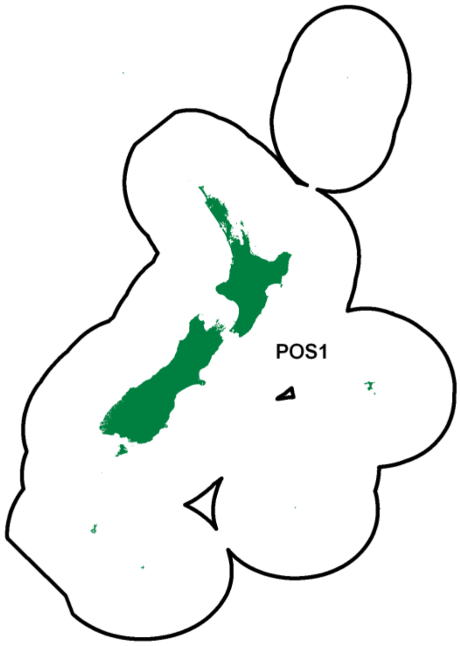
PORBEAGLE SHARK (POS)

(*Lamna nasus)*



1. FISHERY SUMMARY

Porbeagle shark were introduced into the QMS on 1 October 2004 under a single QMA, POS 1, with a TAC of 249 t, a TACC of 215 t and a recreational allowance of 10 t. The TAC was reviewed in 2012 with the reduced allocation and allowances applied from 1 October 2012 in Table 1. The decrease was in response to sustainability concerns surrounding porbeagle sharks which are slow growing and have low fecundity, making them particularly vulnerable to overexploitation.

Table 1: Recreational and Customary non-commercial allowances, TACCs and TACs (all in tonnes) for porbeagle shark.

Fishstock	Recreational Allowance	Customary non-commercial Allowance	Other mortality	TACC	TAC
POS 1	6	2	11	110	129

Porbeagle shark was added to the Third Schedule of the 1996 Fisheries Act with a TAC set under s14 because porbeagle shark is a highly migratory species and it is not possible to estimate MSY for the part of the stock that is found within New Zealand fisheries waters.

Porbeagle shark was also added to the Sixth Schedule of the 1996 Fisheries Act with the provision that:

> "A commercial fisher may return any porbeagle shark to the waters from which it was taken from if –
> (a) that porbeagle shark is likely to survive on return; and
> (b) the return takes place as soon as practicable after the porbeagle shark is taken."

Management of the porbeagle shark throughout the western and central Pacific Ocean (WCPO) is the responsibility of the Western and Central Pacific Fisheries Commission (WCPFC). Under this regional convention New Zealand is responsible for ensuring that the management measures applied within New Zealand fisheries waters are compatible with those of the Commission.

1.1 Commercial fisheries

About three-quarters of the commercial catch of porbeagle shark is taken by tuna longliners, and most of the rest by mid-water trawlers. About 60% of porbeagle sharks caught by tuna longliners are processed, and the rest are discarded. A high proportion of the catch was finned, but an increasing proportion of released sharks was reported as green, and small amounts were processed for their flesh. Figure 1 shows historical landings and longline fishing effort for POS 1.

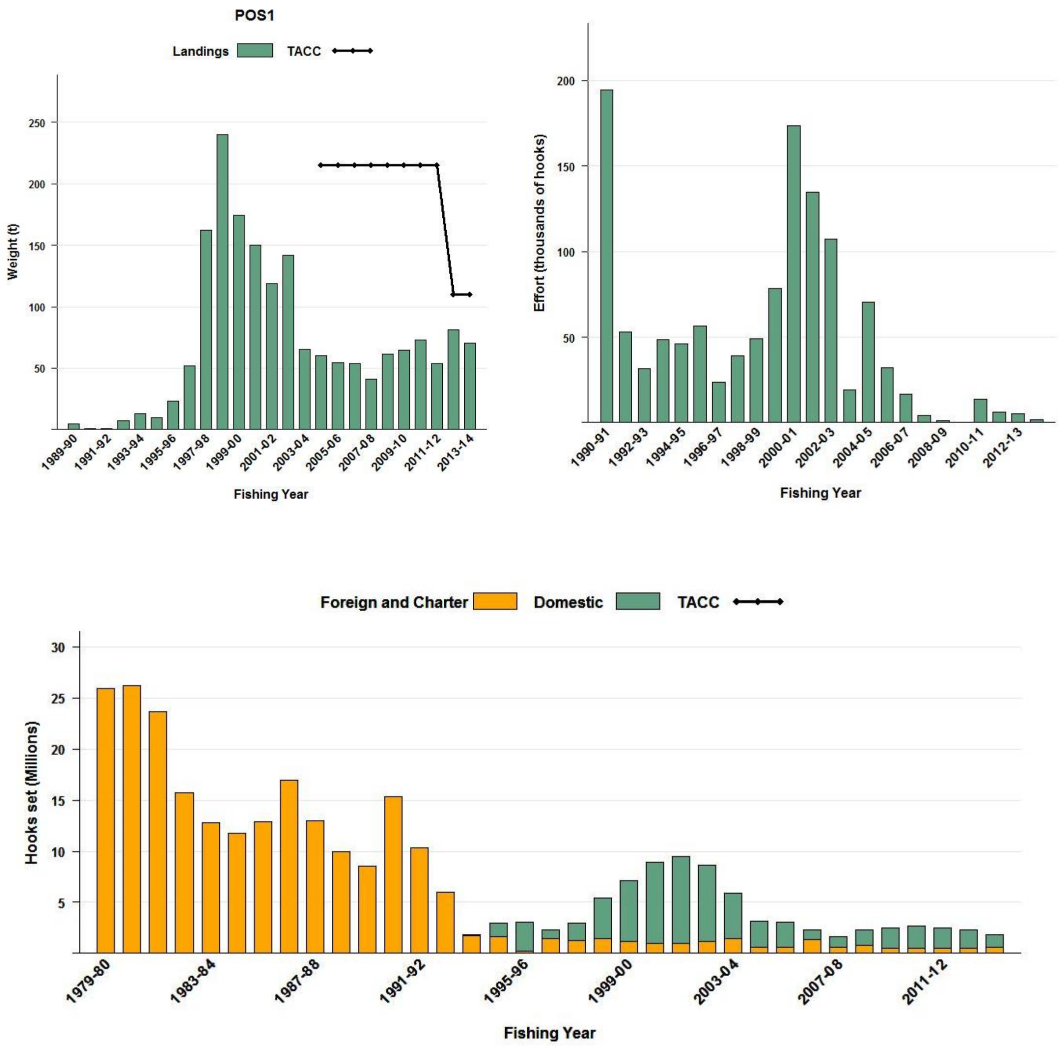


Figure 1: [Top left] Catch of porbeagle sharks from 1989–90 to 2012–13 within NZ waters (POS 1). [Top right] Fishing effort (number of hooks set) for high seas New Zealand flagged surface longline vessels from 1990–91 to 2013–14. [Bottom] Fishing effort for all domestic vessels (including effort by foreign vessels chartered by NZ fishing companies), from 1979–80 to 201–14.

Catches of porbeagle sharks by tuna longliners are concentrated off the west and southwest coast of the South Island, and the northeast coast of North Island. The target species for this fishery are mainly southern bluefin, bigeye and albacore tuna. Most of the porbeagle landings reported on TLCER forms were taken in FMAs 1, 2 & 7, with significant amounts also coming from trawl fisheries in FMAs 3, 5 and 6. Landings of porbeagle sharks reported by fishers on CELR (landed), CLR, or TLCERs and by processors on LFRR and MHR forms are shown in Table 2.

Table 2: New Zealand commercial landings (t) of porbeagle sharks reported by fishers on CELRs, CLRs, or TLCERs) and processors (LFRRs or MHRs) by fishing year. (– no data available).

Year	Total reported	LFRR/MHR
1989–90	–	5
1990–91	1	1
1991–92	1	1
1992–93	7	7
1993–94	10	13
1994–95	16	10
1995–96	26	23
1996–97	39	52
1997–98	205	162
1998–99	301	240
1999–00	215	174
2000–01	188	150
2001–02	161	119
2002–03*	152	142
2003–04*	84	65
2004–05*	62	60
2005–06*	54	55
2006–07*	53	54
2007–08*	43	41
2008–09*	64	61
2009–10*	–	65
2010–11*	–	73
2011–12*	–	54
2012–13*	–	81
2013–14*	–	70

*MHR rather than LFRR data.

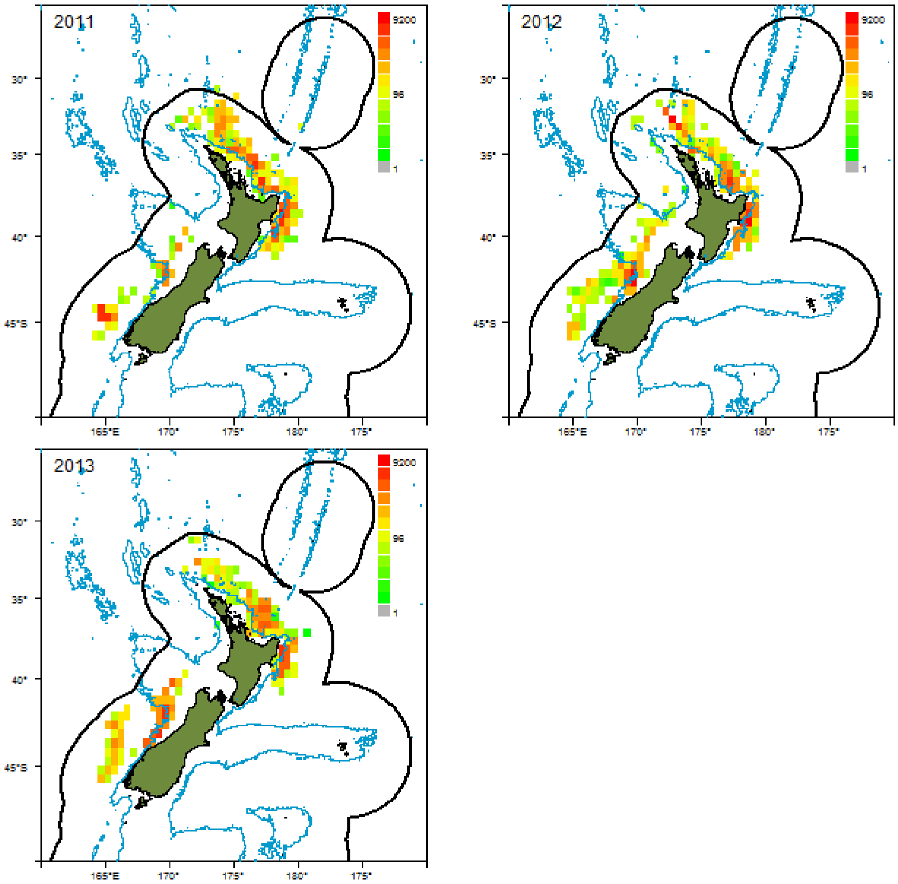


Figure 2: Porbeagle shark catches (kg) by the surface longline fishery in 0.5 degree rectangles by fishing year. Note the log scale used for the colour palette. Depth contour = 1000 m.

The majority of porbeagle shark are caught in the southern bluefin tuna target surface longline fishery (34%), followed by bigeye tuna (16%) and a small proportion (12%) are landed in the hoki target mid-water trawl fishery (Figure 3). Across all surface longline fisheries albacore make up the bulk of the catch (31%) (Figure 4). Longline fishing effort is distributed along the east coast of the North Island and the south west coast of the South Island. The west coast South Island fishery predominantly targets southern bluefin tuna, whereas the east coast of the North Island targets a range of species including bigeye, swordfish, and southern bluefin tuna.

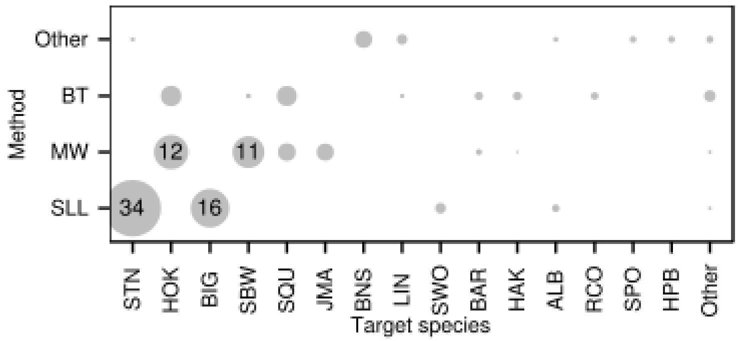


Figure 3: A summary of the proportion of landings of porbeagle shark taken by each target fishery and fishing method for 2012-13. The area of each circle is proportional to the percentage of landings taken using each combination of fishing method and target species. The number in the circle is the percentage (Bentley et al 2013).

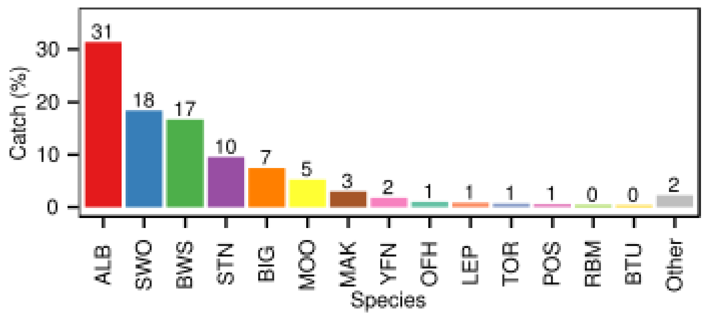


Figure 4: A summary of species composition of the reported surface longline fishery catch for 2012-13. The percentage by weight of each species is calculated for all trips classified under the activity (Bentley et al 2013).

Across all fleets in the longline fishery, 64.2% of the porbeagle sharks were alive when brought to the side of the vessel (Table 3). The domestic fleets retain around 35–47% of their porbeagle shark catch, mostly for the fins, while the foreign charter fleet retain most of the porbeagle sharks (79–92%) (mostly for fins; Table 4).

Table 3: Percentage of porbeagle shark (including discards) that were alive or dead when arriving at the longline vessel and observed during 2006–07 to 2009–10, by fishing year, fleet and region. Small sample sizes (number observed < 20) were omitted (Griggs & Baird 2013).

Year	Fleet	Area	% alive	% dead	Number
2006–07	Charter	North	60.5	39.5	223
		South	87.3	12.7	370
	Domestic	North	44.8	55.2	134
	Total		**71.3**	**28.7**	**727**
2007–08	Charter	South	77.6	22.4	49
	Domestic	North	59.6	40.4	488
	Total		**61.3**	**38.7**	**537**
2008–09	Charter	North	91.0	9.0	78
		South	85.4	14.6	158
	Domestic	North	57.9	42.1	254
	Total		**71.5**	**28.5**	**494**
2009–10	Charter	South	82.4	17.6	68
	Domestic	North	40.4	59.6	322
		South	30.0	70.0	20
	Total		**46.8**	**53.2**	**410**
Total all strata			**64.2**	**35.8**	**2 168**

Table 4: Percentage of porbeagle shark that were retained, or discarded or lost, when observed on a longline vessel during 2006–07 to 2009–10, by fishing year and fleet. Small sample sizes (number observed < 20) omitted (Griggs & Baird 2013).

Year	Fleet	% retained or finned	% discarded or lost	Number
2006–07	Charter	86.6	13.4	628
	Domestic	38.1	61.9	134
	Total	**78.1**	**21.9**	**762**
2007–08	Charter	89.8	10.2	49
	Domestic	35.7	64.3	488
	Total	**40.6**	**59.4**	**537**
2008–09	Charter	91.1	8.9	257
	Domestic	46.9	53.1	258
	Total	**68.9**	**31.1**	**515**
2009–10	Charter	79.2	20.8	72
	Domestic	46.0	54.0	348
	Total	**51.7**	**48.3**	**420**
Total all strata		**62.0**	**38.0**	**2 234**

1.2 Recreational fisheries

An estimate of the recreational harvest is not available. The recreational catch of porbeagle sharks is probably negligible, because they usually occur over the outer continental shelf or beyond. They are occasionally caught by gamefishers but most are tagged and released. In 2001, 40 porbeagle sharks were tagged by recreational fishers but numbers have dwindled from this peak to one or two per year.

1.3 Customary non-commercial fisheries
An estimate of the current customary catch is not available. The Maori customary catch of porbeagle sharks is probably negligible, because they usually occur over the outer continental shelf or beyond.

1.4 Illegal catch
There is no known illegal catch of porbeagle sharks.

1.5 Other sources of mortality
Many of the porbeagle sharks caught by tuna longliners are alive when the vessel retrieves the line, but it is not known how many of the released, discarded sharks survive.

2. BIOLOGY

Porbeagles live mainly in the latitudinal bands 30–50°S and 30–70°N. They occur in the North Atlantic Ocean, and in a circumglobal band in the Southern Hemisphere. Porbeagles are absent from the North Pacific Ocean, where the closely related salmon shark, *Lamna ditropis*, fills their niche. In the South Pacific Ocean, porbeagles are caught north of 30°S in winter–spring only; in summer they are not found north of about 35°S. They appear to penetrate further south during summer and autumn, and are found near many of the sub-Antarctic islands in the Indian and South-west Pacific Oceans. Porbeagle sharks are not found in the equatorial tropics.

Porbeagles are live-bearers (aplacental viviparous), and the length at birth is 58–67 cm fork length (FL) in the South-west Pacific. Females mature at around 170–180 cm FL and males at about 140–150 cm FL. The gestation period is about 8–9 months. In the North-west Atlantic, all females sampled in winter were pregnant, suggesting that there is no extended resting period between pregnancies, and that the female reproductive cycle lasts for one year. Litter size is usually four embryos, with a mean litter size in the South-west Pacific of 3.75. If the reproductive cycle lasts one year, annual fecundity would be about 3.75 pups per female.

A study of the age and growth of New Zealand porbeagles produced growth curves and estimates of the natural mortality rate (Table 5). However, attempts to validate ages using bomb radiocarbon analysis were unsuccessful, but suggested that the ages of porbeagles older than about 20 years were progressively under-estimated; for the oldest sharks the age under-estimation may have been as much as 50%. Consequently, the growth parameters provided in Table 5 are probably only accurate for ages up to about 20 years. Males mature at 8–11 years, and females mature at 15–18 years. Longevity is unknown but may be about 65 years.

In New Zealand, porbeagle sharks recruit to commercial fisheries during their first year at about 70 cm FL, and much of the commercial catch is immature. Most sharks caught by tuna longliners are 70–170 cm FL. The size and sex distribution of both sexes is similar up to about 150 cm, but larger individuals are predominantly male; few mature females are caught. Regional differences in length composition suggest segregation by size. The size and sex composition of sharks caught by trawlers are unknown.

Porbeagles are active pelagic predators of fish and cephalopods. Pelagic fish dominate the diet but squid are also commonly eaten, especially by the small sharks.

Table 5: Estimates of biological parameters.

Fishstock	Estimate			Source
1. Natural mortality (M)				
POS 1	0.05–0.10			Francis (unpub. data)
2. Weight = a (length)^b (Weight in kg, length in cm fork length)				
		a	*b*	
POS 1, both sexes		2.143×10^{-5}	2.924	Ayers et al (2004)
3. Von Bertalanffy model parameter estimates				
	k	t_0	L_∞	
POS 1 males	0.112	-4.75	182.2	Francis et al (2007)
POS 1 females	0.060	-6.86	233.0	Francis et al (2007)

3. STOCKS AND AREAS

In the North-west Atlantic, most tagged sharks moved short to moderate distances (up to 1500 km) along continental shelves, although one moved about 1800 km off the shelf into the mid-Atlantic Ocean. Sharks tagged off southern England were mainly recaptured between Denmark and France, with one shark moving 2370 km to northern Norway. Only one tagged shark has crossed the Atlantic: it travelled 4260 km from South-west Eire to 52°W off eastern Canada. Thus porbeagles from the northwest and northeast Atlantic appear to form two distinct stocks. There have been no genetic studies to determine the number of porbeagle stocks, but based on the disjunct (antitropical) geographical distribution and differences in biological parameters, North Atlantic porbeagles are probably reproductively isolated from Southern Hemisphere porbeagles.

The stock structure of porbeagle sharks in the Southern Hemisphere is unknown. However, given the scale of movements of tagged sharks, it seems likely that sharks in the South-west Pacific comprise a single stock. There is no evidence to indicate whether this stock extends to the eastern South Pacific or Indian Ocean.

4. ENVIRONMENTAL AND ECOSYSTEM CONSIDERATIONS

This section was updated for the November 2014 Fishery Assessment Plenary after review by the Aquatic Environment Working Group. This summary is from the perspective of the porbeagle shark but there is no directed fishery for them and the incidental catch sections below reflect the New Zealand longline fishery as a whole and are not specific to this species; a more detailed summary from an issue-by-issue perspective is available in the Aquatic Environment and Biodiversity Annual Review where the consequences are also discussed (www.mpi.govt.nz/document-vault/5008) (Ministry for Primary Industries 2014).

4.1 Role in the ecosystem

4.1.1 Diet

Porbeagle shark (*Lamna nasus*) are active pelagic predators of fish and cephalopods. Porbeagle sharks less than 75 cm feed mostly on squid but their diet changes to fish as they grow, with fish comprising more than 60% of the diet for porbeagle sharks 75 cm and over (Figure 5) (Griggs et al 2007).

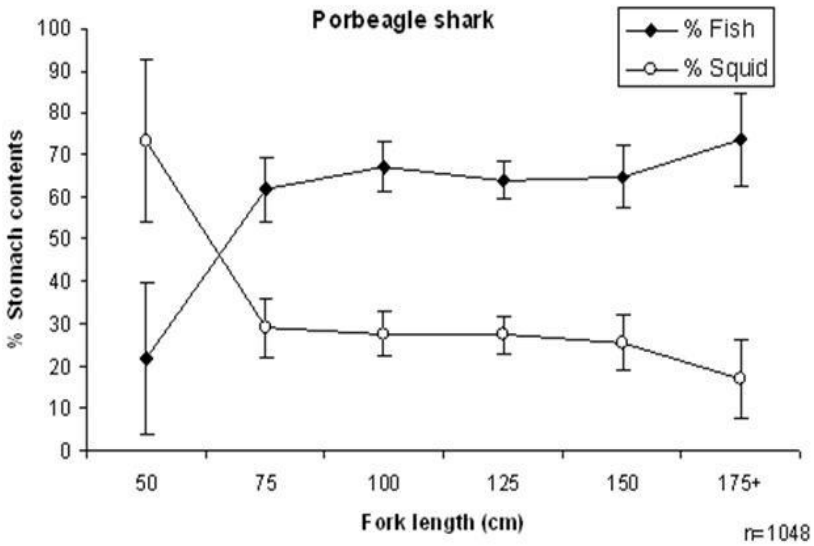


Figure 5: Changes in percentage of fish and squid in stomachs of porbeagle sharks as a function of fork length.

4.2 Incidental catch (seabirds, sea turtles and mammals)

The protected species, capture estimates presented here include all animals recovered onto the deck (alive, injured or dead) of fishing vessels but do not include any cryptic mortality (e.g., seabirds caught on a hook but not brought onboard the vessel)[1].

4.2.1 Seabird bycatch

Between 2002–03 and 2013–14, there were zero observed captures of birds across other surface longline target fisheries (those not targeting albacore tuna, bigeye tuna, southern bluefin tuna, and swordfish). Seabird capture rates since 2003 are presented in Figures 7 and 8. Seabird captures were more frequent off the south west coast of the South Island (Figure 9). Bayesian models of varying complexity dependent on data quality have been used to estimate captures across a range of methods (Richard & Abraham 2014). Observed and estimated seabird captures in longline fisheries are provided in Table 6.

Through the 1990s the minimum seabird mitigation requirement for surface longline vessels was the use of a bird scaring device (tori line) but common practice was that vessels set surface longlines primarily at night. In 2007 a notice was implemented under s 11 of the Fisheries Act 1996 to formalise the requirement that surface longline vessels only set during the hours of darkness and use a tori line when setting. This notice was amended in 2008 to add the option of line weighting and tori line use if setting during the day. In 2011 the notices were combined and repromulgated under a new regulation (Regulation 58A of the Fisheries (Commercial Fishing) Regulations 2001) which provides a more flexible regulatory environment under which to set seabird mitigation requirements.

Risk posed by commercial fishing to seabirds has been assessed via a level 2 method which supports much of the NPOA-Seabirds 2013 risk assessment framework (MPI 2013b). The method used in the level 2 risk assessment arose initially from an expert workshop hosted by the Ministry of Fisheries in 2008. The overall framework is described in Sharp et al. (2011) and has been variously applied and improved in multiple iterations (Waugh et al. 2009, Richard et al. 2011,

[1] As part of its data reconciliation processes, MPI has identified that less than 2% of observed protected species captures between 2002 and 2015 were not recorded in COD. Steps are being taken to update the database and estimates of protected species captures and associated risks. Accordingly, some estimates of protected species captures or risk in this document may have a small negative bias. Neither Maui nor Hector's dolphins are affected. Updated estimates will be reviewed by the Aquatic Environment Working Group in the second quarter of 2016.

Richard and Abraham 2013, Richard et al. 2013 and Richard & Abraham in press). The method applies an “exposure-effects” approach where exposure refers to the number of fatalities is calculated from the overlap of seabirds with fishing effort compared with observed captures to estimate the species vulnerability (capture rates per encounter) to each fishery group. This is then compared to the population’s productivity, based on population estimates and biological characteristics to yield estimates of population-level risk.
The 2014 iteration of the seabird risk assessment (Richard & Abraham in press) assessed other surface longline target fisheries (those not targeting albacore tuna, bigeye tuna, southern bluefin tuna, and swordfish) contribution to the total risk posed by New Zealand commercial fishing to seabirds (see Table 7). These target fisheries contribute 0.003 of PBR_1 to the risk to Southern Buller’s albatross which was assessed to be at very high risk from New Zealand commercial fishing (Richard & Abraham in press).

Table 6: Effort, observed and estimated seabird captures by fishing year for the New Zealand surface longline fishery within the EEZ. For each fishing year, the table gives the total number of hooks; the number of observed hooks; observer coverage (the percentage of hooks that were observed); the number of observed captures; the capture rate (captures per thousand hooks); and the mean number of estimated total captures (with 95% confidence interval). Estimates are based on methods described in Estimates from 2002–03 to 2010–11 and preliminary estimates for 2013–14 are based on data version 2015003.

Fishing year			Fishing effort	Observed captures		Estimated captures	
	All hooks	Observed hooks	% observed	Number	Rate	Mean	95% c.i.
2002–2003	173 410	0	0	0	-	34	11–76
2003–2004	220 787	13 000	5.9	0	0	37	12–83
2004–2005	100 290	800	0.8	0	0	87	32–198
2005–2006	40 320	0	0	0	-	11	2–30
2006–2007	45 795	0	0	0	-	12	2–30
2007–2008	47 755	0	0	0	-	12	2–32
2008–2009	16 178	0	0	0	-	5	0–17
2009–2010	26 800	0	0	0	-	8	1–22
2010–2011	20 100	0	0	0	-	5	0–16
2011–2012	18 900	0	0	0	-	3	0–11
2012–2013	43 160	0	0	0	-	10	2–28
2013–2014	19 700	820	4.2	0	0	4	0–14

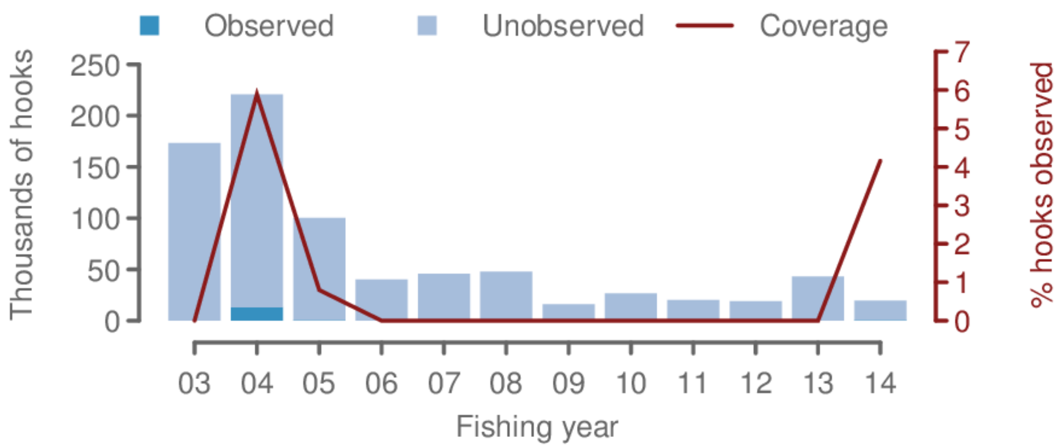


Figure 6: Observed captures of seabirds in the New Zealand surface longline fisheries from 2002–03 to 2013–14.

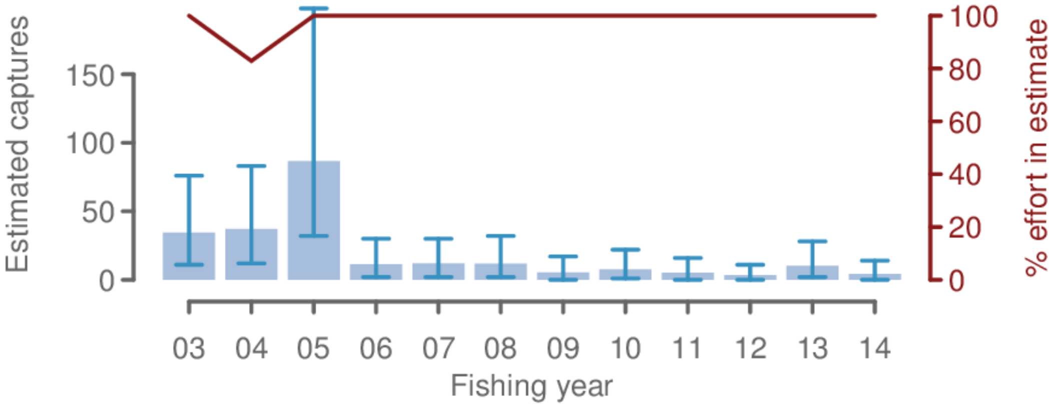


Figure 7 Estimated captures of seabirds in the New Zealand surface longline fisheries from 2002–03 to 2013–14.

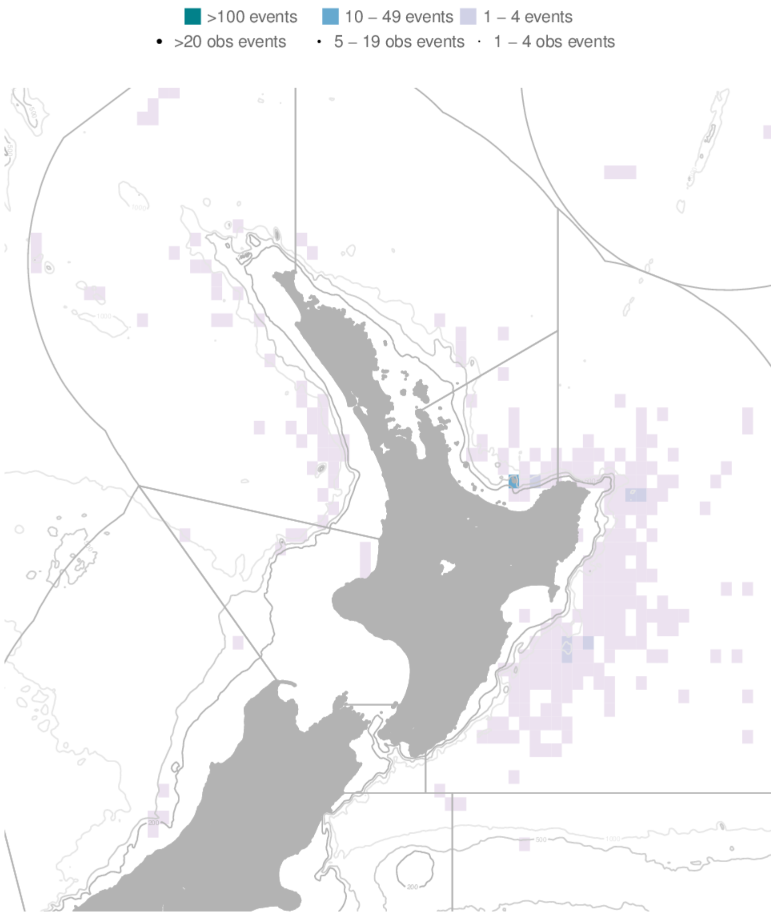


Figure 8: Distribution of fishing effort in the New Zealand surface longline fisheries and observed seabird captures, 2002–03 to 2013–14. Fishing effort is mapped into 0.2-degree cells, with the colour of each cell being related to the amount of effort. Observed fishing events are indicated by black dots, and observed captures are indicated by red dots. Fishing is only shown if the effort could be assigned a latitude and longitude, and if there were three or more vessels fishing within a cell. In this case, 89.4% of the effort is shown. See glossary for areas used for summarising the fishing effort and protected species captures.

Table 7: Risk ratio of seabirds predicted by the level two risk assessment for the other species target surface longline fisheries (those not targeting albacore tuna, bigeye tuna, southern bluefin tuna, pacific bluefin tuna and swordfish) and all fisheries included in the level two risk assessment, 2006–07 to 2012–13, showing seabird species with risk category of very or high, or a medium risk category and risk ratio of at least 1% of the total risk. The risk ratio is an estimate of aggregate potential fatalities across trawl and longline fisheries relative to the Potential Biological Removals, PBR_1 (from Richard and Abraham 2014 where full details of the risk assessment approach can be found). PBR_1 applies a recovery factor of 1.0. Typically a recovery factor of 0.1 to 0.5 is applied (based on the state of the population) to allow for recovery from low population sizes as quickly as possible. This should be considered when interpreting these results. The New Zealand threat classifications are shown (Robertson et al 2013 at http://www.doc.govt.nz/documents/science-and-technical/nztcs4entire.pdf)

	Risk ratio				
Species name	OTH target SLL	Total risk from NZ commercial fishing	% of total risk from NZ commercial fishing	Risk category	NZ Threat Classification
Black petrel	0.000	15.095	0.00	Very high	Threatened: Nationally Vulnerable
Salvin's albatross	0.000	3.543	0.00	Very high	Threatened: Nationally Critical
Southern Buller's albatross	0.003	2.823	0.10	Very high	At Risk: Naturally Uncommon
Flesh-footed shearwater	0.000	1.557	0.00	Very high	Threatened: Nationally Vulnerable
Gibson's albatross	0.000	1.245	0.00	Very high	Threatened: Nationally Critical
New Zealand white-capped albatross	0.000	1.096	0.01	Very high	At Risk: Declining
Chatham Island albatross	0.000	0.913	0.00	High	At Risk: Naturally Uncommon
Antipodean albatross	0.000	0.888	0.00	High	Threatened: Nationally Critical
Westland petrel	0.000	0.498	0.00	High	At Risk: Naturally Uncommon
Northern Buller's albatross	0.000	0.336	0.13	High	At Risk: Naturally Uncommon
Campbell black-browed albatross	0.000	0.304	0.00	High	At Risk: Naturally Uncommon
Stewart Island shag	0.000	0.301	0.00	High	Threatened: Nationally Vulnerable

4.2.2 Sea turtle bycatch

Between 2002–03 and 2013–14, there were 15 observed captures of sea turtles across all surface longline fisheries (Tables 8 and 9, Figure 10). Observer records documented all but one sea turtle as captured and released alive. Sea turtle capture distributions predominantly occur throughout the east coast of the North Island and Kermadec Island fisheries (Figure 11).

Table 8: Number of observed sea turtle captures in the New Zealand surface longline fisheries, 2002–03 to 2013–14, by species and area. Data from Thompson et al (2013), retrieved from http://data.dragonfly.co.nz/psc/. See glossary above for a description of the areas used for summarising the fishing effort and protected species captures.

Species	Bay of Plenty	East Coast North Island	Kermadec Islands	West Coast North Island	Total
Leatherback turtle	1	4	3	3	11
Green turtle	0	1	0	0	1
Unknown turtle	0	1	0	2	3
Total	1	6	3	5	15

Table 9: Effort and sea turtle captures in surface longline fisheries by fishing year. For each fishing year, the table gives the total number of hooks; the number of observed hooks; observer coverage (the percentage of hooks that were observed); the number of observed captures (both dead and alive); and the capture rate (captures per thousand hooks). For more information on the methods used to prepare the data see Thompson et al (2013).

Fishing year	Fishing effort			Observed captures	
	All hooks	Observed hooks	% observed	Number	Rate
2002–2003	10 770 488	2 195 152	20.4	0	0
2003–2004	7 386 484	1 607 304	21.8	1	0.001
2004–2005	3 679 765	783 812	21.3	2	0.003
2005–2006	3 690 869	705 945	19.1	1	0.001
2006–2007	3 739 912	1 040 948	27.8	2	0.002
2007–2008	2 246 139	421 900	18.8	1	0.002
2008–2009	3 115 633	937 496	30.1	2	0.002
2009–2010	2 995 264	665 883	22.2	0	0
2010–2011	3 188 179	674 572	21.2	4	0.006
2011–2012	3 100 177	728 190	23.5	0	0
2012–2013	2 876 932	560 333	19.6	2	0.004
2013-2014	2 546 764	773 527	30.4	0	0

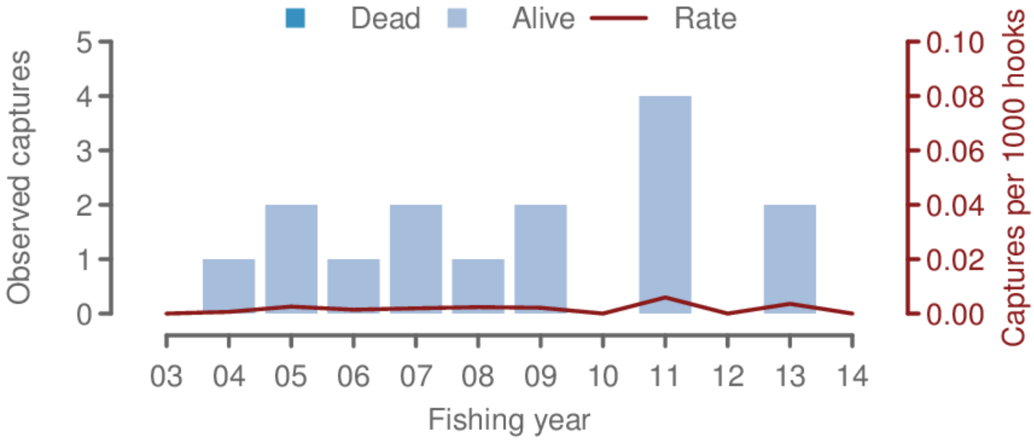


Figure 9: Observed captures of sea turtles in the New Zealand surface longline fisheries from 2002–03 to 2013–14.

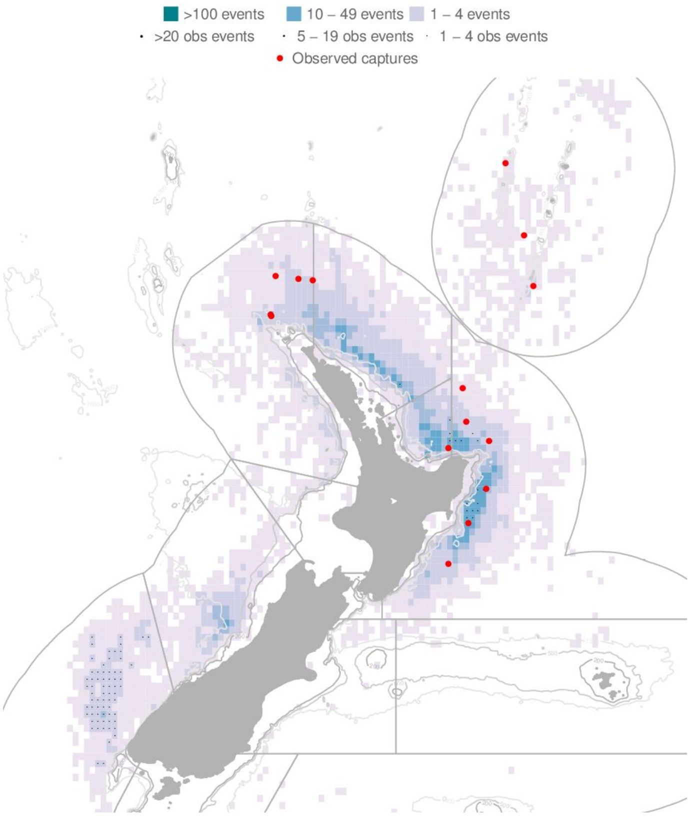


Figure 10: Distribution of fishing effort in the New Zealand surface longline fisheries and observed sea turtle captures, 2002–03 to 2013–14. Fishing effort is mapped into 0.2-degree cells, with the colour of each cell being related to the amount of effort. Observed fishing events are indicated by black dots, and observed captures are indicated by red dots. Fishing is only shown if the effort could be assigned a latitude and longitude, and if there were three or more vessels fishing within a cell. In this case, 89.4% of the effort is shown. See glossary for areas used for summarising the fishing effort and protected species captures.

4.2.3 Marine Mammals

4.2.3.1 Cetaceans

Cetaceans are dispersed throughout New Zealand waters (Perrin et al 2008). The spatial and temporal overlap of commercial fishing grounds and cetacean foraging areas has resulted in cetacean captures in fishing gear (Abraham & Thompson 2009, 2011).

Between 2002–03 and 2013–14, there were seven observed captures of whales and dolphins in surface longline fisheries. Observed captures included 5 unidentified cetaceans and 2 long-finned Pilot whales (Tables 10 and 11, Figure 12) (Thompson et al 2013). All captured animals recorded were documented as being caught and released alive (Thompson et al 2013). Cetacean capture distributions are more frequent off the east coast of the North Island (Figure 13).

Table 10: Number of observed cetacean captures in the New Zealand surface longline fisheries, 2002–03 to 2013–14, by species and area. Data from Thompson et al (2013), retrieved from http://data.dragonfly.co.nz/psc/. See glossary above for a description of the areas used for summarising the fishing effort and protected species captures.

Species	Bay of Plenty	East Coast North Island	Fiordland	Northland and Hauraki	West Coast North Island	West Coast South Island	Total
Long-finned pilot whale	0	1	0	0	0	1	2
Unidentified cetacean	1	1	1	1	1	0	5
Total	1	2	1	1	1	1	7

Table 11: Effort and captures of cetaceans in surface longline fisheries by fishing year. For each fishing year, the table gives the total number of hooks; the number of observed hooks; observer coverage (the percentage of hooks that were observed); the number of observed captures (both dead and alive); and the capture rate (captures per thousand hooks). For more information on the methods used to prepare the data, see Thompson et al (2013).

Fishing year			Fishing effort	Observed captures	
	All hooks	Observed hooks	% observed	Number	Rate
2002–2003	10 770 488	2 195 152	20.4	1	0
2003–2004	7 386 484	1 607 304	21.8	4	0.002
2004–2005	3 679 765	783 812	21.3	1	0.001
2005–2006	3 690 869	705 945	19.1	0	0
2006–2007	3 739 912	1 040 948	27.8	0	0
2007–2008	2 246 139	421 900	18.8	1	0.002
2008–2009	3 115 633	937 496	30.1	0	0
2009–2010	2 995 264	665 883	22.2	0	0
2010–2011	3 188 179	674 572	21.2	0	0
2011–2012	3 100 177	728 190	23.5	0	0
2012–2013	2 876 932	560 333	19.5	0	0
2013–2014	2 546 764	773 527	30.4	0	0

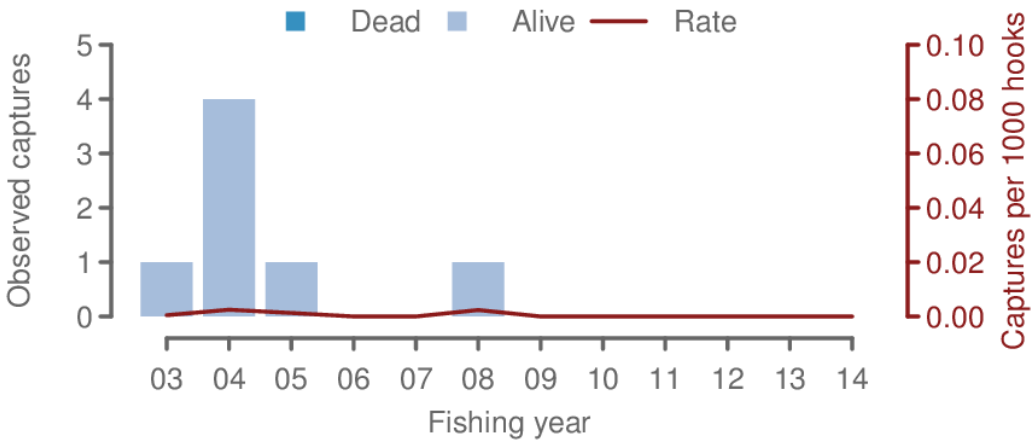


Figure 11: Observed captures of cetaceans in the New Zealand surface longline fisheries from 2002–03 to 2013–14.

Figure 12: Distribution of fishing effort in the New Zealand surface longline fisheries and observed cetacean captures, 2002–03 to 2013–14. Fishing effort is mapped into 0.2-degree cells, with the colour of each cell being related to the amount of effort. Observed fishing events are indicated by black dots, and observed captures are indicated by red dots. Fishing is only shown if the effort could be assigned a latitude and longitude, and if there were three or more vessels fishing within a cell. In this case, 89.4% of the effort is shown. See glossary for areas used for summarising the fishing effort and protected species captures.

4.2.3.2 New Zealand fur seal bycatch

Currently, New Zealand fur seals are dispersed throughout New Zealand waters, especially in waters south of about 40º S to Macquarie Island. The spatial and temporal overlap of commercial fishing grounds and New Zealand fur seal foraging areas has resulted in New Zealand fur seal captures in fishing gear (Mattlin 1987, Rowe 2009). Most fisheries with observed captures occur in waters over or close to the continental shelf, which slopes steeply to deeper waters relatively close to shore, and thus rookeries and haulouts, around much of the South Island and offshore islands. Captures on longlines occur when the fur seals attempt to feed on the bait and fish catch during hauling. Most New Zealand fur seals are released alive, typically with a hook and short snood or trace still attached.

New Zealand fur seal captures in surface longline fisheries have been generally observed in waters south and west of Fiordland, but also in the Bay of Plenty-East Cape area when the animals have attempted to take bait or fish from the line as it is hauled. These capture rates include animals that are released alive (100% of observed surface longline capture in 2008–09; Thompson & Abraham 2010). Capture rates in 2011–12 and 2012-13 were higher than they were in the early 2000s (Figures 14 and 15). While fur seal captures have occurred throughout the range of this fishery most New Zealand captures have occurred off the Southwest coast of the South Island (Figure 16). Between 2002–03 and 2013-14, there were 323 observed captures of New Zealand fur seal in surface longline fisheries (Tables 12 and 13).

Table 12: Number of observed New Zealand fur seal captures in the New Zealand surface longline fisheries, 2002–03 to 201314 by species and area. Data from Thompson et al (2013), retrieved from http://data.dragonfly.co.nz/psc/. See glossary above for a description of the areas used for summarising the fishing effort and protected species captures.

	Bay of Plenty	East Coast North Island	Fiordland	Northland and Hauraki	Stewart Snares Shelf	West Coast North Island	West Coast South Island	Total
New Zealand fur seal	16	33	228	4	4	2	36	323

Table 13: Effort and captures of New Zealand fur seal in the New Zealand surface longline fisheries by fishing year. For each fishing year, the table gives the total number of hooks; the number of observed hooks; observer coverage (the percentage of hooks that were observed); the number of observed captures (both dead and alive); and the capture rate (captures per thousand hooks). Data from Thompson et al (2013), retrieved from http://data.dragonfly.co.nz/psc/. Estimates from 2002–03 to 2012–13 and preliminary estimates for 2012–13 are based on data version 2015003.

Fishing year	Fishing effort			Observed captures		Estimated captures	
	All hooks	Observed hooks	% observed	Number	Rate	Mean	95% c.i.
2002–2003	10 772 188	2 195 152	20.4	56	0.026	299	199–428
2003–2004	7 386 484	1 607 304	21.8	40	0.025	134	90–188
2004–2005	3 679 765	783 812	21.3	20	0.026	66	38–99
2005–2006	3 690 869	705 945	19.1	12	0.017	47	23–79
2006–2007	3 739 912	1 040 948	27.8	10	0.010	32	14–55
2007–2008	2 246 139	421 900	18.8	10	0.024	40	19–68
2008–2009	3 115 633	937 496	30.1	22	0.023	53	29–81
2009–2010	2 995 264	665 883	22.2	19	0.029	77	43–121
2010–2011	3 188 179	674 572	21.2	17	0.025	64	35–101
2011–2012	3 100 177	728 190	23.5	40	0.055	140	92–198
2012–2013	2 876 932	560 333	19.5	21	0.037	110	65–171
2013-2014	2 546 764	773 527	30.4	56	0.072	103	88-121

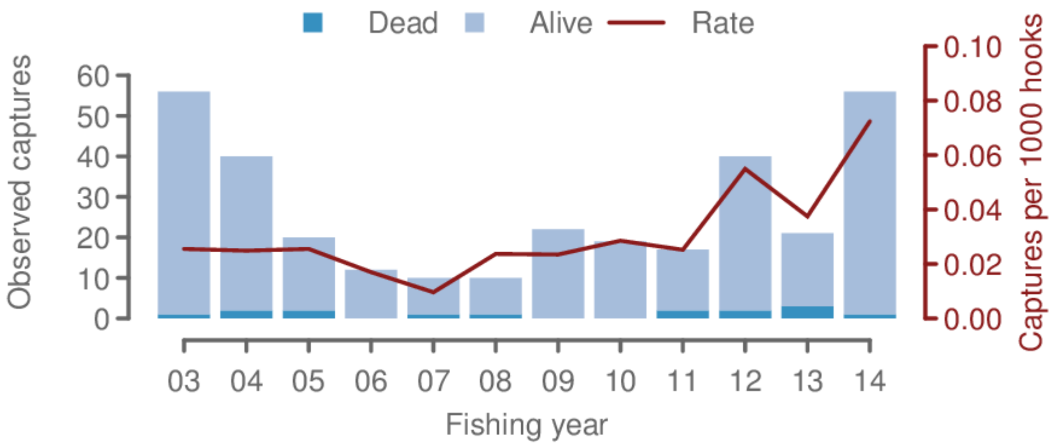


Figure 13: Observed captures of New Zealand fur seal in the New Zealand surface longline fisheries from 2002–03 to 201–14.

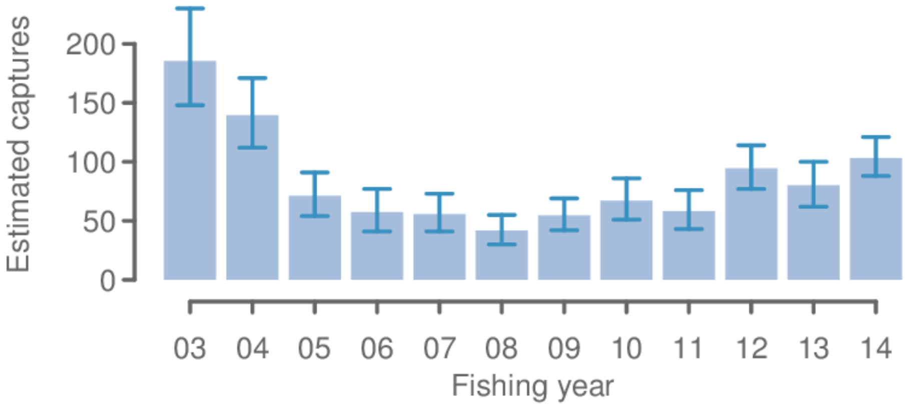


Figure 14: Estimated captures of New Zealand fur seal in the New Zealand surface longline fisheries from 2002–03 to 2013–14.

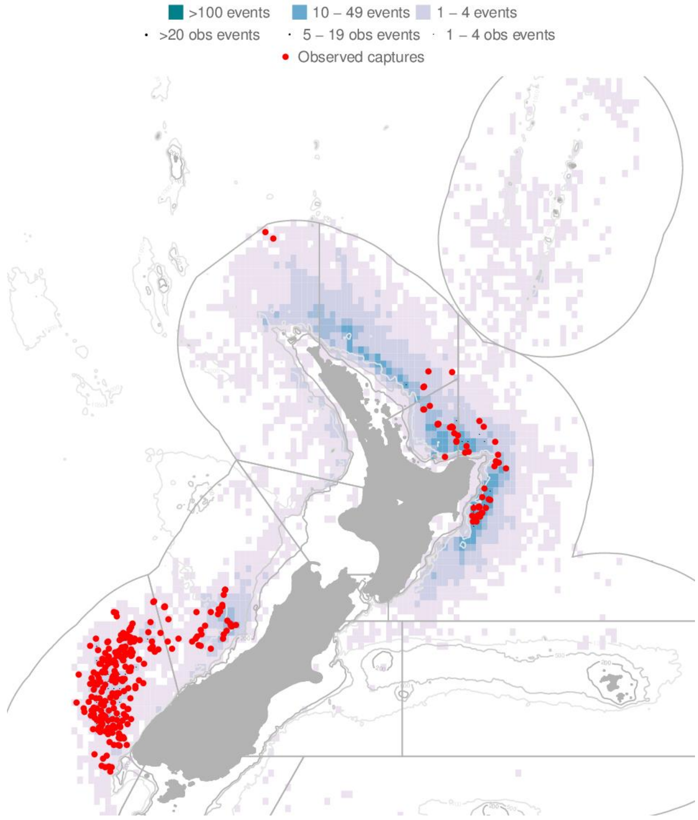


Figure 15: Distribution of fishing effort in the New Zealand surface longline fisheries and observed New Zealand fur seal captures, 2002–03 to 2013–14. Fishing effort is mapped into 0.2-degree cells, with the colour of each cell being related to the amount of effort. Observed fishing events are indicated by black dots, and observed captures are indicated by red dots. Fishing is only shown if the effort could be assigned a latitude and longitude, and if there were three or more vessels fishing within a cell. In this case, 89.4% of the effort is shown. See glossary for areas used for summarising the fishing effort and protected species captures.

4.3 Incidental fish bycatch

Observer records indicate that a wide range of species are landed by the longline fleets in New Zealand fishery waters. Blue sharks are the most commonly landed species (by number), followed by Ray's bream (Table 14).

Table 14: Total estimated catch (numbers of fish) of common bycatch species in the New Zealand longline fishery as estimated from observer data from 2010 to 2014. Also provided is the percentage of these species retained (2013 data only) and the percentage of fish that were alive when discarded, N/A (none discarded).

Species	2011	2012	2013	2014	% retained (2014)	discards % alive (2014)
Blue shark	53 432	132 925	158 736	80 118	16.2	89.2
Lancetfish	37 305	7 866	19 172	21 002	0.3	24.4
Porbeagle shark	9 929	7 019	9 805	5 061	30.6	70.7
Rays bream	18 453	19 918	13 568	4 591	96.1	7.4
Mako shark	9 770	3 902	3 981	4 506	30.3	68.8
Sunfish	3 773	3 265	1 937	1 981	2.4	80.0
Moonfish	3 418	2 363	2 470	1 655	96.6	87.5
Dealfish	223	372	237	910	0.4	24.9
Butterfly tuna	909	713	1 030	699	77.3	3.4
Pelagic stingray	4 090	712	1 199	684	0.0	93.5
Escolar	6 602	2 181	2 088	656	88.6	0.0
Deepwater dogfish	548	647	743	600	1.2	80.9
Oilfish	1 747	509	386	518	82.1	40.0
Rudderfish	338	491	362	327	10.7	83.3
Thresher shark	349	246	256	261	28.6	80.0
Big scale pomfret	139	108	67	164	74.5	75.0
Striped marlin	175	124	182	151	0.0	94.3
School shark	49	477	21	119	72.0	78.6
Skipjack tuna	255	123	240	90	80.0	0.0

4.4 Benthic interactions
N/A

4.5 Key environmental and ecosystem information gaps
Cryptic mortality is unknown at present but developing a better understanding of this in future may be useful for reducing uncertainty of the seabird risk assessment and could be a useful input into risk assessments for other species groups.

The survival rates of released target and bycatch species is currently unknown.

Observer coverage in the New Zealand fleet is not spatially and temporally representative of the fishing effort.

5. STOCK ASSESSMENT

With the establishment of the WCPFC in 2004, future stock assessments of porbeagle shark in the western and central Pacific Ocean stock will be reviewed by the WCPFC. There is currently a shark research plan that has been developed within the context of the Western and Central Pacific Fisheries Commission. Porbeagle sharks will be the focus of Southern Hemisphere wide stock status assessment in the near future.

There have been no stock assessments of porbeagle sharks in New Zealand. No estimates of yield are possible with the currently available data.

Indicator analyses suggest that porbeagle shark populations in the New Zealand EEZ have not been declining under recent fishing pressure, and may have been increasing since 2005 (Figures 16 and 17). These changes are presumably in response to a decline in SLL fishing effort since 2001-02 (Griggs & Baird 2013), and declines in annual landings since peaks in 1999 for porbeagle sharks (Ministry for Primary Industries 2013b). Porbeagle shark abundance may have declined rapidly in the late 1990s before stabilising at a relatively low level, or increasing as indicated by the trend in the TLCER North CPUE index. The quality of observer data and model fits means these interpretations are uncertain. The stock status of porbeagle sharks remains uncertain, but is potentially low. Conclusive determinations of stock status will require regional (i.e. South Pacific) stock assessments (Table 15).

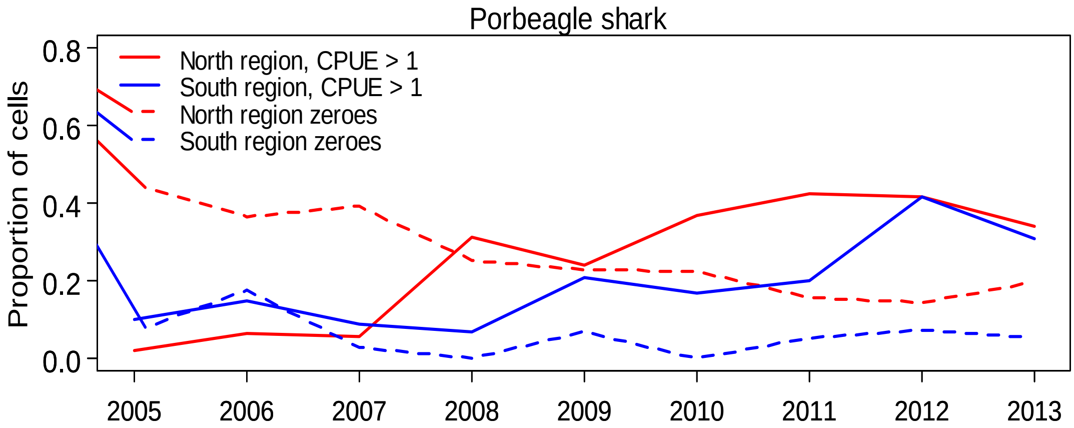


Figure 16: Porbeagle shark distribution indicators. Proportions of 0.5 degree rectangles having CPUE greater than 1 per 1000 hooks, and proportions of rectangles having zero catches, for North and South regions by fishing year, based on estimated catches (processed and discarded combined) reported on TLCERs. North region comprises Fisheries Management Areas (FMAs) 1, 2, 8, and 9, and South region comprises FMAs 5 and 7.

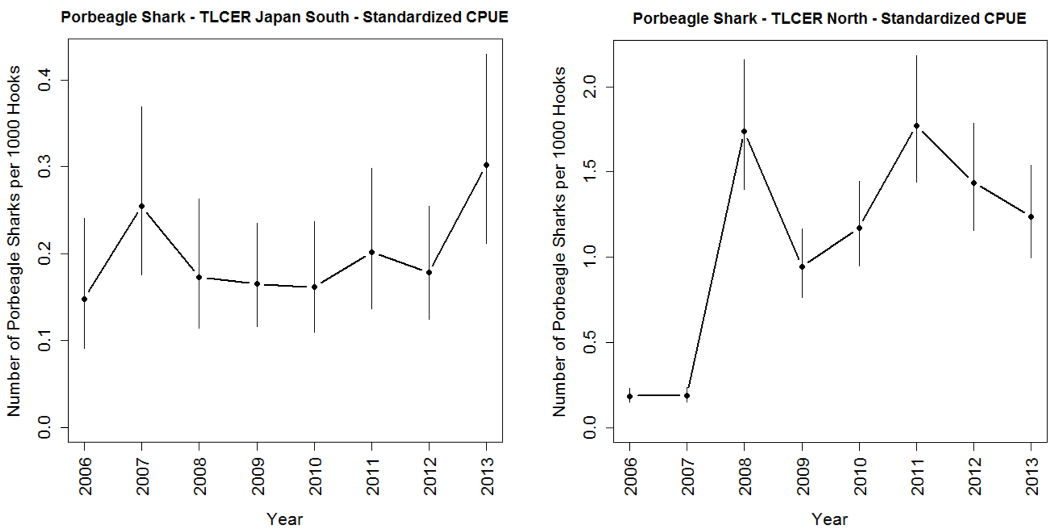


Figure 17: Standardised CPUE indices for commercial TLCER (Japan South and North) and observer datasets (all New Zealand) [Continued on next page].

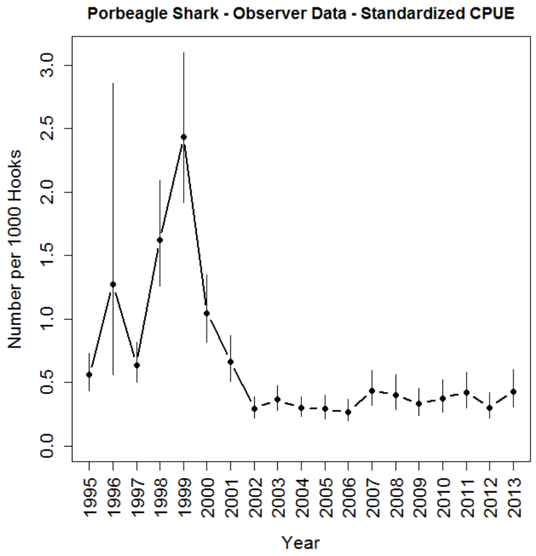


Figure 17 [Continued]: Standardised CPUE indices for commercial TLCER (Japan South and North) and observer datasets (all New Zealand).

Table 15: Summary of trends identified in abundance indicators since the 2005 fishing year based on both TLCER and observer data sets. The CPUE-Obs indicator was calculated for both North and South regions combined. North region comprises Fisheries Management Areas (FMAs) 1, 2, 8, and 9, and South region comprises FMAs 5 and 7. For the CPUE-TLCER indicator in South region, only the Japan dataset indicator is shown (the TLCER Domestic South dataset was small and probably unrepresentative). Green cells show indicators that suggest positive trends in stock size. Note that a downward trend in 'proportion-zeroes' is considered a positive stock trend. NA = indicator not applicable because of small sample size.

		North region			South region		
Indicator class	Indicator	Blue	Porbeagle	Mako	Blue	Porbeagle	Mako
Distribution	High-CPUE	Up	Up	Up	Up	Up	NA
Distribution	Proportion-zeroes	Nil	Down	Down	Nil	Nil	Down
Catch composition	GM index total catch - TLCER	Up (all species)			Up (all species)		
Catch composition	GM index total catch - Obs	Up (all species)			Nil (all species)		
Catch composition	GM index HMS shark catch - TLCER	Up (all species)			Up (all species)		
Catch composition	GM index HMS shark catch - Obs	Up (all species)			Nil (all species)		
Standardised CPUE	CPUE - TLCER	Up	Nil	Up	Up	Nil	Nil
Standardised CPUE	CPUE - Obs	Up	Nil	Nil	Up	Nil	Nil
Sex ratio	Proportion males	Nil	Nil	Nil	Nil	Nil	NA
Size composition	Median length - Males	Nil	Nil	Nil	Nil	Nil	NA
Size composition	Median length - Females	Nil	Nil	Nil	Nil	Nil	NA

Relative to a wide range of shark species, the productivity of porbeagle sharks is very low. Females have a high age-at-maturity, high longevity (and therefore low natural mortality rate) and low annual fecundity. The low fecundity is cause for strong concern, as the ability of the stock to replace sharks removed by fishing is very limited.

Observed length frequency distributions of porbeagle sharks by area and sex are shown in Figure 17 for fish measured between 1993 and 2012. Few mature females are caught by the surface longline fishery, and they are mainly taken around South Island. Mature males are frequently caught throughout New Zealand. A strong mode of 0+ juveniles occurs at 70-85 cm in northern and southwestern New Zealand, but not of the east coast of South Island where water temperatures are significantly colder.

A data informed qualitative risk assessment was completed on all chondrichthyans (sharks, skates, rays and chimaeras) at the New Zealand scale in 2014 (Ford et al. 2015). Porbeagle sharks had a risk score of 15 and were ranked second equal lowest risk of the eleven QMS chondrichthyan species. Data were described as 'exist and sound' for the purposes of the assessment and the risk score was achieved by consensus of the expert panel, but with low confidence. This low confidence was due to the fact that no data was available on adult stock size.

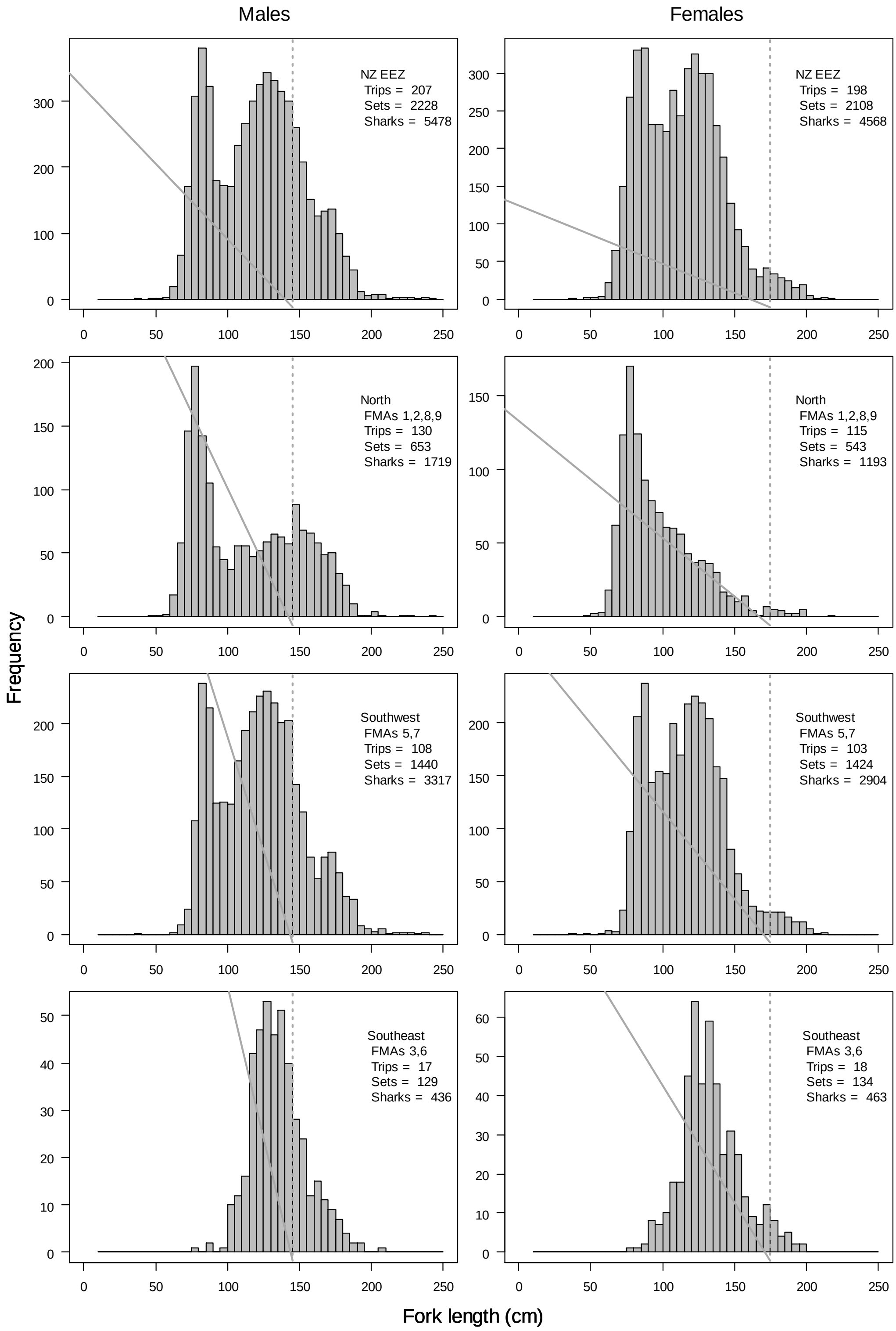


Figure 18: Length-frequency distributions of male and female porbeagle sharks measured by observers aboard surface longline vessels between 1993 and 2012 for the New Zealand EEZ, and North, Southwest and Southeast regions. The dashed vertical lines indicate the median length at maturity. Source: Francis (2013)

6. STATUS OF THE STOCK

Stock structure assumptions

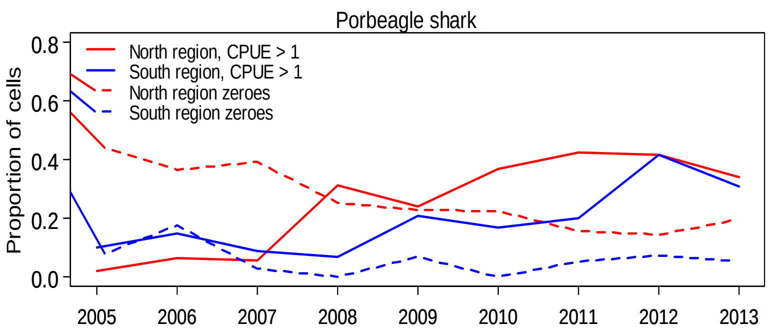
POS 1 is assumed to be part of the wider South Western Pacific Ocean stock. However, there is no stock assessment for this wider stock. The results below are from indicator analyses of the New Zealand component of that stock only.

Stock Status	
Year of Most Recent Assessment	2014
Assessment Runs Presented	Indicator analyses only for NZ EEZ
Reference Points	Target: Not established Soft Limit: Not established but HSS default of 20% SB_0 assumed Hard Limit: Not established but HSS default of 10% SB_0 assumed Overfishing threshold: F_{MSY}
Status in relation to Target	Unknown
Status in relation to Limits	Unknown
Status in relation to Overfishing	Unknown

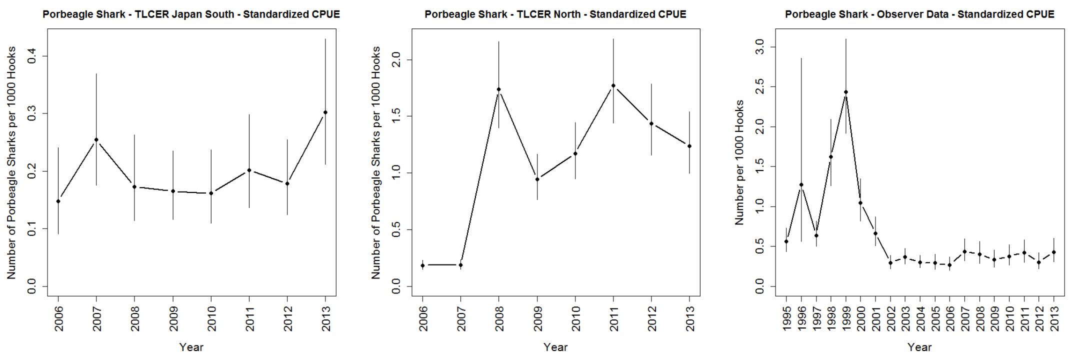
Historical Stock Status Trajectory and Current Status

Summary of trends identified in abundance indicators since the 2005 fishing year based on both TLCER and observer data sets. North region comprises Fisheries Management Areas (FMAs) 1, 2, 8, and 9, and South region comprises FMAs 5 and 7.

		North region			South region		
Indicator class	Indicator	Blue	Porbeagle	Mako	Blue	Porbeagle	Mako
Distribution	High-CPUE	Up	Up	Up	Up	Up	NA
Distribution	Proportion-zeroes	Nil	Down	Down	Nil	Nil	Down
Catch composition	GM index total catch - TLCER	Up (all species)			Up (all species)		
Catch composition	GM index total catch - Obs	Up (all species)			Nil (all species)		
Catch composition	GM index HMS shark catch - TLCER	Up (all species)			Up (all species)		
Catch composition	GM index HMS shark catch - Obs	Up (all species)			Nil (all species)		
Standardised CPUE	CPUE - TLCER	Up	Nil	Up	Up	Nil	Nil
Standardised CPUE	CPUE - Obs	Up	Nil	Nil	Up	Nil	Nil
Sex ratio	Proportion males	Nil	Nil	Nil	Nil	Nil	NA
Size composition	Median length - Males	Nil	Nil	Nil	Nil	Nil	NA
Size composition	Median length - Females	Nil	Nil	Nil	Nil	Nil	NA



Porbeagle shark distribution indicators. Proportions of 0.5 degree rectangles having CPUE greater than 1 per 1000 hooks, and proportions of rectangles having zero catches, for North and South regions by fishing year, based on estimated catches (processed and discarded combined) reported on TLCERs. North region comprises Fisheries Management Areas (FMAs) 1, 2, 8, and 9, and South region comprises FMAs 5 and 7.



Standardised CPUE indices for commercial TLCER (Japan South and North) and observer datasets (all New Zealand).

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Appears to be increasing
Recent Trend in Fishing Intensity or Proxy	Appears to be decreasing
Other Abundance Indices	-
Trends in Other Relevant Indicator or Variables	Catches in New Zealand increased from the late 1980s to a peak in 1998/99 of 301 t, then declined to 41 t in 2007-08, and have remained less than 100 t since.

Projections and Prognosis		
Stock Projections or Prognosis	The stock is likely to increase if effort remains at current levels.	
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Soft Limit: Unknown Hard Limit: Unknown	
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Unknown	
Assessment Methodology and Evaluation		
Assessment Type	Level 2- Partial Quantitative Stock Assessment: Standardised CPUE indices and other fishery indicators	
Assessment Method	Indicator analyses	
Assessment Dates	Latest assessment: 2014	Next assessment: Unknown
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	- Distribution - Species composition - Size and sex ratio - Catch per unit effort	1 – All High quality
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	Historical catch recording before 2005 may not be accurate.	

Qualifying Comments
Relative to a wide range of shark species, the productivity of porbeagle sharks is very low. Females have a high age-at-maturity, high longevity (and therefore low natural mortality rate) and low annual fecundity. The low fecundity and high longevity are cause for strong concern, as the ability of the stock to replace sharks removed by fishing is very limited.

Fishery Interactions
Interactions with protected species are known to occur in the longline fisheries of the South Pacific, particularly south of 30°S. Seabird bycatch mitigation measures are required in the New Zealand and Australian EEZs and through the WCPFC Conservation and Management Measure CMM2007-04. Sea turtles are also incidentally captured in longline gear; the WCPFC is attempting to reduce sea turtle interactions through Conservation and Management Measure CMM2008-03.

7. FOR FURTHER INFORMATION

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