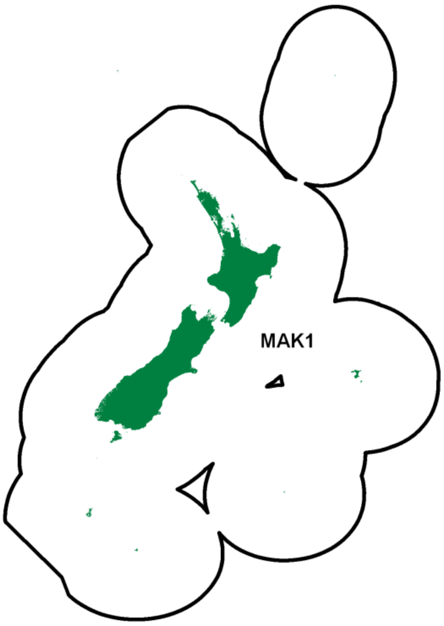
MAKO SHARK (MAK)

(*Isurus oxyrinchus)*
Mako



1. FISHERY SUMMARY

Mako shark were introduced into the QMS on 1 October 2004 under a single QMA, MAK 1, with a TAC of 542 t, a TACC of 406 t and a recreational allowance of 50 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 that mako shark is considered to be a risk of overfishing internationally because of its low productivity.

Table 1: Recreational and Customary non-commercial allowances, TACC and TAC (all in tonnes) for mako shark.

Fishstock	Recreational Allowance	Customary non-commercial Allowance	Other mortality	TACC	TAC
MAK 1	30	10	36	200	276

Mako shark was added to the Third Schedule of the 1996 Fisheries Act with a TAC set under s14 because mako 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.

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

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

Management of the mako 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

Most of the commercial catch of mako sharks is taken by tuna longliners and bottom longliners and they are also incidental bycatch of bottom and mid-water trawlers. About 25% of mako sharks caught by tuna longliners are processed and the rest are discarded.

Landings of mako sharks reported on CELR (landed), CLR, LFRR, and MHR forms are shown in Table 2. The total weights reported by fishers were 74–295 t during 1997–98 to 2008–09. Processors reported 74–319 t on LFRRs during the same period. There was a steady increase in the weight of mako shark landed between 1997–98 and 2000–01, resulting from a large increase in domestic fishing effort in the tuna longline fishery, and probably also improved reporting. Landings have since declined to one-quarter of the peak landings. Estimates of the catch of mako sharks aboard tuna longliners, based on scaled up observer records, are imprecise, and possibly biased, because the observer coverage of the domestic fleet (which accounts for most of the fishing effort) has been low (just below 10% in the last years 2007–2011) and may not have adequately covered the spatial and temporal distribution of the fishery (Figure 1).

In addition to catch taken within New Zealand fisheries waters, a small amount (about 1 t) is taken by New Zealand longline vessels fishing on the high seas.

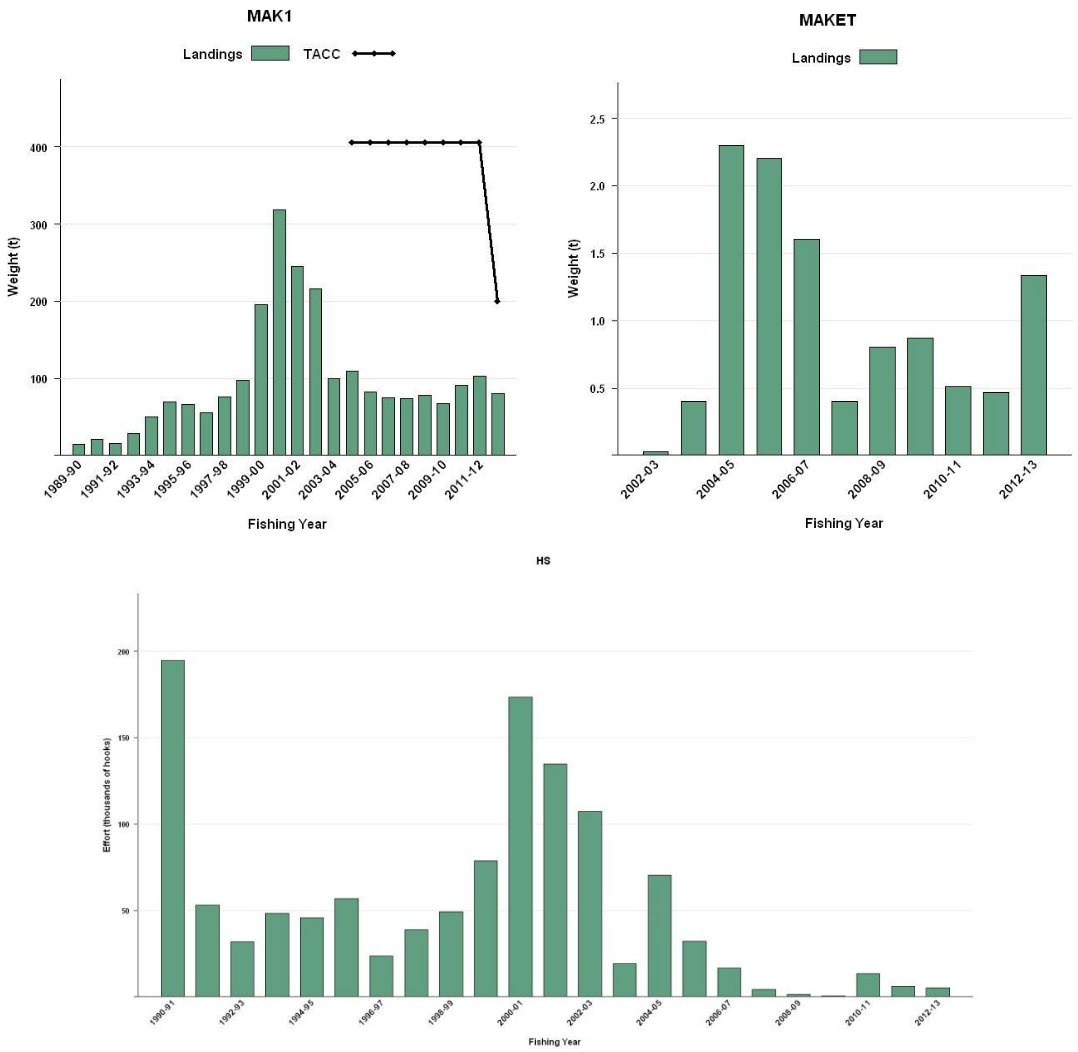


Figure 1: [Top] Mako Shark catch from 1989–90 to 2012–13 within New Zealand waters (MAK 1) and 2002–03 to 2012–13 on the high seas (MAK ET). [Bottom] Fishing effort (number of hooks set) for high seas New Zealand flagged surface longline vessels, from 1990–91 to 2012–13. [Continued on next page].

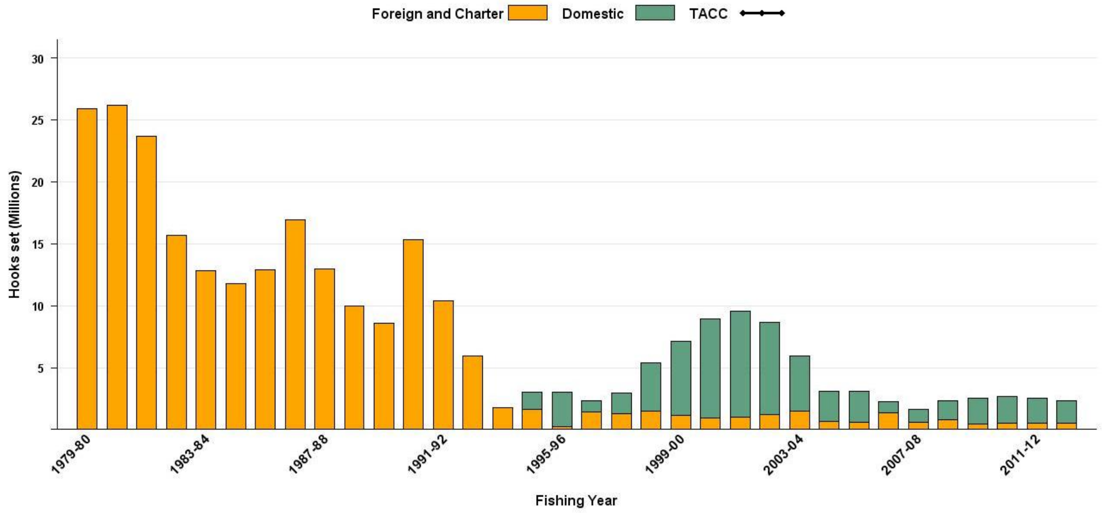


Figure 1 [Continued]: Fishing effort (number of hooks set) for all domestic vessels (including effort by foreign vessels chartered by New Zealand fishing companies), from 1979–80 to 2012–13.

Table 2: New Zealand commercial landings (t) of mako sharks reported by fishers (CELRs and CLRs) and processors (LFRRs) by fishing year. Also shown for some years are the estimated numbers of mako sharks caught by tuna longliners, as reported to the WCPFC

Year	Total reported	LFRR/MHR	Estimated catch by tuna longliners
1989–90	11	15	
1990–91	15	21	
1991–92	17	16	
1992–93	24	29	
1993–94	44	50	
1994–95	63	69	
1995–96	67	66	
1996–97	51	55	
1997–98	86	76	
1998–99	93	98	
1999–00	148	196	
2000–01	295	319	
2001–02	242	245	
2002–03*	233	216	
2003–04*	100	100	
2004–05*	107	112	
2005–06*	83	84	6 560
2006–07*	76	75	3 859
2007–08*	72	74	
2008–09*	82	78	
2009–10*		67	
2010–11*		91	
2011–12*		103	
2012–13*		80	

*MHR rather than LFRR data.

Catches of mako sharks reported by Ministry for Primary Industries (formerly Ministry of Fisheries) Observer Services aboard tuna longliners are concentrated off the west and southwest coast of the South Island, and the northeast coast of the North Island. However, these apparent distributions are biased by the spatial distribution of observer coverage. Mako sharks are probably taken by tuna longliners throughout New Zealand fishery waters. Most of the mako landings reported on CELR and CLR forms were taken in FMAs 1 and 2.

The majority of mako shark (58%) are caught in the bigeye tuna target surface longline fishery (Figure 2), however, across all longline fisheries albacore make up the bulk of the catch (32%) (Figure 3). 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 4).

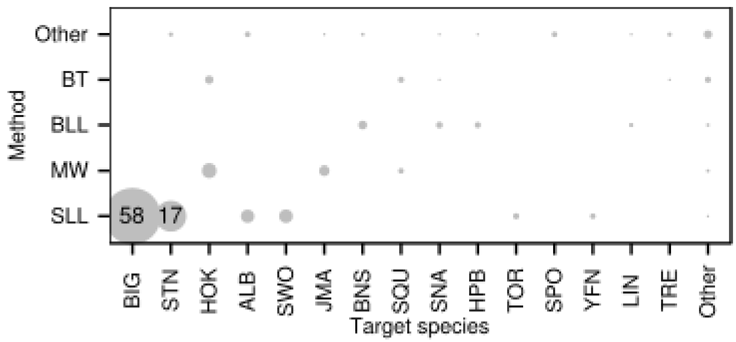


Figure 2: A summary of the proportion of landings of mako shark taken by each target fishery and fishing method. The area of each circle is proportional to the percentage of landings taken using each combination of fishing method and target species. The number in the circle is the percentage. SLL = surface longline, MW = mid-water trawl, BLL = bottom longline, BT = bottom trawl (Bentley et al 2013).

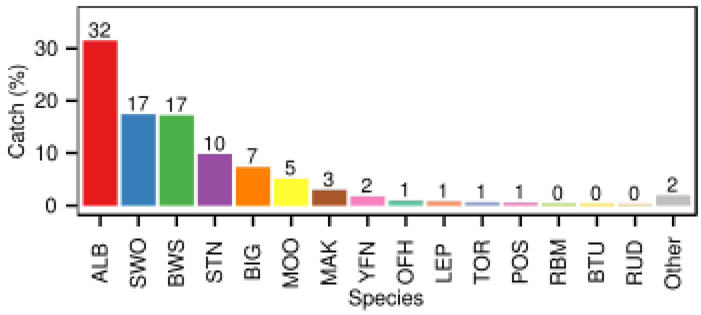


Figure 3: A summary of species composition of the reported surface longline catch. The percentage by weight of each species is calculated for all surface longline trips (Bentley et al 2013).

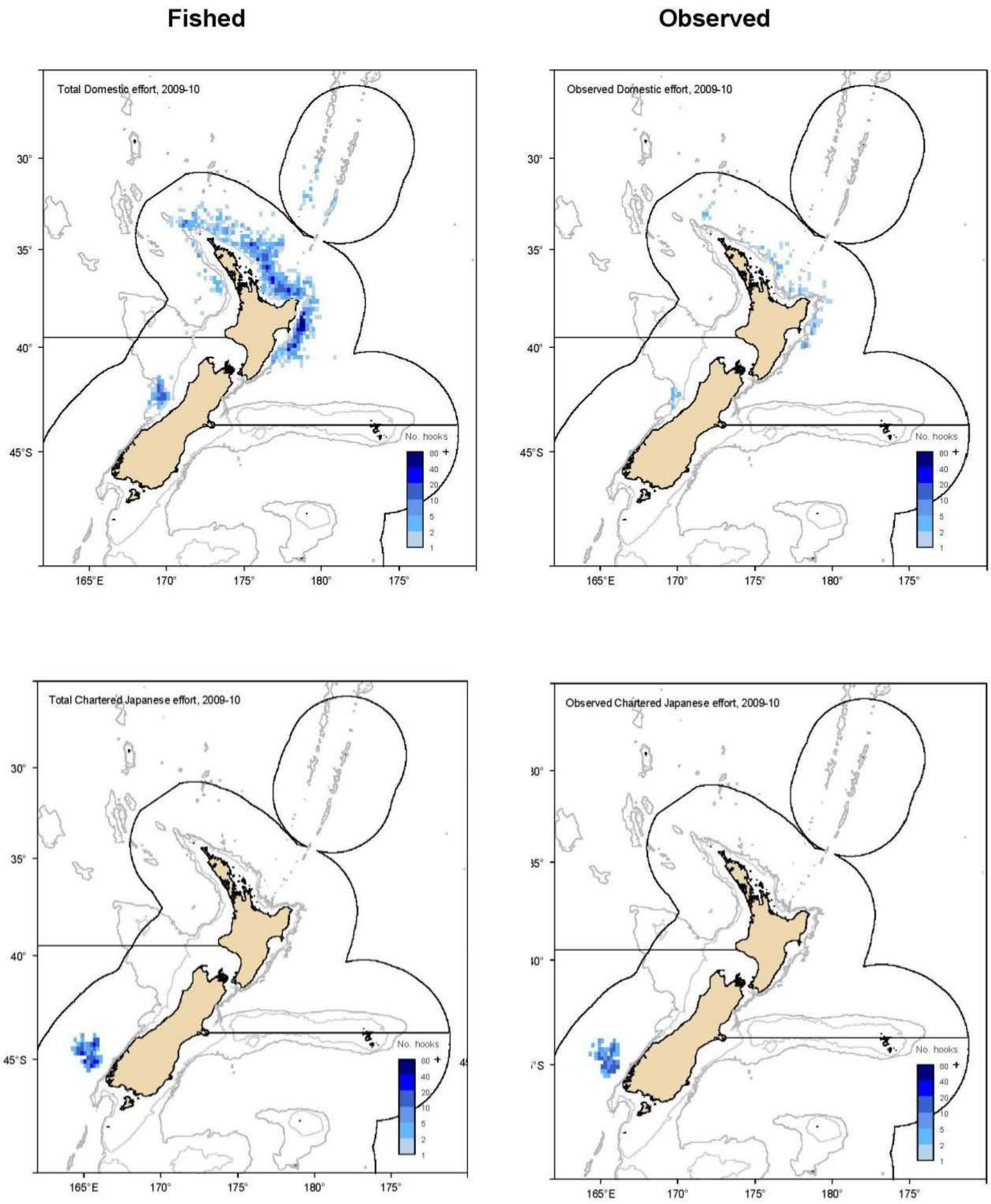


Figure 4: Distribution of fishing positions for domestic (top two panels) and charter (bottom two panels) vessels, for the 2009–10 fishing year, displaying both fishing effort (left) and observer effort (right).

Across all fleets in the longline fishery, 73.6% of the mako sharks were alive when brought to the side of the vessel (Table 3). The domestic fleets retain around 19–67% of their mako shark catch, mostly for the fins, while the foreign charter fleet retain most of the mako sharks (94–100%) (mostly for fins), the Australian fleet that fished in New Zealand waters in 2006–07 retained most (93.8%) of their mako sharks (Table 4).

Table 3: Percentage of mako 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	Australia	North	82.1	17.9	28
	Charter	North	83.0	17.0	276
		South	93.1	6.9	29
	Domestic	North	67.6	32.4	262
	Total		**76.6**	**23.4**	**595**
2007–08	Domestic	North	63.8	36.2	304
	Total		**64.7**	**35.3**	**320**
2008–09	Charter	North	88.6	11.4	44
		South	100.0	0.0	31
	Domestic	North	69.6	30.4	289
	Total		**74.4**	**25.6**	**367**
2009–10	Domestic	North	76.1	23.9	330
	Total		**75.9**	**24.1**	**348**
Total all strata			73.6	26.4	1 630

Table 4: Percentage of mako 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	Australia	17.9	82.1	28
	Charter	93.8	6.2	323
	Domestic	37.0	63.0	262
	Total	**66.1**	**33.9**	**613**
2007–08	Domestic	66.6	33.4	305
	Total	**68.2**	**31.8**	**321**
2008–09	Charter	100.0	0.0	85
	Domestic	58.7	41.3	293
	Total	**68.0**	**32.0**	**378**
2009–10	Domestic	19.1	80.9	350
	Total	21.6	78.4	361
Total all strata		57.3	42.7	1 673

1.2 Recreational fisheries

Historically there was a recreational target fishery for mako sharks and they were highly prized as a sport fish. Most mako sharks are now taken as a bycatch while targeting other species. Reported catch has declined since the mid 1990s. Fishing clubs affiliated to the New Zealand Sports Fishing Council have reported landing about 40 mako sharks per year over the last five seasons. In addition recreational fishers tag and release 300 to 500 mako sharks per season.

1.3 Customary non-commercial fisheries

There are no estimates of Maori customary catch of mako sharks. Traditionally, mako were highly regarded by Maori for their teeth, which were used for jewellery. Target fishing trips were made, with sharks being caught by flax rope nooses to avoid damaging the precious teeth.

1.4 Illegal catch

There is no known illegal catch of mako sharks.

1.5 Other sources of mortality

Many of the mako sharks caught by tuna longliners (about 75%) are alive when the vessel retrieves the line. It is not known how many of the sharks that are returned to the sea alive under the provisions of Schedule 6 of the Fisheries Act survive.

2. BIOLOGY

Mako sharks occur worldwide in tropical and warm temperate waters, mainly between latitudes 50^{o}N and 50^{o}S. In the South Pacific, mako are rarely caught south of 40^{o}S in winter–spring (August–November) but in summer–autumn (December–April) they penetrate at least as far as 55^{o}S. Mako sharks occur throughout the New Zealand EEZ (to at least 49^{o}S), but are most abundant in the north, especially during the colder months.

Mako sharks produce live young around 57–69 cm fork length (FL). In New Zealand, male mako sharks mature at about 1980 cm fork length (Francis and Duffy 2005) (Figure 5) and female mako mature at about 275–285 cm FL (Francis 2005) (Figure 6). The length of the gestation period is uncertain, but is thought to be 18 months with a resting period between pregnancies leading to a two- or three-year pupping cycle. Only one pregnant female has been recorded from New Zealand, but newborn young are relatively common. Litter size is 4–18 embryos. If the reproductive cycle lasts three years, and mean litter size is 12, mean annual fecundity would be 4 pups per year.

Estimates of mako shark age and growth in New Zealand were derived by counting vertebral growth bands, and assuming that one band is formed each year. This assumption has recently been validated for North Atlantic mako sharks. Males and females grow at similar rates until age 7–9 years, after which the relative growth of males declines. In New Zealand, males mature at about 7–9 years and females at 19–21 years. The maximum ages recorded are 29 and 28 years for males and females respectively.

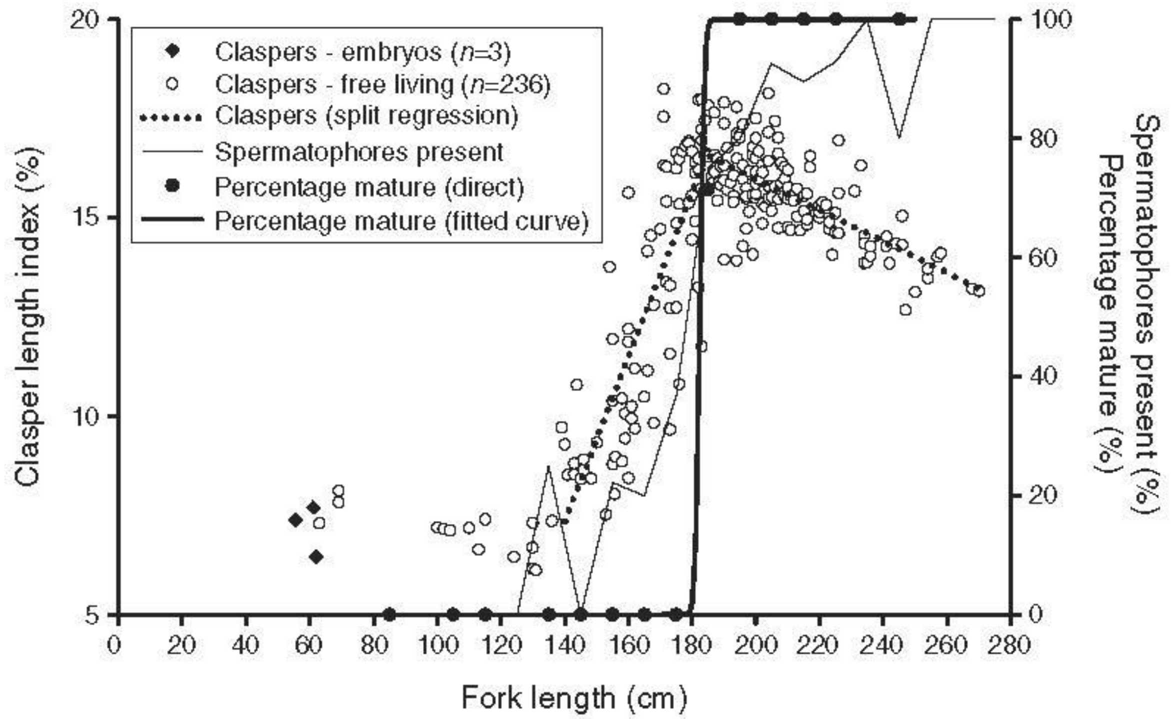


Figure 5: Maturation of male shortfin mako sharks (*Isurus oxyrinchus*): variation in clasper development, presence of spermatophores in the reproductive tract, and direct maturity estimation determined from a suite of maturity indicators (Francis 2005).

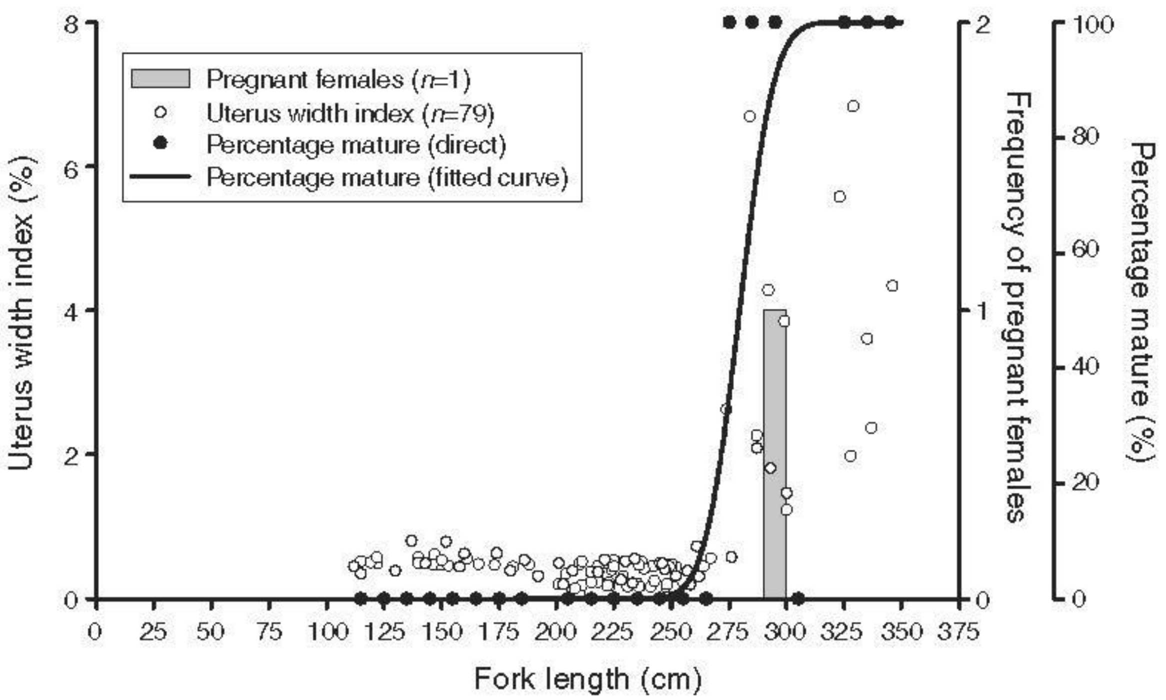


Figure 6: Maturation of female shortfin mako sharks (*Isurus oxyrinchus*): variation in uterus width index, and direct maturity estimation from a suite of maturity indicators. The only pregnant female recorded from New Zealand waters is also indicated (Francis 2005).

The longest reliably measured mako appears to be a 351 cm FL female from the Indian Ocean, but it is likely that they reach or exceed 366 cm FL. In New Zealand, mako recruit to commercial fisheries during their first year at about 70 cm FL, and much of the commercial catch is immature. Sharks less than 150 cm FL are rarely caught south of Cook Strait, where most of the catch by tuna longliners consists of sub-adult and adult males.

Mako sharks are active pelagic predators of other sharks and bony fishes, and to a lesser extent squid. As top predators, mako sharks probably associate with their main prey, but little is known of their relationships with other species.

Estimates of biological parameters are given in Table 5.

Table 5: Estimates of biological parameters.

Fishstock	Estimate				Source
1. Natural mortality (M)					
MAK 1	0.10–0.15				Bishop et al (2006)
2. Weight = a(length)^b (Weight in kg, length in cm fork length)					
Both sexes combined	a		b		
MAK 1	2.388 x 10^{-5}		2.847		Ayers et al (2004)
3. Schnute growth parameters	L_1	L_{10}	κ	γ	
MAK 1 males	100.0	192.1	-	3.40	Bishop et al (2006)
MAK 1 females	99.9	202.9	-0.07	3.67	Bishop et al (2006)

3. STOCKS AND AREAS

Up to June 2012, 13 551 mako sharks had been tagged and released in New Zealand waters and 341 recaptured. Most of the tagged fish in recent years were small to medium sharks with estimated total weights at 90 kg or less, with a mode at 40 to 50 kg, and they were mainly tagged off east Northland and the west coast of the North Island. Most recaptures have been within 500 km of the release site, with sharks remaining around east Northland or travelling to the Bay of Plenty and the west coast of North Island. However, long distance movements out of the New Zealand EEZ are frequent, with mako sharks travelling to Australia or the western Tasman Sea (1500–2000 km), the tropical islands north of New Zealand (New Caledonia, Fiji, Tonga, Solomon Islands; 1500–2400 km) and to the Marquesas Islands in French Polynesia (4600 km).

DNA analysis of mako sharks collected in the North-east Pacific, South-west Pacific (Australia), North Atlantic and South-west Atlantic oceans showed that North Atlantic mako sharks were genetically isolated from those found elsewhere, but there was no significant difference among the remaining sites.

The stock structure of mako 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 also extends to the eastern South Pacific or the North Pacific.

4. ENVIRONMENTAL AND ECOSYSTEM CONSIDERATIONS

This section was updated for the November 2013 Fishery Assessment Plenary after review by the Aquatic Environment Working Group. This summary is from the perspective of mako 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 (http://www.mpi.govt.nz/news-resources/publications.aspx) (Ministry for Primary Industries 2012).

4.1 Role in the ecosystem

Mako sharks (*Isurus oxyrinchus*) are active pelagic predators of other sharks and bony fishes, and to a lesser extent squid (Figure 7 and Figure 8) (Griggs et al 2007). Throughout their life the diet remains dominated by fish with squid making up a small percentage of their gut contents.

4.2 Diet

Mako shark

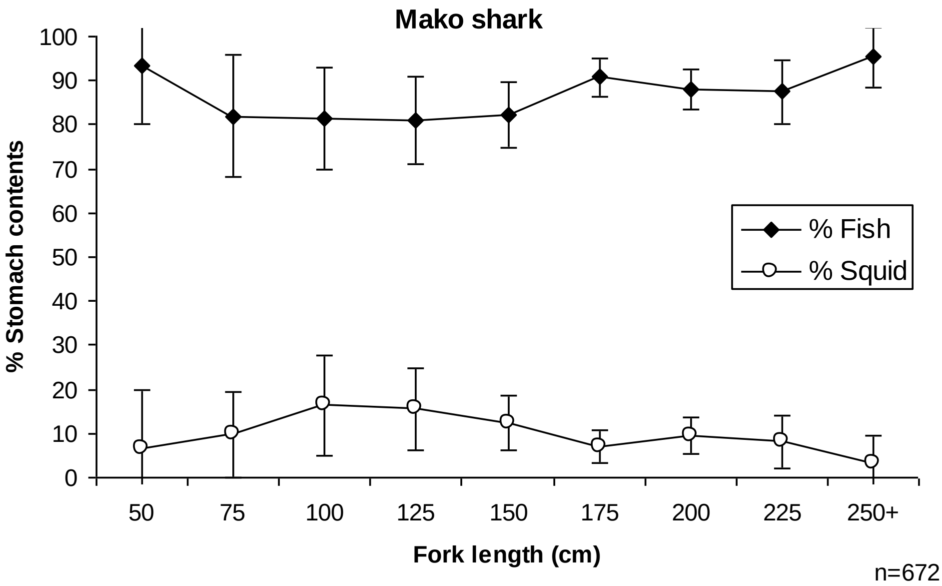


Figure 7: Changes in percentage of fish and squid in stomachs of mako sharks with fork length.

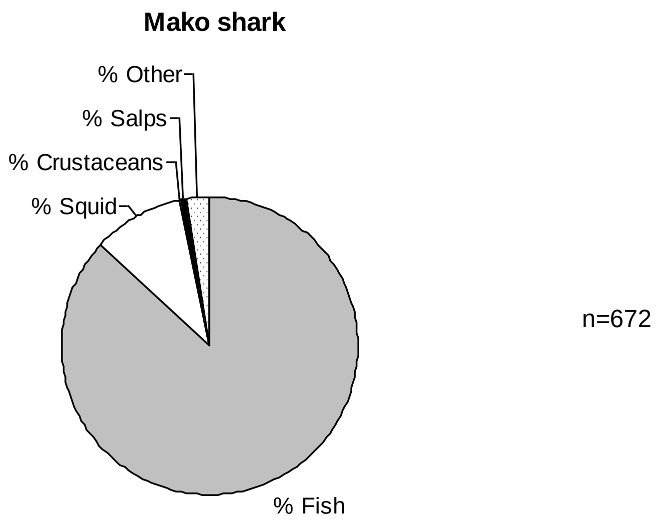


Figure 8: Percentage composition of stomach contents (estimated volumetric) of mako sharks sampled in New Zealand fishery waters.

4.3 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).

4.2.1 Seabird bycatch

Between 2002–03 and 2011–12, there were 791 observed captures of birds across all surface longline fisheries. Seabird capture rates since 2003 are presented in Table 6 and Figure 9. While the seabird capture distributions largely coincide with fishing effort they are more frequent off the south west coast of the South Island (Figure 10). The analytical methods used to estimate capture numbers across the commercial fisheries have depended on the quantity and quality of the data, in terms of the numbers observed captured and the representativeness of the observer coverage. Ratio estimation was historically used to calculate total captures in longline fisheries by target fishery fleet and area (Baird 2008) and by all fishing methods but recent estimates are either ratio or model based as specified in the tables below (Abraham et al 2010).

Table 6: Number of observed seabird captures in the New Zealand surface longline fisheries, 2002–03 to 2011–12, by species and area. See glossary above for a description of the areas used for summarising the fishing effort and protected species captures. The risk ratio is an estimate of aggregate potential fatalities across trawl and longline fisheries relative to the Potential Biological Removals, PBR (from Richard and Abraham (2013) where full details of the risk assessment approach can be found). It is not an estimate of the risk posed by fishing for mako shark using longline gear but rather the total risk for each seabird species. Other data, version 20130305.

Albatross Species	Risk Ratio	Kermadec Islands	Northland and Hauraki	Bay of Plenty	East Coast North Island	Stewart Snares Shelf	Fiordland	West Coast South Island	West Coast North Island	Total
Salvin's	Very high	0	1	2	6	0	0	0	0	9
Southern Buller's	Very high	0	3	2	27	0	278	33	0	343
NZ white-capped	Very high	0	2	0	3	10	60	27	0	102
Northern Buller's	High	0	0	0	1	0	0	0	0	1
Gibson's	High	4	16	0	17	0	6	2	1	46
Antipodean	High	12	9	1	8	0	0	0	1	31
Northern royal	Medium	0	0	1	0	0	0	0	0	1
Southern royal	Medium	0	1	0	0	0	4	0	0	5
Campbell black-browed	Medium	2	9	2	29	0	3	3	1	49
Light-mantled sooty	Very low	0	0	0	0	0	0	1	0	1
Unidentified	N/A	38	2	0	2	0	0	0	1	43
Total	**N/A**	**56**	**43**	**8**	**93**	**10**	**351**	**66**	**4**	**631**
Other seabirds										
Black petrel	Very high	1	10	1	0	0	0	0	1	13
Flesh-footed shearwater	Very high	0	0	0	10	0	0	0	2	12
Cape petrel	High	0	0	0	2	0	0	0	0	2
Westland petrel	Medium	0	0	0	2	0	1	6	0	9
White-chinned petrel	Medium	2	3	3	3	1	19	3	3	37
Grey petrel	Medium	3	4	3	38	0	0	0	0	48
Grey-faced petrel	Very low	12	5	1	2	0	0	0	0	20
Sooty shearwater	Very low	1	0	0	8	3	1	0	0	13
Southern giant petrel	-	0	0	2	0	0	0	0	2	0
White-headed petrel	-	2	0	0	0	0	0	0	0	2
Unidentified	N/A	0	1	0	0	0	1	0	0	2
Total	**N/A**	**21**	**23**	**10**	**65**	**4**	**22**	**9**	**8**	**158**

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.

Table 7: 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 Thompson et al (2013) are available via http://www.fish.govt.nz/en-nz/Environmental/Seabirds/. Estimates from 2002-03 to 2010-11 are based on data version 20120531 and preliminary estimates for 2011-12 are based on data version 20130305.

			Fishing effort	Observed captures		Estimated captures	
Fishing year	All hooks	Observed hooks	% observed	Number	Rate	Mean	95% c.i.
2002–2003	10 764 588	2 195 152	20.4	115	0.052	2 033	1 577–2 737
2003–2004	7 380 779	1 607 304	21.8	71	0.044	1 345	1 044–1 798
2004–2005	3 676 365	783 812	21.3	41	0.052	601	472–780
2005–2006	3 687 339	705 945	19.1	37	0.052	790	585–1 137
2006–2007	3 738 362	1 040 948	27.8	187	0.18	936	720–1 344
2007–2008	2 244 339	426 310	19	41	0.088	513	408–664
2008–2009	3 115 633	937 233	30.1	57	0.061	593	477–746
2009–2010	2 992 285	665 883	22.3	135	0.203	921	732–1 201
2010–2011	3 185 779	674 572	21.2	47	0.07	696	524–948
2011–2012†	3 069 707	728 190	23.7	64	0.088	808	596–1 168

†Provisional data, model estimates not finalised.

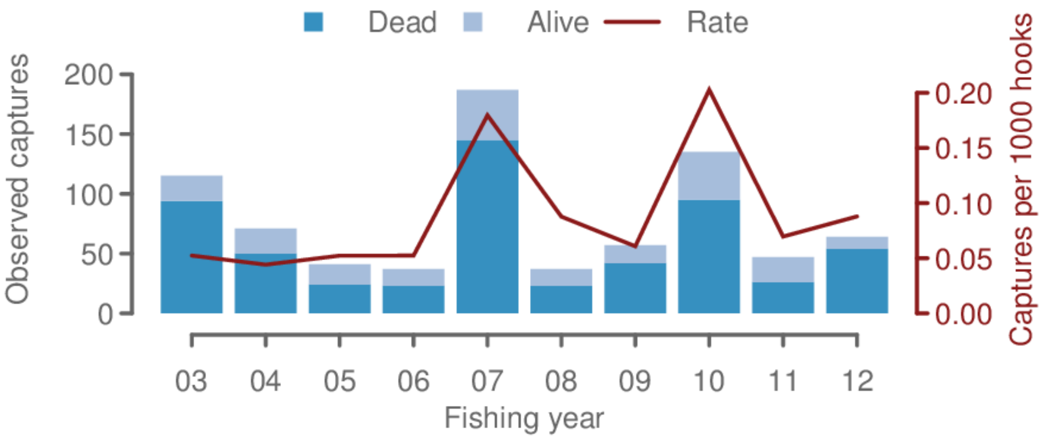


Figure 9: Observed captures of seabirds in the New Zealand surface longline fisheries from 2002–03 to 2011–12.

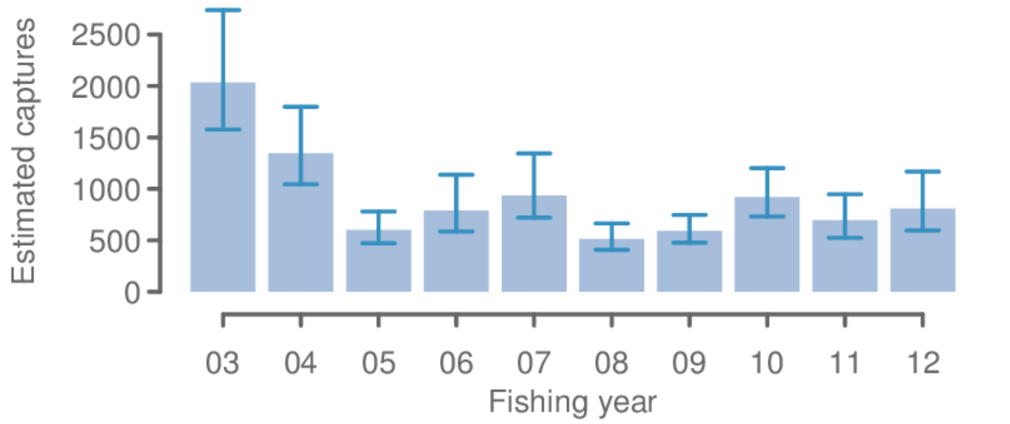


Figure 9 [Continued]: Estimated captures of seabirds in the New Zealand surface longline fisheries from 2002-03 to 2011-12.

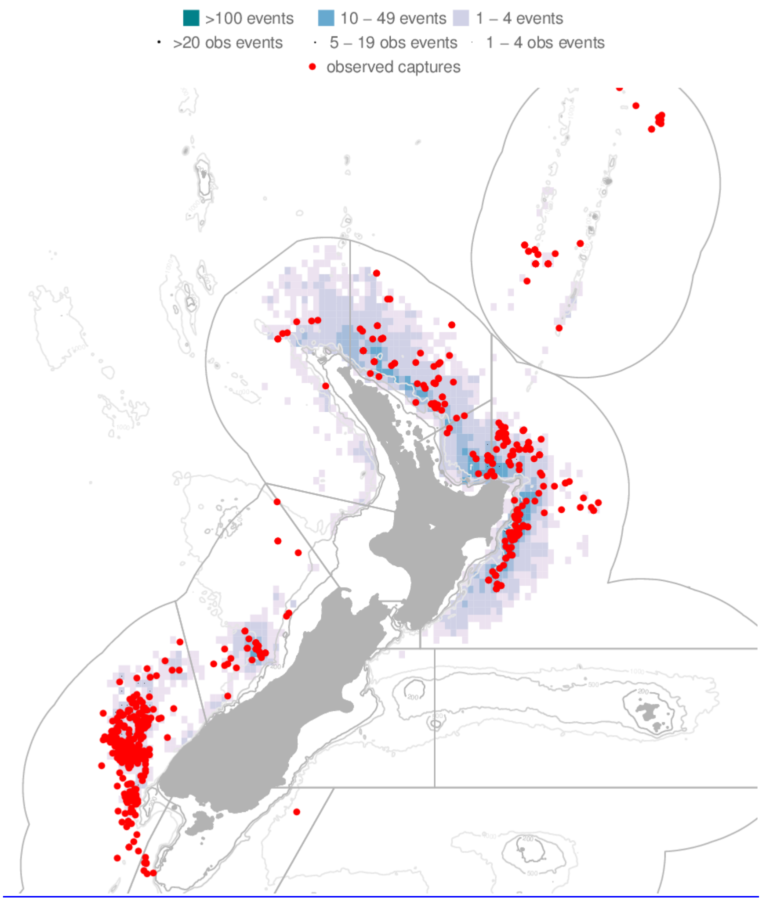


Figure 10: Distribution of fishing effort in the New Zealand surface longline fisheries and observed seabird captures, 2002–03 to 2011–12. Fishing effort is mapped into 0.2-degree cells, with the colour of each cell being related to the amount of effort. Observed fishing events are indicated by black 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, 94.1% of the effort is shown. See glossary for areas used for summarising the fishing effort and protected species captures.

4.2.2 Sea turtle bycatch

Between 2002–03 and 2011–12, there were 13 observed captures of sea turtles across all surface longline fisheries (Tables 8 and 9, Figure 11). 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 12).

Table 8: Number of observed sea turtle captures in the New Zealand surface longline fisheries, 2002–03 to 2011–12, 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	0	1
Total	1	6	3	3	13

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 effort			Observed captures	
Fishing year	All hooks	Observed hooks	% observed	Number	Rate
2002–2003	10 764 588	2 195 152	20.4	0	0
2003–2004	7 380 779	1 607 304	21.8	1	0.001
2004–2005	3 676 365	783 812	21.3	2	0.003
2005–2006	3 687 362	705 945	19.1	1	0.001
2006–2007	3 738 362	1 040 948	27.8	2	0.002
2007–2008	2 244 339	421 900	18.8	1	0.002
2008–2009	3 115 633	937 496	30.1	2	0.002
2009–2010	2 992 285	665 883	22.3	0	0
2010–2011	3 185 779	674 572	21.3	4	0.006
2011–2012	3 069 707	728 190	23.7	0	0

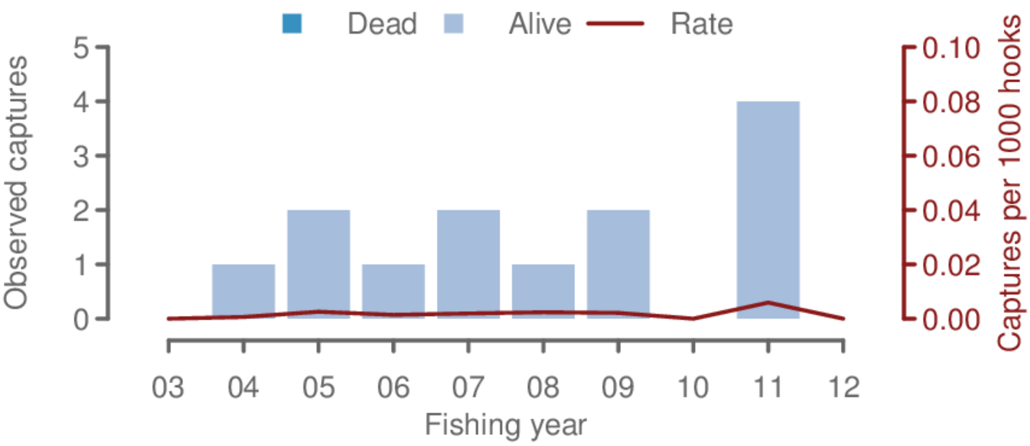


Figure 11: Observed captures of sea turtles in the New Zealand surface longline fisheries from 2002–03 to 2011–12.

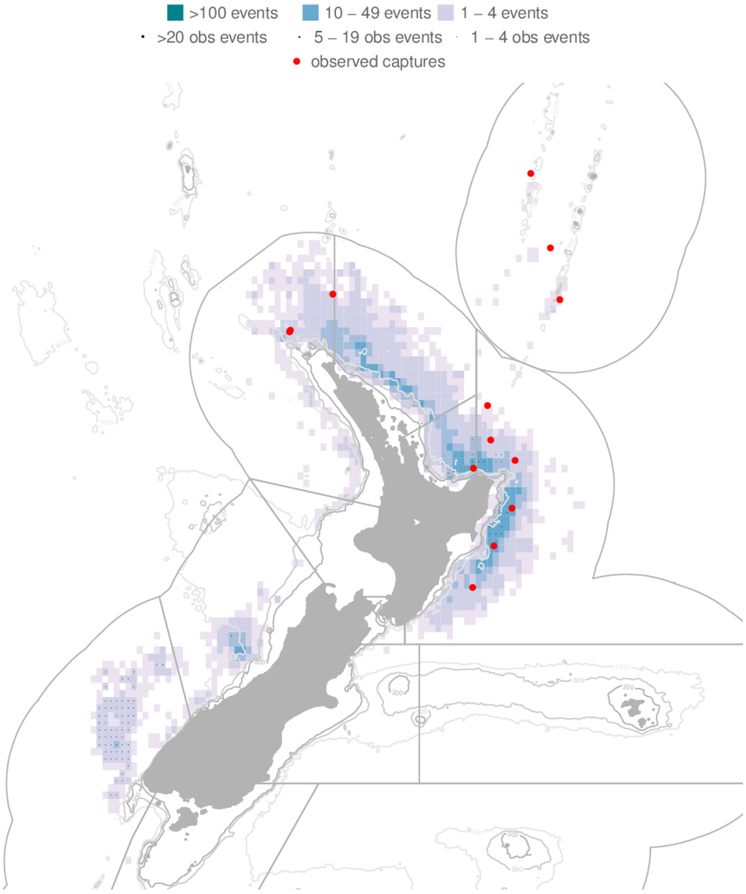


Figure 12: Distribution of fishing effort in the New Zealand surface longline fisheries and observed sea turtle captures, 2002–03 to 2011–12. Fishing effort is mapped into 0.2-degree cells, with the colour of each cell being related to the amount of effort. Observed fishing events are indicated by black 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, 94.1% 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 2011–12, 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 13) (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 14)

Table 10: Number of observed cetacean captures in the New Zealand surface longline fisheries, 2002–03 to 2011–12, 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 effort			Observed captures	
Fishing year	All hooks	Observed hooks	% observed	Number	Rate
2002–2003	10 764 588	2 195 152	20.4	1	0.0005
2003–2004	7 380 779	1 607 304	21.8	4	0.002
2004–2005	3 676 365	783 812	21.3	1	0.001
2005–2006	3 687 339	705 945	19.1	0	0
2006–2007	3 738 362	1 040 948	27.8	0	0
2007–2008	2 244 339	421 900	18.8	1	0.002
2008–2009	3 115 633	937 496	30.1	0	0
2009–2010	2 992 285	665 883	22.3	0	0
2010–2011	3 185 779	674 572	21.2	0	0
2011–2012	3 069 707	728 190	23.7	0	0

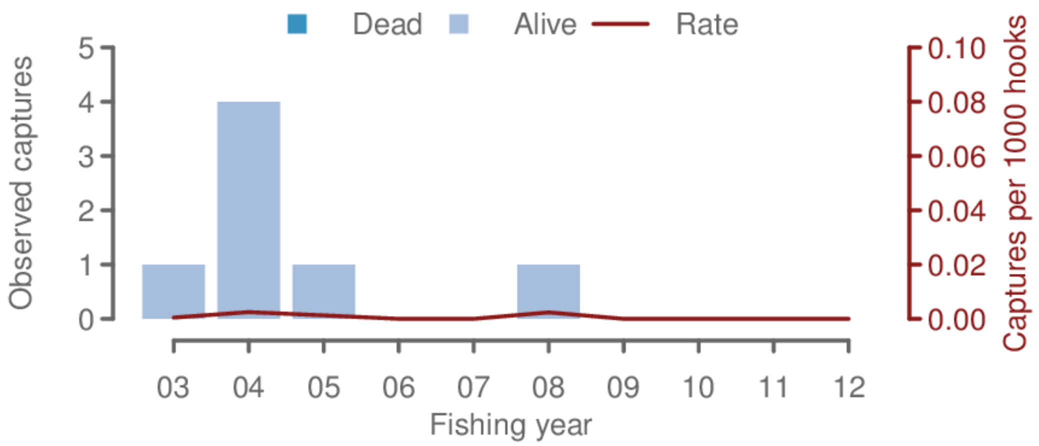


Figure 13: Observed captures of cetaceans in the New Zealand surface longline fisheries from 2002–03 to 2011–12.

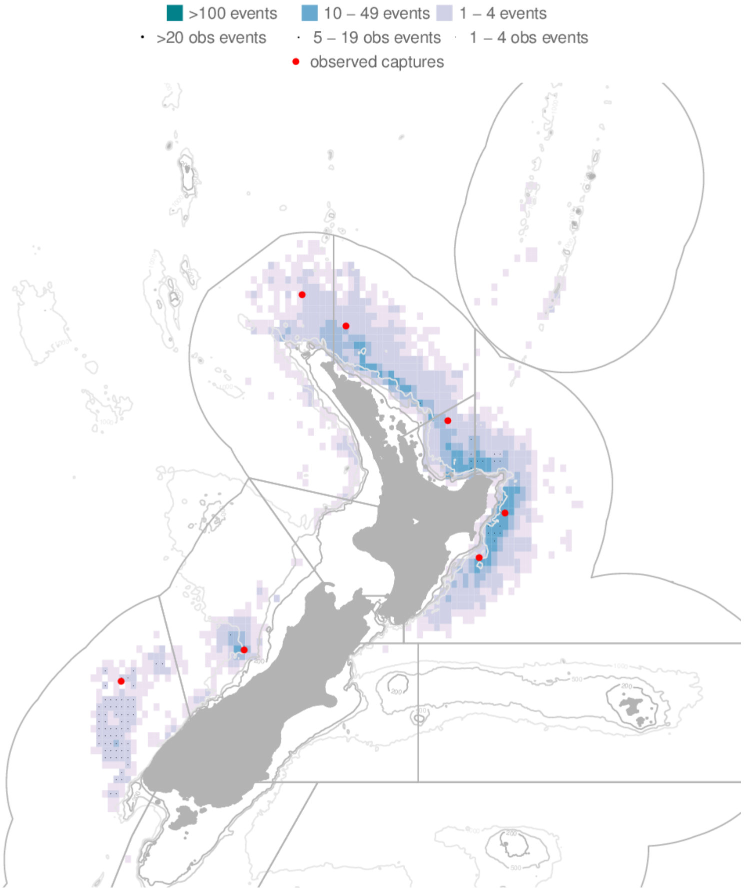


Figure 14: Distribution of fishing effort in the New Zealand surface longline fisheries and observed cetacean captures, 2002–03 to 2011–12. Fishing effort is mapped into 0.2-degree cells, with the colour of each cell being related to the amount of effort. Observed fishing events are indicated by black 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, 94.1% 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 around much of the South Island and offshore islands slopes steeply to deeper waters relatively close to shore, and thus rookeries and haulouts. Captures on longlines occur when the seals attempt to feed on bait or fish from the line 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). Bycatch rates in 2011–12 were, low and lower than they were in the early 2000s (Figures 15 and 16). 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 17). Between 2002–03 and 2011–12, there were 246 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 2011–12, 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	10	16	139	3	4	2	32	206

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). Estimates are based on methods described in Thompson et al (2013) are available via http://www.fish.govt.nz/en-nz/Environmental/Seabirds/. Estimates from 2002-03 to 2010-11 are based on data version 20120531 and preliminary estimates for 2011-12 are based on data version 20130305.

	Fishing effort			Observed captures		Estimated captures	
Fishing year	All hooks	Observed hooks	% observed	Number	Rate	Mean	95% c.i.
2002–2003	10 764 588	2 195 152	20.4	56	0.026	157	138-178
2003–2004	7 380 779	1 607 304	21.8	40	0.025	116	99-133
2004–2005	3 676 365	783 812	21.3	20	0.026	77	63-93
2005–2006	3 687 339	705 945	19.1	12	0.017	70	55-85
2006–2007	3 738 362	1 040 948	27.8	10	0.010	52	40-66
2007–2008	2 244 339	426 310	19.0	10	0.023	45	34-56
2008–2009	3 115 633	937 233	30.1	22	0.023	57	46-69
2009–2010	2 992 285	665 883	22.3	19	0.029	78	64-94
2010–2011	3 164 159	674 522	21.3	17	0.025	57	45-69
2011–2012†	3 069 707	728 190	23.7	40	0.055	96	81-111

†Provisional data, model estimates not finalised.

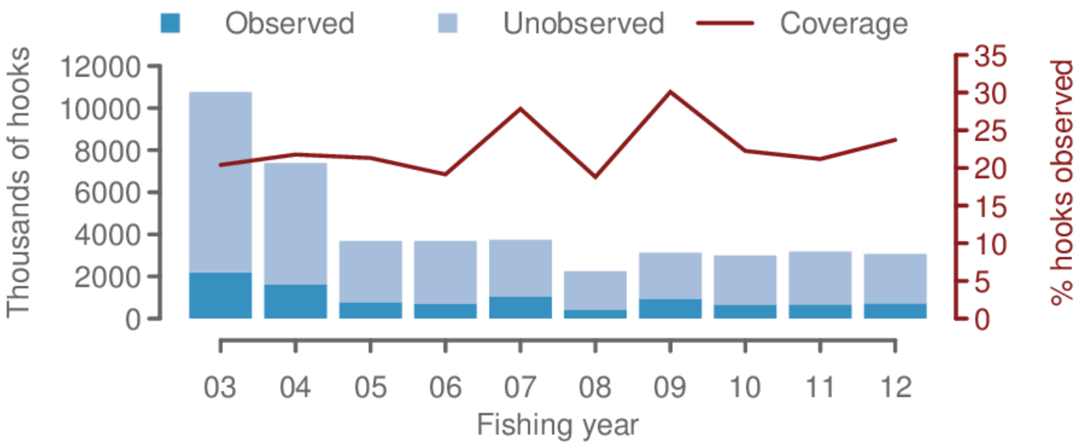


Figure 15: Observed captures of New Zealand fur seal in the New Zealand surface longline fisheries from 2002–03 to 2011–12.

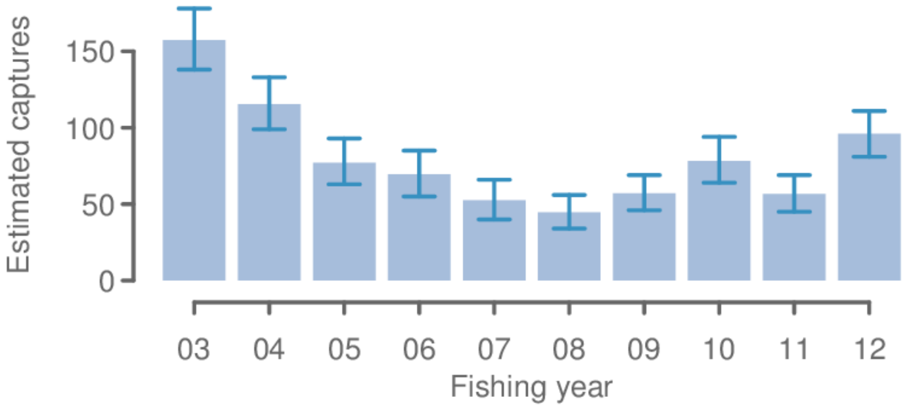


Figure 16: Estimated captures of New Zealand fur seal in the New Zealand surface longline fisheries from 2002–03 to 2011–12.

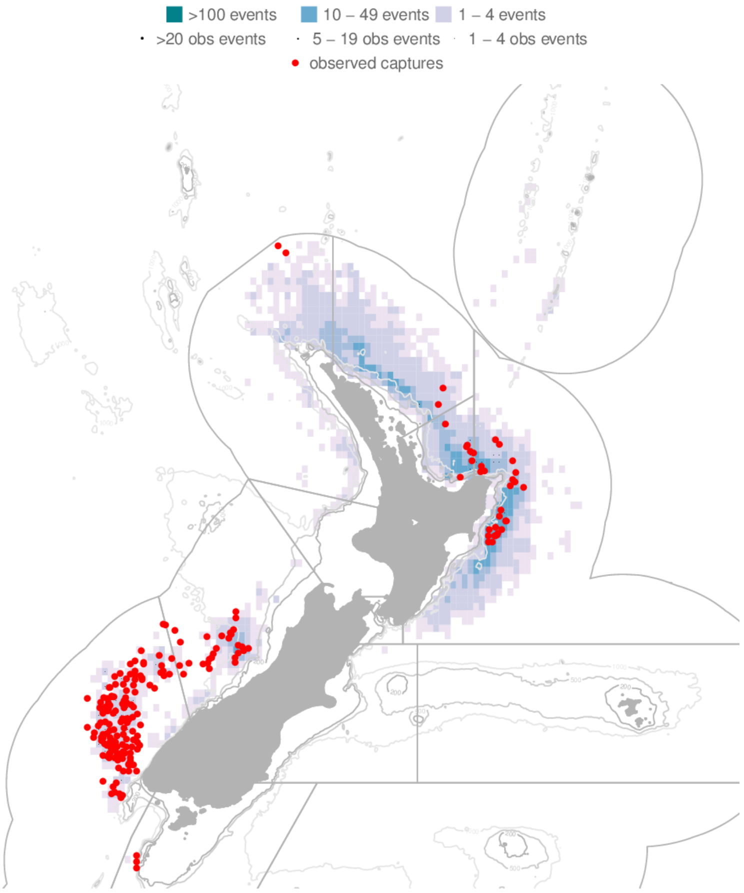


Figure 17: Distribution of fishing effort in the New Zealand surface longline fisheries and observed New Zealand fur seal captures, 2002–03 to 2011–12. Fishing effort is mapped into 0.2-degree cells, with the colour of each cell being related to the amount of effort. Observed fishing events are indicated 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, 94.1% 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). Southern bluefin tuna and albacore tuna are the only target species that occur in the top five of the frequency of occurrence.

Table 14: Numbers of the most common fish species observed in the New Zealand longline fisheries during 2009–10 by fleet and area. Species are shown in descending order of total abundance (Griggs & Baird 2013).

	Charter	Domestic		Total
Species	South	North	South	number
Blue shark	2 024	4 650	882	7 556
Ray's bream	3 295	326	88	3 709
Southern bluefin tuna	3 244	211	179	3 634
Lancetfish	3	2 139	1	2 143
Albacore tuna	90	1 772	42	1 904
Dealfish	882	0	7	889
Swordfish	3	452	2	457
Moonfish	76	339	6	421
Porbeagle shark	72	328	20	420
Mako shark	11	343	7	361
Big scale pomfret	349	4	0	353
Deepwater dogfish	305	0	0	305
Sunfish	7	283	5	295
Bigeye tuna	0	191	0	191
Escolar	0	129	0	129
Butterfly tuna	15	100	3	118
Pelagic stingray	0	96	0	96
Oilfish	2	75	0	77
Rudderfish	39	20	2	61
Flathead pomfret	56	0	0	56
Dolphinfish	0	47	0	47
School shark	34	0	2	36
Striped marlin	0	24	0	24
Thresher shark	7	17	0	24
Cubehead	13	0	1	14
Kingfish	0	10	0	10
Yellowfin tuna	0	9	0	9
Hake	8	0	0	8
Hapuku bass	1	6	0	7
Pacific bluefin tuna	0	5	0	5
Black barracouta	0	4	0	4
Skipjack tuna	0	4	0	4
Shortbill spearfish	0	4	0	4
Gemfish	0	3	0	3
Bigeye thresher shark	0	2	0	2
Snipe eel	2	0	0	2
Slender tuna	2	0	0	2
Wingfish	2	0	0	2
Bronze whaler shark	0	1	0	1
Hammerhead shark	0	1	0	1
Hoki	0	0	1	1
Louvar	0	1	0	1
Marlin, unspecified	0	1	0	1
Scissortail	0	1	0	1
Broadnose seven gill shark	1	0	0	1
Shark, unspecified	0	1	0	1
Unidentified fish	2	30	8	40
Total	10 545	11 629	1 256	23 430

4.4 Benthic interactions

N/A

4.5 Key environmental and ecosystem information gaps

Cryptic mortality is unknown at present.

Observer coverage in the New Zealand fleet has historically not been spatially or temporally representative of the fishing effort. However in 2013 the observer effort was re-structured to rectify this by planning observer deployment to correspond with recent spatial and temporal trends in fishing effort.

5. STOCK ASSESSMENT

With the establishment of the WCPFC in 2004, future stock assessments of the western and central Pacific Ocean stock of mako shark 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 but mako sharks will not be a focus of that plan in the near future.

There have been no stock assessments of mako sharks in New Zealand, or elsewhere in the world. No estimates of yield are possible with the currently available data.

CPUE estimates were calculated for each fleet and area stratum in which eight or more sets were observed and at least 2% of the hooks were observed. CPUE estimates were calculated for mako sharks for each fleet and area in 2006–07 to 2009–10 and added to the time series for 1988–89 to 2005–06 (Griggs et al 2008) and these are shown in Figure 18 (Griggs & Baird 2013). The CPUE results from the Domestic fleet should be interpreted with caution due to the lower observer coverage of this fleet. CPUE estimates for the Charter fleet can be considered reliable from 1992–93 onwards (Griggs & Baird 2013). Unstandardised CPUE analysis of tuna longline catches recorded by observers show no long-term trends over the period 1992–93 to 2009–10 (Figure 18).

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

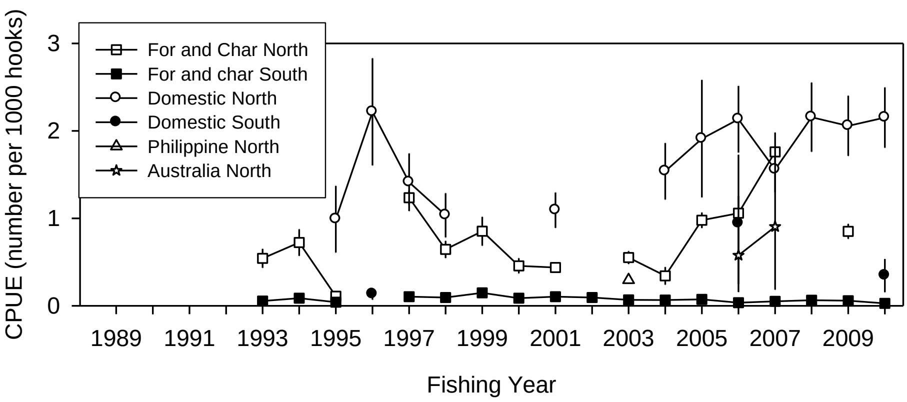


Figure 18: Annual variation in CPUE by fleet and area. Plotted values are the mean estimates with 95% confidence limits. Fishing year 1989 = October 1988 to September 1989.

Observer records show that there were few mako sharks were observed in the South. The distributions were roughly bimodal with a wide size range and no discernible difference between males and females (Figure 19). There were more females (60.9%) than males. With mean length of maturity of 182.5 cm FL for males and 280 cm fork length for females (Francis & Duffy 2005), most mako sharks were immature (85.1% of males and 100.0% of females, overall) (Griggs & Baird 2013).

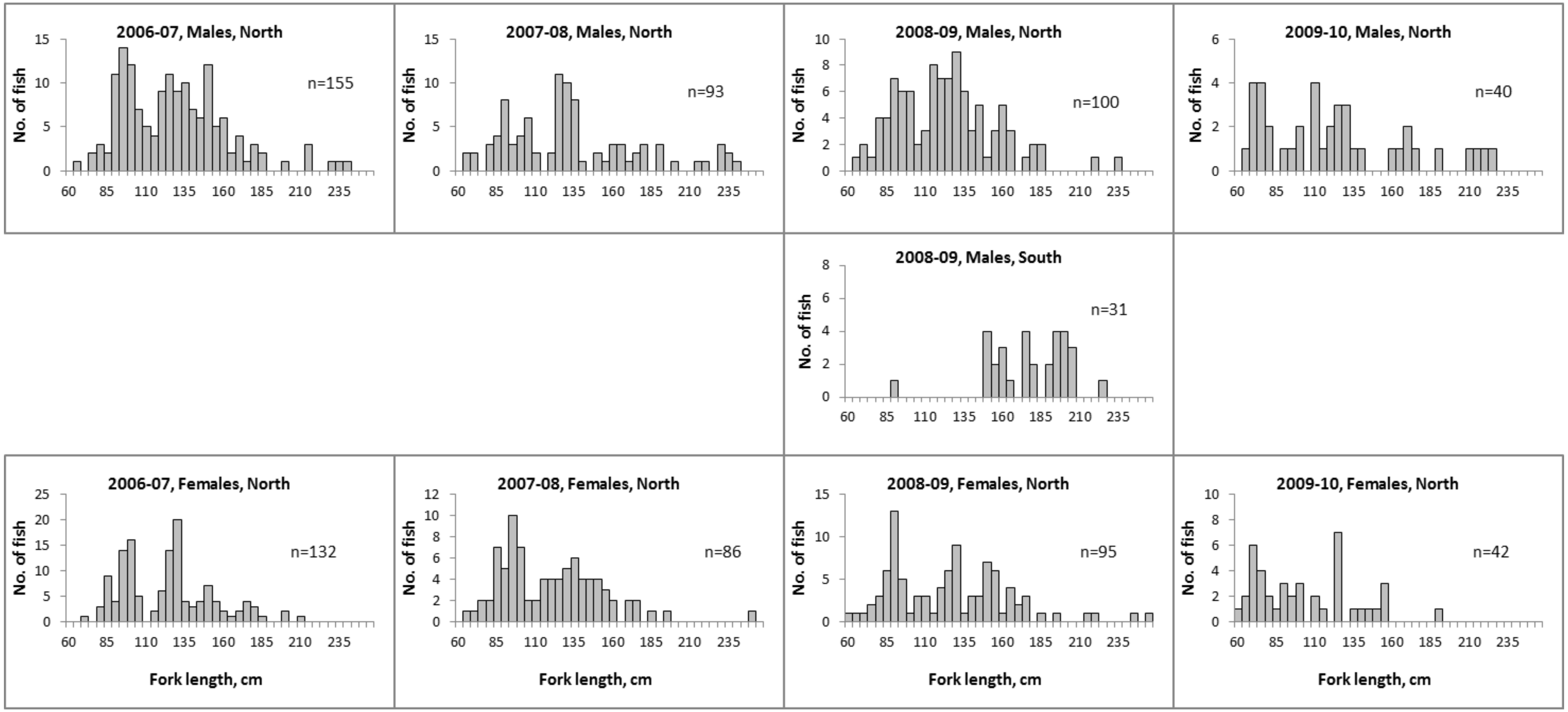


Figure 19: Length-frequency distributions of mako shark by fishing year, sex, and region. Sample sizes of less than 20 fish not shown (Griggs & Baird 2013).

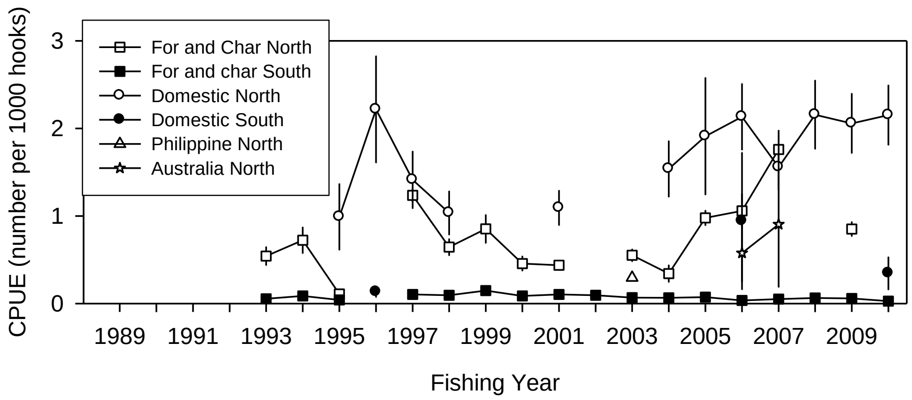
6. STATUS OF THE STOCK

Stock structure assumptions

MAK 1 is assumed to be part of the wider South Western Pacific Ocean stock but the assessment below relates only to the New Zealand component of that stock.

Stock Status	
Year of Most Recent Assessment	2008
Assessment Runs Presented	Base case model only
Reference Points	Target: Not established Soft Limit: Not established by WCPFC; but HSS default of 20% SB_0 assumed Hard Limit: Not established by WCPFC; 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



Annual variation in CPUE by fleet and area. Plotted values are the mean estimates with 95% confidence limits. Fishing year 1989 = October 1988 to September 1989.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Unknown
Recent Trend in Fishing Intensity or Proxy	Unknown
Other Abundance Indices	CPUE analyses have been undertaken in New Zealand but are not considered to have generated reliable estimates of abundance.
Trends in Other Relevant Indicator or Variables	Catches in New Zealand increased from the early 1980s to a peak in the early 2000s but have declined from highs of 295 t to 74 t in 2007-08. This decline in catch coincides with a decline in longline fishing effort.

Projections and Prognosis	
Stock Projections or Prognosis	Unknown
Probability of Current Catch or TACC causing Biomass to	Soft Limit: Unknown

remain below or to decline below Limits	Hard Limit: Unknown	
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Unknown	
Assessment Methodology and Evaluation		
Assessment Type	Level 3- Qualitative Evaluation: Fishery characterisation with evaluation of fishery trends (e.g., catch, effort and nominal CPUE) - there is no agreed index of abundance	
Assessment Method	CPUE analysis	
Assessment Dates	Latest assessment: 2008	Next assessment: 2014[1] (SPC)
Overall assessment quality rank	2 – Medium or Mixed Quality: information has been subjected to peer review and has been found to have some shortcomings	
Main data inputs (rank)	- Commercial reported catch and effort	1 - High quality for the charter fleet but low for all the other fleets
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	Historical catch recording may not be accurate	
Qualifying Comments		
-		

Fishery Interactions
Interactions with protected species are known to occur in the longline fisheries of the South Pacific, particularly south of 25°S. Seabird bycatch mitigation measures are required in the New Zealand and Australian EEZ's and through the WCPFC Conservation and Management Measure CMM2007-04. Sea turtles also get 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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