Summary of the capture of seabirds, marine mammals, and turtles in New Zealand commercial fisheries, 1998–99 to 2008–09

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EXECUTIVE SUMMARY

Thompson, F.N.; Abraham, E.R. (2010). Summary of the capture of seabirds, marine mammals, and turtles in New Zealand commercial fisheries, 1998–99 to 2008–09.

New Zealand Aquatic Environment and Biodiversity Report No. 80

A summary is presented of all captures of seabirds, marine mammals, and turtles during trawl, longline, and setnet fishing within the outer boundary of the New Zealand Exclusive Economic Zone (EEZ), between 1 October 1998 and 30 September 2009. Ministry of Fisheries observers record captures of seabirds, marine mammals, and turtles, and these data, along with information on fishing effort, are used for estimating total captures. Protected species captures reported by fishers are also summarised. In 2008–09, the Ministry of Fisheries observer programme introduced a project to increase observer coverage of inshore fishing, including setnet and trawl fisheries. Captures reported from this project were included, greatly increasing observer coverage for inshore trawl and setnet fisheries.

Within this report, captures are divided into the following groups: sooty shearwater (*Puffinus griseus*), white-chinned petrel (*Procellaria aequinoctialis*), white-capped albatross (*Thalassarche steadi*), other albatrosses, other birds, New Zealand sea lion (*Phocarctos hookeri*), New Zealand fur seal (*Arctocephalus forsteri*), dolphins, whales, and turtles. Captures are also reported by fishery, based on method (trawl, bottom longline, surface longline, and setnet), target species, and vessel size for bottom longline vessels. The report contains time series and maps of the observed and estimated captures.

In the 2008–09 fishing year, there were 465, 66, 34, and 21 seabirds observed caught in trawl, surface longline, bottom longline, and setnet fisheries, respectively. Observed captures in trawl fisheries, surface longline fisheries, and setnet fisheries increased compared to the 2007–08 year, and observed captures in bottom longline fisheries decreased. The most frequently caught seabird species were sooty shearwater, white-chinned petrel, and white-capped albatross, with 132, 90, and 81 observed caught, respectively. In addition to seabirds, 92 New Zealand fur seals, 3 New Zealand sea lions, 20 common dolphins (*Delphinus delphis*), 2 pilot whales (*Globicephalus mela*), 2 leatherback turtles (*Dermochelys coriacea*), 1 Hector's dolphin (*Cephalorhynchus hectori*), and 1 green turtle (*Chelonia mydas*) were observed caught during 2008–09.

Estimates of captures made using statistical modelling were available for some species groups and fisheries. These estimates were able to account for some non-representivity of observer coverge. Model estimates were avaliable for seabirds in trawl, surface longline, large vessel (over 34 m in length) bottom longline fisheries, and snapper bottom longline fisheries in northeastern New Zealand. Model-based estimates were also available for common dolphin captures in the North Island jack mackerel fishery, fur seal captures in trawl fisheries, and sea lion captures in trawl fisheries. In fisheries, areas, and years where model based estimates had not been made, and where there was sufficient observer coverage, a simpler ratio-estimation method was used to estimate total captures.

The estimated captures of seabirds in trawl fisheries increased to 1601 (95% c.i.: 1351 to 1949, based on 43.2% of effort) in 2008–09 from 1111 (95% c.i.: 887 to 1431, based on 44.1% of effort) in 2007–08. These figures include estimated captures in offshore trawl fisheries, and observed captures in inshore trawl fisheries. During 2008–09, the estimated total seabird captures in surface longline fisheries was 591 (95% c.i.: 351 to 987, based on 100.0% of effort), and the estimated seabird captures in bottom longline fisheries was 1320 (95% c.i.: 778 to 2414, based on 69.6% of effort). In both surface and bottom longline fisheries, estimated captures of seabirds in 2008–09 were similar to the estimated number of captures in 2007–08. In both cases, there were increases in the mean number of estimated captures, but the increases were not significant.

The estimated number of New Zealand sea lion interactions in all trawl fisheries for 2007–08 was 74 (95% c.i.: 31 to 147, based on 41.0% of effort); the lowest estimated number of interactions since 2002–03. In the Auckland Islands squid fishery, sea lion exclusion devices (SLEDs) are used. These devices prevent sea lions from entering the codend, and are designed to allow them to escape from the net. The estimated number of interactions is an estimate of the number of sea lions that would have been caught if no SLEDs had been fitted. Model estimated captures of fur seals in trawl fisheries were 550 (95% c.i.: 338 to 826, based on 42.8% of effort), the second lowest estimated number of captures in the eleven year period covered by the summary.

Data from setnet fisheries were included in the report. In 2008–09, there were increased observations of setnet fishing as part of the inshore coverage programme. Observer coverage reached 13%, with 2008–09 being the first year that coverage of setnet fishing exceeded 1%. Observed captures in setnet fisheries in 2008–09 included 8 Cape petrels, 5 sooty shearwaters, 5 yellow-eyed penguins, 1 Hector's dolphin, and 1 fur seal. The Hector's dolphin was caught in a setnet targeting tarakihi, south of Kaikoura. A 3.5 m white-pointer shark was also caught in a setnet targeting butterfish, to the southeast of Stewart Island.

1. INTRODUCTION

In this report, a summary is presented of the capture of seabirds, marine mammals, and turtles during trawl, longline, and setnet fishing in New Zealand waters. A comprehensive summary of captures in trawl and longline fisheries, from the 1998–99 to the 2006–07 fishing year, was provided by Abraham & Thompson (2009). The report was revised to give similar information up to the 2007–08 year (Abraham et al. 2010). This report extends the summaries to include capture data from the 2008–09 fishing year (1 October 2008 to 30 September 2009, inclusive). The report is prepared as part of Ministry of Fisheries projects PRO2007/01 and PRO2007/02, which have the objective of estimating seabird and marine mammal captures in New Zealand fisheries.

Information on protected species captures is recorded by Ministry of Fisheries observers when they are on fishing vessels. In fisheries where there has been sufficient observer coverage, these systematically collected data provide a basis for estimating total captures. Within the report, captures are divided into the following groups: sooty shearwater (*Puffinus griseus*), white-chinned petrel (*Procellaria aequinoctialis*), white-capped albatross (*Thalassarche steadi*), other albatrosses, other birds, New Zealand sea lion (*Phocarctos hookeri*), New Zealand fur seal (*Arctocephalus forsteri*), dolphins, whales, and turtles. The three individual seabird species were chosen as these are the species that were most frequently caught in New Zealand trawl and longline fisheries. For each species group, there is a sequence of pages in the results section showing the captures within the different fisheries where those animals were caught. The captures are also summarised by fishery (defined by the method and target species). Summaries are included for every species-fishery combination that had observed captures in either the 2007–08 or 2008–09 years. The summaries give the effort, observer coverage, and observed captures over the 11 year period of the data. For the 2007–08 and 2008–09 fishing years, a more detailed breakdown of the captures is provided.

Model-based statistical estimates of captures for common dolphins, New Zealand fur seals, New Zealand sea lions, and seabirds have been presented in other reports (Thompson et al. 2010, Thompson & Abraham 2010, 2011, Abraham & Thompson 2011). In order to provide a comprehensive summary of the best available information, these model estimates were incorporated into this report. The original reports should be referred to for further details of the model methods and results. When model estimates were not available, and there was sufficient observer coverage, stratified ratio estimates of total captures were calculated. By aligning the strata between the models and the ratio estimation, estimates using the different methodologies were able to be combined.

Inshore fishing activity has had very low observer coverage for most of the period covered by this report. In the summer of 2008–09, a new observer programme was started that specifically focused on protected species captures in inshore fisheries, including setnet fisheries. Although there were some issues with data from this project, enough information was available to allow the protected species captures reported by this programme to be included in the analysis.

Beginning in the 2008–09 fishing year, a new form was deployed to help commercial fishers record captures of protected species. The new non-fish / protected species catch return replaced the earlier non-fish incidental catch reporting form. A short summary of captures from both sources is presented in this report. The fisher-reported captures were not included in any of the estimation.

Because this is essentially a summary of the data, and of the results of the estimation, not all the tables and figures are referred to in the text as is usual. There is only brief commentary on the presented data, and reference to tables and figures is not sequential.

2. METHODS

2.1 Data sources

Ministry of Fisheries observers on commercial fishing vessels record captures of protected species, including seabirds and marine mammals. The capture events are recorded on paper forms by the observers and entered into a database maintained by the National Institute of Water and Atmospheric Research (NIWA) on behalf of the Ministry of Fisheries. Currently, data are housed in the Centralised Observer Database (COD). The following protected species bycatch information from COD was used in this analysis.

Species	The identification made by the observer. This may either be a species level or a more general classification, depending on how precisely the observer was able to identify the animal.
Capture method	A code indicating where the animal was captured. For example, in the net, on the warps, or tangled in line. Additional information from the observer's comments has also been used to identify the capture method.
Life status	Observers record whether the animal was alive, dead, killed by the crew, or decomposed (long dead).
Station details	Trip number, station number, date at beginning of the tow or set, and target species. This information is required for all observed stations, including those where there was no protected species bycatch.

In addition to the observer data, fishing effort data were required to allow for the observed captures to be appropriately scaled. Commercial fishing vessels return a record of all fishing effort on each trip to the Ministry of Fisheries. Skippers complete either a Trawl Catch Effort Processing Return (TCEPR), Trawl Catch Effort Return (TCER), Tuna Longline Catch Effort Return (TLCER), Catch Effort Landing Return (CELR), Lining Catch Effort Return (LCER), Lining Trip Catch Effort Return (LTCER) form, or Netting Catch Effort Landing Return (NCELR) form. During the 2007–08 fishing year, inshore trawl fisheries moved to reporting fishing effort on TCER forms, rather than CELR forms. The TCER form requires the latitude and longitude of fishing effort to be recorded, instead of giving only the statistical area. This has allowed a more accurate understanding of where inshore fishing is occurring. Data from these forms are stored in databases administered by the Ministry of Fisheries (Ministry of Fisheries 2008). In this report, information on station date, position, and effort (either number of trawls, number of hooks, or total net length) was used.

Data were checked for a range of errors, following previously used grooming rules (Abraham & Thompson 2009, Abraham et al. 2010). In the 2008–09 trawl effort data, the start positions of 35 tows were shifted, and 8 tows had missing CELR effort numbers added (Table 1). Much of the bottom longline effort data was recorded on CELR forms. These record the number of sets in each day (the effort number), along with the total number of hooks set. In 2008–09, grooming rules updated the effort number of 26 bottom longline sets (Table 2). For both trawl and bottom-longline data, the grooming primarily affected earlier records, with more reliable data being obtained from the new form types. No grooming of surface longline effort was required (Table 3).

Grooming rules were applied to the observer records from COD, but no changes were necessary. Observer data were linked to the fisher-reported effort data where possible. Observed fishing effort is reported using the linked fisher-reported data. This allows a direct comparison between the observed and unobserved fishing effort, removing a potential bias resulting from the different way that observers report effort. Where a link was made, the location and target species details were taken from the effort data. For the 2008–09 fishing year, 98.3% of observed trawl events, 96.2% of observed surface longline

Table 1: Annual summary of fisher-reported trawl effort. The table gives the number of tows reported by form type. The number of tows affected by the grooming are also given. The East/West indicator on longitude was flipped, or the start point shifted, when the speed implied between consecutive tows was greater than 40 km/h. The number of tows indicated on CELR records was groomed if it was either missing or greater than 10 tows in a day, by setting it to the average number of tows per day for the vessel.

		Form types			Grooming applied		
		CELR	TCEPR	TCER	Flip E/W	Start point	CELR effort
2008–09	87 213	1 727	38 956	46 529	1	34	8
2007–08	89 223	1 261	42 152	45 810	2	49	3
2006–07	103 793	53 923	49 868	2	0	2	73
2005–06	109 982	55 814	54 168	0	0	5	138
2004–05	120 476	59 605	60 871	0	0	6	67
2003–04	120 878	56 936	63 942	0	0	5	201
2002–03	130 177	59 456	70 719	0	0	4	105
2001–02	127 883	55 847	72 030	0	0	16	167
2000–01	134 243	61 043	73 200	0	0	20	229
1999–00	139 057	64 324	74 733	0	13	203	666
1998–99	153 412	71 730	81 682	0	26	272	1 464

Table 2: Annual summary of fisher-reported bottom longline effort. The table gives the total number of sets and hooks by year, and the number of sets by form type. The number of sets affected by the grooming are also given. If the reported number of hooks was less than or equal to the reported number of sets, the two values were swapped. The hook number was groomed if it was missing or too low; similarly the number of sets was groomed when it was missing or too high. In both cases, they were replaced by the average number for that vessel. The date was set where it was missing.

	Total effort		Form types (sets)			Grooming applied (sets)			
	Hooks	Sets	CELR	LCER	LTCER	Swap	Hook num	Set num	Date
2008–09	37 389 649	17 337	1 317	4 223	11 795	0	0	26	0
2007–08	41 462 259	18 400	1 167	5 079	12 154	0	1	73	0
2006–07	38 389 449	19 067	14 843	4 223	1	9	9	211	0
2005–06	37 125 639	17 464	13 890	3 574	0	0	0	277	0
2004–05	41 840 933	20 156	16 490	3 666	0	0	1	290	1
2003–04	43 449 733	20 574	18 125	2 449	0	3	13	698	0
2002–03	37 753 337	21 957	21 957	0	0	10	38	1 002	0
2001–02	47 014 737	24 306	24 306	0	0	4	6	992	1
2000–01	50 939 347	26 986	26 986	0	0	57	75	1 156	3
1999–00	53 205 774	27 759	27 759	0	0	94	259	2 315	16
1998–99	54 942 642	28 016	28 016	0	0	67	571	2 615	0

sets, and 98.5% of observed bottom longline hooks were linked to the fisher reported effort following previously described rules (Abraham & Thompson 2009).

The location of fishing effort is commercially sensitive, and must be anonymised before being displayed in plots. The position of effort and observations were binned to $0.2^\circ \times 0.2^\circ$ cells before plotting, and the capture locations were jittered (randomly displaced) by adding a random number, uniformly distributed between $\pm 0.1^\circ$, to both the latitude and longitude.

Table 3: Annual summary of fisher-reported surface longline effort. The table gives the number of hooks by form type. The surface longline effort data did not need grooming.

	Total effort		Form types (hooks)	
	Hooks	Records	CELR	TLCER
2008–09	3 106 028	2 623	0	3 106 028
2007–08	2 233 039	1 944	200	2 232 839
2006–07	3 746 673	2 767	80	3 746 593
2005–06	3 687 569	3 055	280	3 687 289
2004–05	3 676 795	3 013	9 000	3 667 795
2003–04	7 382 294	5 568	11 000	7 371 294
2002–03	10 781 178	7 876	25 413	10 755 765
2001–02	10 874 288	8 781	42 800	10 831 488
2000–01	9 756 403	8 094	126 546	9 629 857
1999–00	8 283 927	6 999	247 803	8 036 124
1998–99	6 832 220	5 925	202 521	6 629 699

2.1.1 Inshore coverage programme

In the summer of 2008–09, an inshore coverage programme was started that specifically focused on monitoring inshore fisheries for the capture of protected species. The programme was initially designed to cover areas within the range of Hector's dolphin. New observers were recruited for the project, and hand held electronic data collection was trialled at the same time (using a Trimble Nomad device). The first trip was in January 2009. Data recorded on the Nomads included the start and end time of trips, the time and position of fishing events, and the time and position of incidents (including protected species captures). Standard paper non-fish bycatch forms were used to detail protected species captures.

After the initial deployment, various issues were discovered with the electronic data collected from the project and so they were not used. However, a log of observer activity that included the trip number of observed trips, vessel keys, and the start and end dates of voyages was prepared by the Ministry of Fisheries data management team. From this log, and from fishing effort reported by fishers that was stored in the *warehou* database, the observed effort was reconstructed on the assumption that all effort on each observed trip was observed. If, in fact, trips were only partially observed, then this would cause the bycatch to be correspondingly underestimated.

The paper non-fish bycatch forms were keyed by staff at NIWA, and these allowed the protected species captures to be identified. Events recorded on the paper forms were matched to the fisher-reported events by using the closest date, and the station number recorded by the observers. All capture events were matched to effort. While there was sometimes ambiguity about which fishing event the captures should have been associated with, these issues were not material for this project, as we are presenting only broad summaries of the data.

2.1.2 Setnet observations

Setnet effort data were prepared in a similar way as the trawl, surface longline, and bottom longline effort. Following previous work characterising setnet fisheries (Paul 2003), the total length of nets set was used as the measure of effort, reported in kilometres. Setnet effort was most frequently reported on CELR forms, using the passive nets template. On these forms, the effort was characterised by the mesh size and the total net length used in each day. Since 2006–07, setnet fisheries moved to reporting on the specialised NCELR form. More detail was collected on these forms, including the latitude and

longitude of fishing effort, the number of sets made, and information on the dimensions of the nets. To allow consistent comparisons from before the introduction of the NCELR form, we used only the total length of nets set. Note that the NCELR forms record the total length of nets hauled each day, whereas the CELR forms record the total length of nets set. This was not considered a material difference when aggregating effort from the two form types.

The total net-length field required grooming. Recording errors were clearly present, where the length entered was one or two orders of magnitude different from surrounding records for the same vessel. There were also missing net length records. Following Paul (2003), we groomed the total net length to correct for both these errors. Within annual effort reported by a fishing vessel, recorded total net length was considered to be an outlier if the value was more than five times (or less than one fifth) the median, if the value occurred less than four times, and if it appeared in less than 5% of records. The net length field of 2743 records that were either outliers, or had missing values, were set to the median value for the vessel operating in that year. Setnet effort is summarised by form type in Table 4, and both the number of records and the total net length that was changed by grooming are included.

Table 4: Annual summary of setnet effort. The table gives the number of records, and the total net length, reported by form type. The number of records, and total net length, affected by the setnet grooming are also given.

			Form types				Net length grooming applied			
			CELR		NCELR		Outlier		Missing	
	No. recs.	km	No. recs.	km	No. recs.	km	No. recs.	km	No. recs.	km
2008–09	22 481	20 911	14 552	10 265	7 929	10 646	96	138	8	5
2007–08	22 734	20 977	14 192	9 650	8 542	11 327	83	112	0	0
2006–07	26 467	24 235	17 763	13 040	8 704	11 195	114	135	46	46
2005–06	24 707	24 284	24 707	24 284	0	0	129	163	0	0
2004–05	26 488	27 196	26 488	27 196	0	0	113	145	4	2
2003–04	26 145	27 051	26 145	27 051	0	0	124	160	18	31
2002–03	27 114	28 274	27 114	28 274	0	0	107	128	8	16
2001–02	27 601	27 944	27 601	27 944	0	0	123	153	8	6
2000–01	30 525	31 051	30 525	31 051	0	0	114	156	88	114
1999–00	29 616	30 360	29 616	30 360	0	0	177	215	1 065	800
1998–99	28 389	29 325	28 389	29 325	0	0	168	211	1 512	1 338

Observers reported setnet effort with a separate record for each set, but did not report the length of the nets set. A linking algorithm was developed to associate each observed set with the corresponding fisher-reported effort. A sequence of linking rules was applied, E1 to E6 (Table 5), that became progressively more relaxed. All the rules required that vessel keys matched. The first three rules required that the day matched exactly, with E1 matching the number of sets on the day, as reported by the effort number field, E2 matching when the number of sets was out by one, and E3 not requiring the number of sets to match. The rules E3, E4, and E6 relaxed the date requirement, with E3 matching when the observer reported time was within 12 hours of the fisher-reported day, E4 within 3 days, and E6 within 20 days. The first two rules, E1 and E2, could only link observer records to fisher effort reported on the NCELR form, as they used the total number of nets set each day. The last rule, E6, was used to ensure that no observed effort was missing. Data collected by the inshore coverage programme were matched by making the assumption that all effort on observed trips was observed. This may lead to the estimated bycatch being underestimated if, in fact, not all the effort was observed.

Observer coverage of setnet effort was low in all years, other than 2008–09, not reaching 1% until the start of the inshore coverage programme. There were no observations of setnet fishing during the four fishing years from October 2001 to October 2005.

Table 5: Summary of setnet observer data. The table gives the total observed setnet effort in kilometres, the percentage of all setnet effort observed, and the amount of setnet effort linked to fisher reported effort with each of six matching rules. The inshore coverage observations were linked to the effort data as whole trips.

			Linking rules applied						
	Length obs. (km)	% obs.	E1	E2	E3	E4	E5	E6	Inshore coverage
2008–09	460.6	2.20	3.4	1.7	14.5	-	0.4	-	440.5
2007–08	194.8	0.93	27.5	37.5	128.8	0.3	0.7	-	-
2006–07	149.0	0.61	20.4	28.8	97.9	-	0.8	1.0	-
2005–06	134.6	0.55	-	-	133.8	0.8	-	-	-
2000–01	34.2	0.11	-	-	33.2	1.0	-	-	-
1999–00	40.2	0.13	-	-	35.2	1.5	1.2	2.3	-
1998–99	1.8	0.01	-	-	-	-	1.8	-	-

2.1.3 Necropsy information

Observers retain some animals for necropsy. When the capture data were supplied, the necropsy information for 2008–09 had not been integrated into the observer database. The seabird necropsy data were obtained directly from David Thompson (NIWA) and merged with the observer records. Where the observer had incorrectly identified a species, or had provided only a general classification, the records were updated to the species identified by necropsy. The necropsied seabirds are listed in Table 6 with both the observer and necropsy identifications.

2.1.4 Fisher-reported incidental non-fish catch

Commercial fishers are required to complete a non-fish incidental catch reporting form whenever they catch seabirds, marine mammals, or other protected species. The form was developed in 1996 and was used from December of that year. Data from the non-fish incidental catch form were summarised; in particular capture rates reported by fishers and observers were compared. The identification of fisher reported non-fish catch could not be confirmed, with many generic codes being used, and so all bird captures were aggregated together.

From 1 October 2008, the non-fish / protected species catch return (NFPSCR or NPC) replaced the old incidental bycatch form. Along with the new form a check-box was added to the catch effort forms, so the fisher could indicate that an NPC form had been completed. This allowed the reported captures to be linked back to catch effort data from the *warehou* database. An extract of the NPC data was obtained and summarised.

2.2 Excluded captures

Animals that landed on the deck or collided with the vessel's superstructure were not considered to be fishing related bycatch. The capture method code and observer comments were used to identify these non-fishing related captures, and they were excluded from the data. In addition, decomposing animals were assumed to have died of causes unrelated to the fishing effort and were excluded. Occasional records of unidentified fish or tissue that were reported as non-fish bycatch were also excluded.

Animals caught during trips carried out under special permit were also excluded. There were no such trips during 2008–09. During 2007–08, a trial was carried out on a surface longline vessel

Table 6: Necropsied seabirds returned by the Ministry of Fisheries observer programme from 1 October 2008 to 30 September 2009, with the species as identified by the observer and the species identified by necropsy. The codes are those used by the Ministry of Fisheries for non-fish catch.

Species as identified at necropsy		Species as identified by observer		Number
Sooty shearwater	*Puffinus griseus*	XSH	Sooty shearwater	87
		XWC	White-chinned petrel	3
		XPE	Unidentified petrel	1
White-chinned petrel	*Procellaria aequinoctialis*	XWC	White-chinned petrel	52
		XXP	Petrels, prions and shearwaters	9
		XPE	Unidentified petrel	8
		XBM	Buller's albatross	1
		XWP	Westland petrel	1
		XSH	Sooty shearwater	1
		XBP	Black petrel	1
White-capped albatross	*Thalassarche steadi*	XWM	White-capped albatross	44
		XSY	Shy albatross	9
		XAL	Unidentified albatrosses	6
		XMA	Smaller albatrosses	3
		XRA	Southern royal albatross	2
		XSA	Salvin's albatross	1
		XGA	Great albatrosses	1
Spotted shag	*Phalacrocorax punctatus*	XHG	Shags	32
Buller's albatross	*Thalassarche bulleri bulleri*	XBM	Buller's albatross	27
		XGM	Grey-headed albatross	1
		XWC	White-chinned petrel	1
Salvin's albatross	*Thalassarche salvini*	XSA	Salvin's albatross	16
		XAL	Unidentified albatrosses	10
		XGM	Grey-headed albatross	1
Grey petrel	*Procellaria cinerea*	XGP	Grey petrel	9
Black petrel	*Procellaria parkinsoni*	XBP	Black petrel	8
Cape petrel	*Daption capense*	XCP	Cape petrels	5
Yellow-eyed penguin	*Megadytes antipodes*	XYP	Yellow-eyed penguin	4
Flesh-footed shearwater	*Puffinus carneipes*	XFS	Flesh-footed shearwater	3
Chatham albatross	*Thalassarche eremita*	XCI	Chatham albatross	2
Unidentified albatrosses	Diomedeidae (Family)	XAL	Unidentified albatrosses	1
		XWM	White-capped albatross	1
Westland petrel	*Procellaria westlandica*	XWC	White-chinned petrel	1
		XWP	Westland petrel	1
Antarctic prion	*Pachyptila desolata*	XDP	Common diving petrel	1
Antipodean albatross	*Diomedea antipodensis antipodensis*	XWA	Unidentified wandering albatross	1
Campbell albatross	*Thalassarche impavida*	XKM	Unidentified black-browed albatross	1
Gibson's albatross	*Diomedea antipodensis gibsoni*	XWA	Unidentified wandering albatross	1
Black-bellied storm petrel	*Fregetta tropica*	XFT	Black-bellied storm petrel	1
Common diving petrel	*Pelecanoides urinatrix*	XDP	Common diving petrel	1
Fairy prion	*Pachyptila turtur*	XPN	Unidentified prions	1
Northern royal albatross	*Diomedea sanfordi*	XNR	Northern royal albatross	1

to test the efficacy of dyeing bait blue at reducing the number of birds that are hooked. Three Antipodean albatrosses (*Diomedea antipodensis*) and one Campbell albatross (*Thalassarche impavida*) were observed killed during this trip. In past years, captures recorded on trips carrying out research on bycatch mitigation have also been excluded (Abraham & Thompson 2009, Abraham et al. 2010).

2.3 Fishery and area classification

Trawl fishing events were assigned to fisheries on the basis of the species targeted by the fishing effort, following the classification used by Abraham & Thompson (2009). Deepwater and middle depth trawl

fisheries included squid, hoki, hake, ling, southern blue whiting, other deepwater fish (orange roughy, oreos, and cardinalfish), and scampi. Mackerel trawl included effort targeting jack and blue mackerel. Other middle depth trawl included effort targeting barracouta, ribaldo, rubyfish, alfonsino, bluenose, frostfish, ghost shark, gemfish, spiny dogfish, sea perch, and warehou. All inshore target species were reported as inshore trawl, including 89 distinct species codes. The most frequently targeted inshore fish were flatfish (9 species), tarakihi, snapper, red cod, gurnard, trevally, John dory, and giant stargazer.

Surface longline fisheries were defined by the fisher-declared target species, with southern bluefin tuna, bigeye tuna, swordfish, and other target species being used to define four fisheries. Charter surface longline vessels primarily targeted southern bluefin tuna, and domestic vessels primarily targeted bigeye tuna. Bottom longline fishing effort was assigned to either ling, snapper, bluenose, other species targets. In addition, all bottom longline effort was divided into fishing by vessels smaller than 34 m, and fishing by vessels larger than 34 m. The larger vessels typically set more than 20 000 hooks per day, using automatic line setting equipment. The small vessels typically set fewer than 15 000 hooks per day, with most of them setting their lines manually. By grouping the bottom longline effort in this way, a potential of 8 different fisheries were defined. The division of bottom longline fisheries by vessel length differs from previous reporting (Abraham et al. 2010), but is aligned with treatment of bottom longline effort in the seabird modelling (Abraham & Thompson 2011). Setnet fishing was treated as a single fishery.

Captures in all fisheries, apart from surface longline, were reported for the areas shown in Figure 1(a) (Abraham & Thompson 2009, Thompson & Abraham 2009). These were chosen to surround the prominent bathymetric features that are the focus of fishing effort. The areas included the Cook Strait, Stewart-Snares shelf, and Auckland Islands areas used in previous reports of protected species bycatch (e.g., Baird & Smith 2007, 2008). Away from these areas, the boundaries were chosen to avoid cutting through fishing grounds, and were aligned with the boundaries of the Fisheries Management Areas where possible. The areas used for reporting surface longline effort followed those defined previously (e.g., Baird & Smith 2007, 2008) and are shown in Figure 1(b).

2.4 Estimation of total captures

From the fisheries and areas, individual strata were defined. In this report, target species, method, and vessel size were used to define 24 fisheries: 10 trawl fisheries; 5 surface longline fisheries; 8 bottom longline fisheries; and 1 setnet fishery. The EEZ was divided into 11 areas for the trawl, bottom longline, and setnet fisheries, and into 4 areas for surface longlining. Using these definitions, there were 229 fishery-area strata. Combining these strata with the species (or species groups), there were a potential 2290 species-fishery-area combinations, each estimated separately. Not all of the species-fishery-area strata have fishing effort. For example there has never been any southern blue whiting trawl effort reported in the Cook Strait, or setnet effort reported around the Auckland Islands. A total of 189 fishery-area strata had effort reported during the 11 years from 1998–99 to 2008–09.

Bayesian models have been developed to estimate captures of seabirds, fur seals, common dolphins, and sea lions in commercial fisheries. Estimates of seabird captures were made separately for white-capped albatross, white-chinned petrel, sooty shearwater, other albatrosses, and other birds. Models were fitted where there were both sufficient observer coverage and sufficient capture events to warrant using a modelling approach. The capture models were developed for fur seals in trawl fisheries (Thompson & Abraham 2010), common dolphins in the jack mackerel trawl fishery (Thompson et al. 2010), sea lions in trawl fisheries (Thompson & Abraham 2011), and seabirds in trawl and longline fisheries (Abraham & Thompson 2011).

The models were first used to predict the captures in the individual strata-species-year combinations

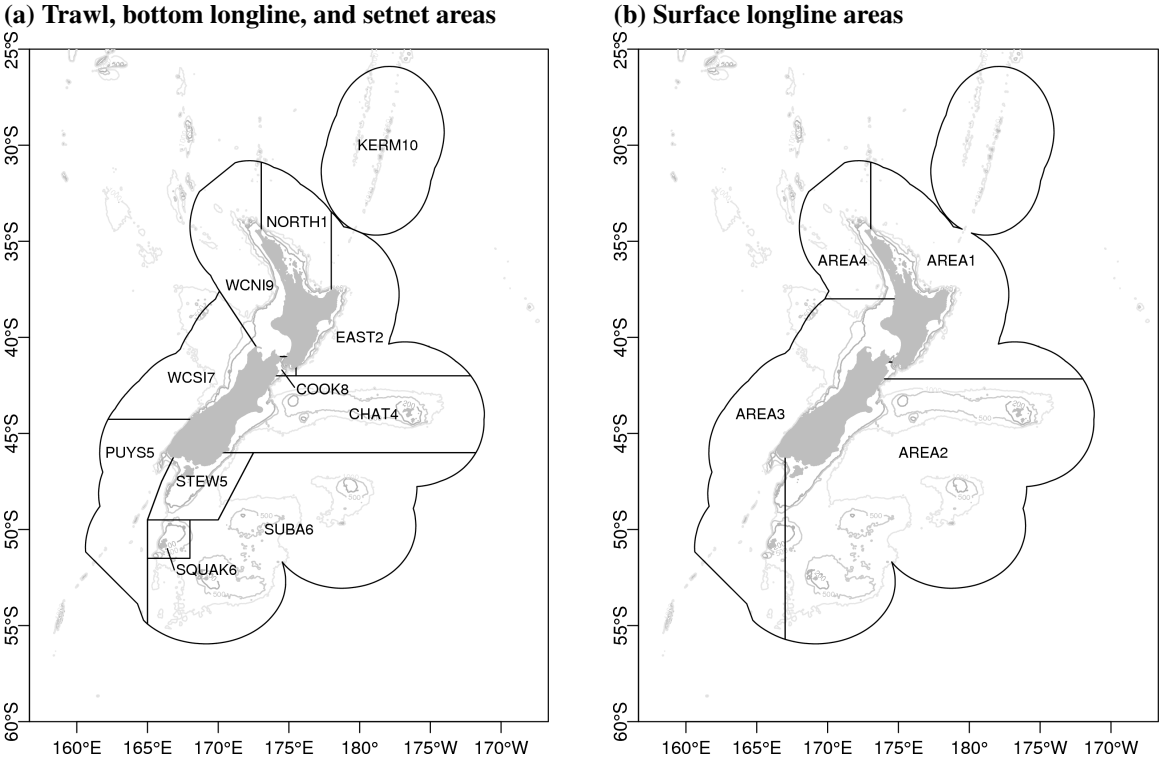

Figure 1: Reporting areas used in summary tables.

in which the models were defined. From each model, 5000 samples were drawn from the posterior distribution of the estimated captures of the modelled species within each year and stratum.

In the remaining strata, captures were estimated using a ratio method, provided that there had been more than 1% observer coverage, and at least a minimum number of fishing events observed. For trawl fisheries, more than 100 observed tows were required to make a ratio estimate; for longline fisheries more than 10 000 observed hooks were required; and for setnet fisheries more than 100 km of observed net were required.

2.4.1 Common dolphin capture model (mackerel trawl fishery)

Common dolphin captures by vessels over 90 metres targeting jack mackerel on the west coast of the of the North Island were modelled by Thompson et al. (2010). The smaller vessels operating there that target jack mackerel have not been observed to catch common dolphins, and it was assumed in the model that these smaller vessels caught no dolphins.

The model estimated captures using a two stage structure, known as a hurdle model. Firstly, the model estimated whether a dolphin capture event occurred on a trawl, and secondly, how many dolphins were caught given that there was a capture event. The model was fitted using Bayesian methods. Estimated captures were made for the fishing years 1995–96 to 2008–09, covering all the years presented in this report.

2.4.2 New Zealand fur seal capture model (trawl fisheries)

Fur seal captures in trawl fisheries were estimated using a Generalised Linear Model (GLM), fitted using Bayesian methods (Thompson & Abraham 2010). A single model was used to estimate fur seal captures in all trawl fisheries, other than those targeting flatfish or other inshore fish species. There has been low observer coverage in these inshore fisheries, and so all effort targeting inshore fisheries was excluded from the estimation.

There were no observed captures of fur seals in the northern, northeastern North Island, or eastern Chatham Rise areas. These areas were excluded from the fur seal model, but it was assumed that there were no fur seal captures in any trawl fishing in those areas. The trawl effort in those areas (other than inshore trawl) was included in the estimation, with no associated fur seal captures. For this reason, the trawl effort reported by (Thompson & Abraham 2010) differs from the trawl effort reported here.

2.4.3 Models of New Zealand sea lion captures and interactions (trawl fisheries)

Four separate methods were used to estimate sea lion captures in trawl fisheries, with the methods described by Thompson & Abraham (2011). The four estimates included a model of sea lion captures in the Auckland Islands squid fishery; a model of sea lion captures in the southern blue whiting fishery near Campbell Island; ratio estimation of captures in other trawl fisheries in the Auckland Islands region; and ratio estimation of captures in trawl fisheries on the Stewart-Snares shelf. The models of the squid and southern blue whiting fisheries were both GLMs fitted using Bayesian methods.

Since 2001, vessels fishing in the Auckland Islands squid fishery have used sea lion exclusion devices (SLEDs), with SLEDs being used on nearly all tows in this fishery since the 2004–05 fishing year. The intention of the SLEDs is that the sea lions are able to exit from the net without being drowned; however the survival rate of sea lions that enter a net and escape through a SLED is not well known. In modelling of sea lion captures in the squid fishery, the number of interactions was estimated; this was the total number of sea lions that would have been observed caught if (1) all tows were observed, and (2) no SLEDs were used. In this report, we included estimates of the total number of interactions made by Thompson & Abraham (2011).

2.4.4 Seabird capture model (trawl fisheries)

Model estimates of the capture of seabirds in New Zealand trawl fisheries were made by Abraham & Thompson (2011). The models were GLMs, fitted using Bayesian methods, with separate models being made for white-capped albatrosses, white-chinned petrels, sooty shearwaters, other albatrosses, and other birds. Captures were estimated for all trawl fisheries, except inshore and flatfish species, for the 2002–03 to 2008–09 fishing years.

2.4.5 Seabird capture model (bottom longline fisheries)

Model estimates of the capture of seabirds in New Zealand bottom longline fisheries were made by Abraham & Thompson (2011). The models were GLMs, fitted using Bayesian methods, with separate models being made for white-capped albatrosses, white-chinned petrels, sooty shearwaters, other albatrosses, and other birds. Bottom longline fishing was divided into fishing by vessels over 34 m in length, and vessels less than 34 m in length. Captures were estimated in all fishing by the larger vessels. These vessels all set an average of over 20 000 hooks per day, and had consistent observer

coverage. Estimates were made for the 1998–99 to 2008–09 fishing years.

In addition, model-based capture estimates were made of other birds in small vessel bottom longline fisheries targeting snapper in the northeastern area (NORTH1, or FMA1). There have been sporadic observations of the small vessel snapper longline fishery in this area. All observed captures were of birds in the 'other birds' group, with the exception of a single live capture that was reported as a white-chinned petrel by the observer. In the modelling, this capture was included with the other birds. Estimation of other bird captures in the northeastern snapper fishery was made from 2002–03 to 2008–09.

2.4.6 Seabird capture model (surface longline fisheries)

Model estimates of the capture of seabirds in New Zealand surface longline fisheries were made by Abraham & Thompson (2011). The models were GLMs, fitted using Bayesian methods, with separate models being made for white-capped albatrosses, white-chinned petrels, sooty shearwaters, other albatrosses, and other birds. Seabird captures were estimated for all surface longline fishing between 1998–99 and 2008–09.

2.4.7 Ratio estimation

The ratio-estimated total number of captures in a stratum, s, is

$$N_t^s = N_o^s + N_e^s \tag{1}$$

where N_o^s are the observed captures and N_e^s are the estimated captures during unobserved fishing. Note that the estimated total captures includes the observed captures. The captures during unobserved fishing, N_e^s, were calculated by multiplying the unobserved effort by the observed capture rate,

$$N_e^s = \frac{N_o^s}{O^s}(E^s - O^s)$$

where O^s is the amount of observed fishing effort, and E^s is the total fishing effort. Effort is measured in tows for trawl fisheries, hooks for longline fisheries, and kilometres of net for setnet fishing. The observed capture rate was estimated using observations from the whole 11 year period, and then applied to the unobserved effort in each year,

$$N_e^{sy} = \frac{\sum_y N_o^{sy}}{\sum_y O^{sy}}(E^{sy} - O^{sy}). \tag{2}$$

In previous reporting (e.g., Abraham et al. 2010) the ratio estimate was carried out independently within each year for species-area-fishery strata where there had been both sufficient observations, and a sufficient number of observed captures. Most of the single-year ratio estimates were replaced by more reliable model based estimates, and in this report all ratio estimation assumed that the capture rate was constant across all years, following Equation 2.

The uncertainty in the total captures, N_t, was estimated by simple bootstrap resampling (e.g., Davison & Hinkley 1997). The observed fishing events were resampled 5000 times, and the total bycatch was recalculated for each sample from Equations 2 and 3. The bootstrap resampling did not represent the hierarchical trip structure of the data, and so may underestimate the uncertainty to some extent. The 95% confidence interval in the estimate was calculated from the 2.5% and 97.5% quantiles in the distribution of the resampled total catch. The confidence interval of the ratio estimates was a fixed proportion of the estimate in each year. This is because the uncertainty came from the capture rate estimate, which was then applied across all years.

2.4.8 Combining estimates

Both the ratio estimation and the model estimates produced 5000 samples at the finest scale (each species-fishery-area-year combination). The samples from each stratum were combined in various ways to present useful aggregates. Where model estimates were available, they were used in preference to the ratio estimates. The estimate of captures in an aggregate is a sum over the strata of the total captures N_t^s in each of the strata,

$$N_t = \sum_s N_t^s. \tag{3}$$

By carrying out the sum for each of the 5000 samples, 95% confidence intervals of aggregated quantities could be derived from the 2.5% and 97.5% quantiles. Posterior intervals from Bayesian analyses are often summarised using credible intervals; all uncertainties reported here are derived from the quantile-based confidence intervals.

Where the estimates are presented, the percentage of effort included in the estimate, f, is also given,

$$f = 100 \sum_{sy} E_e^{sy} / E, \tag{4}$$

where E_e^{sy} is the effort in stratum s and year y that is included in the estimation, and $E = \sum_{sy} E^{sy}$ is the total effort in all strata within the aggregate. The estimated effort in an individual stratum was either 0, if the stratum was not observed in that year; O^{sy}, if no estimation was carried out in the stratum; or E^{sy}, if the captures were estimated. This percentage indicates how much of the effort was observed at a level sufficient for making the estimate. Note that this includes the observed effort as well as effort over which captures were estimated. If all strata were included in the estimate of N_e then $f = 100\%$.

3. RESULTS AND DISCUSSION

3.1 Observed captures

A summary of all observed captures of seabirds, marine mammals, and turtles is given in Table 7. This table reports the number of captures of each species identified either by necropsy or by observers. Where animals had been necropsied, the necropsy identification was given precedence. The captures were categorised by whether the animals were dead or were released alive (with unknown prognosis). The captures are also given by fishing method, with the trawl captures being categorised by whether they were warp captures, net captures, or reported caught through some other means. For white-capped and Salvin's albatrosses, there were fewer trawl captures on the trawl warps than in the net. This contrasts with before the introduction of mandatory warp mitigation in January 2006, when warp captures were more frequent than net captures for albatross species (Abraham 2010).

Non-fishing related captures recorded by observers, and decomposed or skeletal remains, were excluded from the summary. In total, 51 birds were excluded from the 2008–09 fishing year, 4 of which were decomposing, while the rest were identified as non-fishing related captures. Birds that were reported as non-fishing related captures were generally released alive. An exception was a white-faced storm petrel that landed on the deck, which, according to observer comments, was subsequently accidentally killed by a wire. Five decomposing whales (two toothed whales, two baleen whales, and one unknown cetacean) were caught in trawl nets. A capture of an unidentified seal was reported by an observer (Table 7); this capture was not included elsewhere in the report as it was unclear whether or not it was a fur seal, a sea lion, or another pinniped.

The animals that were most frequently observed caught during the 2008–09 fishing year were sooty shearwaters, with 132 captures. Of these, 127 were caught in trawl fisheries. One quarter of the

sooty shearwaters that were caught were released alive. Observed captures of white-chinned petrels, white-capped albatrosses, and Buller's albatrosses were also relatively frequent, with 90, 81, and 48 observed captures respectively. Buller's albatrosses (*Thalassarche bulleri*) were the species that was most frequently observed caught in surface longline fisheries (29 captures).

In 2008–09, three Westland petrels (*Procellaria westlandica*) were caught in the west coast South Island area, two in trawl fisheries, and one during southern bluefin tuna surface longline fishing. The identification of two Westland petrels was confirmed by necropsy, and the other one was released alive. Ten black petrels (*Procellaria parkinsoni*; eight confirmed by necropsy) were caught in the northeast fishing area: eight in the bottom longline fishery targeting snapper, and two in surface longline fishery targeting bigeye tuna. Both Westland and black petrels are classified as vulnerable by the IUCN (2008).

One Campbell albatross (*Thalassarche impavida*), positively identified by necropsy, was observed caught in 2008–09 on a surface longline in the northeast bigeye tuna fishery. Two other black-browed type albatrosses (*T. melanophris* or *T. impavida*) were reported caught in 2008–09, both in the surface longline fishery targeting southern bluefin: one in the northeast and the other in the west coast South Island area. Tese birds were not necropsied, however, and may have been misidentified. There were six great albatrosses (genus *Diomedea*) observed caught: two unidentified wandering-type albatrosses (*D. exulans*, *D. antipodensis antipodensis*, or *D. antipodensis gibsoni*) caught on surface longline sets; one unidentified large albatross caught in an Auckland Islands squid trawl, but released alive; one Antipodean albatross (confirmed by necropsy) killed in the northeast bigeye tuna fishery; one Gibson's albatross (confirmed by necropsy) killed in the northeast southern bluefin tuna; and a Northern royal albatross (*D. sanfordi*), positively identified by necropsy and classified as endangered (IUCN 2008), was killed by surface longline fishing in the northeast area targeting bigeye tuna.

In 2008–09, there were 95 observed fur seal captures, mainly in trawl fisheries (77%), and during surface longlining (22%). This was fewer than in 2007–08, when 151 fur seals were observed caught. In 2008–09, all fur seals observed caught during surface longline fishing were released alive, but more than three-quarters of trawl captures were reported as dead. Most observed fur seal captures in trawl fisheries occurred in fisheries targeting hoki (51%) and southern blue whiting (24%).

Whereas there were 11 observed captures of New Zealand sea lions in 2007–08, there were only 3 observed captures in 2008–09, all killed in trawl nets around the Auckland Islands. Two were caught in the squid fishery and one in the scampi fishery. New Zealand sea lions are classified as vulnerable by the IUCN (2008). Sea lion exclusion devices (SLEDs) are used in the Auckland Islands squid fishery. These have grids that prevent sea lions from entering the codend, with a hole in the top of the net where sea lions can exit. The observed captures do not include animals that exit via SLEDs. In the Auckland Islands squid fishery, observers were requested to record the location where the sea lion was first observed. Of the two animals observed caught in the squid fishery, one was found stuck in the SLED grid and one in the SLED lengthener.

Common dolphins (*Delphinus delphis*) were the most frequently caught cetacean in 2008–09, with 20 observed caught in the west coast North Island area. Of these, 11 were caught in the jack mackerel trawl fishery, 2 were caught on tows targeting flatfish, and 7 were caught on tows targeting barracouta. Of the dolphins caught in the jack mackerel fishery, 10 were caught during a single fishing trip. Two pilot whales (*Globicephala melas*) were also observed killed in the west coast North Island jack mackerel fishery.

Two leatherback turtles (*Dermochelys coriacea*) were caught in the bigeye tuna surface longline fishery in the northwestern area, and were subsequently released alive. One green turtle (*Chelonia mydas*) was caught in a trawl targeting John dory in the northeastern area, and was also released alive.

Table 7: All seabird, marine mammal, and other non-fish captures in trawl, bottom longline, and surface longline fisheries recorded by Ministry of Fisheries observers from 1 October 2008 to 30 September 2009, showing the number of captures (excluding non-fishing related captures (NFR) and decomposing animals (Deco.)), the number reported alive, the number necropsied, the number observed caught in trawl, surface longline (SLL), bottom longline (BLL), or setnet (SN) fisheries.

Species	All	Capture status		Nec.	Trawl			SLL	BLL	SN	Exclusions	
		Alive	Dead		Net	Warp	Oth.				NFR	Deco.
Sooty shearwater	132	36	96	91	126	1	-	-	-	5	2	1
New Zealand fur seal	93	25	68	-	72	-	-	20	-	1	-	1
White-chinned petrel	90	14	76	73	86	-	-	3	1	-	3	-
White-capped albatross	81	11	70	66	47	26	5	3	-	-	1	-
Buller's albatross	48	15	33	29	5	13	1	29	-	-	1	-
Unidentified petrel	34	33	1	-	34	-	-	-	-	-	1	-
Salvin's albatross	33	3	30	27	17	12	-	3	1	-	2	-
Spotted shag	32	-	32	32	32	-	-	-	-	-	-	1
Unid. albatross	23	8	15	2	9	10	4	-	-	-	8	1
Common dolphin	20	-	20	-	20	-	-	-	-	-	-	-
Flesh-footed shearwater	16	10	6	3	2	-	1	-	13	-	3	-
Petrels, prions and shearw.	12	8	4	-	9	-	1	-	1	1	5	-
Cape petrels	12	6	6	-	2	-	-	1	1	8	4	-
Black petrel	10	-	10	8	-	-	-	2	8	-	3	-
Grey petrel	9	-	9	9	-	-	-	6	3	-	-	1
Cape petrel	5	-	5	5	2	2	-	-	1	-	-	-
Smaller albatrosses	5	4	1	-	5	-	-	-	-	-	-	-
Yellow-eyed penguin	5	-	5	4	-	-	-	-	-	5	-	-
Westland petrel	3	1	2	2	2	-	-	1	-	-	2	-
New Zealand sea lion	3	-	3	-	2	-	1	-	-	-	-	-
Chatham albatross	2	-	2	2	-	1	-	-	1	-	1	-
Black-browed albatross	2	1	1	-	-	-	-	2	-	-	-	-
Gulls and terns	2	-	2	-	-	2	-	-	-	-	-	-
Leatherback turtle	2	2	-	-	-	-	-	2	-	-	-	-
Penguins	2	1	1	-	-	-	-	-	2	-	-	-
Pilot whale	2	-	2	-	2	-	-	-	-	-	-	-
Unid. large seabird	2	1	1	-	1	-	-	-	-	1	-	-
Wandering albatross	2	1	1	-	-	-	-	2	-	-	-	-
Common diving petrel	1	-	1	1	1	-	-	-	-	-	3	-
Fairy prion	1	-	1	1	1	-	-	-	-	-	2	-
Black-bellied storm petrel	1	-	1	1	1	-	-	-	-	-	1	-
Unid. prion	1	1	-	-	-	-	1	-	-	-	1	-
Antarctic prion	1	-	1	1	1	-	-	-	-	-	-	-
Antipodean albatross	1	-	1	1	-	-	-	1	-	-	-	-
Black-backed gull	1	-	1	-	-	-	-	-	1	-	-	-
Buller's shearwater	1	-	1	-	-	-	-	-	1	-	-	-
Campbell albatross	1	-	1	1	-	-	-	1	-	-	-	-
Unid. giant petrel	1	1	-	-	-	-	-	-	-	1	-	-
Gibson's albatross	1	-	1	1	-	-	-	1	-	-	-	-
Great albatrosses	1	1	-	-	1	-	-	-	-	-	-	-
Green turtle	1	1	-	-	1	-	-	-	-	-	-	-
Hector's dolphin	1	-	1	-	-	-	-	-	-	1	-	-
Northern royal albatross	1	-	1	1	-	-	-	1	-	-	-	-
Unid. seal	1	-	1	-	1	-	-	-	-	-	-	-
Shy albatross	1	1	-	-	1	-	-	-	-	-	-	-
White pointer shark	1	-	1	-	-	-	-	-	-	1	-	-
Baleen whales	-	-	-	-	-	-	-	-	-	-	-	2
Dolphins and toothed whales	-	-	-	-	-	-	-	-	-	-	-	2
Grey-backed storm petrel	-	-	-	-	-	-	-	-	-	-	1	-
Southern royal albatross	-	-	-	-	-	-	-	-	-	-	1	-
Unid. storm petrel	-	-	-	-	-	-	-	-	-	-	1	-
Unid. fish	-	-	-	-	-	-	-	-	-	-	1	-
Unid. tissue	-	-	-	-	-	-	-	-	-	-	-	1
White-faced storm petrel	-	-	-	-	-	-	-	-	-	-	1	-

Table 8: Observed seabird, marine mammal, and turtle captures in trawl, bottom longline, and surface longline fisheries by species group and target species in 2008–09, from 1 October 2007 to 30 September 2009. The fisheries are presented in decreasing order of the total captures (seabirds and mammals). Cetacean captures include 1 Hector's dolphin caught by a setnet, and 2 pilot whales caught in the jack mackerel trawl fishery, with the remainder being common dolphin. Other captures include a white pointer shark (setnet), 2 leatherback turtles (surface longline); 1 green turtle (John dory trawl), and an unidentified seal (white warehou trawl).

		Fishing effort	% observed	Sooty shearwater	White-capped albatross	Other albatrosses	White-chinned petrel	Other birds	**All birds**	New Zealand fur seal	New Zealand sea lion	Cetaceans	Others
Trawl (tows)	All	87 220	11.2										
Squid	SQU	3 832	33.1	74	53	15	80	37	**259**	1	2	-	-
Hoki	HOK	8 171	20.5	17	5	8	1	6	**37**	37	-	-	-
Flatfish	FLA	16 611	2.8	1	-	-	-	32	**33**	-	-	2	-
Barracouta	BAR	2 516	10.1	15	1	7	2	1	**26**	1	-	7	-
Silver warehou	SWA	1 079	14.4	5	8	9	-	5	**27**	1	-	-	-
Scampi	SCI	3 973	9.9	-	1	14	-	4	**19**	1	1	-	-
Jack mackerel	JMA	2 136	35.8	-	-	-	3	3	**6**	7	-	13	-
Tarakihi	TAR	12 570	2.6	-	5	9	-	-	**14**	-	-	-	-
Hake	HAK	1 779	19.7	6	1	2	-	-	**9**	5	-	-	-
White warehou	WWA	325	34.8	5	1	3	-	-	**9**	-	-	-	1
Southern blue whiting	SBW	1 187	25.3	-	-	-	-	-	-	17	-	-	-
Red cod	RCO	2 930	8.5	-	1	6	-	1	**8**	-	-	-	-
Orange roughy	ORH	3 543	40.5	-	-	3	-	2	**5**	-	-	-	-
Spiny dogfish	SPD	432	13.2	-	3	2	-	-	**5**	-	-	-	-
Ling	LIN	1 406	10.1	4	-	-	-	-	**4**	-	-	-	-
Lemon sole	LSO	829	9.7	-	-	-	-	2	**2**	-	-	-	-
Black oreo	BOE	1 011	34.3	-	-	-	-	1	**1**	-	-	-	-
Gemfish, southern kingfish	SKI	134	7.5	-	-	-	-	1	**1**	-	-	-	-
Blue mackerel	EMA	33	100.0	-	-	-	-	-	-	1	-	-	-
John dory	JDO	1 941	3.0	-	-	-	-	-	-	-	-	-	1
Giant stargazer	STA	1 428	4.7	-	-	-	-	-	-	1	-	-	-
Surface longline (hooks)	All	3 106 028	26.0										
Southern bluefin tuna	STN	1 473 533	48.6	-	3	45	2	7	**57**	22	-	-	-
Bigeye tuna	BIG	1 566 817	5.4	-	-	5	1	3	**9**	-	-	-	2
Bottom longline (hooks)	All	37 389 649	10.8										
Snapper	SNA	8 955 340	3.2	-	-	-	-	21	**21**	-	-	-	-
Ling	LIN	17 578 262	21.1	-	-	2	1	6	**9**	-	-	-	-
Hapuku	HAP/HPB	2 214 059	2.1	-	-	-	-	3	**3**	-	-	-	-
Red snapper	RSN	141 701	3.2	-	-	-	-	1	**1**	-	-	-	-
Setnet (kilometres)	All	20 911	2.2										
Tarakihi	TAR	711	11.0	4	-	-	-	8	**12**	-	-	1	-
School shark	SCH	2 937	8.2	1	-	-	-	5	**6**	1	-	-	-
Rig	SPO	3 646	1.9	-	-	-	-	2	**2**	-	-	-	-
Blue moki	MOK	313	4.9	-	-	-	-	1	**1**	-	-	-	-
Butterfish	BUT	510	3.5	-	-	-	-	-	-	-	-	-	1

A summary of all observed seabird, marine mammal, and turtle captures, categorised by target species, is presented in Table 8. The numbers of seabirds, mammals, and turtles caught within trawl, surface longline, bottom longline, and setnet fisheries are given in decreasing order of the number of observed captures. Fishing effort and the percentage of effort observed is also given, to provide a context for the number of captures. Target fisheries are separately included in this table only if they had observed captures during 2008–09.

Most observed bird captures in trawl fisheries (259 out of 465, or 55.7%) were on squid target tows. Fur seals were most frequently observed caught on hoki target tows. Of the surface longline fisheries, the southern bluefin tuna fishery had the most observed captures of both birds (57 of 66) and fur seals (22 of 22). In the southern bluefin tuna fishery, albatrosses (other than white-capped albatross) were the birds that were observed caught most frequently. In bottom longline fisheries, most of the observed effort targeted ling, and 9 birds were observed caught. Although only 0.5% of the effort targeting snapper using bottom longline was observed, 21 birds were observed killed, all caught off the north coast of the North Island. The observed seabird fatalities included 8 black petrels (*Procellaria parkinsoni*, 7 of them positively identified by necropsy), and 10 flesh-footed shearwaters (*Puffinus carneipes*).

Seabird, marine mammal, or other protected species captures in setnets have not been previously reported. In 2008–09, 2.2% of setnet effort was observed, and there were 21 birds observed caught in setnets. The bird captures included 8 Cape petrels, 5 sooty shearwaters, and 5 yellow-eyed penguins. The yellow-eyed penguins were caught in four setnets targeting school sharks and moki. Three nets were set off the north Otago coast, and one was set south of Invercargill.

A Hector's dolphin was observed caught in a setnet targeting tarakihi, south of Kaikoura. Two other Hector's dolphins were observed to have been caught in commercial fishing during the period covered by this report; they were also caught during setnet fishing on the east coast of the South Island. These two captures were before 2008–09, and so were not included in Table 8. There have not been any Hector's dolphins or Maui's dolphins (*Cephalorhynchus hectori maui*) observed caught in trawl or longline fisheries, although there has been poor observer coverage in the inshore waters where these dolphins live. Other observed setnet captures included a 3.5 m white-pointer shark that was caught in a setnet targeting butterfish, to the southeast of Stewart Island. As setnet captures have not previously been reported, all observed setnet captures from before October 1 2009 are listed in detail in Table 9.

3.2 Inshore coverage programme

Most of the fishing observed by the inshore coverage programme was either trawl or setnet, with a focus on the east coast of the South Island (within the Chatham Rise area, see Table 10). The programme began in January 2009, and most observations were either in January or February, with a smaller number being spread through the remainder of the fishing year (Figure 2).

Protected species captures from the inshore coverage programme are included in the summary information in Tables 7, 8, and 9. The focus of observer coverage on inshore fisheries resulted in observed captures of species that are not frequently observed caught during routine observer coverage. In particular the setnet captures of a Hector's dolphin, five yellow-eyed penguins, and a white-pointer shark, were all made as part of the inshore coverage programme.

There were 30 albatross captures reported by the inshore coverage programme during 2008–09, with 10 confirmed as Salvin's albatross at necropsy and 9 confirmed as white-capped albatrosses. The Salvin's albatrosses were caught on the east coast of the South Island, and the white-capped albatrosses were caught on the Stewart-Snares shelf and on the west coast of the South Island. The albatrosses were all

Table 9: All observed captures in setnet fisheries, giving the area, date, target species, alive or dead, and whether the animal was necropsied. Captures in the Chatham Rise area were all on the east coast of the South Island.

Species or species group	Date	Area	Target species		
Spotted shag	09 Nov 2005	West Coast NI	Rig	Dead	Necropsied
Spotted shag	09 Nov 2005	West Coast NI	School shark	Dead	Necropsied
New Zealand fur seal	10 Feb 2006	Puysegur	School shark	Dead	
New Zealand fur seal	11 Feb 2006	Stewart-Snares	School shark	Dead	
New Zealand fur seal	11 Feb 2006	Stewart-Snares	School shark	Dead	
White-chinned petrel	07 Apr 2006	Chatham Rise	Spiny dogfish	Alive	
Dusky dolphin	13 Nov 2006	Chatham Rise	Rig	Dead	
Fluttering shearwater	22 Nov 2006	West Coast NI	Rig	Dead	Necropsied
Hector's dolphin	30 Nov 2006	Chatham Rise	Rig	Dead	
Yellow-eyed penguin	18 Dec 2006	Stewart-Snares	School shark	Dead	Necropsied
Yellow-eyed penguin	19 Jan 2007	Stewart-Snares	School shark	Dead	Necropsied
New Zealand fur seal	06 Feb 2007	Puysegur	School shark	Dead	
Westland petrel	04 Nov 2007	Chatham Rise	Blue moki	Alive	
Cape petrels	05 Nov 2007	Chatham Rise	Blue moki	Alive	
Westland petrel	06 Nov 2007	Chatham Rise	Blue moki	Alive	
Sooty shearwater	11 Nov 2007	Chatham Rise	Blue moki	Dead	
New Zealand fur seal	12 Nov 2007	Chatham Rise	Blue moki	Dead	
Westland petrel	13 Nov 2007	Chatham Rise	Blue moki	Alive	
Yellow-eyed penguin	14 Dec 2007	Stewart-Snares	Rig	Dead	
Pilot whale	31 Dec 2007	West Coast NI	School shark	Alive	
Hector's dolphin	13 Feb 2008	Chatham Rise	Rig	Dead	
Yellow-eyed penguin	23 Jan 2009	Chatham Rise	Blue moki	Dead	
New Zealand fur seal	31 Jan 2009	West Coast SI	School shark	Dead	
White pointer shark	05 Feb 2009	Stewart-Snares	Butterfish	Dead	
Yellow-eyed penguin	14 Feb 2009	Stewart-Snares	School shark	Dead	Necropsied
Yellow-eyed penguin	15 Feb 2009	Chatham Rise	School shark	Dead	Necropsied
Yellow-eyed penguin	15 Feb 2009	Chatham Rise	School shark	Dead	Necropsied
Seabird - large	15 Feb 2009	Chatham Rise	Tarakihi	Alive	
Yellow-eyed penguin	17 Feb 2009	Chatham Rise	School shark	Dead	Necropsied
Petrels, prions and shearwaters	17 Feb 2009	Chatham Rise	School shark	Dead	
Sooty shearwater	23 Apr 2009	Chatham Rise	Tarakihi	Alive	
Sooty shearwater	24 Apr 2009	Chatham Rise	School shark	Alive	
Cape petrels	28 Apr 2009	Chatham Rise	Rig	Dead	
Cape petrels	30 Apr 2009	Chatham Rise	Tarakihi	Alive	
Cape petrels	01 May 2009	Chatham Rise	Tarakihi	Alive	
Unidentified giant petrels	04 May 2009	Chatham Rise	Rig	Alive	
Sooty shearwater	08 May 2009	Chatham Rise	Tarakihi	Alive	
Hector's dolphin	08 May 2009	Chatham Rise	Tarakihi	Dead	
Sooty shearwater	10 May 2009	Chatham Rise	Tarakihi	Alive	
Cape petrels	13 May 2009	Chatham Rise	Tarakihi	Alive	
Sooty shearwater	14 May 2009	Chatham Rise	Tarakihi	Alive	
Cape petrels	15 May 2009	Chatham Rise	Tarakihi	Alive	
Cape petrels	15 May 2009	Chatham Rise	Tarakihi	Alive	
Cape petrels	25 May 2009	Chatham Rise	Tarakihi	Alive	
Cape petrels	04 Jun 2009	Chatham Rise	Tarakihi	Dead	

Table 10: Summary of fishing observed by the inshore coverage programme during the 2008–09 fishing year. Other fishing methods (with the number of events observed) included cod pots (25), diving (24), rock lobster pots (12), surface longline (5), hand lines (4), troll (3), crab pots (2), and drop lines (2).

Area	Trips	Events				
		Total	Trawl	BLL	Setnet	Other
Chatham Rise	29	1223	606	0	597	20
Stewart-Snares	13	848	389	0	439	20
West coast SI	9	707	379	0	327	1
West coast NI	11	490	302	18	168	2
Far north	25	447	281	157	0	9
Puysegur	3	34	0	0	9	25
All areas	74	3749	1957	175	1540	77

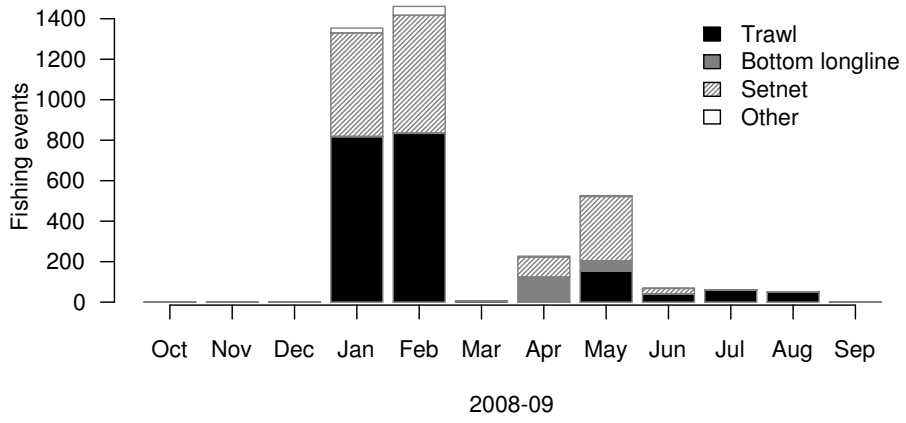

Figure 2: Number of events observed by the inshore coverage programme during the 2008–09 fishing year, by month and by fishing method.

caught during inshore trawl fishing, with 24 of the captures (80%) being reported from the trawl warps. Four of the remaining albatross captures were reported as tori line entanglements; all these birds were released alive by the crew.

Other captures included 32 spotted shags, 31 of which were caught during a trawl targeting flatfish on the east coast of the South Island. There were 11 sooty shearwaters caught during trawl fishing, with 10 being caught on tows targeting barracouta, and 1 on a tow targeting flatfish. Nine common dolphins were caught by two boats operating off Abel Tasman National Park in the west coast North Island area: three tows were targeting barracouta and two targeted flatfish species. Three New Zealand fur seals were caught, two in trawl nets, and one in a setnet north of Westport. A green turtle was caught on a tow targeting John dory, to the north of Kawau Island in the Hauraki Gulf.

3.3 Fisher-reported incidental non-fish bycatch

Many captures of seabird, marine mammal, and other protected species were reported by fishers (Table 11). However, reporting of captures by fishers was at a lower rate than reporting of captures by observers. Although almost twice as many bird captures were reported by fishers as by observers in trawl fisheries, only 6.5% of trawl effort was observed. In surface longline fisheries more captures of both seabirds and fur seals were reported by observers than by fishers.

The fisheries with the highest number of fisher-reported captures of seabirds and marine mammals were hoki trawl fisheries, squid trawl fisheries, and large vessel ling longline fisheries. Fur seals were also reported by the southern bluefin surface longline fisheries. Even when restricted to those fisheries that reported most of the captures, the fisher-reported capture rates were still below the observed capture rates in most cases. In 2008–09, fisher-reported capture rates increased, with a rate of 9.7 birds per 100 tows in the squid fishery, the highest in the period. However, this was still only half the capture rate of around 20 birds per 100 tows reported by Ministry of Fisheries observers (Figure 3). In 2008–09, the fisher-reported bird capture rate in the large-vessel ling longline fishery was higher than the observer reported rate. Observer coverage in the large-vessel ling longline fishery was biased towards vessels that used integrated weight line, and these vessels typically have lower seabird bycatch rates (Abraham & Thompson 2011).

All fisher-reported captures in 2008–09 are tabulated in Table 12, using the species classes defined in this report. Most of the captures reported in 2008–09 on the new NPC form used generic codes, such as 372 birds reported as 'petrels, prions and shearwaters' (XXP) and 117 birds reported as 'unidentified albatrosses' (XAL). Despite this problem, the NPC data are able to highlight patterns that are only poorly known in fisheries that have not been well observed. For example, there were 76 shags (XHG) reported caught, and 72 of these were in inshore trawl fisheries targeting flatfish on the east coast of the South Island (32 of these were also reported by an observer).

There is no way to confirm the identification of the fisher-reported seabird captures. There were 24 birds reported as being 'black petrels' (XBP), 11 of which were reported from the North Island snapper longline fishery. The use of the XBP code by observers has been problematic, because of a tendency to treat the name 'black petrel' as a descriptive term (i.e., for any petrel that appeared to be black). Similar problems may be expected with the fisher-reported captures. There were 8 birds reported by fishers as Chatham albatross (XCI), 2 from hoki trawlers 4 on bottom longliners, and 2 from events that could not be matched to the catch-effort data. The 6 matched capture events all occurred near the Chatham Islands. When one of the fishers was questioned as to why they had identified the albatrosses as Chatham albatrosses, they responded that it was due to the fishing being close to the Chatham Islands (Richard Wells, Deepwater Group Limited, pers. comm.).

One humpback whale was reported caught in a setnet targeting hapuku near Kaikoura and then released uninjured. The same vessel also reported catching an unidentified toothed whale in the same area (statistical area 018) on a setnet targeting ling. This whale was recorded as dead. Two other toothed whales were also reported by fishers as being caught in setnets targeting warehou. No further information on these whale captures was available.

Because of the lower rate of fisher-reported captures, and issues with the species identification, it would not be straightforward to use the fisher-reported data to estimate total captures, and these data are not used elsewhere in this report. The value of these data would be greatly improved if reliable identifications could be made. This could be done by returning photographs of captured animals, allowing verification of the identifications.

Table 11: Seabirds, mammals, and turtles reported by fishers on the non-fish incidental catch reporting and the non-fish / protected species catch return forms in trawl, longline, and setnet fisheries, from October 1998 to September 2009. The number of captures reported by Ministry of Fisheries observers over the same period is included for comparison. Over the 11 year period, 6.5% of trawl effort, 10.8% of bottom longline effort, 15.4% of surface longline effort, and 1.1% of setnet effort was observed.

	Trawl		Bottom longline		Surface longline		Setnet	
	Non-fish	Observer	Non-fish	Observer	Non-fish	Observer	Non-fish	Observer
Birds	8191	4201	2708	1778	669	932	45	34
Fur seals	2916	1513	3	4	392	401	10	6
Seals	194	4	1		88		3	
Sea lions	177	196						
Dolphins	88	132			1	3	4	1
Common dolphins	28						1	
Turtles	4	1	1	1	10	16	1	
Pilot whales	9	11	2	3	3	2	1	1
Whales			1		1	6	4	
Hector's dolphins	1						2	3

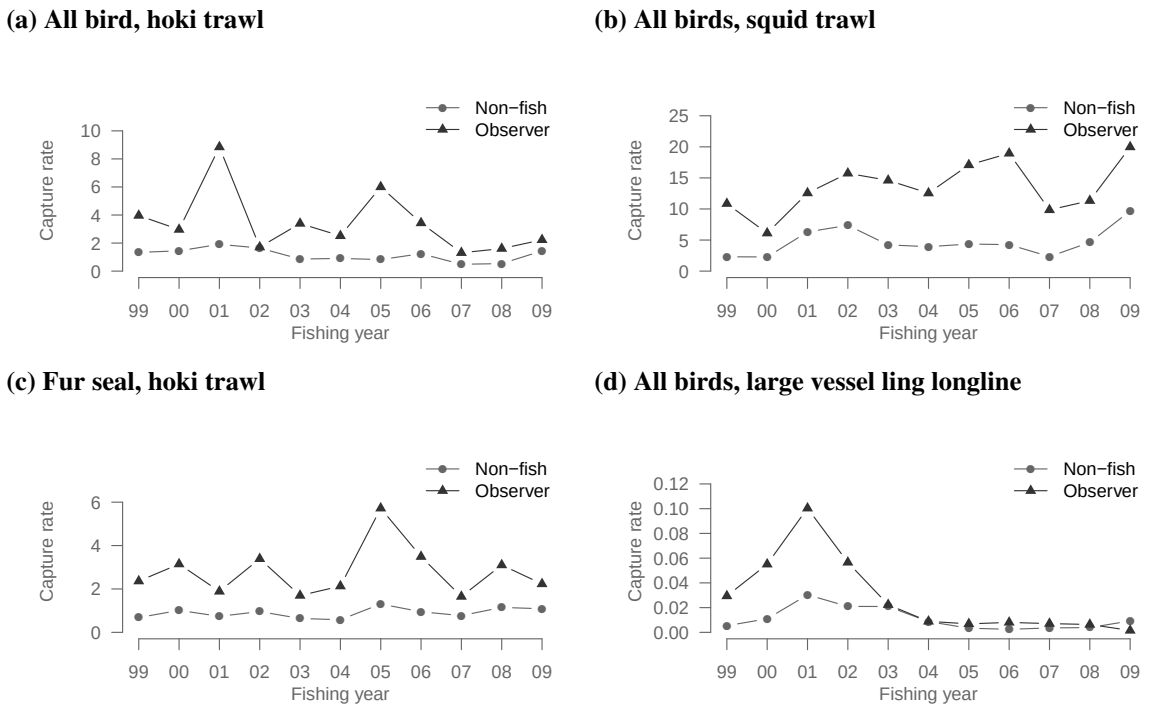

Figure 3: Comparison of the capture rate reported by fishers and the capture rate reported by Ministry of Fishery observers. The selected species and fisheries are (a) all bird captures in hoki trawl fisheries, (b) all bird captures in squid trawl fisheries, (c) fur seal captures in hoki trawl fishery, and (d) all bird captures in large vessel ling longline fisheries. The capture rates are captures per 100 fishing events.

3.4 Comparison between ratio and model estimates

Capture estimates were taken from the statistical models where possible, and ratio estimates were also calculated for all strata. Comparisons between the ratio estimates and model estimates are presented in Figure 4. In general there was close agreement between the ratio and model estimates, even though the ratio estimates presented here all assumed constant capture rates within each fishery-area stratum. The notable exception was the sea lion captures. The sea lion model estimated sea lion interactions, an

Table 12: All fisher-reported captures in 2008–09, grouped by fishery group and species group. All captures were reported on the non-fish / protected species catch return (NPC) form.

	Sooty shearwater	White-capped albatross	Other albatrosses	White-chinned petrel	Other birds	**All birds**	New Zealand fur seal	Dolphins	Other seals	New Zealand sea lion	Pilot whales	Whales	Hector's dolphins	Turtles
Trawl														
Squid	39	38	55	28	214	**374**	5			5				
Hoki	22	5	35	1	52	**115**	89	3	9					
Inshore	3	7	26		85	**121**		2						1
Scampi		3	32		24	**59**	4		1					
SBW			1		3	**4**	59							
Hake	3	1	6		33	**43**	15							
Jack mackerel			3	3	6	**12**	9	11			2			
Middle depth	21	11	33		37	**102**	9	4	1					
Deepwater			10		5	**15**	2							
Ling			3		8	**11**	3							
Bottom longline														
Large ling	22		6	55	25	**108**								
Small snapper	1				29	**30**								
Small ling			1		23	**24**								
Small bluenose	1		3		9	**13**								
Small other			2		8	**10**								
S. Bluefin		8	47	1	7	**63**	16		13					1
Surface longline														
Bigeye	2	3	2		3	**10**					1			3
Swordfish		1	2			**3**								
Other														
Setnet	4				14	**18**	5	1	1			4	1	1
Purseine					5	**5**								

estimate of the number of sea lions that would have been caught had no SLEDs been used. This estimate is higher than the ratio estimated captures, which take no account of SLED use.

Across all the capture estimates, uncertainties in the model estimates were higher than the uncertainties arising from the ratio estimates. Uncertainties in the ratio estimates were calculated using a bootstrap procedure that ignored correlations in the captures due to observations being on all tows within a trip, or due to the influence of covariates that were included in the models. This will have led to the ratio-estimation underestimating the true uncertainty. The use of the simpler ratio-estimation methods could lead to an over-interpretation in the significance of changes in the number of captures from year to year.

3.5 Data summaries

The following sections of the report summarise the captures of seabirds, marine mammals, and turtles in time-series form for the fishing years 1998–99 to 2008–09, with more detailed information provided for the 2007–08 and 2008–09 fishing years. Summaries are given in two groups: the first, Sections 3.10 to 3.20, are of captures of protected species groups (for example, white-capped albatrosses, or sea lions); the second set, Sections 3.21 to 3.38, are of captures of birds, mammals, and turtles by fishery (for example, the hake trawl fishery).

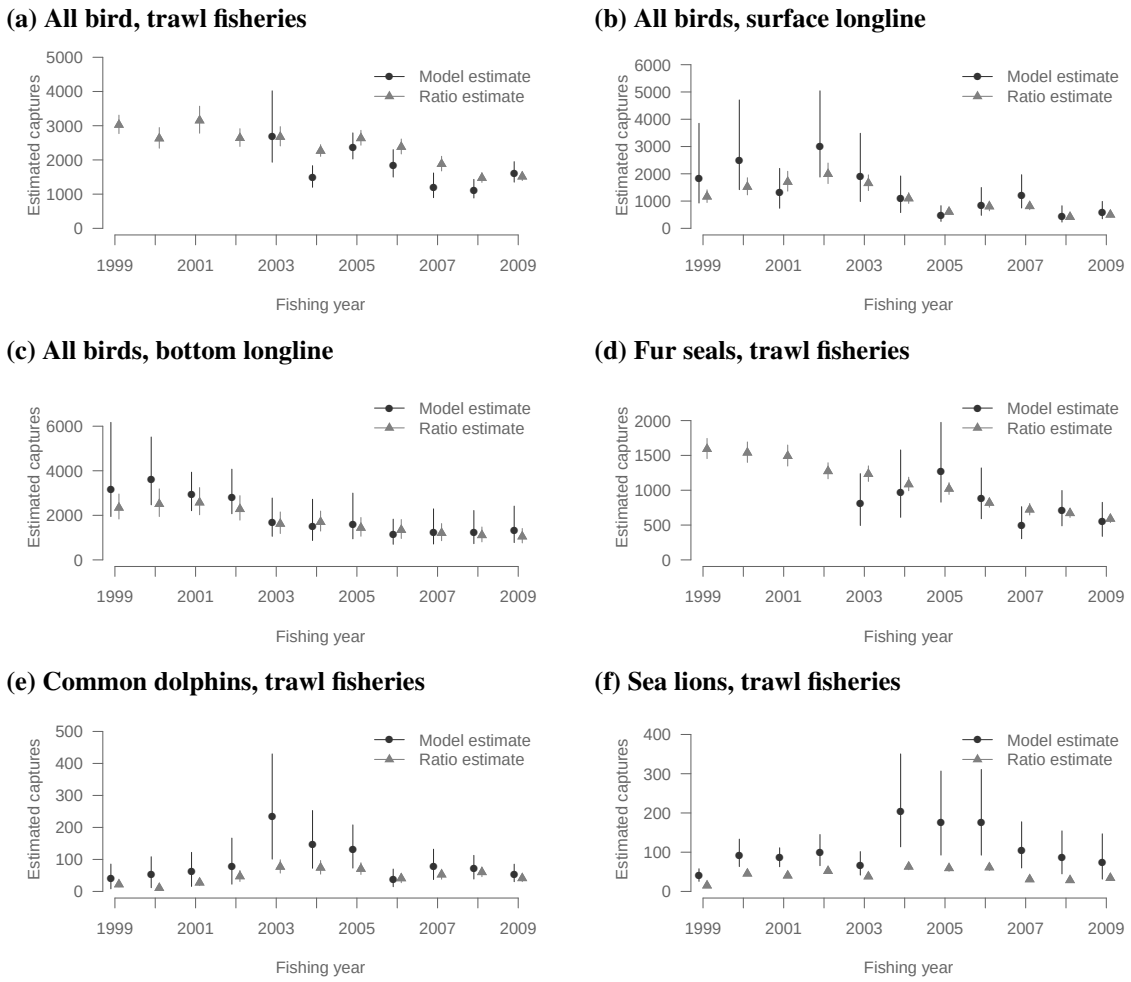

Figure 4: Comparisons of model and ratio estimates for eleven years, of all bird captures in (a) trawl fisheries, (b) surface longline fisheries, (c) bottom longline fisheries, and, (d) fur seal captures in trawl fisheries, (e) common dolphin captures in trawl fisheries, and (f) sea lion interactions in trawl fisheries.

Each summary includes a set of tables and plots. The content of these tables changes depending on the particular species and fishery. For sections that refer to individual species groups or specific fisheries (for example, white-capped albatross or the hoki trawl fishery) the first table summarises effort, observed and estimated captures by fishing area for the 2007–08 and 2008–09 fishing years only. The second table lists all the data given in the accompanying sets of plots summarising the effort, observations, captures, and estimated captures for the previous 11 years (1998–99 to 2008–09). In two cases, namely all bird captures in all trawl fisheries (Table 14) and fur seal captures in all trawl fisheries (Table 50) there were captures in too many fishery-area strata to present them all individually. Rather, tables are given that separately aggregate captures by fishery and by area. Where the captures of composite groups are summarised, a breakdown of observed captures by individual species over the whole 11 year period is given (see, for example, other bird captures in surface longline fisheries, Table 45).

Accompanying the tables are a set of plots that are in the same format for all species groups and fisheries. In subfigure (a) the estimated captures are shown, calculated following one of the methods given in Section 2.4. The estimated number of captures is given, with the error bars indicating the 95% bootstrap confidence intervals. The red line indicates the percentage of effort that was included in each yearly ratio estimate, following Equation 4.

Subfigure (b) gives a map of the effort (as determined from the start position of the tow or set), observations, and observed captures for the 2008–09 fishing year. The cells are coloured by the fishing effort within each $0.2^\circ \times 0.2^\circ$ area. The number of observations is shown by a black dot, where the increasing size of the dot reflects increasing numbers of observations. Coloured cells with no black dot indicate unobserved effort. The location of captures is indicated by a red dot (with the location being accurate only to within 0.2° of latitude and longitude).

In subfigure (c), a time series of the observed captures is represented by a bar plot. Bar height represents the total number of captures, with the dark part of the bar representing dead captures and light part representing live captures. The red line shows the raw capture rate: the ratio of the number of captures in each year to the observed fishing effort.

In subfigure (d), the total effort and total observed effort within each year are given. This helps in making an assessment of whether trends in (a) and (c) were due to changes in effort or observer coverage. The red line indicates the percentage of effort within the fishery that was observed.

The report includes summary pages only for species-fisheries groups that had observed captures during either of the 2007–08 or 2008–09 fishing years. There were a number of other seabird, marine mammal, and turtle captures that occurred before 2007–08 and are not presented elsewhere. These are listed in Table 13.

3.6 Seabird captures – estimates and trends

In trawl fisheries, estimates were made across all fishing other than tows targeting inshore or flatfish species. Despite a steady decline in the total effort, there was no clear trend in the total number of seabird captures in offshore trawl fisheries. There were five years that had lower mean estimated captures than in 2008–09, and five years that had higher mean estimated captures. However, total seabird captures in trawl fisheries increased significantly between 2007–08 and 2008–09, with the estimated number of captures increasing from 1111 (95% c.i.: 887 to 1431, based on 44.1% of effort) to 1601 (95% c.i.: 1351 to 1949, based on 43.2% of effort). This increase in the mean estimated captures was seen in a range of trawl fisheries (including the squid, hoki, middle depth, and scampi targets). The increase in the mean number of estimated captures was also seen in the areas where most captures occurred (including the Chatham Rise, Auckland Islands, and Stewart-Snares shelf).

Although inshore and flatfish trawls represent almost 60% of the total trawl effort, only 3.5% were observed in 2008–09. This was the first year that observer coverage of inshore trawl fisheries was above 0.5%, with the increase being due to the inshore coverage programme. In order to make ratio estimates, a minimum of 1% coverage across all years was required and so no estimation has been made of seabird captures in inshore fisheries. This lack of observations in inshore fisheries prevented a full understanding of the impact of trawl fisheries on seabirds.

There was a decrease in the number of estimated seabird captures in surface longline fisheries over the period covered by the data, with the mean number of captures falling from 1838 (95% c.i.: 929 to 3850, based on 99.8% of effort) in 1998–99 to 591 (95% c.i.: 351 to 987, based on 100.0% of effort) in 2008–09. All surface longline effort was included in the estimation, and the decrease in estimated seabird captures was associated with a reduction in the number of hooks set, which had fallen by 2008–09 to less than 50% of the number that were set in 1998–99. Against the trend of this general decrease, the estimated number of seabird captures in surface longline fisheries increased between 2007–08 and 2008–09, although the increase was not significant.

Table 13: Captures that occurred in trawl and longline fisheries between October 1998 and September 2009, but that were not in strata that had observed captures in the 2007–08 or 2008–09 fishing years. These captures are not included in the summary tables.

Species		Fishing method	Captured	Necropsied
Sooty shearwater	*Puffinus griseus*	Surface longline	18	7
White-capped albatross	*Thalassarche steadi*	Bottom longline	8	1
New Zealand fur seal	*Arctocephalus forsteri*	Bottom longline	4	0
Pilot whale	*Globicephala melas*	Bottom longline	3	0
Common dolphin	*Delphinus delphis*	Surface longline	2	0
Dusky dolphin	*Lagenorhynchus obscurus*	Surface longline	2	0
Pilot whale	*Globicephala melas*	Surface longline	2	0
Shy albatross	*Thalassarche cauta*	Bottom longline	1	0
Green turtle	*Chelonia mydas*	Bottom longline	1	0
New Zealand sea lion	*Phocarctos hookeri*	Surface longline	1	0
Bottlenose dolphin	*Tursiops truncatus*	Surface longline	1	0
Porpoise		Surface longline	1	0

Across all years, there has been a decrease in the the total captures of seabirds in bottom longline fisheries, falling from a peak of 3599 (95% c.i.: 2473 to 5515, based on 89.5% of effort) seabird captures in 1999–2000, to 1320 (95% c.i.: 778 to 2414, based on 69.6% of effort) seabird captures in 2008–09. The decrease in the number of captures was due to a decrease in the observed capture rate in large-vessel ling-longline fisheries, associated with the introduction of integrated weight line, and to a decrease in effort in both the large-vessel ling-longline and the small-vessel snapper-longline fisheries.

3.6.1 Sooty shearwater

Between 2003–04 and 2008–09, mean estimated captures of sooty shearwaters in trawl fisheries have remained between 300 and 800 birds. It was estimated that 515 sooty shearwaters (95% c.i.: 336 to 830, based on 43.2% of effort) were caught in trawl fisheries in 2008–2009. This was in the middle of the range estimated for each of the previous five years. Before 2002–03, estimates were made using the ratio method, and the estimates in this period were all over 1100 captures. Although model estimated captures in 2002–03 were also high, it is possible that the marked change between the beginning and end of the series was partly due to the change in estimation methods.

Observed sooty shearwater captures were primarily on the Stewart-Snares shelf and on the east coast of the South Island. Estimated captures in trawl fisheries were primarily in middle-depths fisheries on the Chatham Rise, and squid fisheries on the Stewart-Snares shelf.

No sooty shearwater were observed caught in surface longline or bottom longline fisheries in 2008–09, and the estimated number of captures was low (a mean estimate of 2 in surface longline fisheries, and a mean estimate of 12 in bottom longline fisheries).

3.6.2 White-chinned petrel

In 2008–09, estimated captures of white-chinned petrel were highest in bottom longline fisheries, with an estimated 417 birds being caught (95% c.i.: 81 to 1418, based on 69.6% of effort). These estimated captures were high despite only a single white-chinned petrel being observed caught in bottom longline fisheries. Integrated weight lines were introduced by some vessels in 2002–03 and the use of these lines has markedly reduced the captures of white-chinned petrels by those vessels. However, not all vessels

use integrated weight line. In 2008–09 around 50% of large bottom longliners (over 34 m in length) used integrated weight line. In contrast, around 80% of the observations were on vessels that used integrated weight line (Abraham & Thompson 2011). The high uncertainties are also due to the previous occasional captures of large numbers of white-chinned petrel by some bottom longlining vessels. For example, in 2001–02 there were observed captures of over 300 white-chinned petrels by one vessel. Improved coverage of vessels fishing without integrated weight line would reduce the uncertainty in the capture estimates.

White-chinned petrels are also caught in trawl fisheries, with an estimated 214 captures (95% c.i.: 162 to 285, based on 43.2% of effort) in 2008–09. This was an increase from the number of captures in 2007–08 (191; 95% c.i.: 136 to 268, based on 44.1% of effort). As in previous years, most estimated captures (72% of mean estimated captures) were in squid fisheries on the Stewart-Snares shelf and around the Auckland Islands.

There were few captures of white-chinned petrels in surface longline fisheries in 2008–09, with 3 observed captures and 16 estimated captures (95% c.i.: 5 to 35, based on 100.0% of effort).

3.6.3 White-capped albatross

Observed captures of white-capped albatross in trawl fisheries are concentrated in the Auckland Islands and Stewart-Snares shelf areas, close to the Auckland Islands breeding colonies. They are predominantly caught in the squid fisheries that operate in these areas during the breeding season. Since warp mitigation was made mandatory in January 2006, there has been a decrease in the estimated number of white-capped albatross captures in trawl fisheries, with mean captures in each of 2006–07, 2007–08, and 2008–09 being lower than in any of the other years. Captures of white-capped albatross are now primarily in trawl nets (Table 7), whereas before the introduction of mandatory warp mitigation they were primarily caught on the trawl warps (Abraham 2010).

Against the trend of this decrease, estimated captures of white-capped albatrosses in trawl fisheries increased from 137 (95% c.i.: 96 to 194, based on 44.1% of effort) in 2007–08 to 263 (95% c.i.: 205 to 343, based on 43.2% of effort) in 2008–09. There was an increase in the observed capture rates in squid fisheries on the Stewart-Snares shelf and around the Auckland Islands. Mean estimated captures in the squid trawl fisheries in these two areas accounted for 58% of estimated captures of white-capped albatross in all trawl fisheries.

There were also some white-capped albatrosses caught in surface longline fisheries, with an estimated capture of 10 birds (95% c.i.: 3 to 29, based on 100.0% of effort). No white-capped albatrosses were observed caught in bottom longline fisheries.

3.6.4 Other albatrosses

Other albatross species are caught across a range of fisheries, with the highest number of estimated captures in 2008–09 being in trawl fisheries, with 360 (95% c.i.: 261 to 482, based on 43.2% of effort) captures. Over the whole period, observed captures of other albatrosses in trawl fisheries were mainly of Salvin's albatross, Buller's albatross, or of unidentified albatrosses. In 2008–09, there were 9 Salvin's albatross caught in inshore trawl fisheries in the Chatham Rise area. Despite these captures, unobserved inshore trawl fishing was not included in the estimated total captures because of the low overall observer coverage. Estimated captures of other albatrosses in 2008–09 were significantly higher than in 2007–08, when estimated captures were 221 (95% c.i.: 150 to 314, based on 44.1% of effort). The observed

capture rate of other albatrosses in 2008–09 was 0.80 birds per 100 tows, close to the maximum rate of 0.87 birds per 100 tows that was observed in 2004–05. There is no evidence in these data of a reduction in other albatross captures in trawl fisheries since the introduction in 2006 of mandatory warp mitigation on larger trawl vessels (over 28 m in length).

In surface longline fisheries, there were an estimated 256 (95% c.i.: 135 to 467, based on 100.0% of effort) other albatross captures during 2008–09. Over the period of the data, observed captures have mainly been of Buller's albatross, but observer coverage has been biased to the southwestern area (Area 3) where Buller's albatrosses are relatively abundant. The estimated captures of other albatrosses in surface longline fisheries were variable, with peaks in 2001–02 and 2006–07. There were also other albatross captures in bottom longline fisheries, with an estimated 125 (95% c.i.: 56 to 212, based on 69.6% of effort) captures in 2008–09. Observed captures of other albatrosses in bottom longline fisheries have primarily been of Salvin's albatross, with estimated captures being highest in small vessel ling fisheries on the Chatham Rise. As with surface longline fisheries, there are no strong trends in the total estimated captures.

3.6.5 Other birds

Other birds are caught in a range of fisheries. In trawl fisheries, other bird captures were largely of unidentified petrels, with Cape petrel being the identified species that was most frequently observed caught. In surface long line fisheries, observed captures of other birds were primarily of flesh-footed shearwater, and in bottom longline fisheries other bird captures were primarily of grey petrel.

Estimated captures of other bird species were highest in bottom longline fisheries, with 763 (95% c.i.: 454 to 1267, based on 69.6% of effort) estimated captures in 2008–09. Most of these captures were in the small-vessel snapper-longline fishery, with flesh-footed shearwater and black petrel being the most frequently observed caught species. In recent years, there has been a decline in the number of estimated other birds captures in bottom longline fisheries, associated with a decrease in effort in the northern snapper fishery.

During 2008–09, there were 249 (95% c.i.: 180 to 347, based on 43.2% of effort) other bird captures in trawl fisheries, and 307 (95% c.i.: 120 to 693, based on 100.0% of effort) other bird captures in surface longline fisheries. There was no clear trend in other bird captures in trawl fisheries, but the number of other birds caught in surface longline fisheries has decreased, reflecting the decrease in surface longline effort.

3.7 Marine mammal captures – estimates and trends

3.7.1 New Zealand sea lions

There were an estimated 74 (95% c.i.: 31 to 147, based on 41.0% of effort) sea lion interactions in 2008–09. The estimated interactions were almost entirely in the squid and scampi trawl fisheries in the Auckland Islands area. The mean estimated number of interactions was lower in 2008–09 than in 2007–08, but the difference was not statistically significant. The estimates of sea lion interactions were all model based, and more detail on the derivation and interpretation of these results is is given by Thompson & Abraham (2011). The estimated number of interactions may be interpreted as the number of animals that would have been caught if no SLEDs were used. Depending on the survival rate of sea lions that exit trawls via SLEDs, the number of sea lions killed may be considerably lower than the number of interactions.

3.7.2 New Zealand fur seals

Estimated captures of New Zealand fur seals were mainly in trawl fisheries, with captures of 550 (95% c.i.: 338 to 826, based on 42.8% of effort) fur seals in 2008–09. This was fewer than were estimated to have been caught in 2007–08, but more than were estimated to have been caught in 2006–07. Fur seals were caught in a wide range of fisheries and areas, with estimated captures being highest in hoki and other middle-depths fisheries, and in the Cook Strait and subantarctic areas. Fur seal captures in trawl fisheries before 2002–03 were estimated using a ratio method, whereas from 2002–03 they were estimated using a statistical model.

There were an estimated 49 (95% c.i.: 43 to 56, based on 99.2% of effort) fur seal captures in surface longline fisheries. Fur seal captures in surface longline fisheries were estimated using ratio methods, and so the number of captures follows the variations in effort. Almost all fur seals observed caught in surface longline fisheries were released alive. As in 2007–08, no fur seals were observed caught in bottom longline fisheries.

3.7.3 Dolphins and whales

Common dolphins and pilot whales were observed caught in 2008–09 in the west coast North Island jack mackerel trawl fishery. Across all delphinid species, there were an estimated 32 captures (95% c.i.: 17 to 56, based on 100.0% of effort) in trawl fisheries. These captures are dominated by model-estimated common dolphin captures in the west coast North Island mackerel fishery (Thompson et al. 2010). Dolphins were also observed caught in inshore and middle depth trawl fisheries. No estimate could be made for inshore trawl fisheries due to the low observed fishing effort, while in middle depth trawl fisheries there were an estimated 21 (95% c.i.: 7 to 41, based on 100.0% of effort) common dolphin captures during 2008–09.

Sporadic whale captures in surface longline fisheries over the 11 year period resulted in an estimate of 2 whale captures in 2008–09 (95% c.i.: 0 to 5, based on 99.2% of effort), 1 in the northeastern southern bluefin fishery and 1 in the northeastern bigeye tuna fishery (see Table 58). These estimates were calculated by applying the catch rate calculated from all years to the 2008–09 effort data.

3.8 Turtle captures – estimates and trends

In 2008–09, one turtle was observed caught in inshore trawl fisheries. Two leatherback turtles were observed caught in 2008–09 in surface longline fisheries and were released alive. There were 22 (95% c.i.: 12 to 34, based on 99.2% of effort) estimated captures in surface longline fisheries during 2008–09, mostly in the northern bigeye tuna fishery. The estimate was made assuming a constant capture rate across all years, and so changes in estimated captures follow changes in fishing effort.

3.9 Captures by fishery

3.9.1 Trawl fisheries

Summaries of the bycatch data for all trawl fisheries are given in Section 3.21. The squid trawl fishery had the highest number of estimated seabird captures, followed by the middle depths, hoki, and scampi trawl fisheries (see Table 14).

The squid trawl fishery in 2008–09 had the lowest effort of any of the 11 years of the data, with a decrease of 63.2% from 2004–05, when the effort was highest. Despite this decrease, the estimated captures of all birds in the squid fishery was 625 (95% c.i.: 522 to 776, based on 100.0% of effort) in 2008–09, similar to the number of captures in 2006–07 and 2007–08 (see Table 64). The estimated captures were primarily of white-capped albatross, sooty shearwater, and white-chinned petrel.

In 2008–09, there were 58 (95% c.i.: 16 to 130, based on 99.8% of effort) estimated sea lion interactions, (see Table 67) and 20 (95% c.i.: 8 to 43, based on 99.9% of effort) estimated fur seal captures in squid fisheries (see Table 69). The mean estimated number of fur seal captures in the squid fishery were the lowest of any estimate during the last 11 years.

Effort in the hoki fishery was the lowest in the 11 years of data, with a 75% decrease from 1999–2000 when the effort was highest. Estimated captures of birds in the hoki trawl fishery were higher in 2008–09 than in 2007–08, with 232 captures (95% c.i.: 163 to 345, based on 100.0% of effort; see Table 70), partly due to increased estimated captures of sooty shearwater and other albatross in the Chatham Rise area. Although there was an increase in the number of captures between 2007–08 and 2008–09, the number of captures was significantly less than the number estimated for 2002–03, or in years before that, reflecting the decrease in effort in hoki fisheries.

In 2008–09, there were estimated to be 191 (95% c.i.: 112 to 306, based on 99.2% of effort) fur seals caught in the hoki fishery, predominantly in the Cook Strait area (see Table 75). This was the lowest mean number of estimated fur seal captures in the hoki fishery in any of the 11 years. There have been occasional sea lion captures in the hoki trawl fishery, but in 2008–09 there were no estimated captures.

Seabirds and fur seals were also caught in hake and ling trawl fisheries, but these captures were estimated to be low (relative to the hoki fishery), mainly due to lower fishing effort in these fisheries.

Estimated captures in deepwater trawl fisheries remained low in 2008–09, with an estimated capture of 23 birds (95% c.i.: 12 to 40, based on 100.0% of effort), 4 (95% c.i.: 0 to 12, based on 100.0% of effort) fur seals, and no captures of sea lions.

Estimated captures of birds in the scampi fishery have also not varied widely, with a peak of 216 (95% c.i.: 138 to 332, based on 100.0% of effort) seabird captures in 2004–05. In 2008–09, there were 182 (95% c.i.: 119 to 271, based on 100.0% of effort) estimated bird captures in the scampi fishery (see Table 89). The difference in these estimates was not significant. The seabird captures were spread across all the scampi fishing areas (see Table 88).

The scampi fishery is one of the three main fisheries, with southern blue whiting and squid, that have had observed sea lion captures. The estimated number of sea lions caught in the scampi fishery during 2008–09 was 15 (95% c.i.: 6 to 24, based on 100.0% of effort), similar to in previous years. These captures were estimated using a ratio method, with the capture rate assumed to have been constant through the period covered by the data. Fur seal captures in the scampi fishery have been sporadic, from the Chatham Rise, Auckland Islands, and east of North Island areas (see Table 92). The 2008–09 estimate of 6 (95% c.i.: 1 to 16, based on 100.0% of effort) captures was consistent with estimates for the previous eleven years (see Table 93).

The southern blue whiting fishery caught an estimated 106 (95% c.i.: 47 to 207, based on 100.0% of effort) fur seals in 2008–09 (see Table 99). It was estimated that one sea lion was caught in 2008–09 in the southern blue whiting trawl fishery, in contrast to previous years when there have been a mean of up to 13 estimated sea lion captures in this fishery. Estimated seabird captures in the southern blue whiting fishery were low, with only 5 (95% c.i.: 0 to 16, based on 100.0% of effort) seabirds estimated to have

been caught in 2008–09 (see Table 95).

Estimated common dolphin captures in the jack mackerel fishery for 2008–09 were 25 (95% c.i.: 13 to 52, based on 100.0% of effort). This was the only fishery in which common dolphin captures were estimated. Captures of seabirds in the mackerel fishery were low and sporadic, with a 2008–09 estimate of 17 (95% c.i.: 9 to 32, based on 100.0% of effort) (see Table 101). Similarly there were few fur seal captures, with 18 fur seals (95% c.i.: 10 to 33, based on 100.0% of effort) estimated to have been caught in the jack mackerel trawl fishery in 2008–09.

In inshore trawl fisheries there was observer coverage of 3.4% during 2008–09. No estimation of seabird (see Table 107) or marine mammal captures (see Table 109) was made in the inshore trawl fisheries. This represents a substantial gap in our knowledge of the impact of commercial fishing on seabirds or marine mammals.

The fishing effort in middle-depth trawl fisheries has been declining, with the lowest effort in the 11 year period being during 2008–09. However, in 2008–09 the estimated captures of 356 (95% c.i.: 246 to 543, based on 100.0% of effort) seabirds were higher than in the previous six years. Estimated captures of fur seals increased in middle-depth fisheries trawl fisheries from 173 in 2007–08 (95% c.i.: 89 to 312, based on 99.9% of effort) to 150 in 2008–09 (95% c.i.: 57 to 307, based on 99.2% of effort), although the increase was not significant. An estimated 24 dolphins were caught by middle depth trawl fisheries in 2008–09 (95% c.i.: 9 to 46, based on 89.0% of effort) .

3.9.2 Surface longline fisheries

Captures of seabirds in surface longline fisheries largely followed changes in effort, with increases between 2007–08 and 2008–09 in southern bluefin and bigeye tuna longline fisheries, and a decrease in swordfish fisheries. The number of seabird captures was highest in bigeye tuna fisheries, with an estimated 445 (95% c.i.: 235 to 804, based on 100.0% of effort) seabird captures during 2008–09.

Some fur seals were caught in surface longline fisheries, with an estimated 46 (95% c.i.: 41 to 53, based on 100.0% of effort) fur seal captures in southern bluefin tuna fisheries during 2008–09.

As turtle captures were calculated using a ratio method that assumed a constant capture rate across all years, the estimated turtle captures also followed changes in effort. Most estimated turtle captures were in the bigeye longline fisheries, with 21 (95% c.i.: 11 to 33, based on 99.5% of effort) estimated captures in 2008–09.

3.9.3 Bottom longline fisheries

Summaries of the bycatch data for bottom longline fisheries are given in Section 3.34. Most estimated seabird captures were in the small-vessel northern snapper fishery, with a total of 673 (95% c.i.: 375 to 1173, based on 97.5% of effort) estimated captures in 2008–09. The uncertainty in the number of captures in this fishery is high, due to the low number of observations (0.5% of hooks observed in 2008–09). There were also an estimated 413 (95% c.i.: 75 to 1407, based on 100.0% of effort) seabird captures in large-vessel ling longline fisheries during 2008–09. Most of these estimated captures were of white-chinned petrel on the Chatham Rise.

No marine mammals or turtles were observed caught in bottom longline fisheries in 2008–09.

3.9.4 Setnet fisheries

Summaries of the setnet bycatch data are given in Section 3.38. Although captures of a range of species, including Hector's dolphin, have been observed in setnet fisheries, estimates could be made in only a few strata (the Stewart-Snares, west coast South Island, and Puysegur areas). In the Stewart-Snares area, there were observed captures of seabirds and fur seals. In the Puysegur and west coast South Island areas, there were observed captures of fur seals in 2006–07 and 2008–09, respectively.

When observed captures from other areas were included with the ratio estimates, there were 34 (95% c.i.: 24 to 47, based on 8.9% of effort) estimated seabird captures, and 25 (95% c.i.: 5 to 55, based on 8.9% of effort) estimated fur seal captures. The three Hector's dolphin captures that have been observed in setnet fisheries were all in the Canterbury region, and no estimate was made of the total captures within this region (other than reporting the captures from the observed fishing effort).

Given the small number of setnet observations, it is unlikely that the observed captures of either birds or marine mammals are representative of captures in all setnet fishing.

3.10 All bird captures

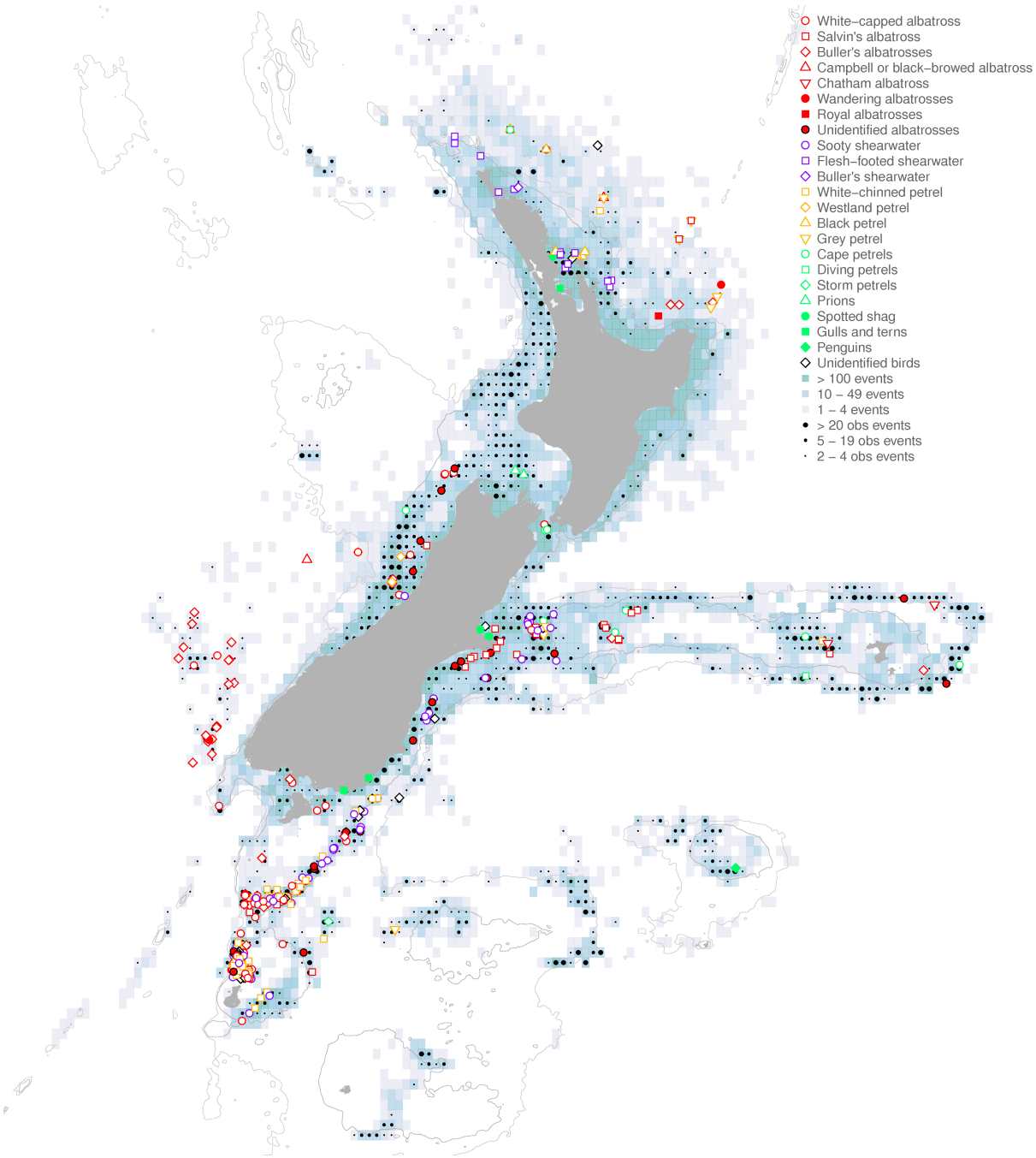

Figure 5: All observed seabird captures in trawl, surface longline, and bottom longline fishing within the New Zealand region, between 1 October 2008 and 30 September 2009. The colour within each 0.2° cell indicates the number of fishing events (tows and sets) and the black dots indicate the number of observed events. The coloured symbols indicate the location of observed seabird captures, randomly jittered by ±0.2°. The 500 m and 1000 m bathymetric contours are shown.

3.10.1 All birds, trawl fisheries, New Zealand EEZ

Table 14: Summary by year with number of tows, number of tows observed, percentage of tows observed, number of observed captures, capture rate per 100 tows, total estimated captures with 95% confidence intervals, and percentage of tows included in the estimate. Estimated type: M - modelled; R - ratio estimated; B - both methods; N - not estimated. Fishery: SBW - southern blue whiting.

(a) All bird captures by fishery

		Observed				Estimated			
	Tows	No. obs	% obs	Capt.	Rate	Type	Est. captures		% inc.
2008–09									
Squid	3 864	1 297	33.6	259	19.97	M	625	(522 - 776)	100.0
Middle depth	7 234	735	10.2	68	9.25	M	356	(246 - 543)	100.0
Hoki	8 172	1 658	20.3	37	2.23	M	232	(163 - 345)	100.0
Scampi	3 975	396	10.0	19	4.80	M	182	(119 - 271)	100.0
Hake	1 779	350	19.7	9	2.57	M	67	(42 - 108)	100.0
Inshore	51 293	1 723	3.4	57	3.31	N			
Ling	1 407	146	10.4	4	2.74	M	38	(22 - 61)	100.0
Deepwater	6 130	2 373	38.7	6	0.25	M	23	(12 - 40)	100.0
Jack mackerel	2 172	814	37.5	6	0.74	M	17	(9 - 32)	100.0
SBW	1 187	299	25.2	0	0.00	M	5	(0 - 16)	100.0
2007–08									
Squid	4 236	1 456	34.4	165	11.33	M	521	(389 - 737)	100.0
Middle depth	7 397	435	5.9	10	2.30	M	201	(130 - 323)	100.0
Hoki	8 773	1 869	21.3	30	1.61	M	152	(107 - 222)	100.0
Scampi	4 807	524	10.9	12	2.29	M	133	(87 - 195)	100.0
Hake	1 559	395	25.3	4	1.01	M	24	(14 - 39)	100.0
Inshore	50 052	158	0.3	2	1.27	N			
Ling	2 207	241	10.9	8	3.32	M	50	(30 - 88)	100.0
Deepwater	6 730	2 810	41.8	6	0.21	M	14	(8 - 23)	100.0
Jack mackerel	2 646	817	30.9	1	0.12	M	9	(3 - 19)	100.0
SBW	816	331	40.6	3	0.91	M	5	(3 - 9)	100.0

(b) All bird captures by area

		Observed				Estimated			
	Tows	No. obs	% obs	Capt.	Rate	Type	Est. captures		% inc.
2008–09									
Chatham Rise	20 866	2 986	14.3	118	3.95	M	551	(404 - 798)	59.4
Stewart-Snares	11 058	1 671	15.1	175	10.47	M	456	(369 - 595)	43.7
Auckland Is.	3 505	882	25.2	142	16.10	M	380	(310 - 470)	100.0
West Coast SI	10 041	1 271	12.7	18	1.42	M	66	(46 - 91)	40.7
Cook Strait	3 854	173	4.5	3	1.73	M	47	(27 - 74)	69.1
North East	10 114	531	5.3	3	0.56	M	41	(14 - 106)	16.9
East of NI	11 445	106	0.9	0	0.00	M	29	(14 - 51)	18.6
West Coast NI	13 064	1 183	9.1	2	0.17	M	15	(7 - 27)	23.9
Subantarctic	2 889	922	31.9	3	0.33	M	10	(3 - 21)	99.9
Puysegur	377	66	17.5	1	1.52	M	5	(1 - 11)	84.1
Kermadec Is.	0								
2007–08									
Chatham Rise	21 912	2 559	11.7	28	1.09	M	371	(255 - 551)	63.9
Stewart-Snares	12 453	1 536	12.3	118	7.68	M	400	(289 - 587)	41.5
Auckland Is.	2 743	753	27.5	64	8.50	M	195	(144 - 269)	100.0
West Coast SI	10 738	957	8.9	14	1.46	M	46	(32 - 63)	41.2
Cook Strait	3 229	208	6.4	0	0.00	M	22	(10 - 37)	70.7
North East	9 555	495	5.2	6	1.21	M	26	(11 - 55)	16.8
East of NI	11 569	218	1.9	0	0.00	M	19	(9 - 35)	19.5
West Coast NI	13 635	929	6.8	0	0.00	M	11	(4 - 21)	25.9
Subantarctic	2 624	1 310	49.9	11	0.84	M	15	(12 - 21)	99.8
Puysegur	765	71	9.3	0	0.00	M	5	(1 - 13)	91.2
Kermadec Is.	0								

Table 15: Summary of all bird captures in trawl fisheries, for 11 fishing years, with the number of tows, number of tows observed, percentage of tows observed, number of observed captures, capture rate per hundred tows, total estimated captures with 95% confidence intervals, and percentage of tows included in the estimate. Estimated type: M - modelled; R - ratio estimated; B - both methods; N - not estimated.

		Observed				Estimated			
	Tows	No. obs	% obs	Capt.[s]	Rate	Type	Est. captures		% inc.
2008–09	87 213	9 791	11.2	465	4.75	M	1 601	(1 351 - 1 949)	43.2
2007–08	89 223	9 036	10.1	241	2.67	M	1 111	(887 - 1 431)	44.1
2006–07	103 793	7 918	7.6	212	2.68	M	1 189	(897 - 1 618)	42.7
2005–06	109 982	6 554	6.0	354	5.40	M	1 839	(1 499 - 2 300)	43.7
2004–05	120 476	7 710	6.4	481	6.24	M	2 375	(2 028 - 2 790)	44.2
2003–04	120 878	6 546	5.4	262	4.00	M	1 481	(1 201 - 1 832)	47.2
2002–03	130 177	6 835	5.3	270	3.95	M	2 674	(1 933 - 4 019)	51.2
2001–02	127 883	7 716	6.0	318	4.12	R	2 638	(2 393 - 2 912)	50.2
2000–01	134 243	9 114	6.8	726	7.97	R	3 155	(2 783 - 3 572)	50.0
1999–00	139 057	7 650	5.5	172	2.25	R	2 627	(2 343 - 2 945)	49.9
1998–99	153 412	7 257	4.7	308	4.24	R	3 025	(2 769 - 3 308)	47.5

[s] All observed captures by species: sooty shearwater (1203), white-capped albatross (1191), white-chinned petrel (461), Salvin's albatross (171), Buller's albatross (142), albatrosses (unidentified) (88), petrel (unidentified) (76), Cape petrels (67), seabird – small (60), short-tailed shearwater (33), spotted shag (32), seabird – large (31), flesh-footed shearwater (28), black-browed albatross (unidentified) (27), shy albatross (25), grey petrel (19), prions (unidentified) (14), Campbell albatross (13), common diving petrel (11), prions and shearwaters (10), other species (107)

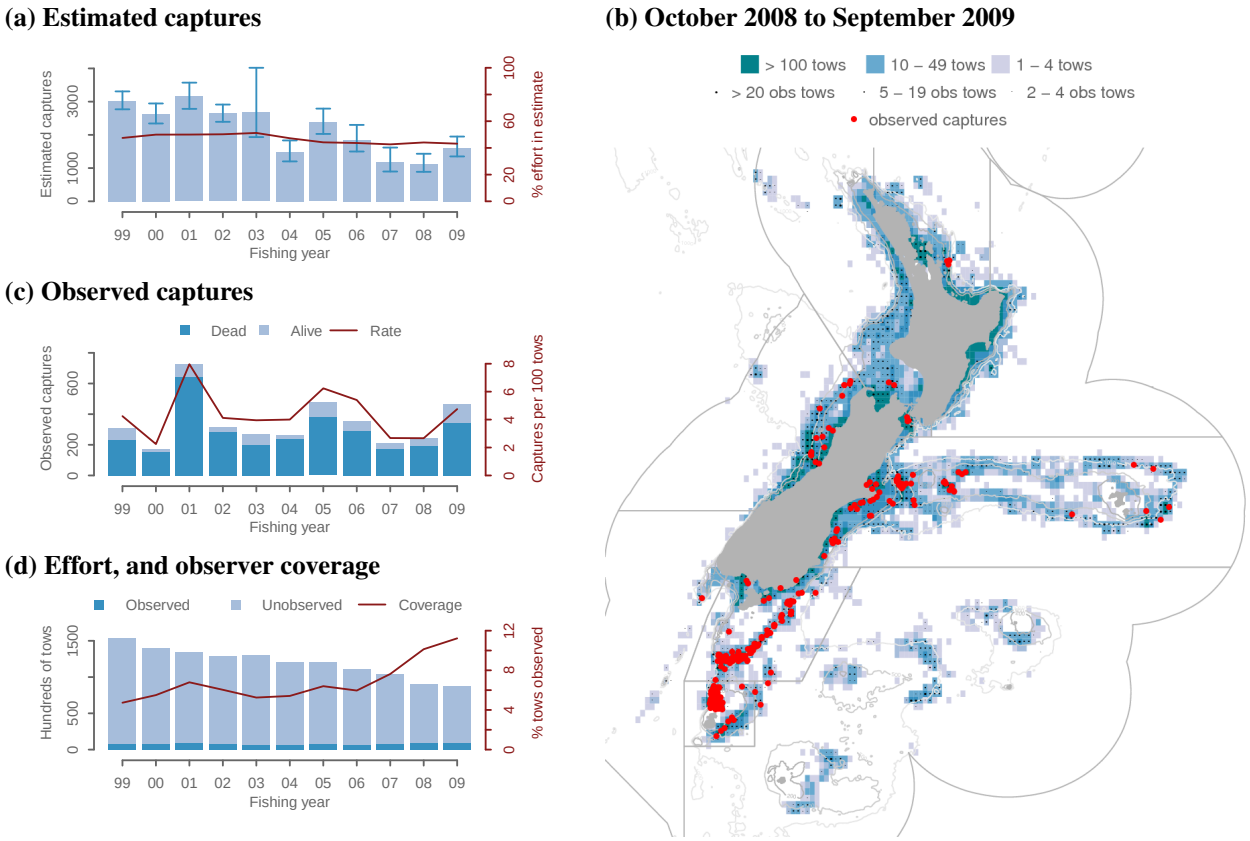

Figure 6: Bird captures in all trawl fisheries. (a) Ratio estimated captures, with 95% bootstrap confidence intervals, (b) Mapped effort and captures from 2008–09, (c) Observed captures, (d) Effort and observed effort. For full explanation of the figure, see Section 3.5.

3.10.2 All birds, surface longline, New Zealand EEZ

Table 16: Summary of all bird captures in surface longline fisheries, broken down by fishing areas, with the number of hooks, number of hooks observed, percentage of hooks observed, number of observed captures, capture rate per thousand hooks, total estimated captures with 95% confidence intervals, and percentage of hooks included in the estimate. Estimated type: M - modelled; R - ratio estimated; B - both methods; N - not estimated.

			Observed				Estimated			
		Hooks	No. obs	% obs	Capt.	Rate	Type	Est. captures		% inc.
2008–09										
Bigeye	Area 1	1 270 417	45 495	3.6	9	0.198	M	399	(206 - 730)	100.0
S. Bluefin	Area 1	585 103	111 912	19.1	13	0.116	M	70	(41 - 115)	100.0
S. Bluefin	Area 3	888 430	604 930	68.1	44	0.073	M	57	(47 - 77)	100.0
Bigeye	Area 4	288 910	39 004	13.5	0	0.000	M	45	(16 - 100)	100.0
Other	Area 1	16 178	0	0.0	-		M	8	(1 - 22)	100.0
Swordfish	Area 1	20 480	3 000	14.6	0	0.000	M	7	(1 - 21)	100.0
Swordfish	Area 4	13 940	3 290	23.6	0	0.000	M	2	(0 - 7)	100.0
Swordfish	Area 3	7 280	0	0.0	-		M	1	(0 - 8)	100.0
Albacore	Area 1	7 800	0	0.0	-		M	1	(0 - 7)	100.0
Bigeye	Area 3	7 490	0	0.0	-		M	1	(0 - 3)	100.0
Albacore	Area 4	0								
S. Bluefin	Area 4	0								
Other	Area 4	0								
2007–08										
Bigeye	Area 1	879 017	15 985	1.8	6	0.375	M	268	(118 - 626)	100.0
S. Bluefin	Area 1	448 700	90 964	20.3	6	0.066	M	45	(24 - 78)	100.0
S. Bluefin	Area 3	654 625	254 208	38.8	24	0.094	M	58	(34 - 112)	100.0
Bigeye	Area 4	88 812	8 360	9.4	0	0.000	M	14	(3 - 35)	100.0
Other	Area 1	31 705	0	0.0	-		M	12	(2 - 32)	100.0
Swordfish	Area 1	83 630	17 540	21.0	1	0.057	M	19	(5 - 46)	100.0
Swordfish	Area 4	35 500	3 350	9.4	0	0.000	M	5	(0 - 16)	100.0
Swordfish	Area 3	6 200	0	0.0	-		M	2	(0 - 10)	100.0
Albacore	Area 1	0								
Bigeye	Area 3	0								
Albacore	Area 4	600	0	0.0	-		M	1	(0 - 5)	100.0
S. Bluefin	Area 4	1 500	0	0.0	-		M	0	(0 - 2)	100.0
Other	Area 4	2 750	0	0.0	-		M	1	(0 - 5)	100.0

Table 17: Summary of all bird captures in surface longline fisheries, with the number of hooks, hooks observed, percentage of hooks observed, number of observed captures, capture rate per thousand hooks, total estimated captures with 95% confidence intervals, and percentage of hooks included in the estimate. Estimated type: M - modelled; R - ratio estimated; B - both methods; N - not estimated.

		Observed				Estimated			
	Hooks	No. obs	% obs	Capt.[s]	Rate	Type	Est. captures		% inc.
2008–09	3 106 028	807 631	26.0	66	0.082	M	591	(351 - 987)	100.0
2007–08	2 233 039	390 407	17.5	37	0.095	M	425	(230 - 828)	100.0
2006–07	3 746 672	956 819	25.5	187	0.195	M	1 205	(746 - 1 966)	100.0
2005–06	3 687 569	636 796	17.3	37	0.058	M	853	(477 - 1 497)	100.0
2004–05	3 676 795	703 669	19.1	41	0.058	M	481	(255 - 831)	100.0
2003–04	7 382 293	1 464 465	19.8	71	0.048	M	1 085	(578 - 1 919)	100.0
2002–03	10 781 875	1 874 448	17.4	115	0.061	M	1 906	(983 - 3 485)	100.0
2001–02	10 876 381	918 159	8.4	167	0.182	M	3 018	(1 882 - 5 041)	100.0
2000–01	9 761 448	1 023 868	10.5	53	0.052	M	1 326	(737 - 2 197)	99.9
1999–00	8 286 120	793 770	9.6	74	0.093	M	2 496	(1 419 - 4 707)	100.0
1998–99	6 845 781	1 242 610	18.2	84	0.068	M	1 838	(929 - 3 850)	99.8

[s] All observed captures by species: Buller's albatross (351), flesh-footed shearwater (139), white-capped albatross (88), grey petrel (52), Campbell albatross (38), albatrosses (unidentified) (36), white-chinned petrel (36), wandering albatross (unidentified) (34), black petrel (22), Gibson's albatross (21), great-winged petrel (19), sooty shearwater (18), antipodean albatross (14), Salvin's albatross (12), black-browed albatross (unidentified) (9), southern black-browed albatross (6), Cape petrels (6), southern royal albatross (6), petrel (unidentified) (5), Westland petrel (5), other species (15)

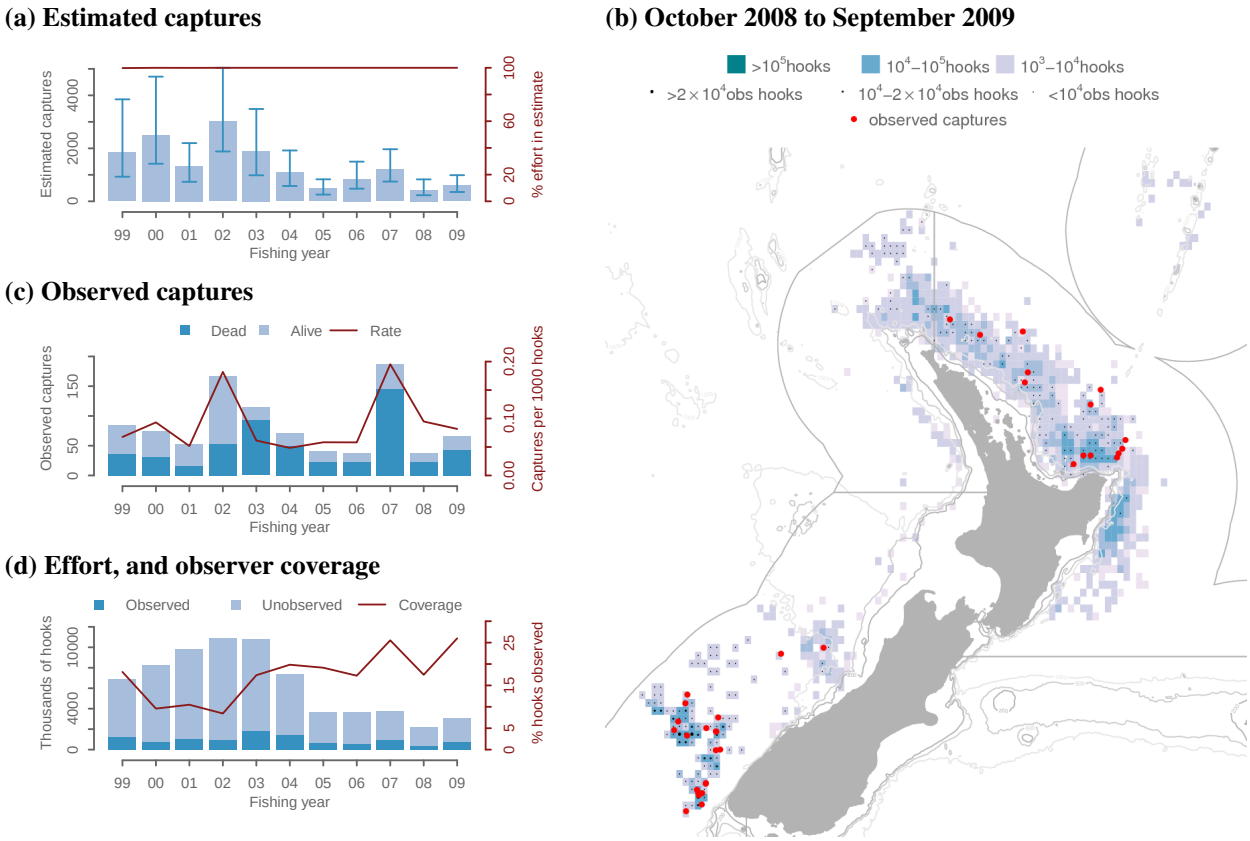

Figure 7: All bird captures in surface longline fisheries. (a) Estimated captures, with 95% confidence intervals, (b) Mapped effort and captures from 2008–09, (c) Observed captures, (d) Effort and observed effort. For a fuller explanation of the figure, see Section 3.5.

3.10.3 All birds, bottom longline, New Zealand EEZ

Table 18: Summary of all bird captures in bottom longline fisheries, broken down by fishing areas, with the number of hooks, number of hooks observed, percentage of hooks observed, number of observed captures, capture rate per thousand hooks, total estimated captures with 95% confidence intervals, and percentage of hooks included in the estimate. Estimated type: M - modelled; R - ratio estimated; B - both methods; N - not estimated.

			Observed				Estimated			
		Hooks	No. obs	% obs	Capt.	Rate	Type	Est. captures		% inc.
2008–09										
Small snapper	North East	8 730 326	46 424	0.5	21	0.452	M	673	(375 - 1 173)	100.0
Large ling	Chatham Rise	6 382 948	1 824 408	28.6	3	0.002	M	320	(44 - 1 125)	100.0
Small ling	Chatham Rise	2 957 030	498 750	16.9	4	0.008	R	146	(79 - 232)	100.0
Small other	North East	847 422	11 776	1.4	1	0.085	R	62	(8 - 139)	100.0
Large ling	Subantarctic	2 786 330	1 391 250	49.9	2	0.001	M	52	(6 - 226)	100.0
Large ling	Puysegur	249 850	0	0.0	-		M	28	(0 - 164)	100.0
Small bluenose	Chatham Rise	944 770	5 250	0.6	0	0.000	R	21	(5 - 44)	100.0
Large ling	Stewart-Snares	1 323 200	0	0.0	-		M	12	(1 - 43)	100.0
Small other	West Coast NI	1 011 095	5 770	0.6	3	0.520	N			
Large other	Puysegur	102 411	0	0.0	-		M	2	(0 - 11)	100.0
Large other	Subantarctic	167 210	9 450	5.7	0	0.000	M	1	(0 - 5)	100.0
Large ling	East of NI	748 800	0	0.0	-		M	1	(0 - 3)	100.0
Small bluenose	North East	1 569 102	0	0.0	-		N			
Small other	Chatham Rise	850 778	11 050	1.3	0	0.000	N			
2007–08										
Small snapper	North East	8 910 037	0	0.0	-		M	644	(293 - 1 253)	100.0
Large ling	Chatham Rise	5 612 870	1 375 300	24.5	8	0.006	M	148	(34 - 597)	100.0
Small ling	Chatham Rise	2 410 020	235 800	9.8	3	0.013	R	128	(69 - 205)	100.0
Small other	North East	1 006 656	73 000	7.3	10	0.137	R	78	(18 - 164)	100.0
Large ling	Subantarctic	3 591 200	1 381 800	38.5	6	0.004	M	114	(22 - 492)	100.0
Large ling	Puysegur	969 053	108 455	11.2	0	0.000	M	16	(1 - 83)	100.0
Small bluenose	Chatham Rise	2 786 303	164 525	5.9	4	0.024	R	63	(18 - 128)	100.0
Large ling	Stewart-Snares	1 194 423	114 423	9.6	5	0.044	M	35	(11 - 90)	100.0
Small other	West Coast NI	902 025	5 000	0.6	0	0.000	N			
Large other	Puysegur	0								
Large other	Subantarctic	0								
Large ling	East of NI	509 560	3 600	0.7	0	0.000	M	0	(0 - 2)	100.0
Small bluenose	North East	1 604 904	42 550	2.7	3	0.071	N			
Small other	Chatham Rise	1 316 770	53 965	4.1	1	0.019	N			

Table 19: Summary of all bird captures in bottom longline fisheries, with the number of hooks, hooks observed, percentage of hooks observed, number of observed captures, capture rate per thousand hooks, total estimated captures with 95% confidence intervals, and percentage of hooks included in the estimate. Estimated type: M - modelled; R - ratio estimated; B - both methods; N - not estimated.

		Observed				Estimated			
	Hooks	No. obs	% obs	Capt.[s]	Rate	Type	Est. captures		% inc.
2008–09	37 389 649	3 804 128	10.2	34	0.009	B	1 320	(778 - 2 414)	69.6
2007–08	41 467 059	3 598 918	8.7	40	0.011	B	1 233	(729 - 2 216)	68.8
2006–07	38 389 449	2 343 955	6.1	58	0.025	B	1 244	(713 - 2 290)	73.8
2005–06	37 125 639	3 828 459	10.3	41	0.011	B	1 124	(700 - 1 828)	78.1
2004–05	41 840 933	2 927 928	7.0	30	0.010	B	1 610	(946 - 2 996)	80.9
2003–04	43 449 733	5 002 370	11.5	54	0.011	B	1 499	(871 - 2 721)	84.4
2002–03	37 753 336	11 308 295	30.0	266	0.024	B	1 675	(1 058 - 2 776)	83.8
2001–02	47 024 332	7 547 517	16.1	427	0.057	B	2 806	(2 071 - 4 070)	89.3
2000–01	51 024 367	5 248 902	10.3	534	0.102	B	2 917	(2 208 - 3 935)	83.9
1999–00	53 277 149	3 611 278	6.8	202	0.056	B	3 599	(2 473 - 5 515)	89.5
1998–99	55 487 193	3 097 198	5.6	92	0.030	B	3 182	(1 946 - 6 171)	87.7

[s] All observed captures by species: white-chinned petrel (819), grey petrel (420), Salvin's albatross (179), sooty shearwater (88), Cape petrels (50), flesh-footed shearwater (37), petrel (unidentified) (30), Chatham albatross (23), black petrel (20), albatrosses (unidentified) (17), northern giant petrel (8), white-capped albatross (8), Buller's albatross (8), Buller's shearwater (7), common diving petrel (7), great-winged petrel (6), wandering albatross (unidentified) (6), southern giant petrel (5), seabird – small (4), giant petrels (unidentified) (4), other species (32)

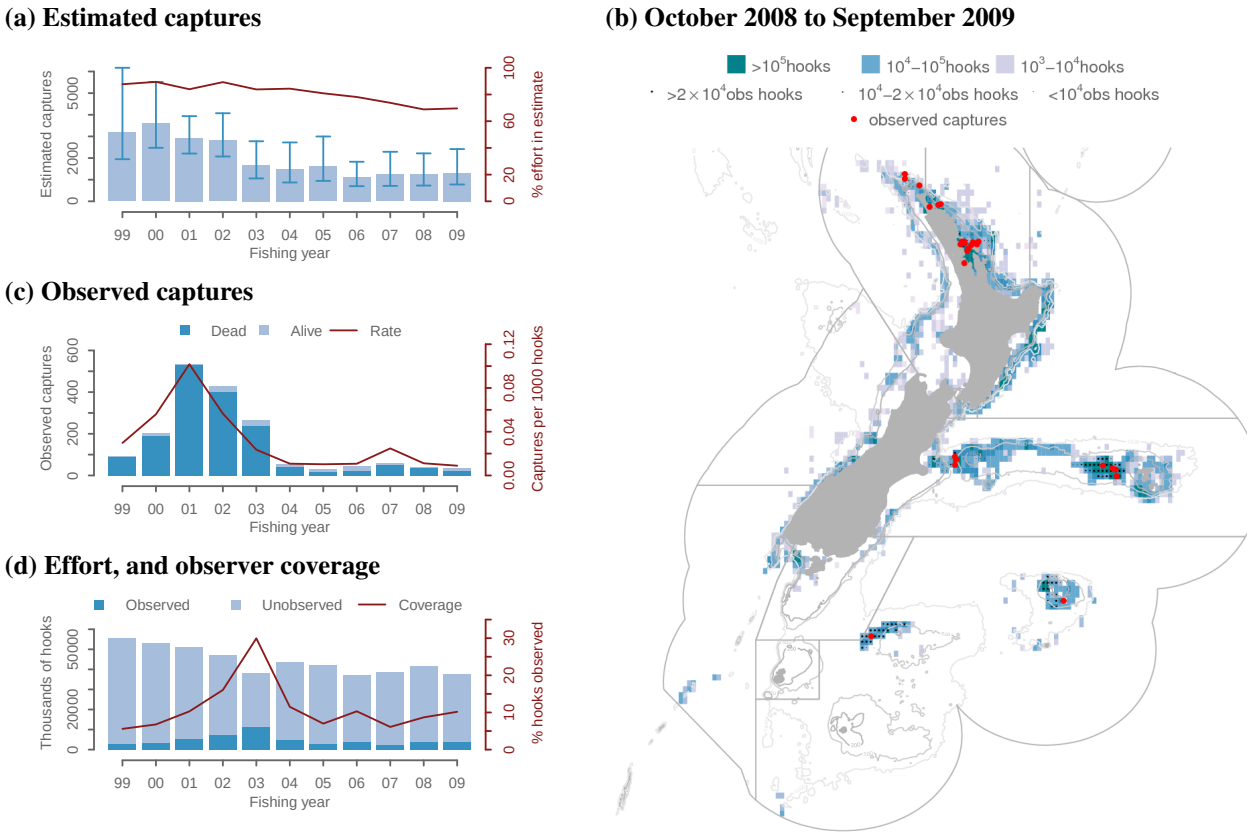

Figure 8: All bird captures in bottom longline fisheries. (a) Estimated captures, with 95% confidence intervals, (b) Mapped effort and captures from 2008–09, (c) Observed captures, (d) Effort and observed effort. For a fuller explanation of the figure, see Section 3.5.

3.11 Sooty shearwater captures

3.11.1 Sooty shearwater, all trawl, New Zealand EEZ

Table 20: Summary of sooty shearwater captures in all trawl fisheries, broken down by fishing areas, with the number of tows, number of tows observed, percentage of tows observed, number of observed captures, capture rate per hundred tows, total estimated captures with 95% confidence intervals, and percentage of tows included in the estimate. Estimated type: M - modelled; R - ratio estimated; B - both methods; N - not estimated.

			Observed				Estimated			
		Tows	No. obs	% obs	Capt.	Rate	Type	Est. captures		% inc.
2008–09										
Middle depth	Chatham Rise	2 723	248	9.1	13	5.24	M	126	(45 - 306)	100.0
Squid	Stewart-Snares	1 805	532	29.5	43	8.08	M	112	(66 - 219)	100.0
Squid	Auckland Is.	1 925	761	39.5	31	4.07	M	80	(50 - 129)	100.0
Hoki	Chatham Rise	3 994	569	14.2	15	2.64	M	72	(30 - 179)	100.0
Middle depth	Stewart-Snares	1 014	251	24.8	12	4.78	M	35	(16 - 87)	100.0
Hake	Chatham Rise	502	63	12.5	6	9.52	M	10	(6 - 20)	100.0
Hake	Stewart-Snares	274	78	28.5	0	0.00	M	9	(0 - 44)	100.0
Hoki	Stewart-Snares	805	301	37.4	2	0.66	M	8	(2 - 27)	100.0
Ling	Chatham Rise	234	18	7.7	4	22.22	M	7	(4 - 16)	100.0
Scampi	Chatham Rise	1 306	204	15.6	0	0.00	M	4	(0 - 16)	100.0
Inshore	West Coast SI	6 315	356	5.6	1	0.28	N			
Scampi	North East	804	91	11.3	0	0.00	M	1	(0 - 5)	100.0
2007–08										
Middle depth	Chatham Rise	2 657	225	8.5	0	0.00	M	63	(19 - 164)	100.0
Squid	Stewart-Snares	2 412	864	35.8	55	6.37	M	170	(93 - 325)	100.0
Squid	Auckland Is.	1 265	590	46.6	13	2.20	M	55	(26 - 113)	100.0
Hoki	Chatham Rise	4 481	751	16.8	2	0.27	M	40	(12 - 96)	100.0
Middle depth	Stewart-Snares	1 014	82	8.1	0	0.00	M	28	(5 - 88)	100.0
Hake	Chatham Rise	318	26	8.2	0	0.00	M	1	(0 - 5)	100.0
Hake	Stewart-Snares	157	49	31.2	3	6.12	M	4	(3 - 8)	100.0
Hoki	Stewart-Snares	743	341	45.9	1	0.29	M	2	(1 - 7)	100.0
Ling	Chatham Rise	559	23	4.1	0	0.00	M	3	(0 - 10)	100.0
Scampi	Chatham Rise	2 014	185	9.2	2	1.08	M	19	(4 - 49)	100.0
Inshore	West Coast SI	6 353	41	0.6	0	0.00	N			
Scampi	North East	843	145	17.2	1	0.69	M	2	(1 - 5)	100.0

Table 21: Summary of sooty shearwater captures in all trawl fisheries, with the number of tows, tows observed, percentage of tows observed, number of observed captures, capture rate per hundred tows, total estimated captures with 95% confidence intervals, and percentage of tows included in the estimate. Estimated type: M - modelled; R - ratio estimated; B - both methods; N - not estimated.

		Observed				Estimated			
	Tows	No. obs	% obs	Capt.	Rate	Type	Est. captures		% inc.
2008–09	87 213	9 791	11.2	127	1.30	M	515	(336 - 830)	43.2
2007–08	89 223	9 036	10.1	77	0.85	M	455	(273 - 765)	44.1
2006–07	103 793	7 918	7.6	83	1.05	M	620	(365 - 1 040)	42.7
2005–06	109 982	6 554	6.0	169	2.58	M	798	(535 - 1 191)	43.7
2004–05	120 476	7 710	6.4	74	0.96	M	463	(272 - 732)	44.2
2003–04	120 878	6 546	5.4	53	0.81	M	336	(179 - 595)	47.2
2002–03	130 177	6 835	5.3	119	1.74	M	1 538	(847 - 2 862)	51.2
2001–02	127 883	7 716	6.0	108	1.40	R	1 184	(966 - 1 436)	50.2
2000–01	134 243	9 114	6.8	278	3.05	R	1 641	(1 296 - 2 041)	50.0
1999–00	139 057	7 650	5.5	32	0.42	R	1 249	(989 - 1 542)	49.9
1998–99	153 412	7 257	4.7	83	1.14	R	1 368	(1 141 - 1 616)	47.5

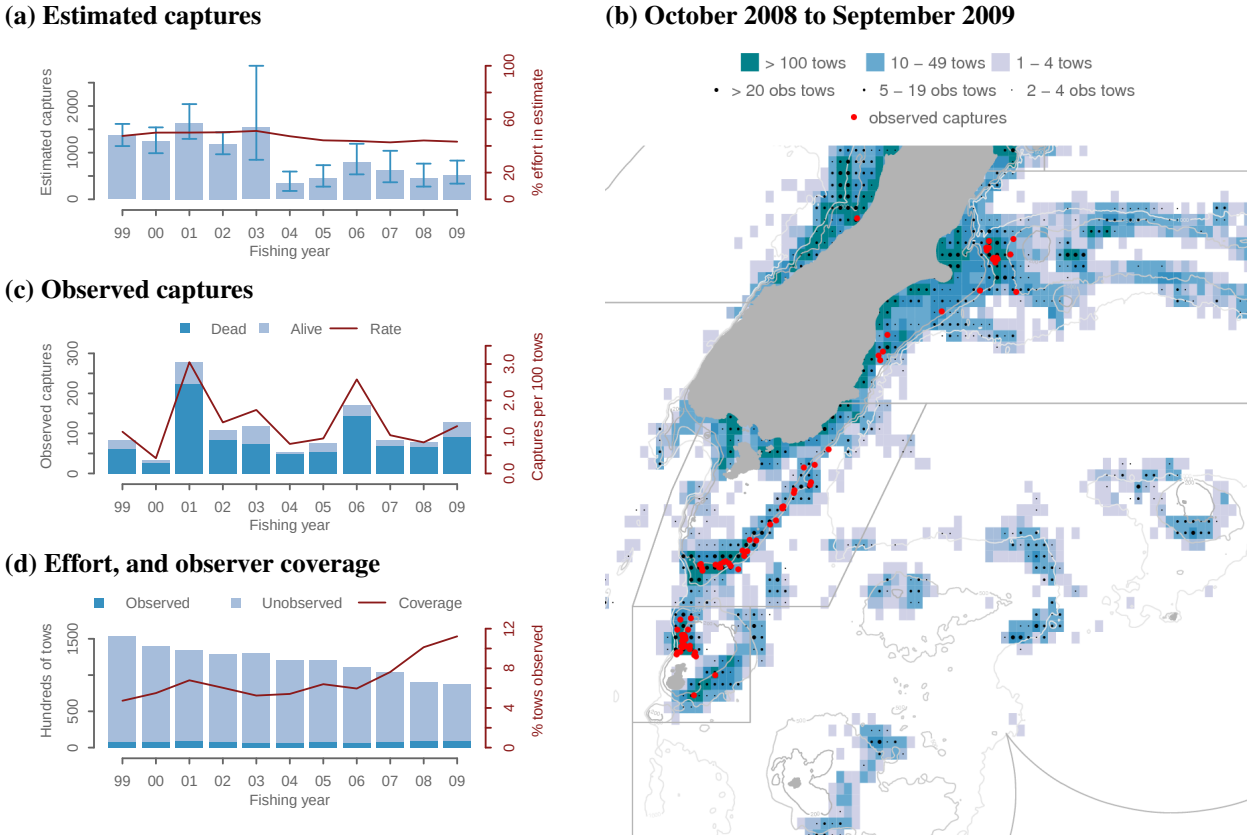

Figure 9: Sooty shearwater captures in all trawl fisheries. (a) Estimated captures, with 95% confidence intervals, (b) Mapped effort and captures from 2008–09, (c) Observed captures, (d) Effort and observed effort. For a fuller explanation of the figure, see Section 3.5.

3.11.2 Sooty shearwater, surface longline, New Zealand EEZ

Table 22: Summary of sooty shearwater captures in surface longline fisheries, broken down by fishing areas, with the number of hooks, number of hooks observed, percentage of hooks observed, number of observed captures, capture rate per thousand hooks, total estimated captures with 95% confidence intervals, and percentage of hooks included in the estimate. Estimated type: M - modelled; R - ratio estimated; B - both methods; N - not estimated.

			Observed				Estimated			
		Hooks	No. obs	% obs	Capt.	Rate	Type	Est. captures		% inc.
2008–09										
Bigeye	Area 1	1 270 417	45 495	3.6	0	0.000	M	2	(0 - 7)	100.0
Bigeye	Area 4	288 910	39 004	13.5	0	0.000	M	0	(0 - 1)	100.0
S. Bluefin	Area 3	888 430	604 930	68.1	0	0.000	M	0	(0 - 1)	100.0
Other	Area 1	16 178	0	0.0	-		M	0	(0 - 0)	100.0
Swordfish	Area 1	20 480	3 000	14.6	0	0.000	M	0	(0 - 0)	100.0
Albacore	Area 1	7 800	0	0.0	-		M	0	(0 - 0)	100.0
Bigeye	Area 3	7 490	0	0.0	-		M	0	(0 - 0)	100.0
S. Bluefin	Area 1	585 103	111 912	19.1	0	0.000	M	0	(0 - 0)	100.0
Swordfish	Area 3	7 280	0	0.0	-		M	0	(0 - 0)	100.0
Swordfish	Area 4	13 940	3 290	23.6	0	0.000	M	0	(0 - 0)	100.0
Albacore	Area 4	0								
S. Bluefin	Area 4	0								
Other	Area 4	0								
2007–08										
Bigeye	Area 1	879 017	15 985	1.8	0	0.000	M	2	(0 - 7)	100.0
Bigeye	Area 4	88 812	8 360	9.4	0	0.000	M	0	(0 - 0)	100.0
S. Bluefin	Area 3	654 625	254 208	38.8	0	0.000	M	0	(0 - 2)	100.0
Other	Area 1	31 705	0	0.0	-		M	0	(0 - 1)	100.0
Swordfish	Area 1	83 630	17 540	21.0	0	0.000	M	0	(0 - 1)	100.0
Albacore	Area 1	0								
Bigeye	Area 3	0								
S. Bluefin	Area 1	448 700	90 964	20.3	0	0.000	M	0	(0 - 0)	100.0
Swordfish	Area 3	6 200	0	0.0	-		M	0	(0 - 0)	100.0
Swordfish	Area 4	35 500	3 350	9.4	0	0.000	M	0	(0 - 0)	100.0
Albacore	Area 4	600	0	0.0	-		M	0	(0 - 0)	100.0
S. Bluefin	Area 4	1 500	0	0.0	-		M	0	(0 - 0)	100.0
Other	Area 4	2 750	0	0.0	-		M	0	(0 - 0)	100.0

Table 23: Summary of sooty shearwater captures in surface longline fisheries, with the number of hooks, hooks observed, percentage of hooks observed, number of observed captures, capture rate per thousand hooks, total estimated captures with 95% confidence intervals, and percentage of hooks included in the estimate. Estimated type: M - modelled; R - ratio estimated; B - both methods; N - not estimated.

		Observed				Estimated			
	Hooks	No. obs	% obs	Capt.	Rate	Type	Est. captures		% inc.
2008–09	3 106 028	807 631	26.0	0	0.000	M	2	(0 - 7)	100.0
2007–08	2 233 039	390 407	17.5	0	0.000	M	3	(0 - 8)	100.0
2006–07	3 746 672	956 819	25.5	2	0.002	M	6	(2 - 13)	100.0
2005–06	3 687 569	636 796	17.3	0	0.000	M	2	(0 - 7)	100.0
2004–05	3 676 795	703 669	19.1	0	0.000	M	4	(0 - 11)	100.0
2003–04	7 382 293	1 464 465	19.8	3	0.002	M	12	(4 - 27)	100.0
2002–03	10 781 875	1 874 448	17.4	10	0.005	M	29	(13 - 58)	100.0
2001–02	10 876 381	918 159	8.4	0	0.000	M	37	(10 - 84)	100.0
2000–01	9 761 448	1 023 868	10.5	2	0.002	M	24	(6 - 55)	99.9
1999–00	8 286 120	793 770	9.6	0	0.000	M	26	(5 - 62)	100.0
1998–99	6 845 781	1 242 610	18.2	1	0.001	M	24	(5 - 55)	99.8

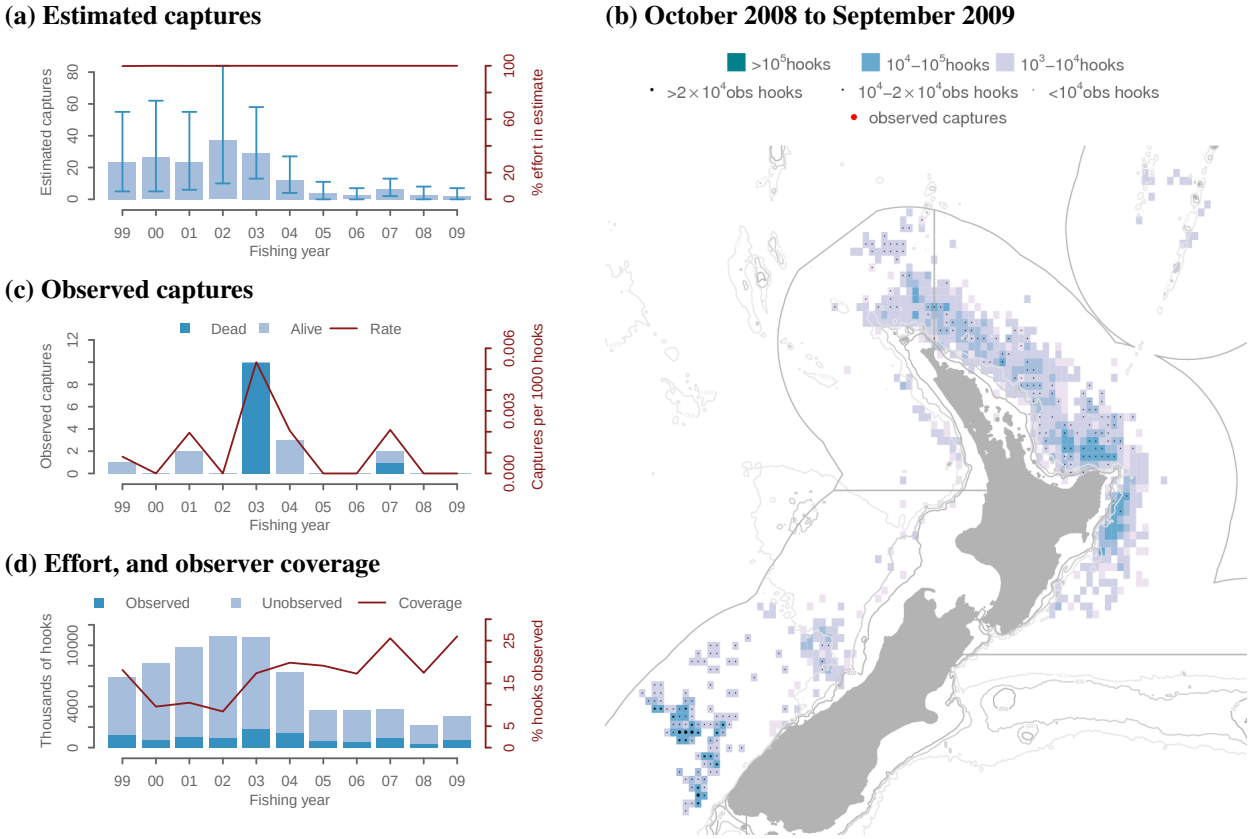

Figure 10: Sooty shearwater captures in surface longline fisheries. (a) Estimated captures, with 95% confidence intervals, (b) Mapped effort and captures from 2008–09, (c) Observed captures, (d) Effort and observed effort. For a fuller explanation of the figure, see Section 3.5.

3.11.3 Sooty shearwater, bottom longline, New Zealand EEZ

Table 24: Summary of sooty shearwater captures in bottom longline fisheries, broken down by fishing areas, with the number of hooks, number of hooks observed, percentage of hooks observed, number of observed captures, capture rate per thousand hooks, total estimated captures with 95% confidence intervals, and percentage of hooks included in the estimate. Estimated type: M - modelled; R - ratio estimated; B - both methods; N - not estimated.

			Observed				Estimated			
		Hooks	No. obs	% obs	Capt.	Rate	Type	Est. captures		% inc.
2008–09										
Large ling	Stewart-Snares	1 323 200	0	0.0	-		M	6	(0 - 21)	100.0
Large ling	Puysegur	249 850	0	0.0	-		M	3	(0 - 13)	100.0
Large ling	Chatham Rise	6 382 948	1 824 408	28.6	0	0.000	M	2	(0 - 8)	100.0
Large ling	Subantarctic	2 786 330	1 391 250	49.9	0	0.000	M	0	(0 - 2)	100.0
Small other	Chatham Rise	850 778	11 050	1.3	0	0.000	N			
2007–08										
Large ling	Stewart-Snares	1 194 423	114 423	9.6	5	0.044	M	12	(5 - 28)	100.0
Large ling	Puysegur	969 053	108 455	11.2	0	0.000	M	4	(0 - 17)	100.0
Large ling	Chatham Rise	5 612 870	1 375 300	24.5	0	0.000	M	1	(0 - 6)	100.0
Large ling	Subantarctic	3 591 200	1 381 800	38.5	0	0.000	M	1	(0 - 3)	100.0
Small other	Chatham Rise	1 316 770	53 965	4.1	1	0.019	N			

Table 25: Summary of sooty shearwater captures in bottom longline fisheries, with the number of hooks, hooks observed, percentage of hooks observed, number of observed captures, capture rate per thousand hooks, total estimated captures with 95% confidence intervals, and percentage of hooks included in the estimate. Estimated type: M - modelled; R - ratio estimated; B - both methods; N - not estimated.

		Observed				Estimated			
	Hooks	No. obs	% obs	Capt.	Rate	Type	Est. captures		% inc.
2008–09	37 389 649	3 804 128	10.2	0	0.000	B	12	(2 - 30)	69.6
2007–08	41 467 059	3 598 918	8.7	6	0.002	B	19	(8 - 43)	68.8
2006–07	38 389 449	2 343 955	6.1	1	0.000	B	13	(3 - 34)	73.8
2005–06	37 125 639	3 828 459	10.3	3	0.001	B	11	(4 - 24)	78.1
2004–05	41 840 933	2 927 928	7.0	3	0.001	B	26	(10 - 56)	80.9
2003–04	43 449 733	5 002 370	11.5	17	0.003	B	28	(19 - 43)	84.4
2002–03	37 753 336	11 308 295	30.0	23	0.002	B	34	(25 - 54)	83.8
2001–02	47 024 332	7 547 517	16.1	16	0.002	B	41	(25 - 67)	89.3
2000–01	51 024 367	5 248 902	10.3	12	0.002	B	23	(15 - 36)	83.9
1999–00	53 277 149	3 611 278	6.8	7	0.002	B	30	(14 - 58)	89.5
1998–99	55 487 193	3 097 198	5.6	0	0.000	B	41	(15 - 89)	87.7

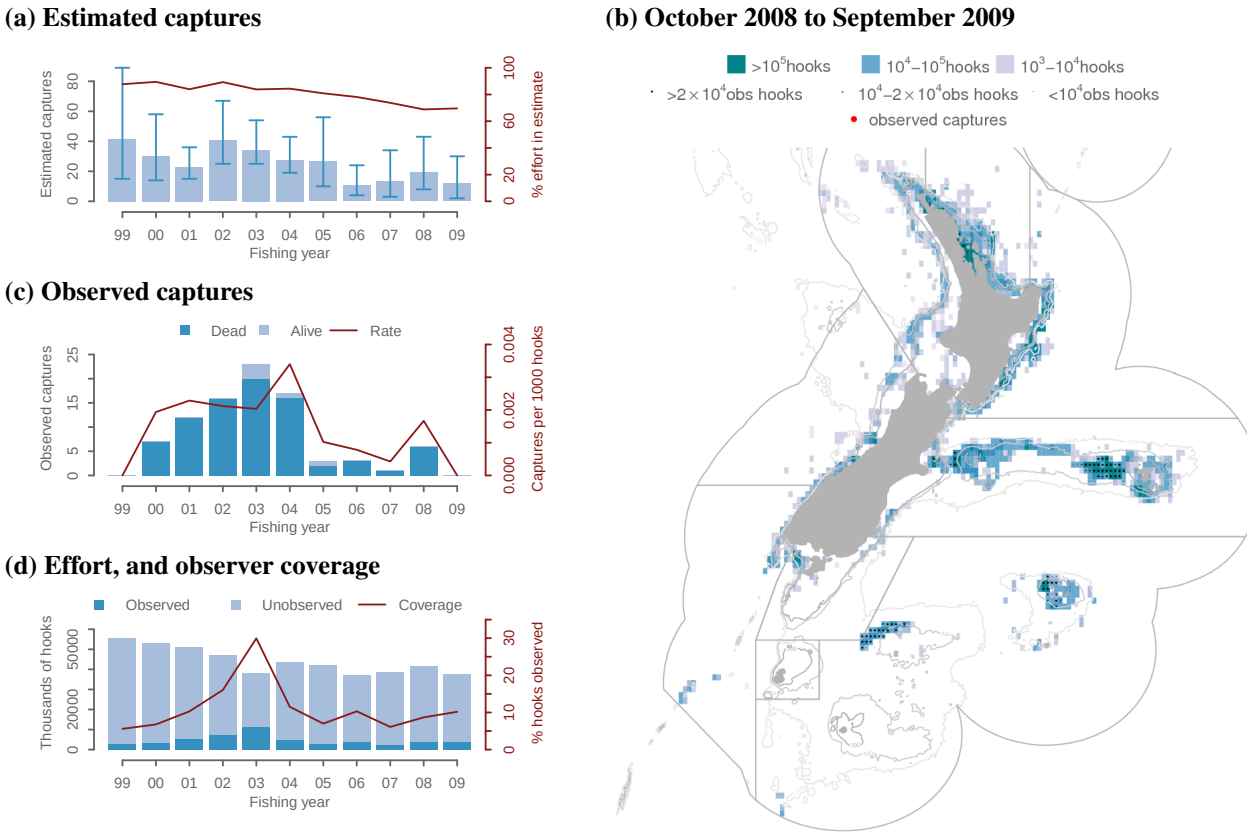

Figure 11: Sooty shearwater captures in bottom longline fisheries. (a) Estimated captures, with 95% confidence intervals, (b) Mapped effort and captures from 2008–09, (c) Observed captures, (d) Effort and observed effort. For a fuller explanation of the figure, see Section 3.5.