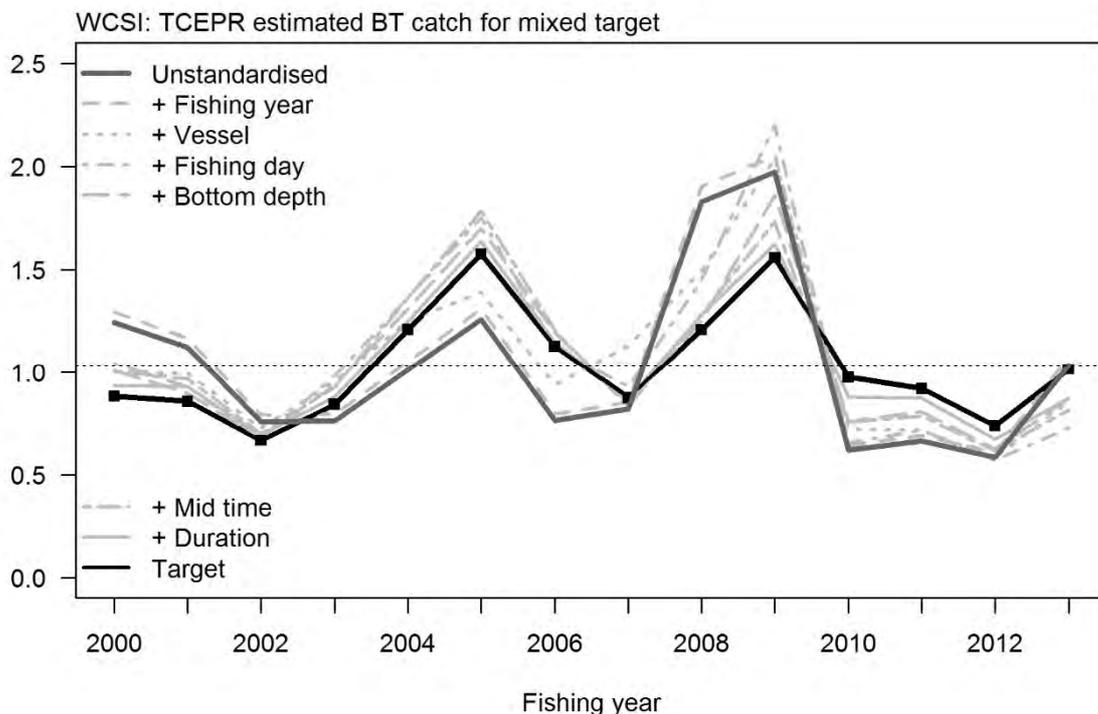
**Figure D5: Addition of variables into the lognormal CPUE from the lognormal model for the SKI 7 trawl fishery using bottom trawls to target arrow squid, barracouta, gemfish, hake, hoki, and silver warehou in Statistical Areas 034 and 035 during May–September of each fishing year, 2000–13.**
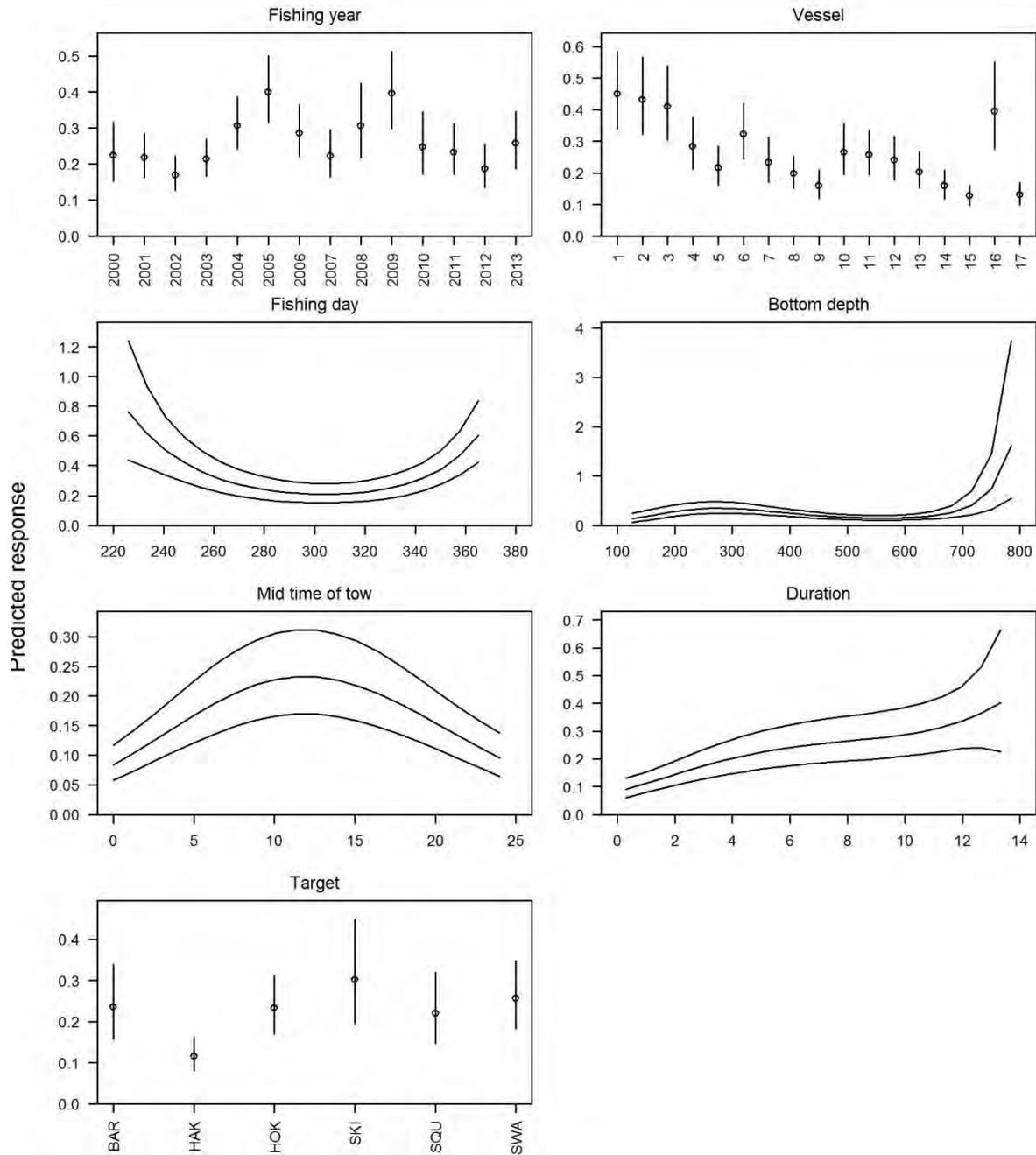
Figure D6: Effects of selected variables in the lognormal model for the SKI 7 TCEPR BT estimated catch for core mixed target vessels, 2000–13. Bars indicate 95% confidence intervals.
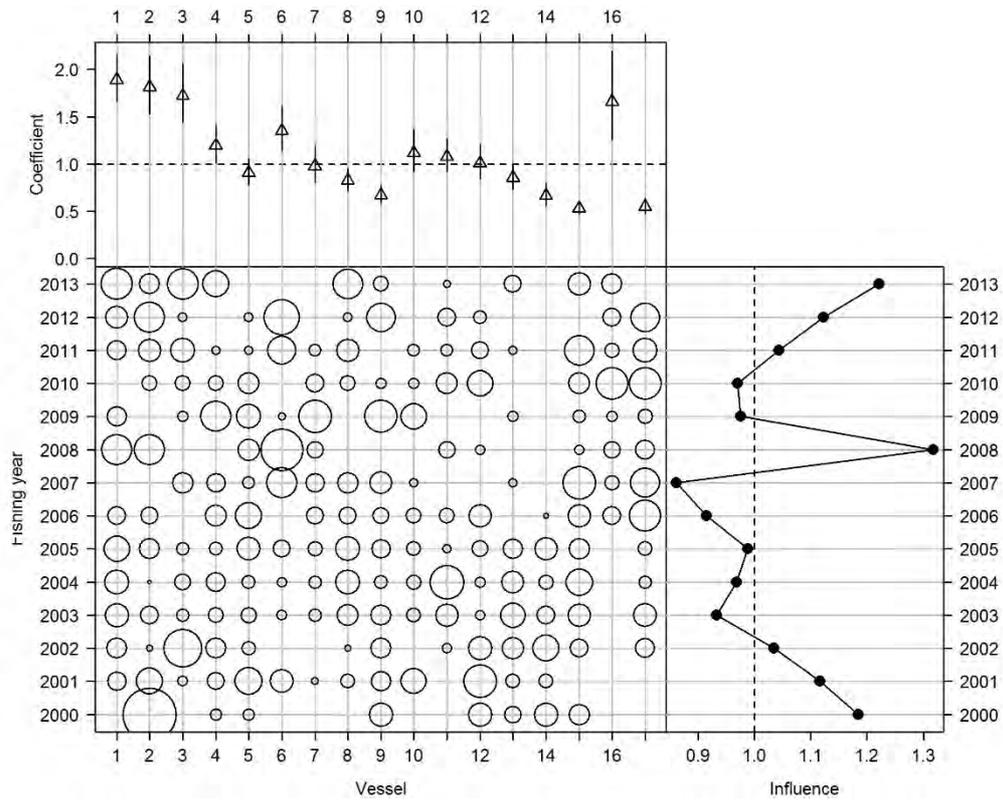
Figure D7a: Effect and influence of vessel in the SKI 7 estimated catch core vessel mixed target BT lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of the effort by variable and fishing year. Bottom right: influence of variable (vessel) on unstandardised CPUE by fishing year.
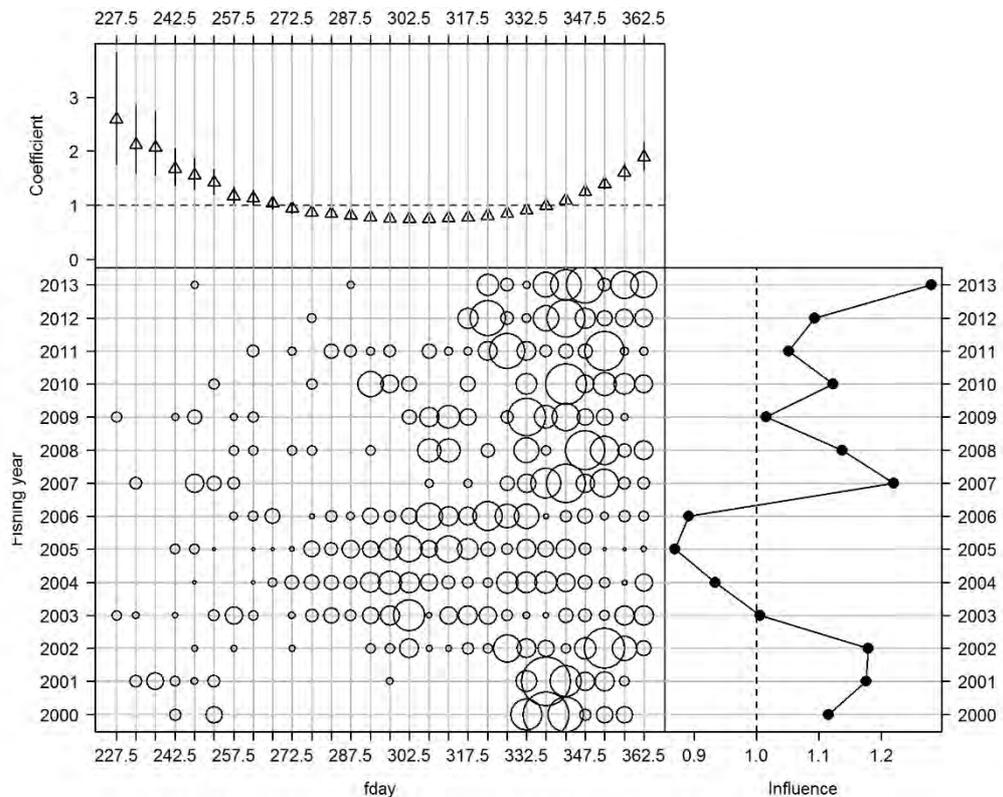
Figure D7b: Effect and influence of day of fishing year (fday) in the SKI 7 estimated catch core vessel mixed target BT lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of the effort by variable and fishing year. Bottom right: influence of variable on unstandardised CPUE by fishing year.
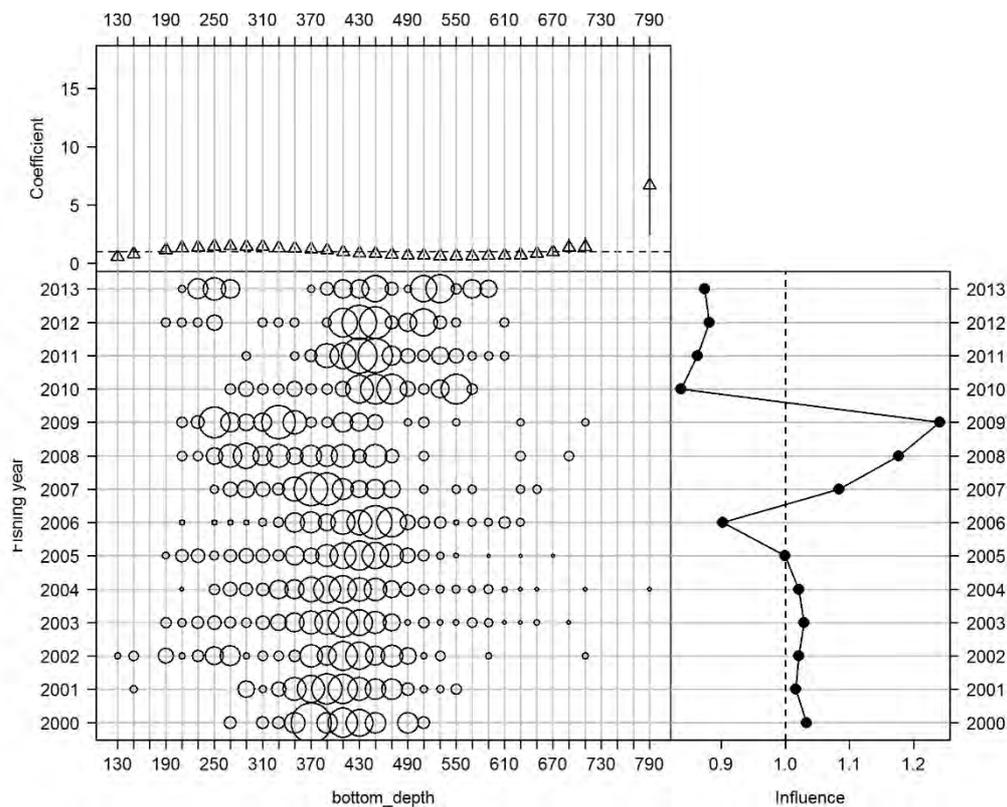
Figure D7c: Effect and influence of bottom depth (m) in the SKI 7 estimated catch core vessel mixed target BT lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of the effort by variable and fishing year. Bottom right: influence of variable on unstandardised CPUE by fishing year.
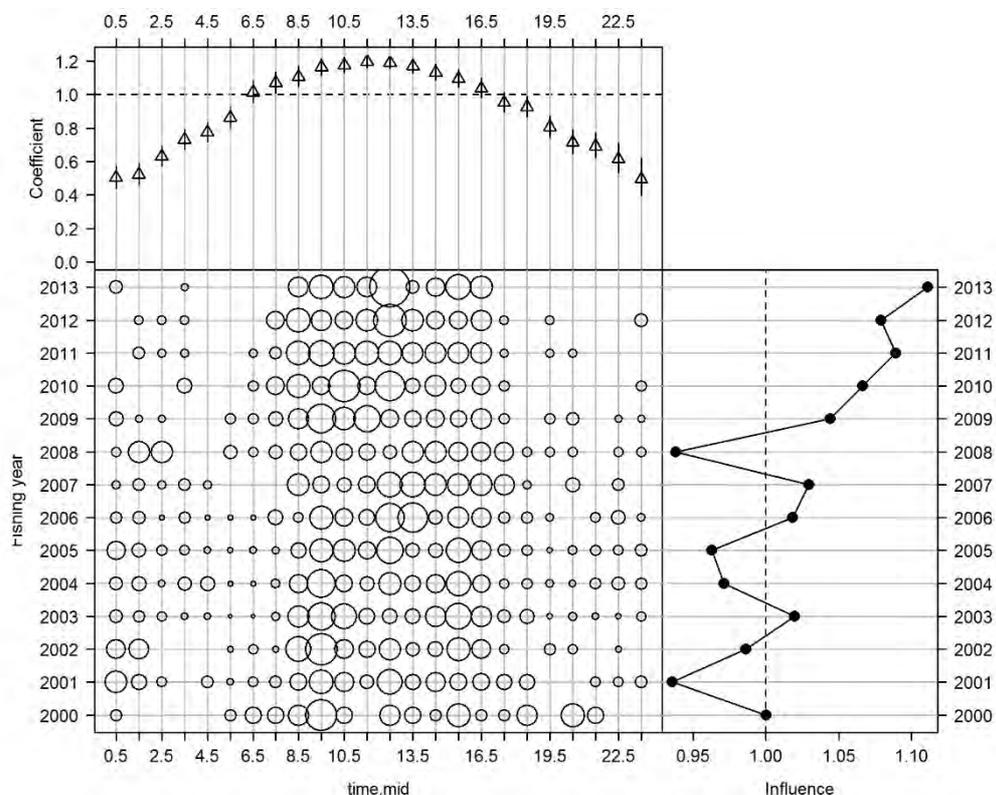

Figure D7d: Effect and influence of mid time of tow in the SKI 7 estimated catch core vessel mixed target BT lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of the effort by variable and fishing year. Bottom right: influence of variable on unstandardised CPUE by fishing year.
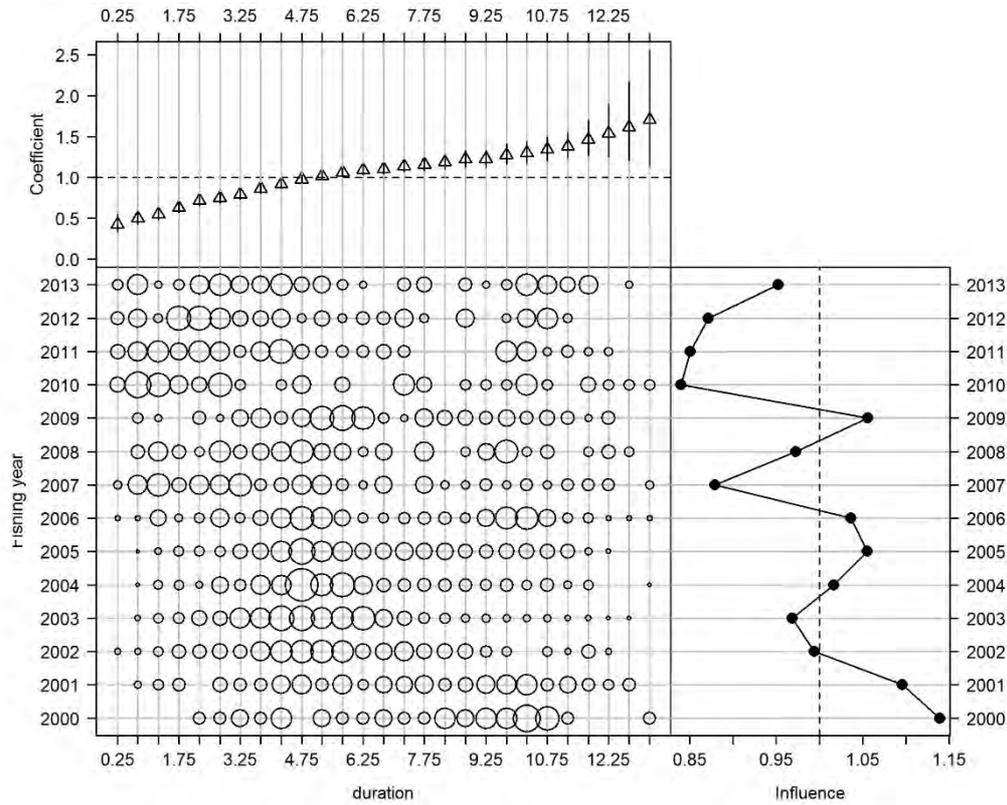
D7e: Effect and influence of tow duration (h) in the SKI 7 estimated catch core vessel mixed target BT lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of the effort by variable and fishing year. Bottom right: influence of variable on unstandardised CPUE by fishing year.
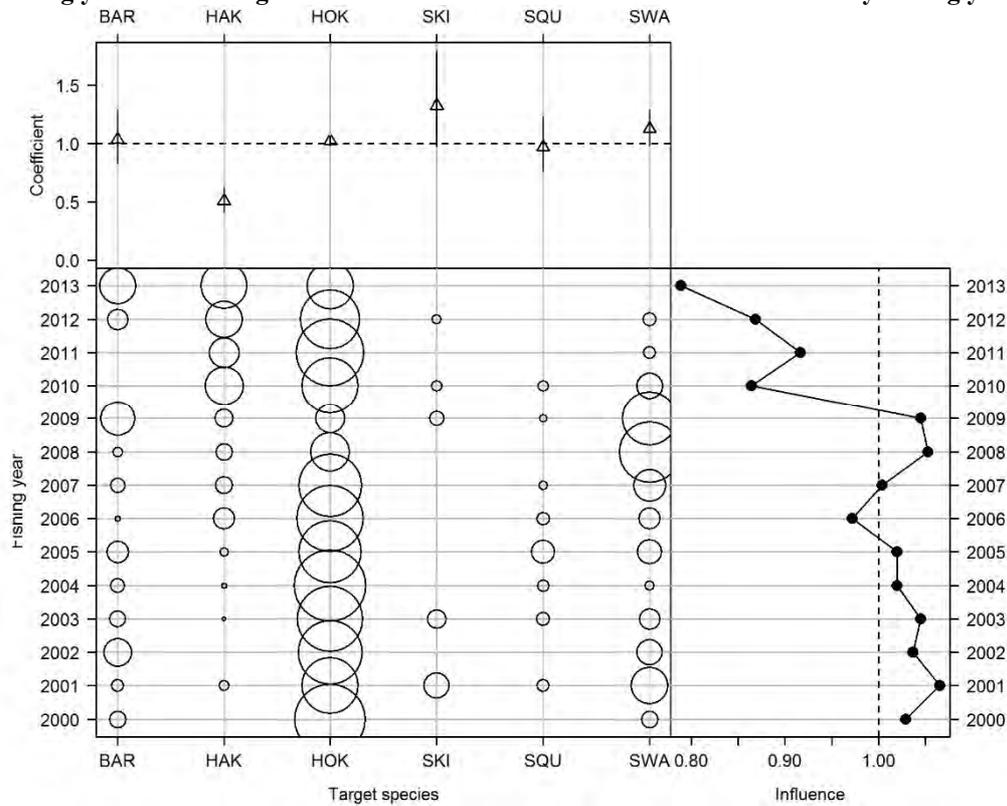

D7f: Effect and influence of target species in the SKI 7 estimated catch core vessel mixed target BT lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of variable by fishing year. Bottom right: influence of variable on unstandardised CPUE by fishing year.
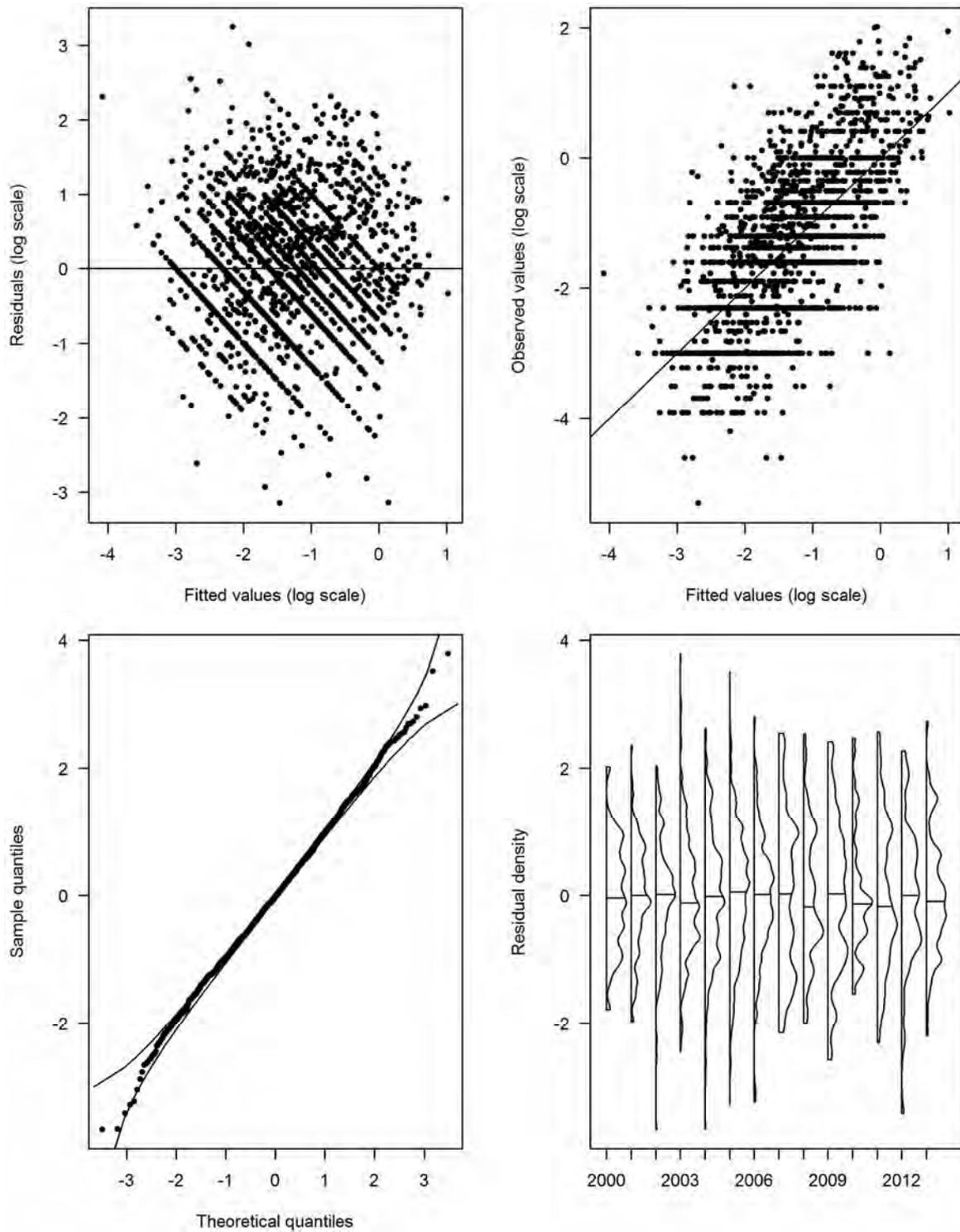
**Figure D8: SKI 7 TCEPR BT lognormal model (estimated tow-by-tow catch for core vessels and mixed target): distribution of the standardised and observed residuals against fitted values (upper), the quantile–quantile plot of the residuals and density plot of the residuals (lower).**
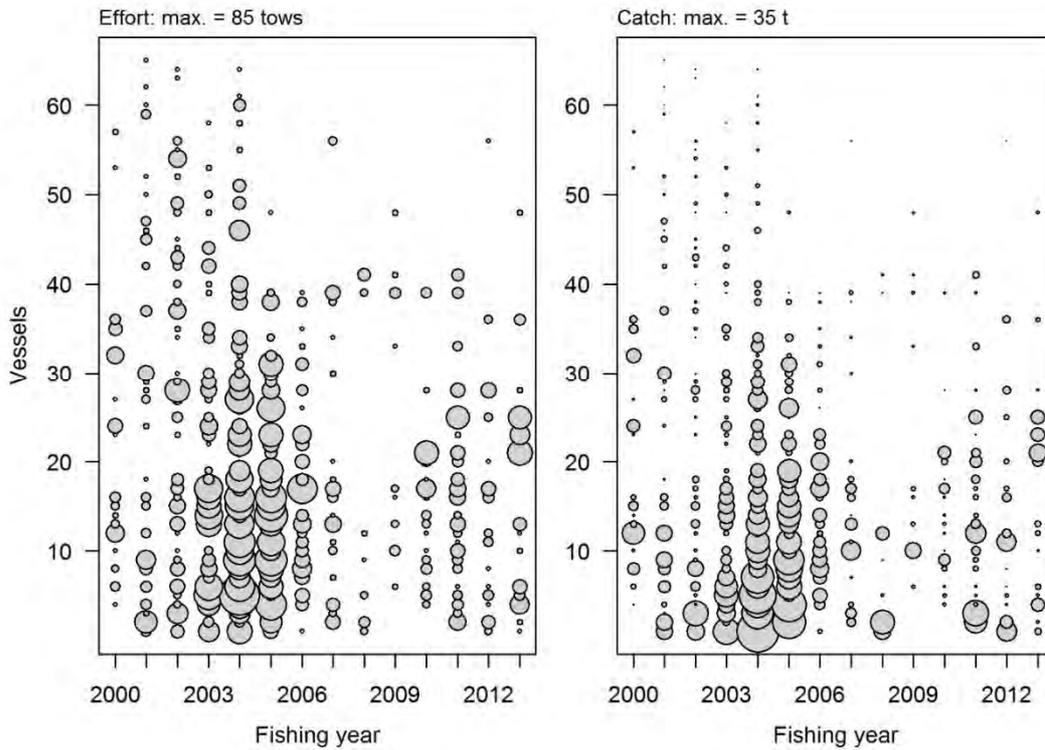
(a) All vessels
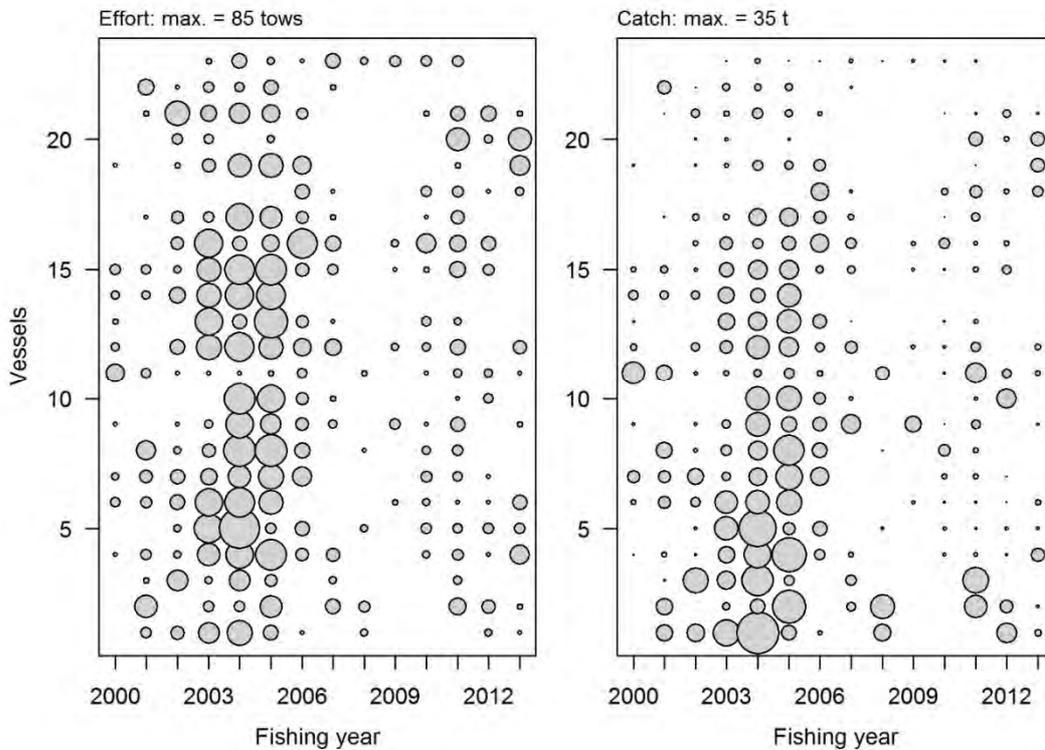
(b) Core vessels

Figure D9: SKI 7 summary of effort (number of TCEPR tows) and estimated gemfish catch (t) by fishing year for 2000–13 from (a) all vessels and (b) from core vessels in the hoki bottom and midwater trawl dataset from Statistical Areas 034 and 035. The symbol area is proportional to either the number of tows or the annual catch, and the maximum circle size is shown in the label on the plot.
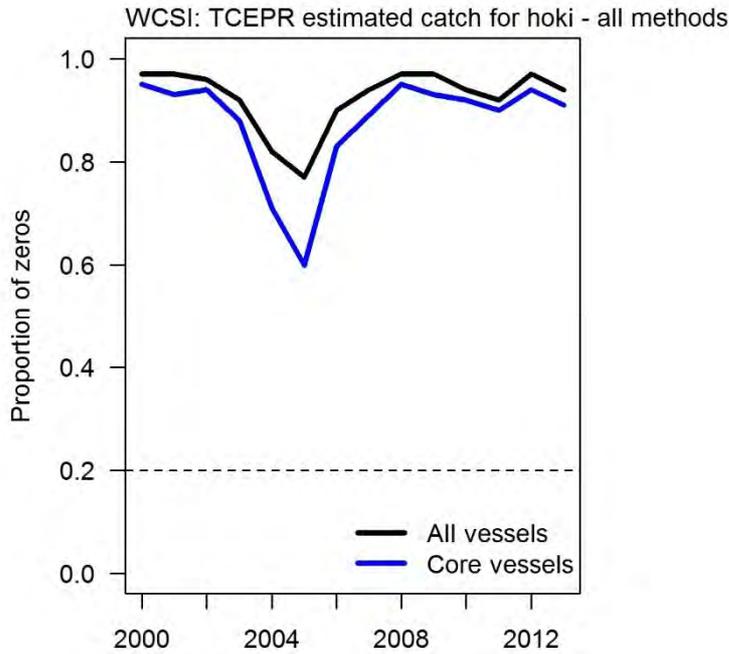
Figure D10: Proportion of zero gemfish catches in the SKI 7 TCEPR hoki bottom and midwater trawl dataset, for all vessels and for core vessels, 2000–13.
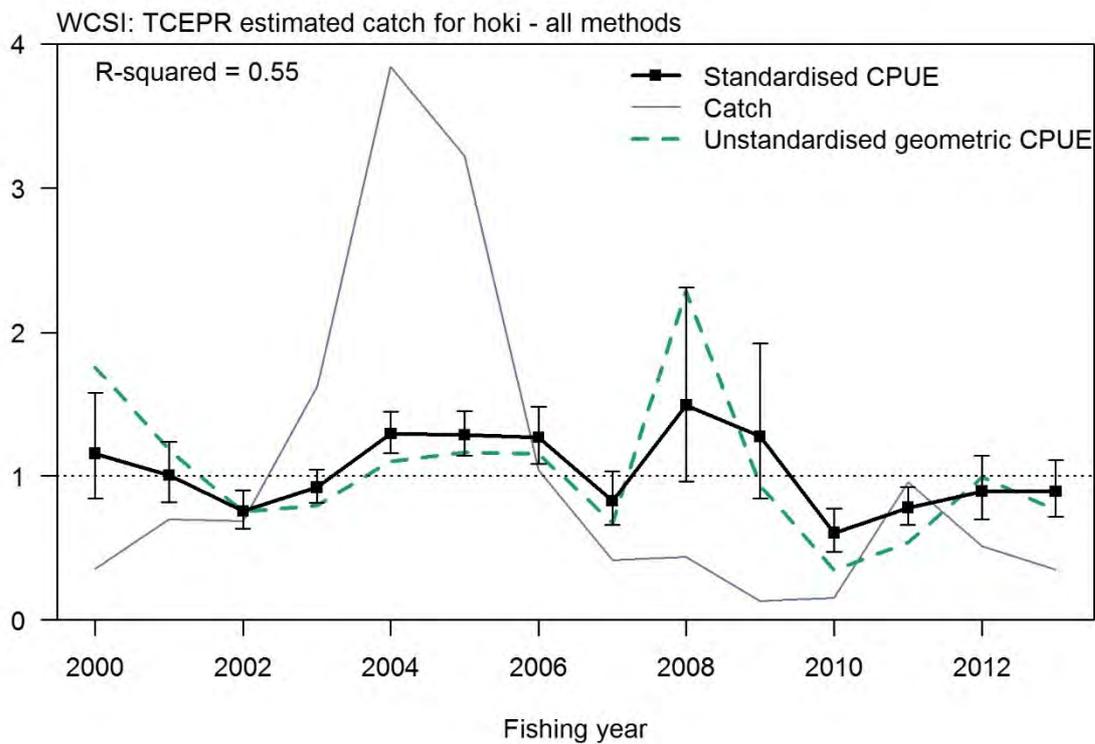
Figure D11a: CPUE lognormal indices for SKI 7, based on the TCEPR hoki bottom and midwater trawl dataset from Statistical Areas 034 and 035 during June-September of fishing years 2000–13, showing catches (scaled to same mean as indices), and lognormal standardised and unstandardised indices. Bars indicate 95% confidence intervals.
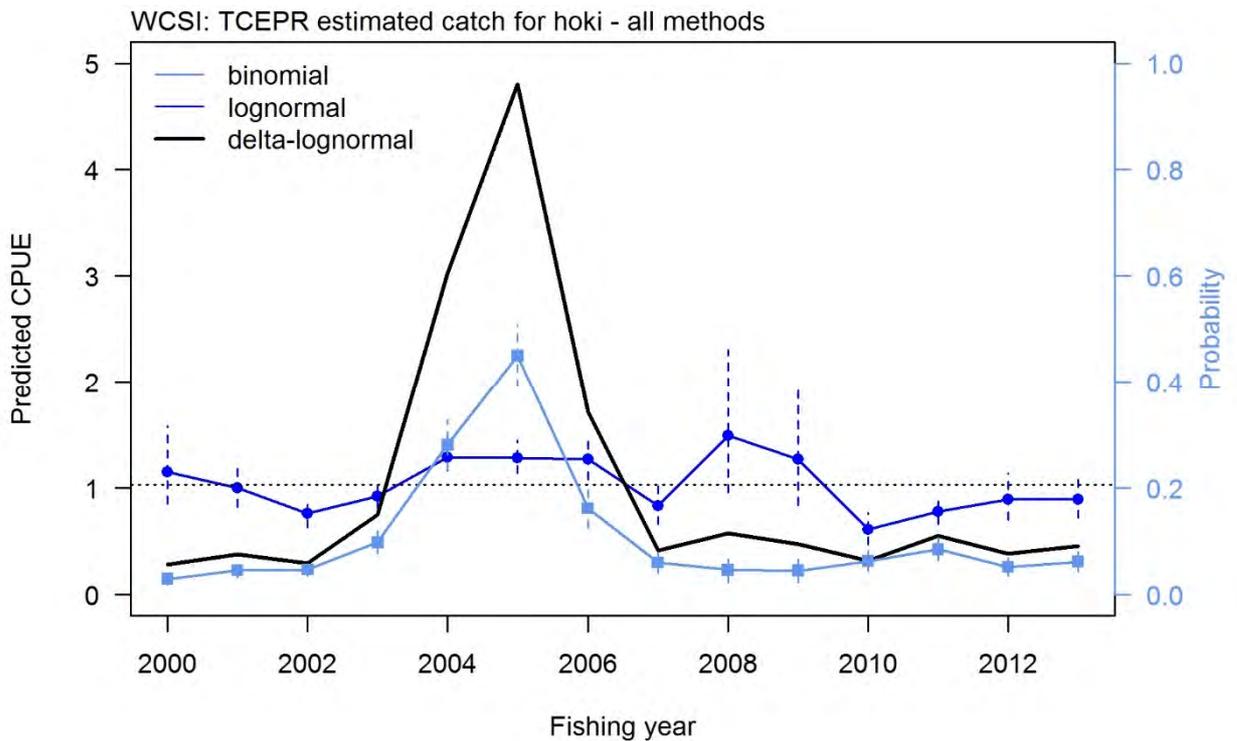
Figure D11b: SKI 7 CPUE from the lognormal, binomial, and delta–lognormal (combined) core vessel hoki bottom and midwater trawl estimated catch model, for June–September, 2000–2013. Bars indicate 95% confidence intervals.
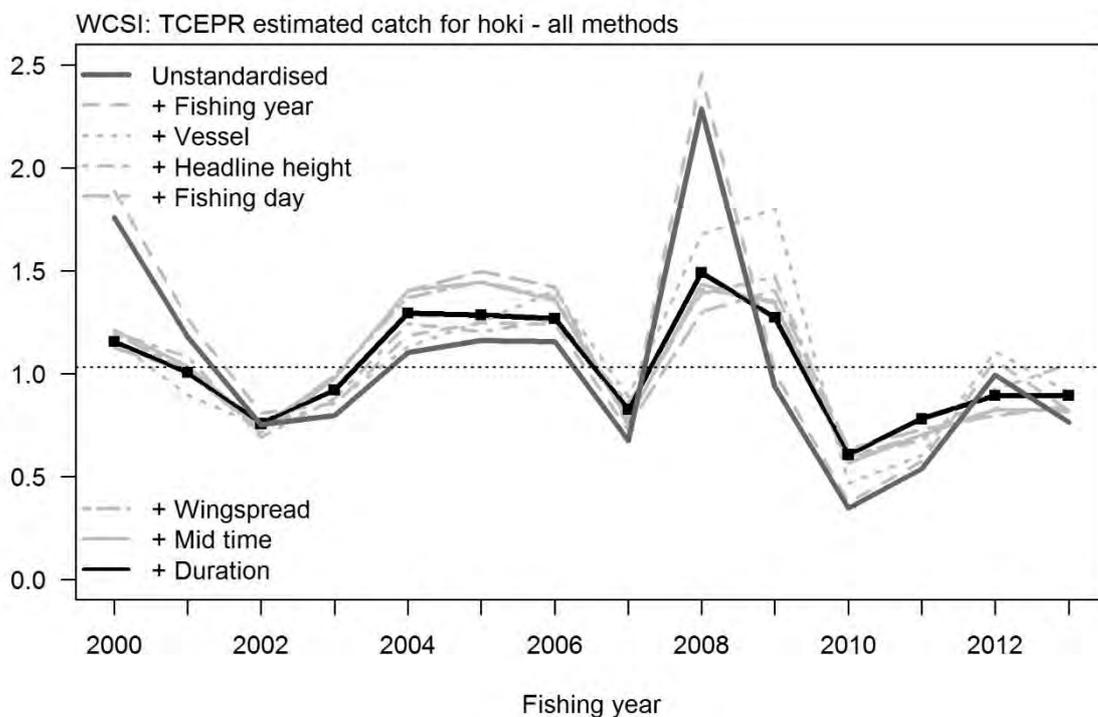
Figure D12: Addition of variables into the lognormal CPUE from the lognormal model for the SKI 7 trawl fishery using bottom and midwater trawls to target hoki in Statistical Areas 034 and 035 during June–September of each fishing year, 2000–13.
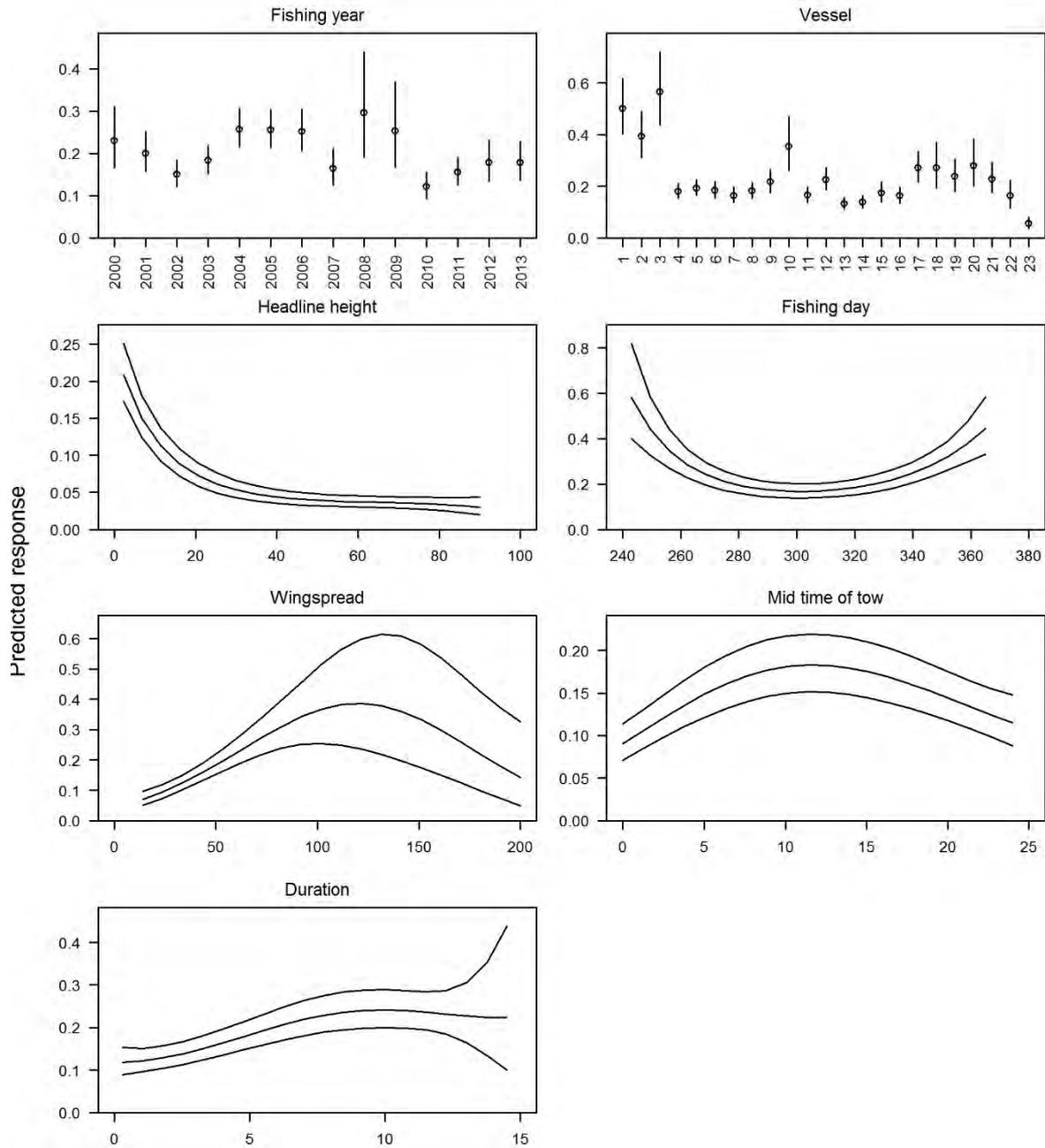
Figure D13: Effects of selected variables in the lognormal model for the SKI 7 TCEPR estimated catch for core hoki target vessels using bottom and midwater trawls in Statistical Areas 034 and 035, during June-September of fishing years 2000–13. Bars indicate 95% confidence intervals.
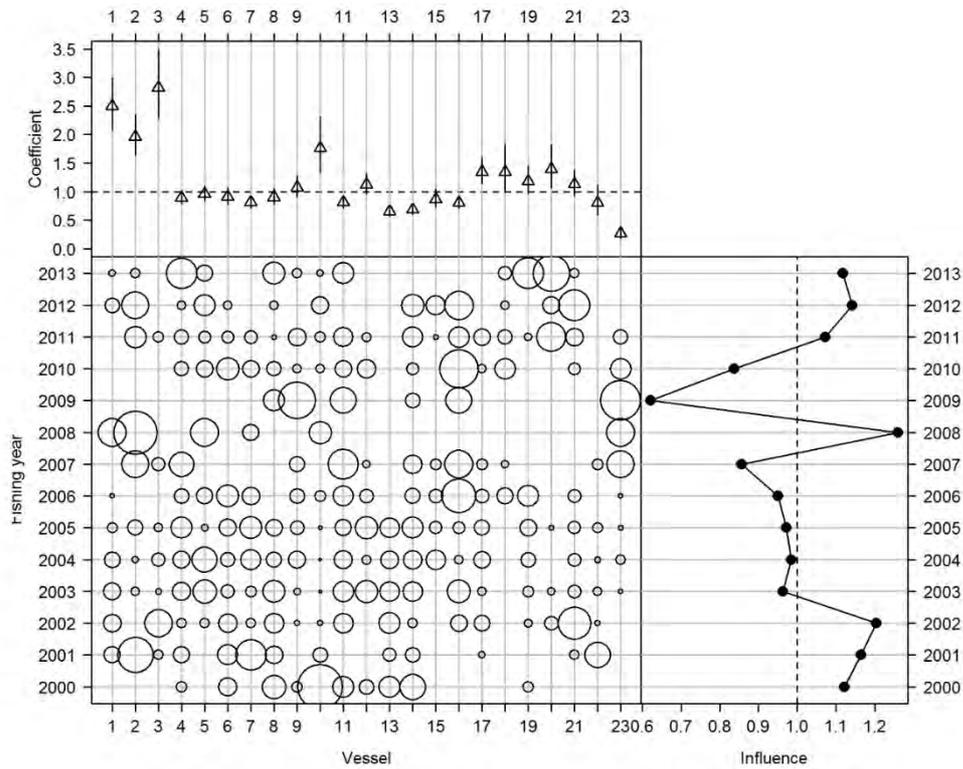
Figure D14a: Effect and influence of vessel in the SKI 7 TCEPR estimated catch core vessel hoki bottom and midwater trawl lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of the effort by variable and fishing year. Bottom right: influence of variable (vessel) on unstandardised CPUE by fishing year.
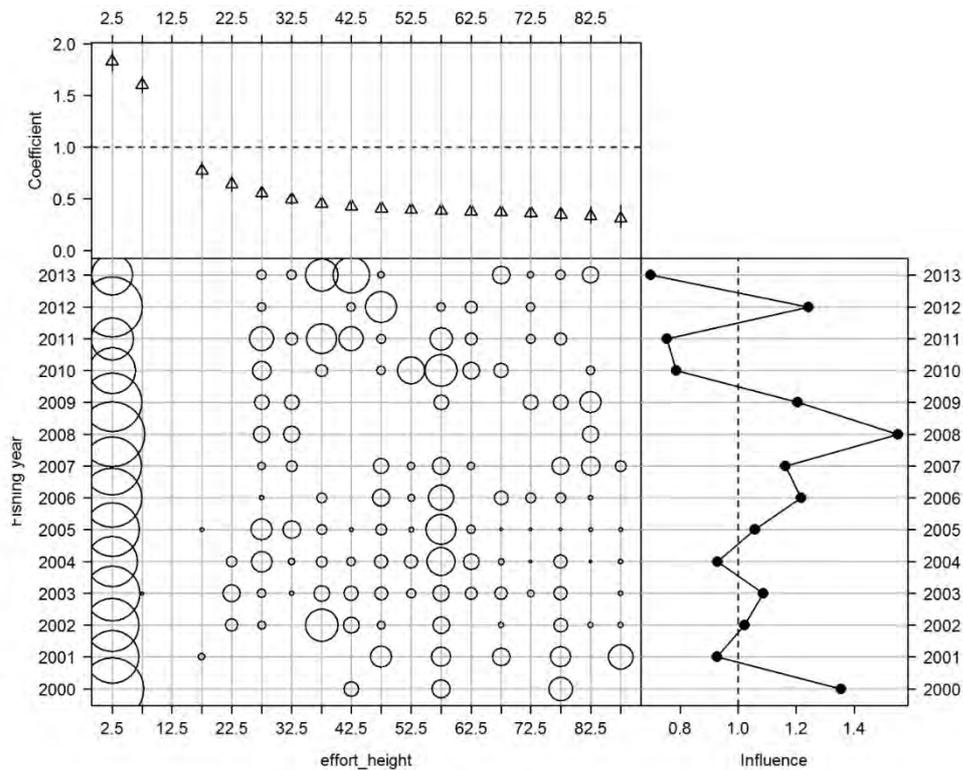
Figure D14b: Effect and influence of headline height (effort_height) in the SKI 7 TCEPR estimated catch core vessel hoki bottom and midwater trawl lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of the effort by variable and fishing year. Bottom right: influence of variable on unstandardised CPUE by fishing year.
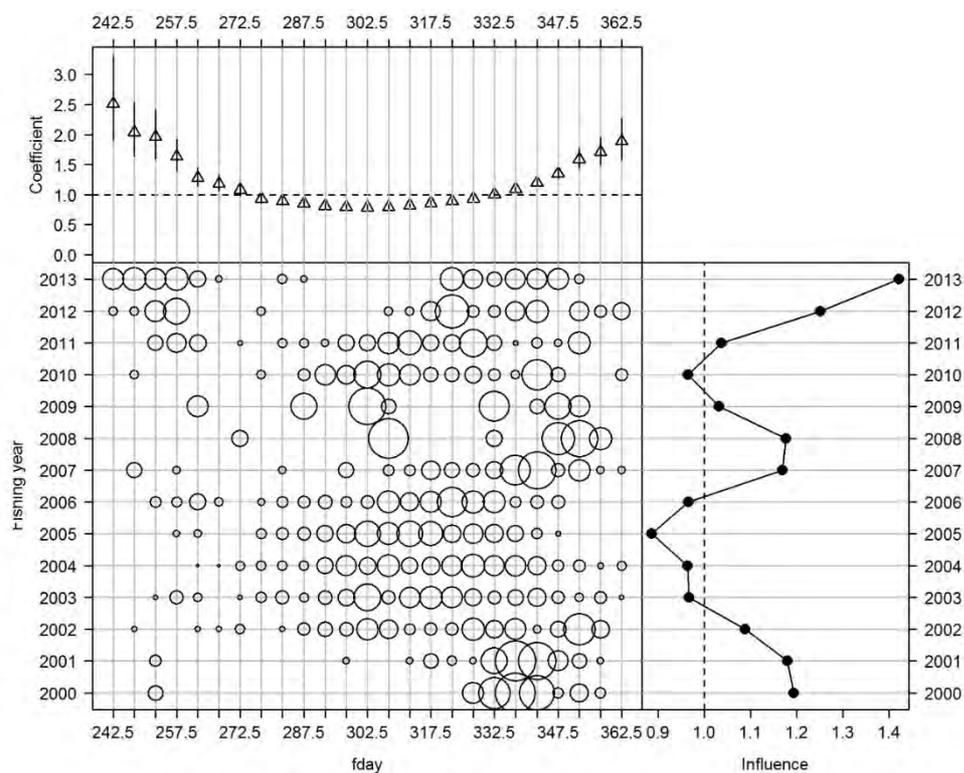
Figure D14c: Effect and influence of day of fishing year (fday) in the SKI 7 TCEPR estimated catch core vessel hoki bottom and midwater trawl lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of the effort by variable and fishing year. Bottom right: influence of variable on unstandardised CPUE by fishing year.
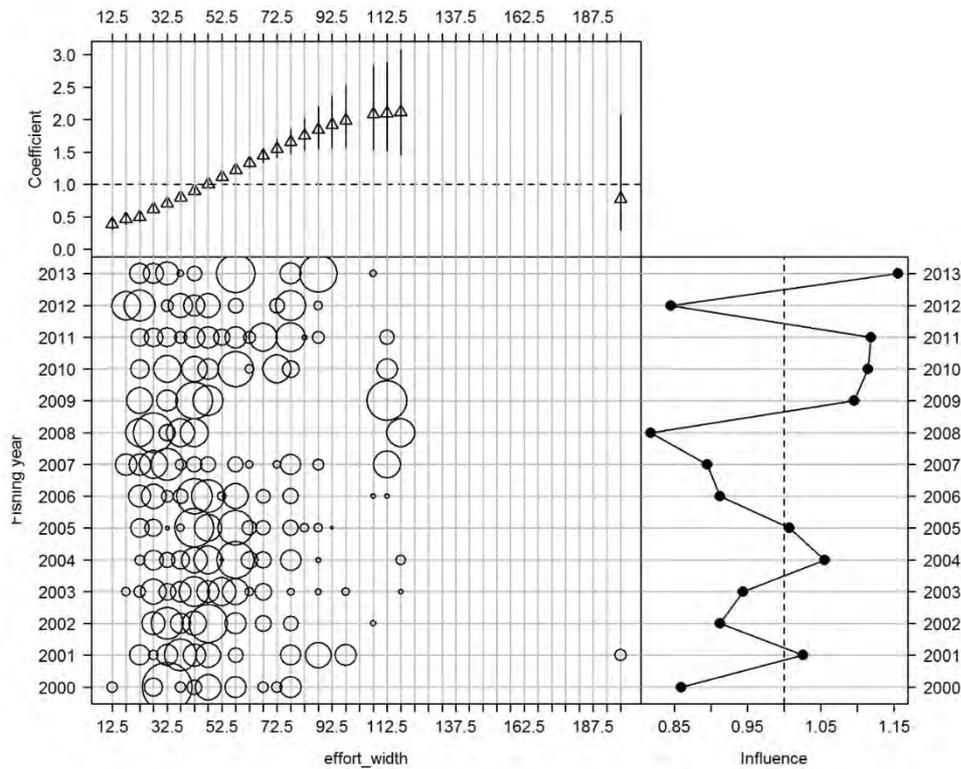
Figure D14d: Effect and influence of wingspread (m) (effort_width) in the SKI 7 TCEPR estimated catch core vessel hoki bottom and midwater trawl lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of variable by fishing year. Bottom right: influence of variable on unstandardised CPUE by fishing year.
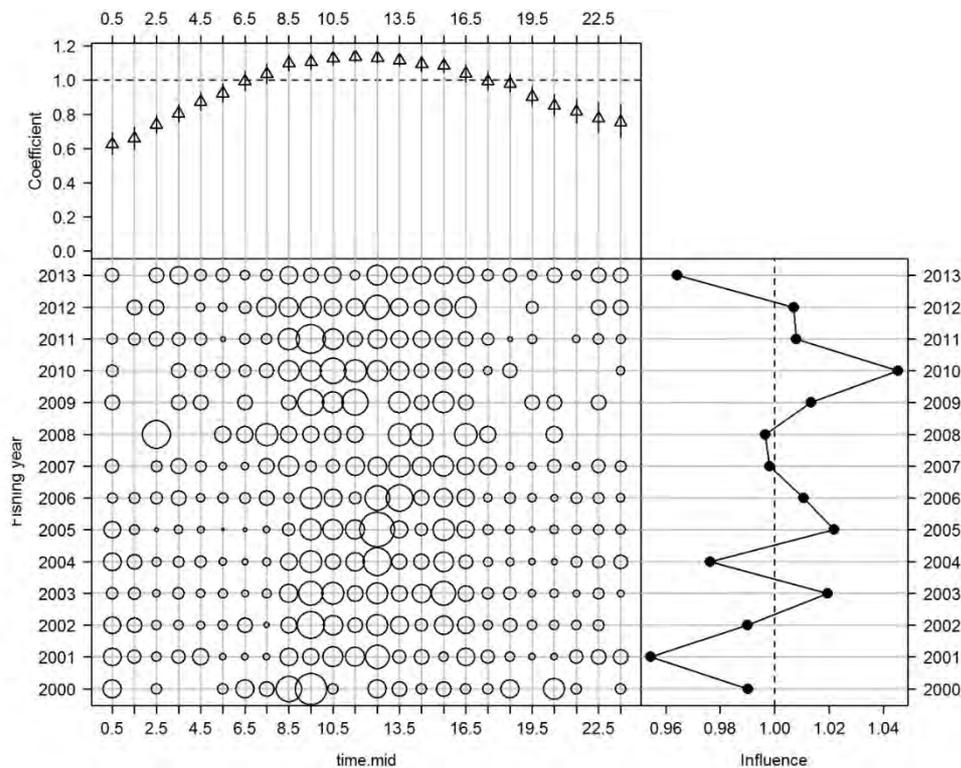
Figure D14e: Effect and influence of mid-time of tow duration (h) (time.mid) in the SKI 7 TCEPR estimated catch core vessel hoki bottom and midwater trawl lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of the effort by variable and fishing year. Bottom right: influence of variable on unstandardised CPUE by fishing year.
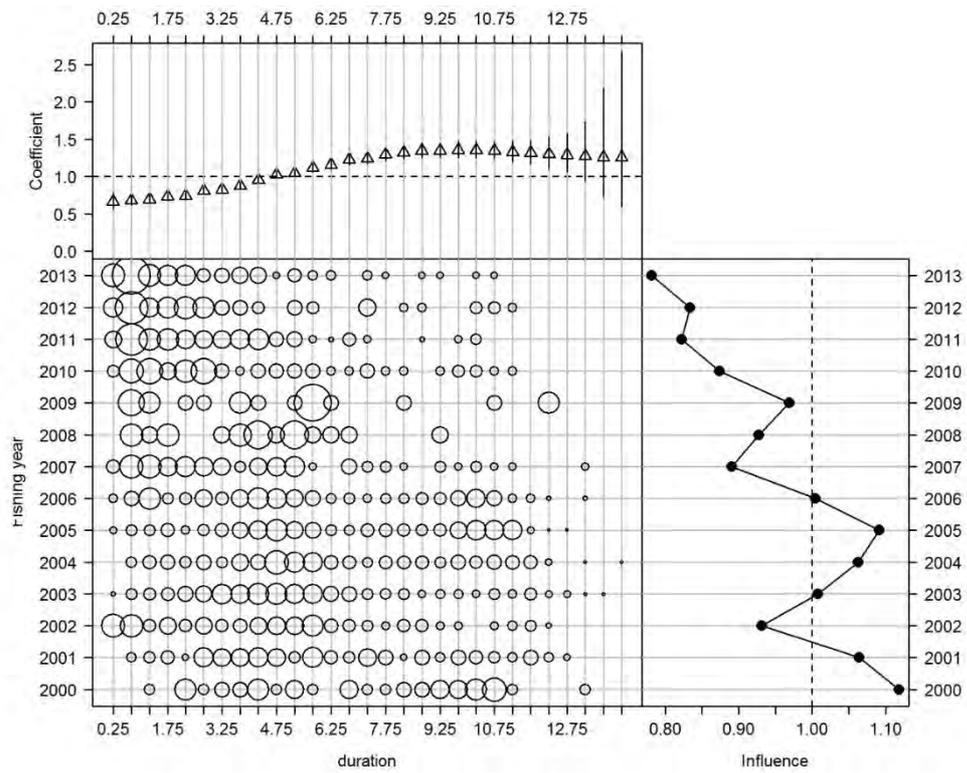
Figure D14f: Effect and influence of tow duration in the SKI 7 TCEPR estimated catch core vessel bottom and midwater trawl lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of the effort by variable and fishing year. Bottom right: influence of variable on unstandardised CPUE by fishing year.
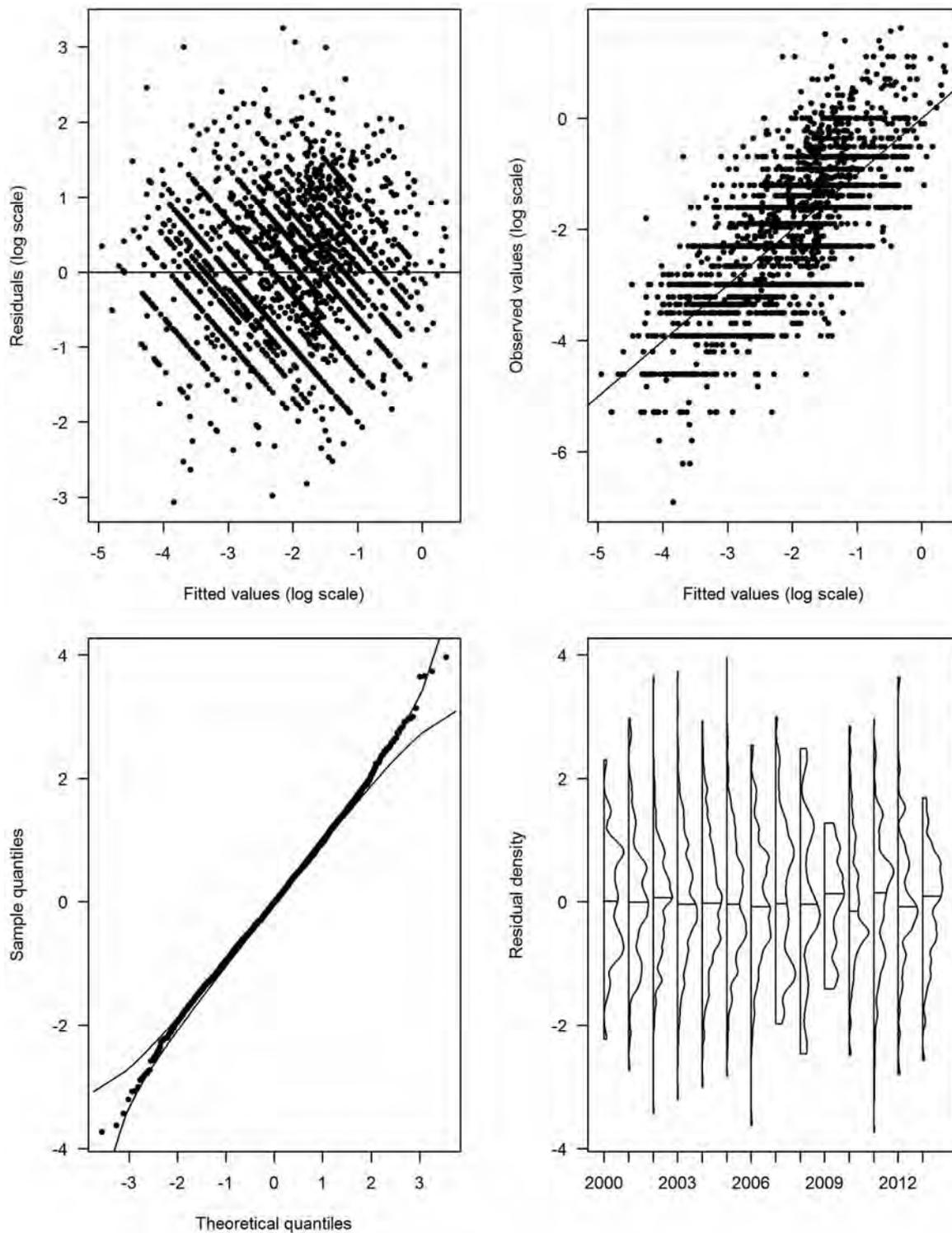
Figure D15: SKI 7 TCEPR lognormal model for estimated tow-by-tow catch for hoki bottom and midwater trawl core vessels: distribution of the standardised and observed residuals against fitted values (upper), the quantile–quantile plot of the residuals and density plot of the residuals (lower).
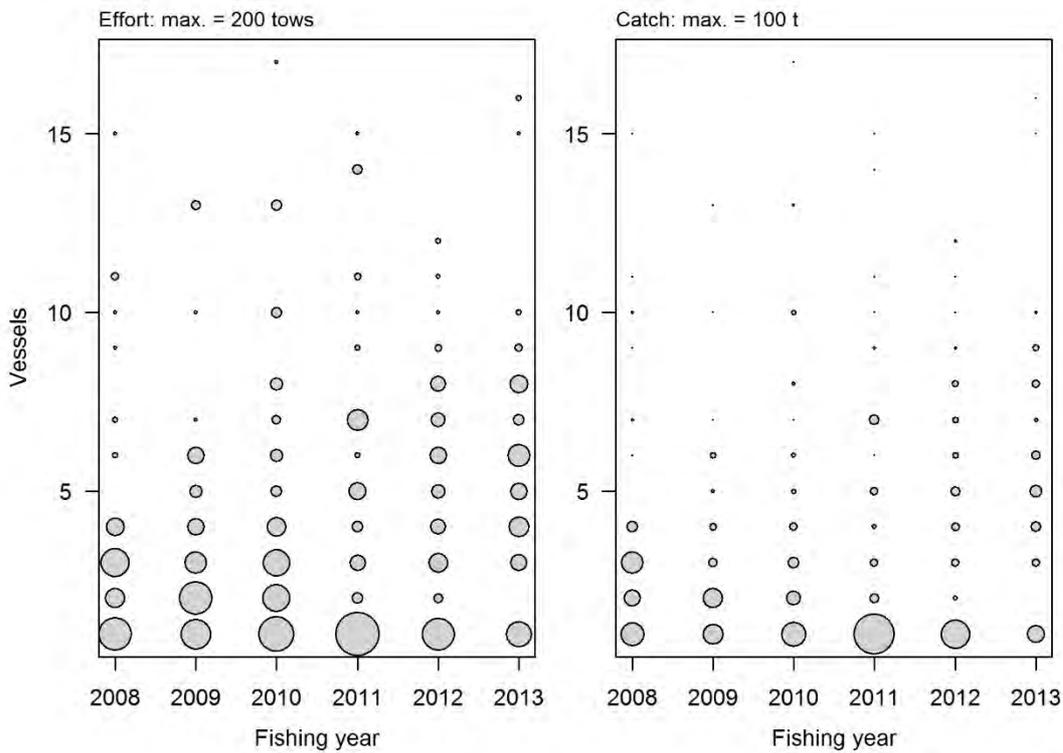
(a) All vessels
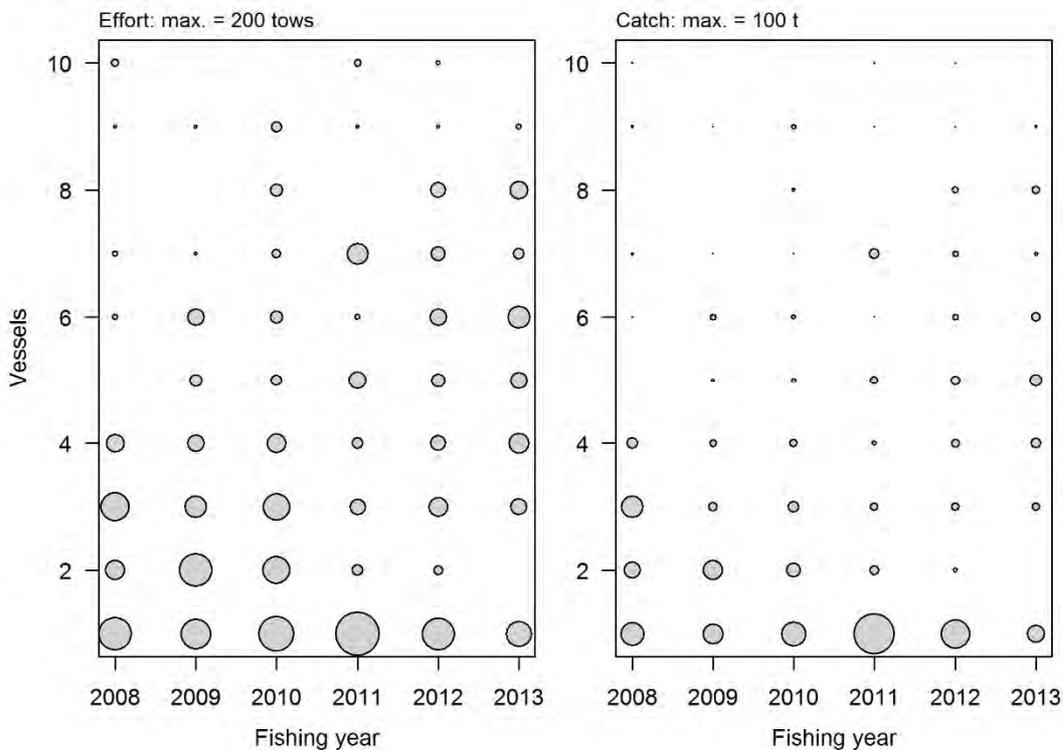
(b) Core vessels

Figure D16: SKI 7 summary of effort (number of TCER tows) and estimated gemfish catch (t) by fishing year for 2008–13 from (a) all vessels and (b) from core vessels in the mixed target bottom trawl dataset from effort in Statistical Areas 033 and 034 during October–June. The symbol area is proportional to either the number of tows or the annual catch, and the maximum circle size is shown in the label on the plot.
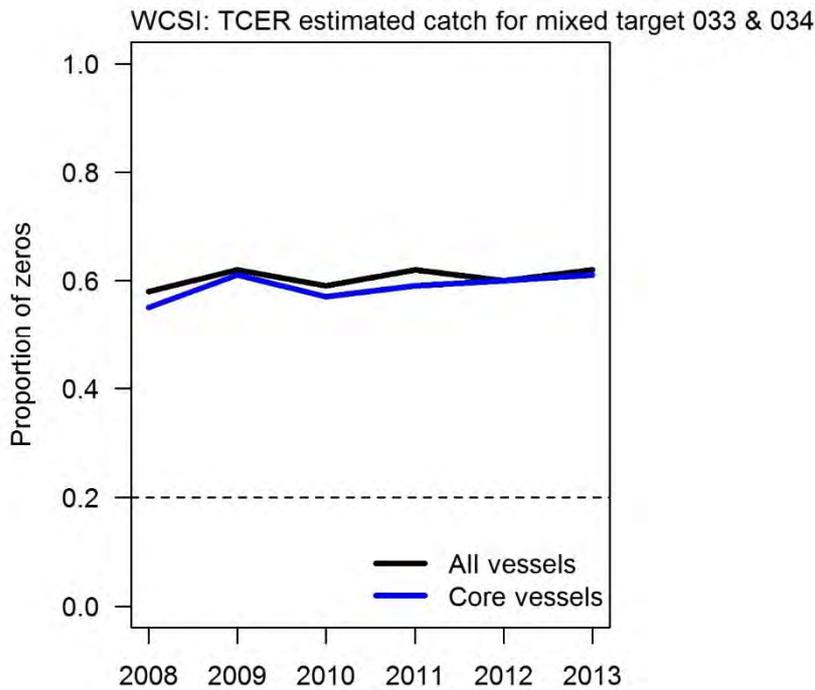
Figure D17: Proportion of zero gemfish catches in the SKI 7 TCER mixed target bottom trawl dataset, for all vessels and for core vessels, during October-June of fishing years 2008–13.
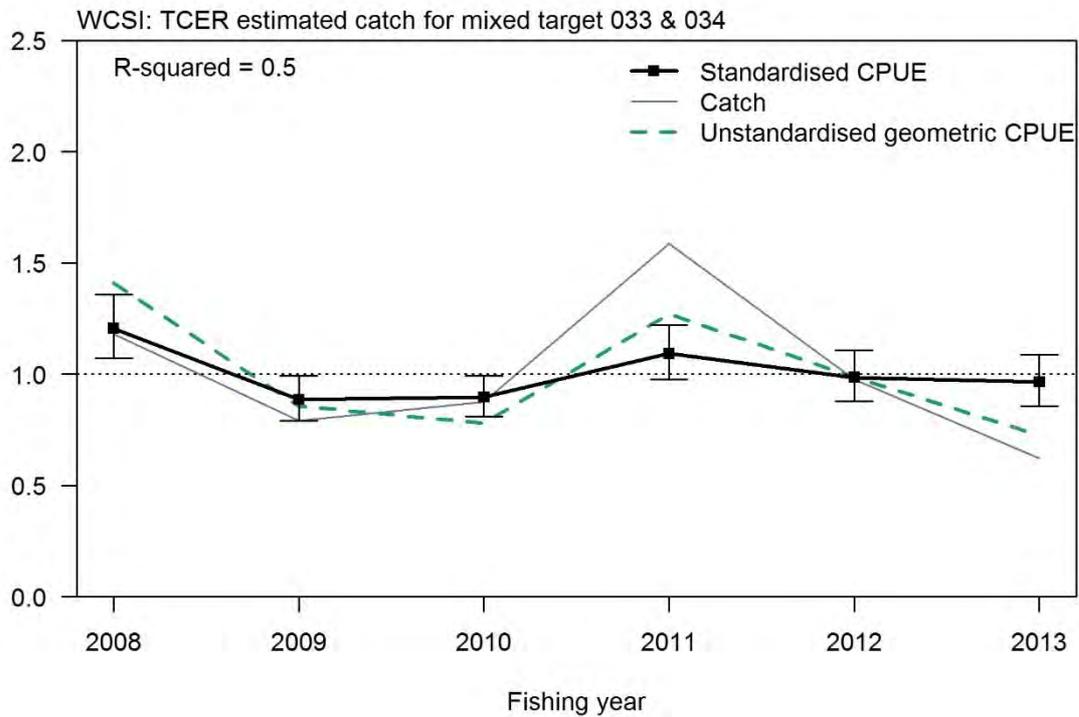
Figure D18: CPUE lognormal indices for SKI 7, based on the TCER mixed target, bottom trawl dataset from Statistical Areas 033 and 034 during October-June of fishing years 2008–13, showing catches (scaled to same mean as indices), and lognormal standardised and unstandardised indices. Bars indicate 95% confidence intervals.
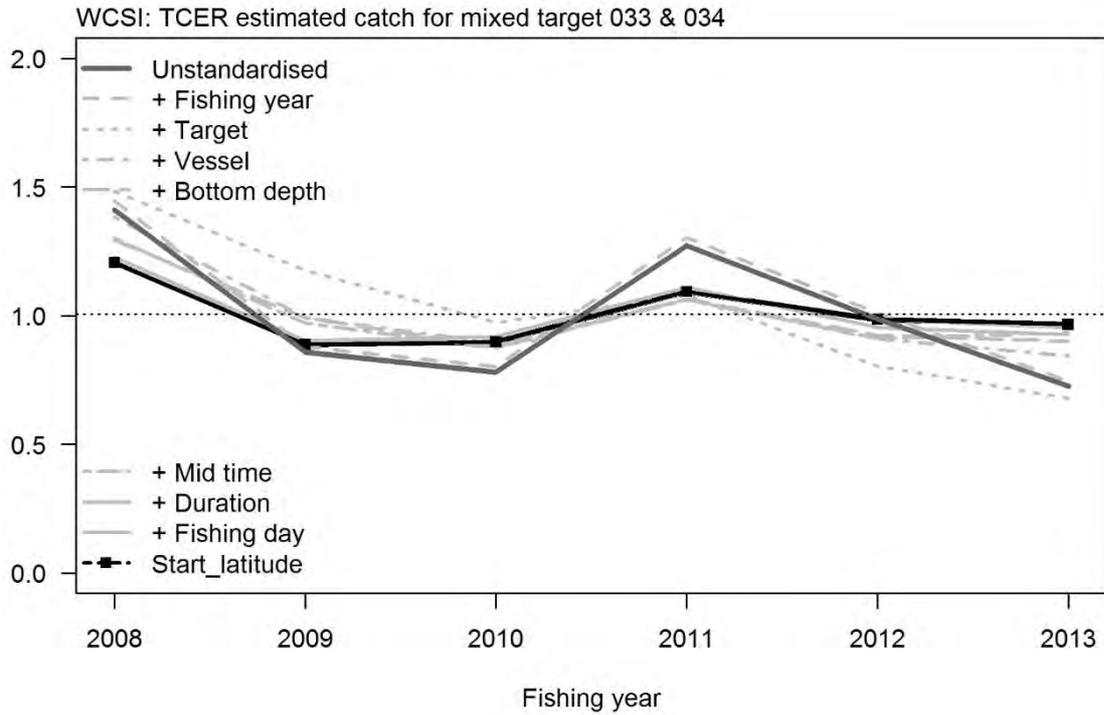
Figure D19: Addition of variables into the lognormal CPUE from the lognormal model for the SKI 7 TCER mixed target, bottom trawl fishery in Statistical Areas 033 and 034 during October-June of each fishing year, 2008–13.
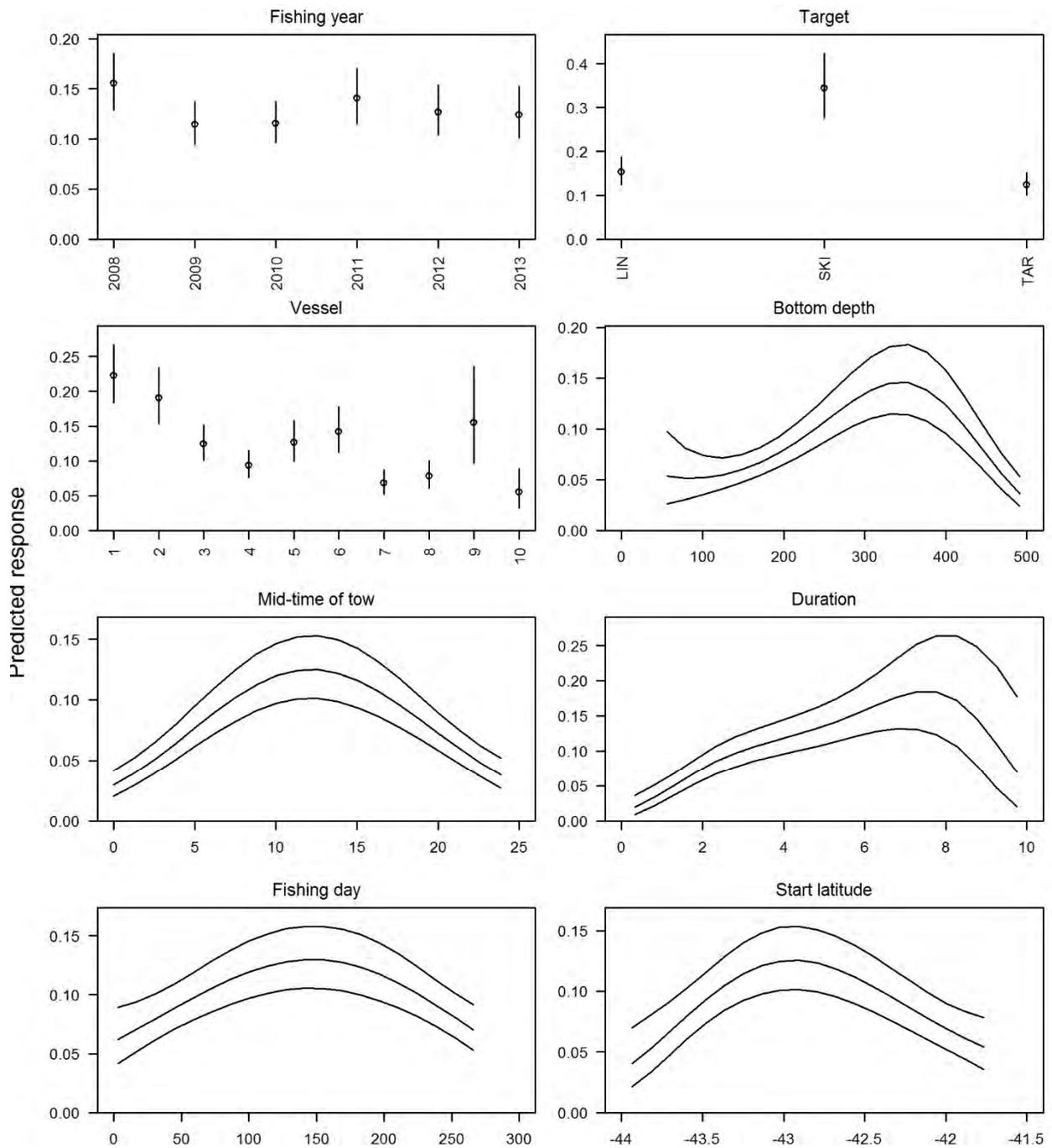
Figure D20: Effects of selected variables in the lognormal model for the SKI 7 TCER BT estimated catch for core mixed target vessels using bottom trawls in Statistical Areas 033 and 034, 2008–13. Bars indicate 95% confidence intervals.
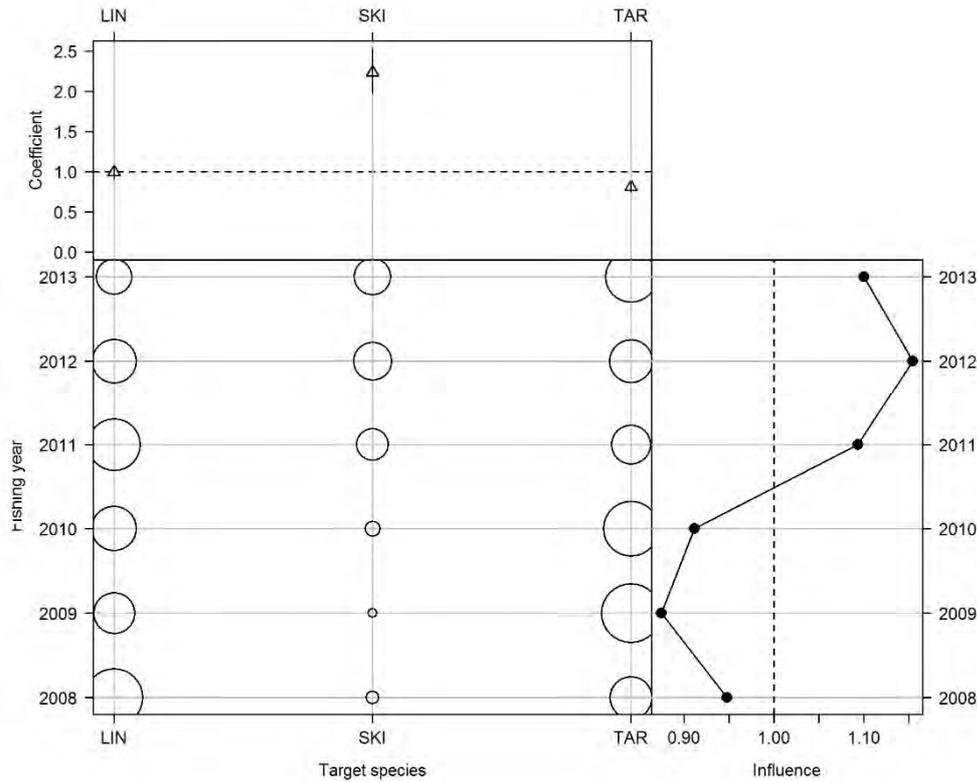
**Figure D21a: Effect and influence of target species in the SKI 7 estimated catch TCER core vessel mixed target bottom trawl lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of variable by fishing year. Bottom right: influence of variable (vessel) on unstandardised CPUE by fishing year.**
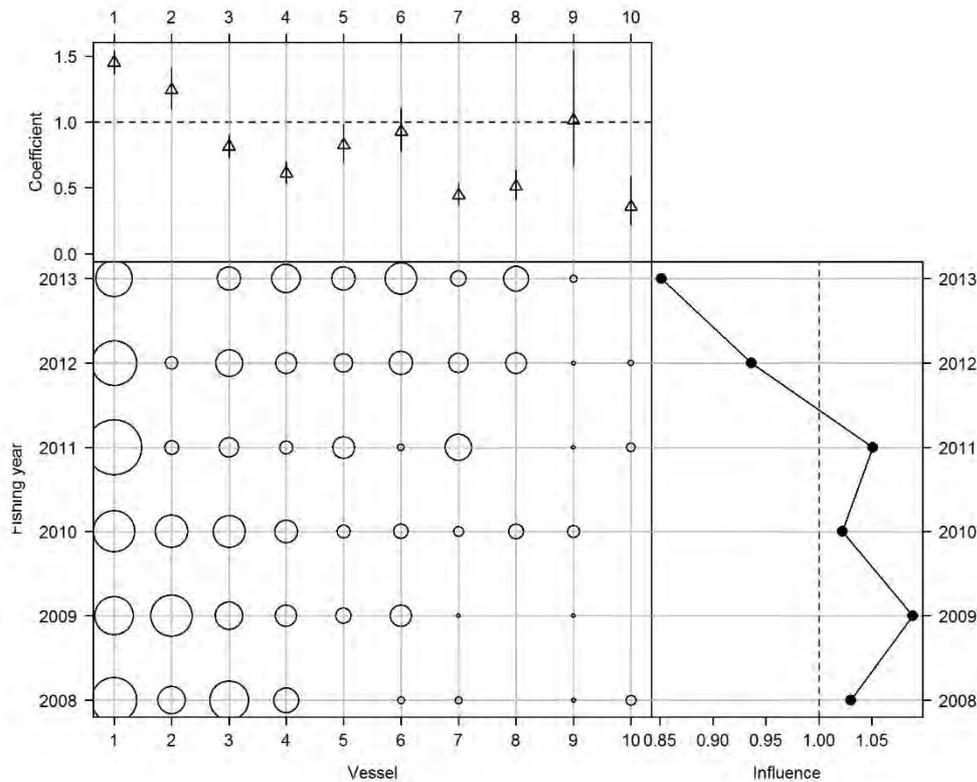
Figure D21b: Effect and influence of vessel in the SKI 7 TCER core vessel mixed target bottom trawl lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of variable by fishing year. Bottom right: influence of variable on unstandardised CPUE by fishing year.
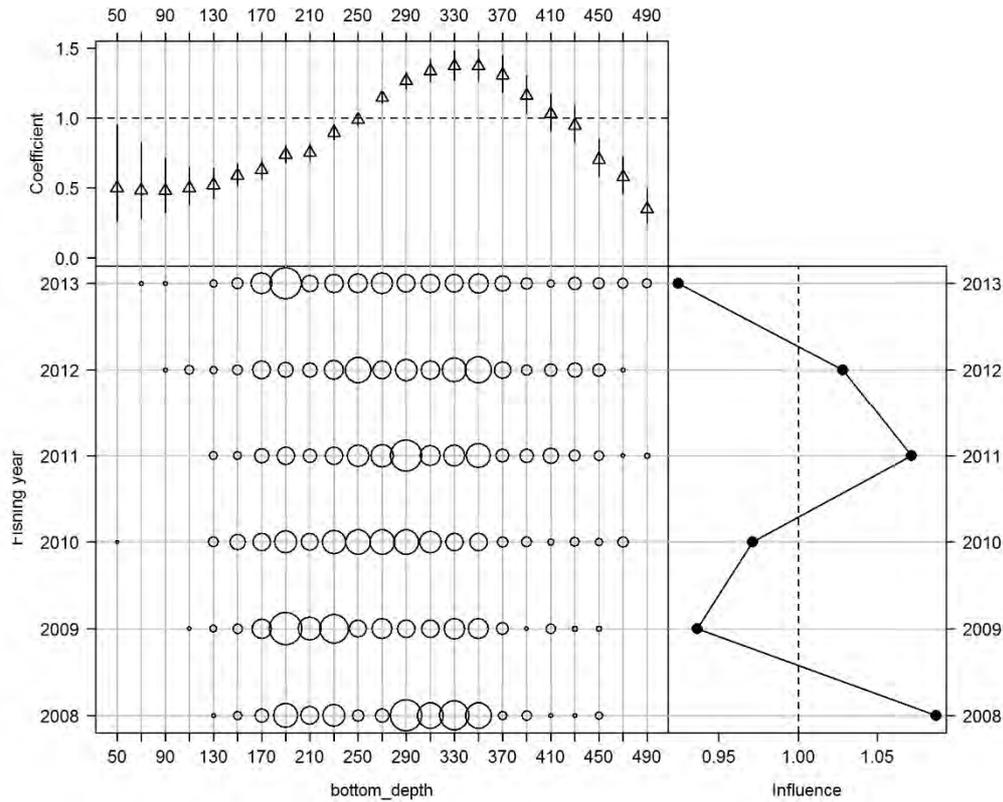
Figure D21c: Effect and influence of bottom depth (m) in the SKI 7 estimated catch TCER core vessel mixed target bottom trawl lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of variable by fishing year. Bottom right: influence of variable on unstandardised CPUE by fishing year.
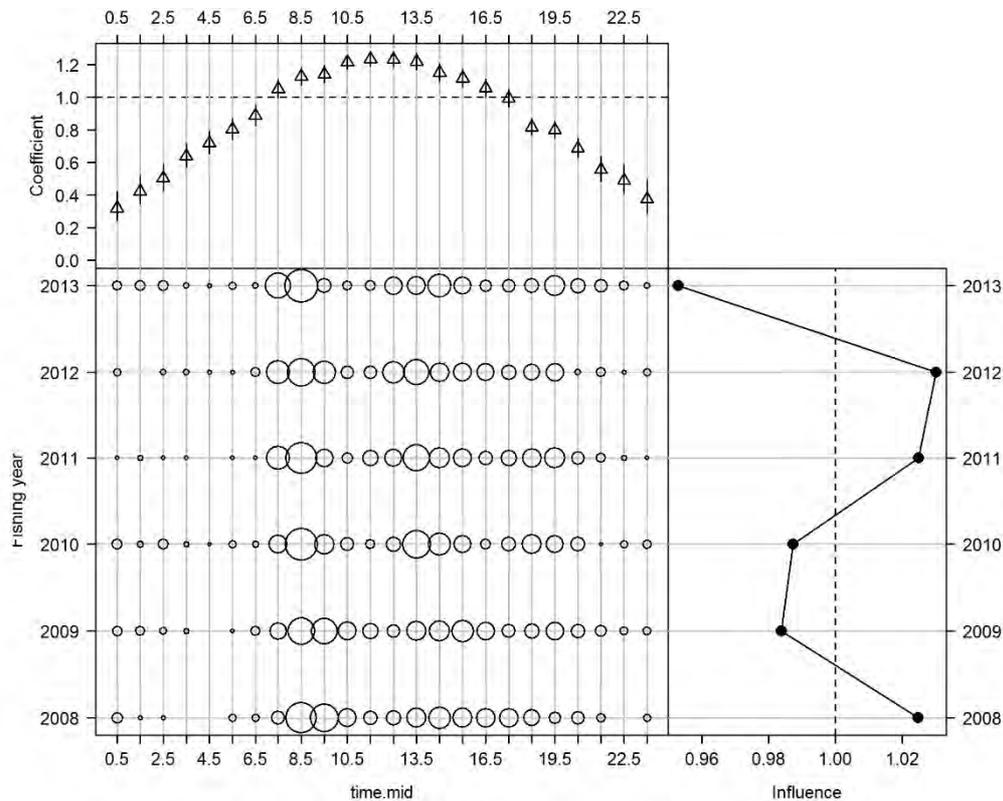
Figure D21d: Effect and influence of mid-time of tow (time.mid, h) in the SKI 7 estimated catch TCER core vessel mixed target lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of variable by fishing year. Bottom right: influence of variable on unstandardised CPUE by fishing year.
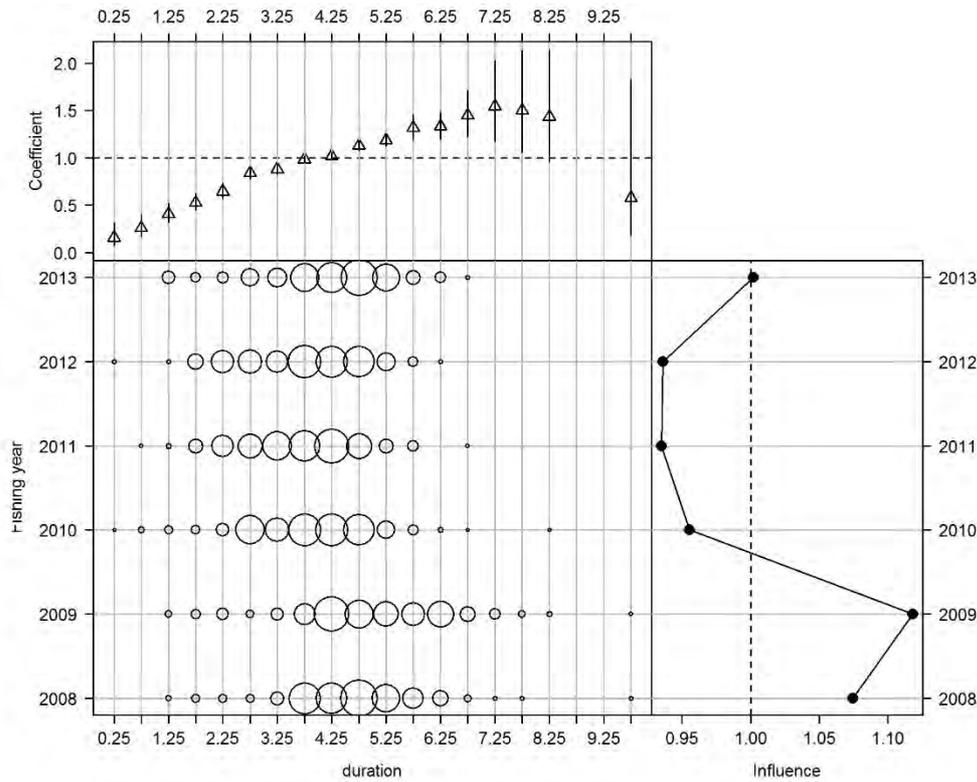
Figure D21e: Effect and influence of tow duration (h) in the SKI 7 estimated catch TCER core vessel mixed target lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of variable by fishing year. Bottom right: influence of variable on unstandardised CPUE by fishing year.
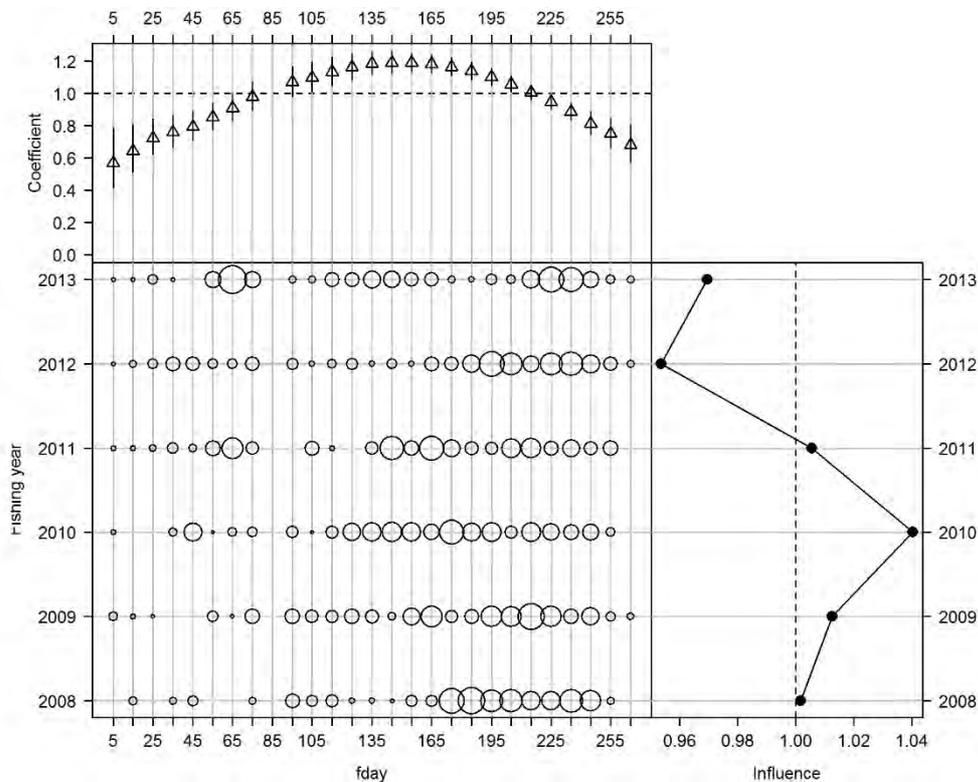
Figure D21f: Effect and influence of day of fishing year (fday) in the SKI 7 estimated catch TCER core vessel mixed target lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of variable by fishing year. Bottom right: influence of variable on unstandardised CPUE by fishing year.
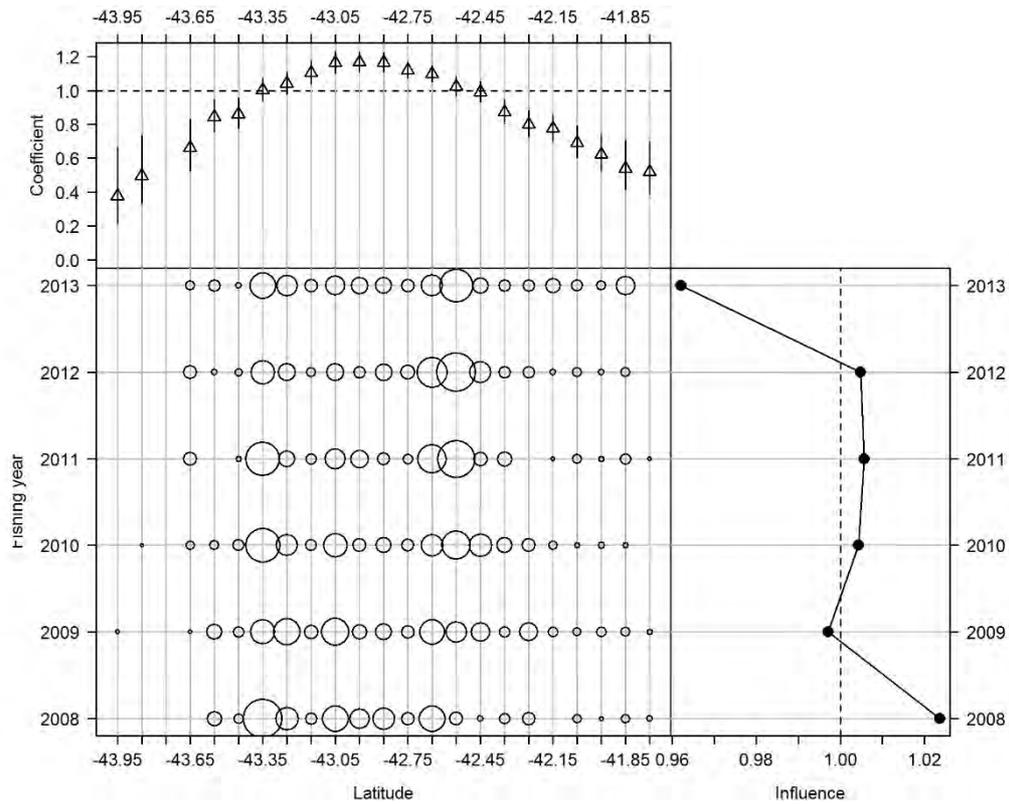
Figure D21g: Effect and influence of day of start latitude (°) in the SKI 7 estimated catch TCER core vessel mixed target lognormal model. Top: relative effect by level of variable. Bottom left: relative distribution of variable by fishing year. Bottom right: influence of variable on unstandardised CPUE by fishing year.
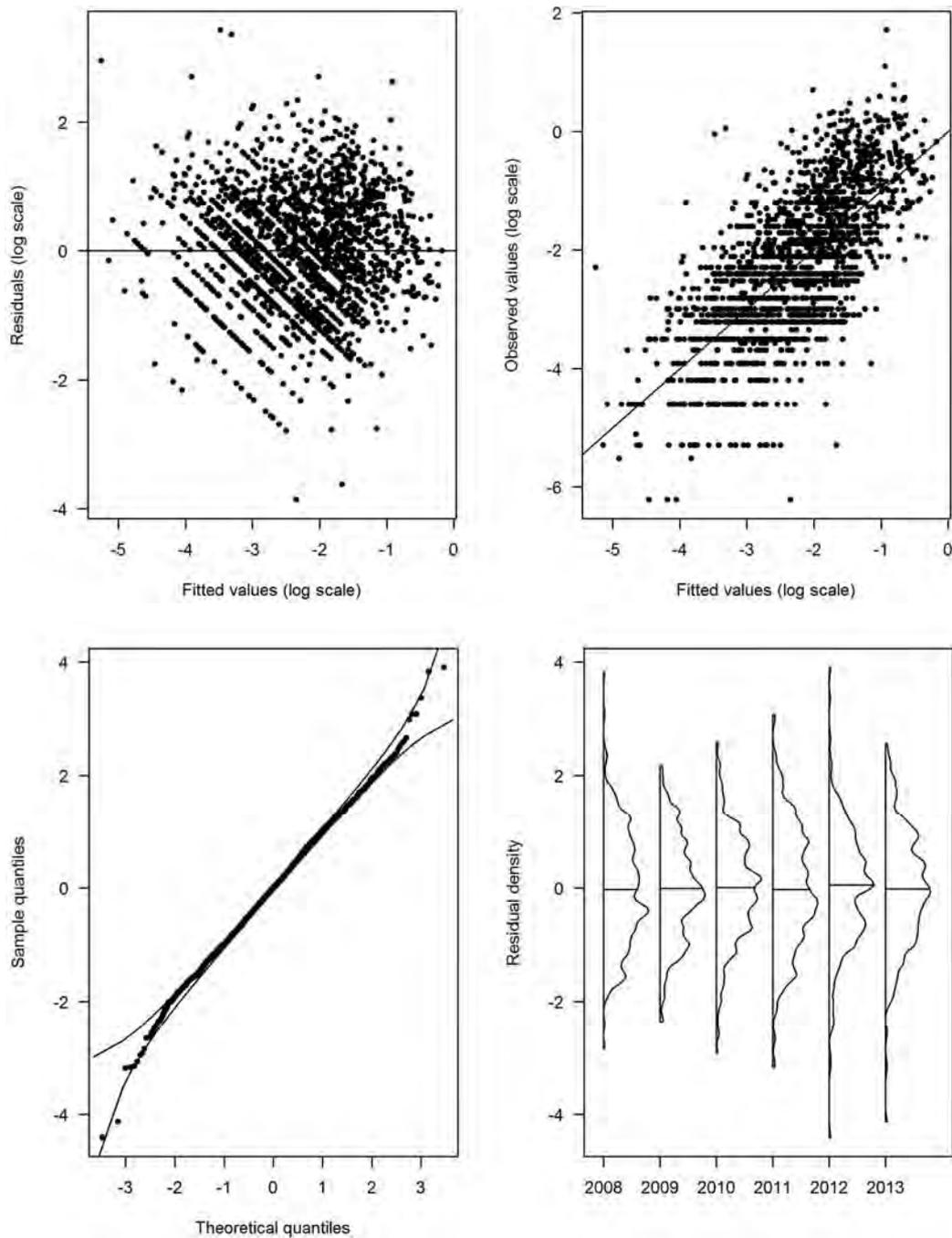
Figure D22: SKI 7 lognormal model (estimated tow-by-tow catch for TCER mixed target bottom trawl core vessels in Statistical Areas 033 and 034): distribution of the standardised and observed residuals against fitted values (upper), the quantile–quantile plot of the residuals and density plot of the residuals (lower).