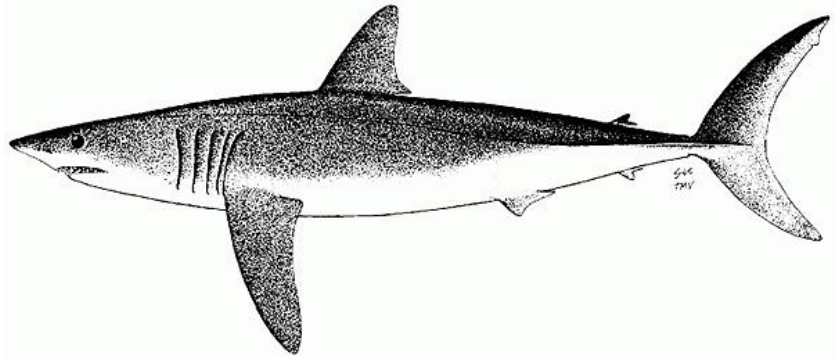
New Zealand non-detriment finding for shortfin mako shark *Isurus oxyrinchus*



Hugh A. Robertson & Sarah J. McIntyre

New Zealand Scientific Authority for CITES
Biodiversity Group
Department of Conservation
PO Box 10-420
Wellington
NEW ZEALAND

Executive summary

The shortfin mako shark *Isurus oxyrinchus* is a large pelagic predator found around the globe in mainly temperate and tropical oceanic waters, including in the New Zealand Exclusive Economic Zone (EEZ). About 94% of shortfin mako are caught as bycatch on surface longlines targeting tuna and swordfish, especially around the North Island and off the west coast of the South Island. Catches were likely very high when 25 million hooks were set each year, but since they entered the Quota Management System (QMS) in October 2004 (2005 fishing year) fewer than 4 million hooks have been set each year. Fisheries indicators, such as proportion of zero captures and catch per unit effort, show that the New Zealand population has been stable or increasing in recent decades. It is therefore reasonable to **allow exports of shortfin mako shark products that were legally obtained within the New Zealand EEZ under the QMS** on the basis that the recent levels of take is at least sustainable.

Tagging studies show that New Zealand stocks of shortfin mako are shared with those of other nations in the southwest Pacific. Most satellite-tagged juveniles and adult males made forays northwards to tropical waters, especially to waters of New Caledonia, Fiji and Tonga. Because stocks are shared, both a local and a regional approach to mako shark fisheries management is required, and a formal stock assessment of the entire southwestern Pacific mako shark population is required to better elucidate its current status. In the meantime, the evidence suggests that **up to 20 tonnes per year of shortfin mako can be sustainably introduced to New Zealand from the high seas within 500 nautical miles of the New Zealand EEZ.** This quantity is arbitrarily set at half of the combined recreational take (30 tonnes) and customary take (10 tonnes) allowed under the QMS, on the basis that it appears that neither of these allowances are anywhere near reached.

1. Introduction

In August 2019, the 18th Conference of the Parties (CoP18) of the Convention on International Trade of Endangered Species of Wild Fauna and Flora (CITES) listed shortfin mako shark *Isurus oxyrinchus* on Appendix II of the Convention, with longfin mako shark *Isurus paucus* also being listed as a "look-alike" species. Of these two species, only shortfin mako has been recorded in the New Zealand EEZ.

As is usual practice, the date of entry onto CITES Appendix II came into force 90 days after the meeting, on 28 November 2019, and within New Zealand these two species were added to Schedule 2 of the Trade in Endangered Species Act (1989) by Order in Council in December 2019.

The CITES convention has three Appendices (I, II and III), based largely on the level of risk that international trade could have on the viability of wild populations of the species. Trade in animal species listed in Appendix II has three requirements that must be fulfilled before permits are issued:

1. The CITES Management Authority of the exporting country (or equivalent recognised authority in the case of countries that are not Parties to the CITES Convention) must verify that the specimen was obtained legally;

2. In the case of live specimens, the CITES Management Authority must verify that specimens will be transported in a humane manner, and

3. The CITES Scientific Authority of the exporting country must advise that such export will not be detrimental to the survival of the species in the wild (known as a non-detriment finding (NDF)).

At CITES CoP16, Parties adopted Resolution 14.6 (Rev. CoP16) which specifies procedures associated with trade in CITES-listed species obtained on the high seas (i.e. marine areas beyond national jurisdiction and outside the 200 nautical mile jurisdiction of any State). In the case of specimens of Appendix II species, the Scientific Authority (usually from the State where the specimen will be landed, but this can vary depending on particular vessel registration arrangements) must issue an NDF before the specimens are transported into the State of introduction

The listing of shortfin mako shark on Appendix II of CITES therefore requires an NDF to be issued in three situations:

- before the export of shortfin mako products that were obtained within the New Zealand Exclusive Economic Zone (EEZ),

- before the introduction of shortfin mako products obtained on the high seas by a vessel registered in New Zealand and landed at a New Zealand port, and

- before shortfin mako products taken on the high seas by a vessel registered in New Zealand is introduced to the EEZ of the foreign country where the product will be landed.

2. Shortfin mako shark ecology

1.1 Distribution

The shortfin mako is a large pelagic predator found around the globe in mainly temperate and tropical oceanic waters warmer than 15°C, from 50°S to 50°– 60°N, but often in shallow coastal waters too (Figure 1). Although shortfin mako use tropical waters, they are most abundant in subtropical and temperate waters between latitudes 20° and 45°. They occur from the surface down to 600 m,

exceptionally up to 1700 m (Sims 2015), but spend most of their time in the top 100 m of the water column (Francis et al. 2019).

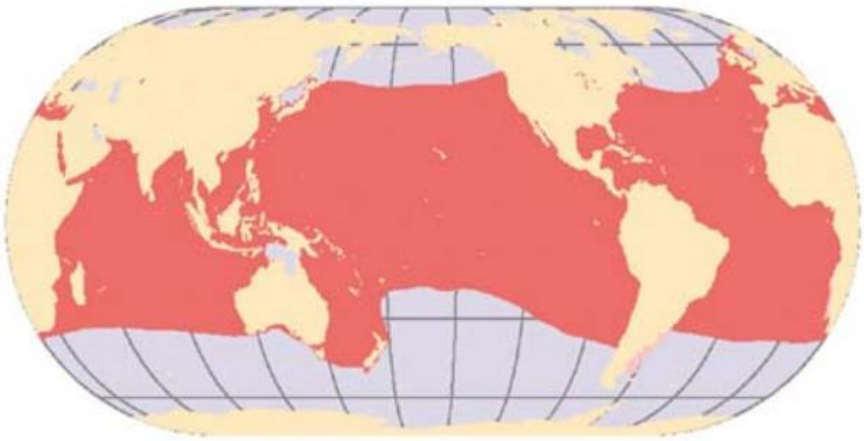


Figure 1: Global distribution of shortfin mako shark; from FAO, based on Compagno (2001).

Genetic studies have shown that there are at least three genetic stocks of shortfin makos in the Pacific Ocean: the North Pacific, the southeast Pacific and the southwest Pacific (including New Zealand), with little movement between them (Francis et al. 2019).

Plastic dart tagging of mako sharks in New Zealand coastal waters by recreational fishers showed that many of the 370 recaptures (mainly by commercial fishers) of the over 15,500 tagged mako were recaptured within 500 km of their tagging site, often several years later. Many others moved long distances into the southwestern Pacific, travelling mainly to eastern Australia, New Caledonia and Fiji, with occasional movements as far north as the Solomon Islands and the New Britain province of Papua New Guinea, and up to 3700 km northeast to French Polynesia and eastern Kiribati (Holdsworth & Saul 2014, 2017).

More recently, Francis et al. (2019) attached satellite tags to the dorsal fins of 13 mainly juvenile (153-240 cm total length) shortfin mako caught in coastal shelf waters around the northern North Island. An additional subadult female tagged off Victoria moved to New Zealand waters and was then included in the study sample. The final sample (9 subadult females, 2 subadult males and 3 adult males) was representative of the age and sex composition of shortfin mako encountered in New Zealand coastal waters; adult females are very rare in New Zealand coastal waters (Francis et al. 2019) but are more frequent over the outer shelf and in oceanic waters (Clinton Duffy, pers. comm.). Observer data from New Zealand tuna longline fisheries, which operated mainly in oceanic waters beyond the continental shelf caught mainly juveniles shorter than 220 cm and only 11% of males were adult and 0.5% of females were adult (Francis 2016); however, adult females are probably under-represented in this sample because they are generally too large to be captured on longline gear (Clinton Duffy, pers. comm.).

The satellite tagged shortfin mako were tracked for 34 - 588 days (mean = 251 days), giving a total of 9.6 years of coverage. The tagged shortfin mako spent most of their time (median 77%) in the New Zealand Exclusive Economic Zone (EEZ), five of the 14 sharks spent >90% of their time in the EEZ, but only one of them remained in the EEZ for its entire tracking period (212 days). Between long periods of residency in the EEZ, presumably because of high coastal productivity and access to abundant prey, most undertook occasional long movements, travelling minimum distances of 311 -

2904 km, with 12 of the 14 sharks travelling more than 1000 km. These long-distance oceanic movements largely followed submarine ridges and took them to the tropical and subtropical islands north of New Zealand, including Lord Howe, Chesterfield Reef in the Coral Sea, Norfolk, New Caledonia, Vanuatu, Fiji and Tonga (Francis et al. 2019).

Tagged shortfin mako tended to move north in autumn – spring and south in summer but there was a lot of variability, and they could be found anywhere between 20°S and 40°S in any season (Francis et al. 2019). Catch rates of shortfin mako on tuna longlines near Fiji and New Caledonia peak in winter, which is consistent with this movement pattern, but when New Zealand shortfin mako ventured into tropical waters they generally remained mobile from day to day and did not appear to become resident.

The electronic tagging study showed that at least juvenile shortfin mako had a relatively high degree of residency in New Zealand waters, but more movement data for adults, especially for females, is needed because they may be more mobile than juveniles. These movement data suggest that shortfin mako need to be managed at a local as well as a regional scale.

1.2 Spatial distribution within New Zealand waters

In the New Zealand EEZ, shortfin mako sharks are caught in all 10 Fisheries Management Areas (FMAs), but mainly in continental shelf and slope waters around the North Island (FMA 1, 2 and 9) and off the West Coast south to about Jackson Head at 44.5°S (FMA 7), but a few are caught as far south as 52°S near the sub-Antarctic Auckland and Campbell islands (Figure 2). They are managed as a single fish stock within the New Zealand EEZ.

Francis (2019) found that between 2005 and 2018, 89-96% (mean 94%) of shortfin mako caught each year within the New Zealand EEZ were taken as bycatch on tuna surface longlines (SLL) set in the top 200 m of the water column. They are caught by SLL fisheries targeting mainly bigeye tuna (*Thunnus obesus*), broad-billed swordfish (*Xiphias gladius*) but also some southern bluefin tuna (*Thunnus maccoyii*), from North Taranaki around North Cape and down the east coast to about Cape Turnagain (FMAs 9, 1 and 2), especially between Great Barrier Island and Hawke Bay (FMAs 1 and 2). Moderate numbers are caught on SLL targeting southern bluefin tuna west of the South Island (FMA 7) (Francis & Finucci 2019). Consistently low numbers of shortfin mako were caught on bottom longlines, and in trawls and set nets in the period 2005-2018 (Francis 2019).

Over every year from 2005 to 2018, and in all fishery management areas, most shortfin mako were caught between March and August. Catches were high off the eastern North Island (FMA 2) from March to July, whereas most catches off the north-eastern North Island (FMA 1) were in July and August. (Francis 2019). Mako sharks were generally taken in cooler waters (12-14°C) in May-June, and warmer waters (14-20° C) at other times (Horn et al. 2013).

Spatial segregation by age and/or sex is common in sharks and has been reported for pelagic sharks elsewhere in the Pacific (Francis et al. 2014). An analysis of shortfin mako catches in the SLL fisheries (Francis & Finucci 2019) showed that there were equal numbers of males and females caught in the North Region (mainly FMAs 1, 2 and 9), but there was a strong bias towards males (80%) in the South region (mainly FMA 7). Most mako caught in the New Zealand EEZ are juveniles aged less than 6 years old, with subadults and some mature males up to about 14 years old making up the rest of the catch (Francis 2016).

In the North region the size distributions of both sexes were dominated by two or three juvenile modes with fork lengths between 70 cm (their size at birth) and 175 cm, but further south the juvenile modes were missing or reduced, with catches dominated by subadult and adult males and subadult females

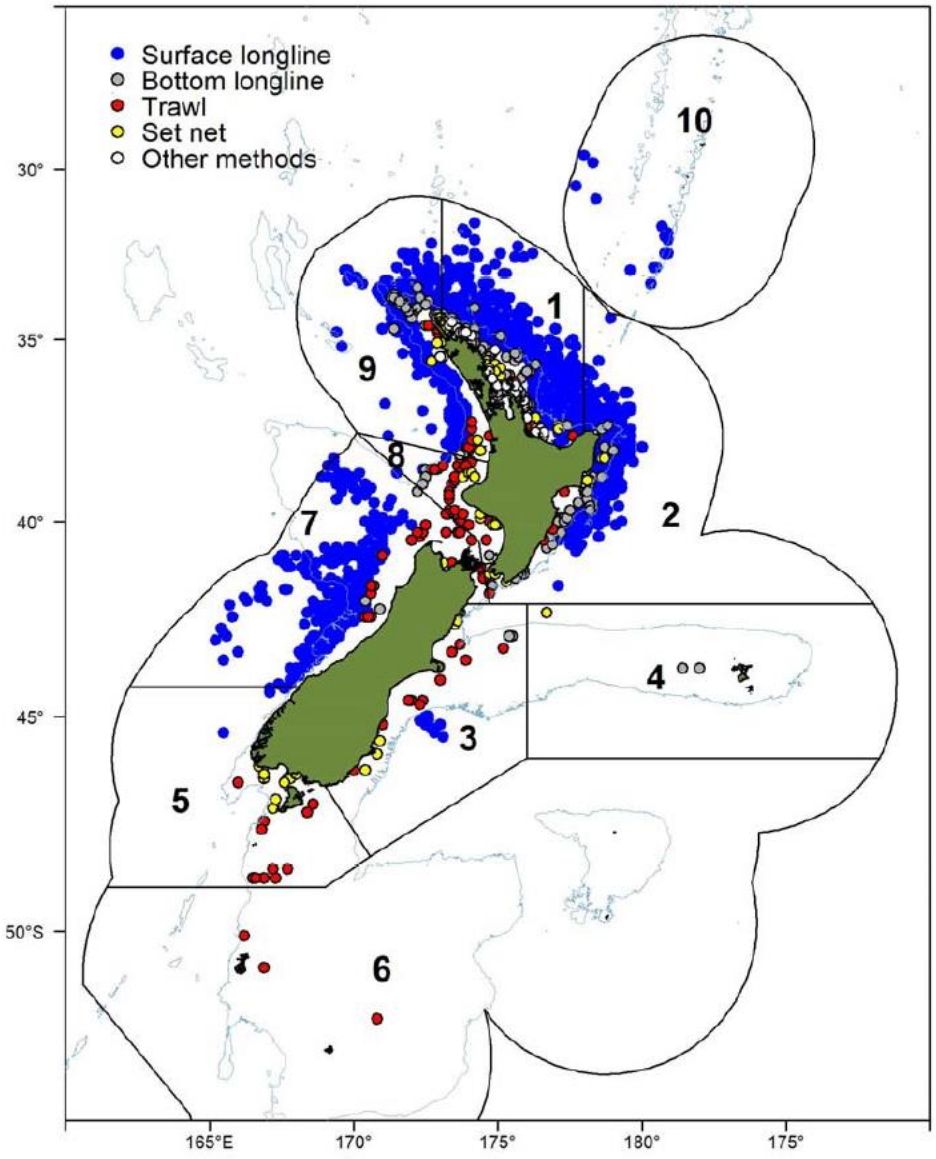


Figure 2: Distribution of the start locations of fishing sets or tows in the New Zealand EEZ that reported catches of shortfin mako shark in 2014-15 to 2017-18 (Francis 2019).

of 160-240 cm fork length. Very few (1-2%) mature females (>275-285 cm fork length) were caught anywhere in the New Zealand EEZ, but mature males (>180-185 cm fork length) made up about 70% of the South region catches and c.20% of the North region catches; however, this dropped to 5-10% of catches in the North after about 2005 (Francis 2013). Sizes of both males and females caught in the North Region declined from median fork lengths of 140-200 cm in 1997-2003 to a period of lower, stable lengths (110-130 cm) in 2005-2011, and an upswing in 2012 (140 cm), but there have not been enough data collected since then to monitor ongoing size trends. With the banning of shark finning in the New Zealand EEZ, most shortfin mako are now discarded or released alive by cutting the traces while they are still in the water, making it increasingly difficult for observers to determine the size, sex and even species of shark taken as bycatch. As a result, there has been a big reduction in data recorded and possible biases introduced; for example, if smaller sharks are brought on board to retrieve the hooks but large sharks are cut free while in the water, the apparent proportion of juveniles will have increased.

2.3 Habitat and food

Mako sharks are an apex predator found throughout New Zealand waters. Of 1889 mako stomachs examined by fisheries observers on tuna surface longliners in New Zealand waters, 896 (47%) were empty or contained only bait (Horn et al. 2013). Of the remaining 993 mako sharks caught in the top 200 m of the water column, fish made up 87% of the volume of stomach contents, and squid made up 10% (Horn et al. 2013). There were some dietary differences with size/age; juveniles ate more small fish and squid (14-15%), and adults ate more large fish, including albacore and other tuna, Ray's bream and sharks, and less squid (6-7%). Some of the prey may have been scavenged from tuna longlines. As expected, there was some geographical and seasonal and longer-term differences in the recorded diet, but fish always made up >80% of the total diet by volume.

2.4 Biological characteristics

Like other lamnid sharks, mako sharks can maintain the temperature of their body above that of the surrounding water, which enables them to have greater activity levels than many sharks. With their very streamlined body and smooth denticle-covered skin, mako sharks are also renowned as the world's fastest fish, reliably attaining speeds of 68 kph, although sometimes claimed to be as fast as 100 kph over short bursts. The shortfin mako is a large shark (family Lamnidae) growing to a maximum recorded total length of c.445 cm, but in waters around New Zealand shortfin mako rarely exceed 300 cm fork length which equates to 330 cm total length (Francis 2013). Based on growth rates, the estimated median ages at maturity in New Zealand are 7-10 years for males and 19-21 years for females (Francis & Duffy 2005, Bishop et al. 2006, Francis 2016). The longevity of New Zealand shortfin mako is not certain, but Bishop et al. 2006 estimated 29 years for males and 28 years for females.

Shortfin mako give birth to 4-25 (average 12) pups but they breed only every third year bringing the annual production of young down to about 4 young per year (Stevens 2008). The growing embryos are nourished by oophagy, whereby the female ovulates many infertile ova which are consumed by the embryos. Excess ova are consumed and stored in a "yolk stomach' for later use. Pup size at birth is 70-80 cm total length (Duffy & Francis 2001; Duffy 2015).

This combination of low productivity, slow growth and long time to reach sexual maturity makes the species intrinsically highly vulnerable to over-exploitation and population depletion.

2.5 Conservation status

In 2009, the global status of shortfin mako was changed from "Near Threatened" to "Vulnerable" in the IUCN Red List (Cailliet et al. 2009), and in 2019 its status was further changed to "Endangered" (Rigby et al. 2019). The weighted global population trend estimated a median decline of 46.6%, with the highest probability of a 50-79% reduction over three generations (72-75 years). The population trends of different geographical stocks have been highly variable. The Mediterranean Sea stock has collapsed and is virtually extinct, and steep declines have been noted in the Atlantic Ocean, lesser declines are evident in the North Pacific Ocean and Indian Ocean, but the South Pacific Ocean population appears to be stable or increasing but with fluctuating catch rates (Rigby et al. 2019).

In 2016, an expert panel assessed the conservation status of the shortfin mako in New Zealand waters as 'Not Threatened' according to the criteria of the New Zealand Threat Classification System (Duffy et al. 2018).

2.6 Population status in New Zealand

Francis et al. (2014) and Francis & Finucci (2019) carried out an indicator-based analysis of the status of shortfin mako and two other highly migratory shark species commonly taken as bycatch in tuna SLL fisheries in the New Zealand EEZ. Because 94% of mako caught in New Zealand waters are taken on SLL, these analyses are likely to be a reliable indicator of overall stock status. Four indicators were used for each species: distribution, percentage catch composition, standardised catch per unit effort (CPUE) and median size/sex ratio. Data came from the Ministry for Primary Industries (MPI) observer database for the 1993 to 2018 fishing years and the MPI commercial catch-effort database for the 2005 to 2018 fishing years, covering the period that shortfin mako has been included in the Quota Management System (QMS) – see Section 4.1.

The mean number of SLL hooks set in the New Zealand EEZ declined from 25.8 million per year in 1980-1982 to 4 million in 2005 when shortfin mako was introduced into the QMS, and has further declined to 2.1 million hooks per year in 2014-18 (Figure 3). Up until 1990, the SLL fleet comprised foreign vessels (mainly from Japan, Korea and Taiwan), but a New Zealand domestic fleet began operating in 1990. Since 1994, when the foreign fleet was reduced to a few vessels (usually four per year) chartered by New Zealand companies, domestic vessels have dominated the fishery. Foreign chartered SLL vessels last fished in the New Zealand EEZ in 2015, and so the SLL fishery has been exclusively carried out by domestic vessels since 2016 (Francis & Finucci 2019).

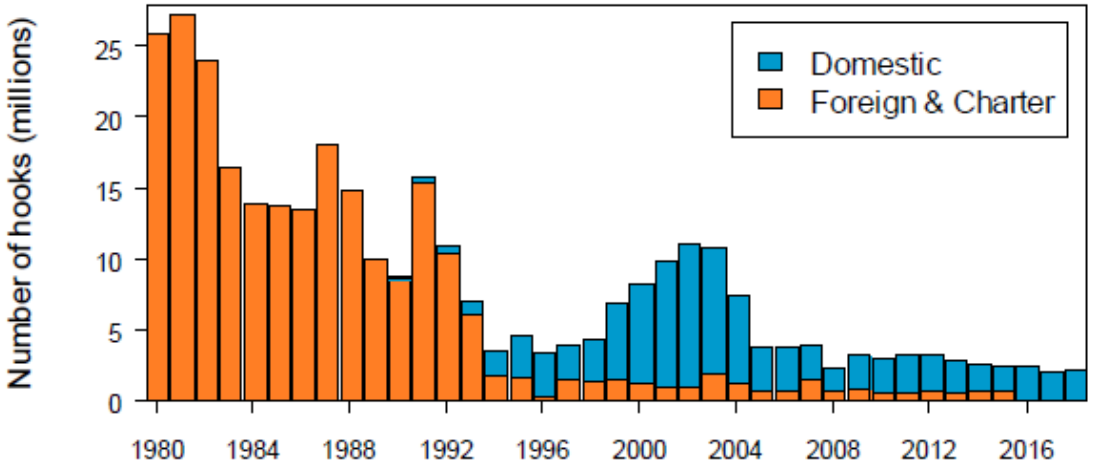


Figure 3: SLL fishing effort in the New Zealand EEZ from 1980 to 2018 (from Francis & Finucci 2019).

Observer CPUE data, which span a longer time period than commercial fisheries Tuna Longline Catch Effort Returns (TLCER) data, suggest that mako sharks may have declined during the late 1990s and early 2000s, and then increased since the mid-2000s, except for an unusually low catch rate, and high proportion of zero catch sets, in 2017 (Francis and Finucci 2019). Given the much greater SLL fishing effort before the early 1990s, and assumed high effort before 1980 (when data

were first collected), we surmise that mako stocks were likely depleted by foreign fishing fleets in New Zealand waters before 1990.

Francis et al. (2014) and Francis & Finucci (2019) have analysed fisheries data from three separate fisheries: Japan South (chartered Japanese vessels with high (c.80%) observer coverage in FMAs 5 and 7) from 1994 to 2015, New Zealand South (domestic vessels in FMAs 5 and 7 with low (<10%) observer coverage) from 2012 to 2018, and North (domestic vessels in FMAs 1, 2, 8, 9 and 10 with low (<10%) observer coverage) from 1994 to 2018. The indicators used included geographical distribution of high catches and zero catches, species composition, catch per unit effort, and median size and sex ratio.

From their analysis of data to 2013, Francis et al. (2014) concluded that none of the indicators suggested that shortfin mako were declining in either of the main tuna fishing grounds, off north-eastern North Island nor off the West Coast of the South Island. There was no evidence that shortfin mako had been adversely affected by fishing at levels experienced since they entered the QMS in 2005. In fact, all datasets indicated peak catch rates during the period 2011-2013.

In a more recent analysis, including an extra five years of data through to 2018, Francis & Finucci (2019) found that most abundance indicators showed declining trends in recent years, particularly in the North region in 2017-18. The authors felt that the indicators may not accurately index mako shark abundance because similar steep declines were noted in the North region, but not in the South region, for the three main pelagic sharks (mako, porbeagle and blue shark), which suggests environmental rather than fisheries drivers. In addition, the retention and discards of dead mako sharks in the past 5 years have been very low, especially after the 2015 finning ban came into force. The extent to which the finning ban has altered reporting behaviour is unknown, but it is likely that discarding and reporting practices have changed. Across all longline fleets fishing in the New Zealand EEZ between 2006 and 2015, 73% of mako sharks were alive when landed (MPI 2018). Most mako are now released alive, often without being landed on board the vessel. Post-release survival of mako sharks has been estimated to be 85% after 60 days (WCPFC unpubl. in Francis & Finucci 2019) which will have greatly reduced overall fisheries mortality.

2. Pressures on shortfin mako

2.1 Fishing pressures

Shortfin mako are apex predators, however juveniles are occasionally eaten by killer whales, marlin, Pacific sleeper sharks, great white sharks and adult mako sharks. The main threat to mako worldwide is bycatch in tuna and broadbill swordfish fisheries, though there are some small target commercial fisheries, such as those off California and Spain (Stevens 2008).

In the Southern Hemisphere, many shortfin mako have been taken as a valuable bycatch in surface longline and gill nets directed at tuna and billfish, especially those targeting albacore tuna (*Thunnus alalunga*), southern bluefin tuna and bigeye tuna. Shortfin mako are caught widely in the South Pacific longline fisheries and some purse-seine fisheries and often feature in the top five shark species observed being caught (Lack & Meere 2013).

In New Zealand waters, shortfin mako are the second most commonly caught shark on tuna long-lines after blue shark (*Prionace glauca*). Mako sharks were therefore likely taken in high numbers at the height of tuna longlining in the 1970s and 1980s, before the implementation of tighter fishing regulations for foreign vessels and before observer coverage started. In the first two years of the

1980s more than 25 million hooks were set, whereas each year since the 2004-05 season there have been fewer than 4 million hooks set (Francis & Finucci 2019).

New Zealand has never had a targeted commercial fishery for shortfin mako, and most of those targeted by sport fishers are released alive, often after being tagged (Holdsworth & Saul 2017). In New Zealand mako sharks are generally only landed by sport fishers during competitions, although some are landed for records or retained for their meat or jaws. Along with blue sharks and porbeagle sharks, two other highly migratory sharks, shortfin mako are a very common bycatch in tuna and swordfish surface longline fisheries around the mainland. The combined catch of these three species often exceeds the number of the target tunas and swordfish that are caught (Griggs & Baird 2013). Overall, 94% of all porbeagle caught in the New Zealand EEZ are caught on surface longlines, but it appears that the proportion caught by other methods (about 10 tonnes per year) may be increasing as SLL effort decreases. Since October 2014, shark-finning in New Zealand waters has been banned, which means that mako shark fins cannot be landed without the appropriate weight of carcass.

A significant proportion of the catch of shortfin mako is now released alive or discarded dead. There has been a major shift in the ratio of shortfin mako retained, discarded dead, or released alive as a result of their inclusion in the QMS in 2004, the October 2014 ban on shark-finning in New Zealand waters, their inclusion on Schedule 6 of the Fisheries Act (which promotes live release of bycatch shortfin mako), fluctuating market prices for fins, and/or difficulties exporting fins now that many airlines refuse to carry shark fins.

In the period 2005-2014, 48% (16-67%) by weight were landed in a finned or dressed state, and 52% discarded or released alive, whereas after the finning ban came into force, observers noted that only 6% (4-10%) were retained (mainly in a dressed state) and 94% were discarded or released alive (Francis 2019).

Small numbers (10 tonnes per year) are caught as bycatch in mid-water trawl fisheries targeting hoki and southern blue whiting, on bottom long lines, in bottom trawls targeting hoki and squid, or in set nets.

Reported landings of shortfin mako in New Zealand have varied considerably over the years, but landings have dropped considerably since the early 2000s, especially after shortfin mako was introduced to the QMS in October 2004 (i.e., the 2005 fishing year) and after the finning ban was introduced in October 2014, at the start of the 2015 fishing year (Table 1).

The limited information on the recreational take of shortfin mako in New Zealand waters indicates that it is negligible compared with the bycatch in commercial fisheries. Francis (1998) noted that mako sharks were targeted as a prime sports fish, renowned for jumping well clear of the water when hooked (Stevens 2008), but that landings had dropped from a peak of c.750 mako sharks in 1980/81 to between 250 and 400 each year between 1990 and 1996, in line with an upsurge in the popularity of tagging-and-releasing all game fish. Holdsworth & Saul (2017) showed that the number of shortfin mako tagged and released by big game fishers between 1995 and 2016 rose to a peak of 1529 sharks in 1995, then declined to 150 sharks in 2007, but rose again to an average of about 500 sharks each year between 2010 and 2016. Fisheries New Zealand (2018) noted that sports fishing clubs reported landings of only 24 mako sharks in 2014, and in 2013, Fisheries New Zealand (2018) noted that 94% of mako sharks caught by recreational gamefishers associated with sport fishing clubs were released alive after being marked with conventional plastic dart tags, which means that only about 33 of 524 mako caught by club members that year (Holdsworth & Saul 2017) were recorded as being landed. Most recreational fishers do not belong to clubs (Clinton Duffy, pers. comm) and the proportion they land is unknown.

There is no information on the current level of take of shortfin mako in customary fisheries in New Zealand waters, but it is thought to be negligible. Mako were traditionally prized for their teeth which were used to make earrings, necklaces and cutting tools, and Maori used bait to attract mako sharks and then caught them with a noose rather than by hook, in order to avoid damaging their teeth (Francis 1998).

Fisheries compliance and enforcement bodies in New Zealand have not recorded any incidents of illegal catch of mako sharks in recreational, customary or commercial fisheries.

Table 1: Annual shortfin mako landings (tonnes) reported by fishers and by fish receivers/ processors, since the 1997-98 fishing year (Fisheries NZ 2018, and Francis et al. 2019).

Fishing Year (to 30 Sept)	QMS TACC (tonnes)	Reported (TLCER) catch including discards by **longline fishers** only (tonnes). Source: Francis et al 2019.	Total landings reported by **longline fishers** (tonnes). Source:(Francis 2019)	Total landings reported by licenced fish receivers or on Monthly Harvest Returns (tonnes). Source:(FNZ 2018)
1998				162
1999				240
2000				196
2001				319
2002				245
2003				216
2004				100
2005	406	94	63	112
2006	406	108	61	84
2007	406	112	64	75
2008	406	84	53	74
2009	406	104	60	78
2010	406	117	48	67
2011	406	150	72	91
2012	406	170	88	102
2013	200	145	51	81
2014	200	136	22	44
2015	200	166	8	50
2016	200	163	9	71
2017	200	73	7	38
2018	200	83	3	37

3.2 Trade pressures

There are no quantitative time series data on international trade in shortfin mako specimens or products because most global trade in sharks have been reported at the generic or species level only since 2010. Before then, they were included in the general Customs commodity code for 'shark species'.

4. Existing management

4.1 National Plan of Action for Sharks and related risk assessments

In 1998, to address global concerns about the conservation and management of sharks, the Food and Agriculture Organisation of the United Nations (FAO) developed an International Plan of Action for the Conservation and Management of Sharks (IPOA-Sharks). The overarching goal of the IPOA- Sharks is *"to ensure the conservation and management of sharks and their long-term sustainable use"*.

To fulfil its obligations under the international plan, New Zealand developed its own National Plan of Action for the Conservation and Management of Sharks (NPOA-Sharks) in 2008 (Ministry of Fisheries 2008) to ensure that domestic management strategies for sharks contribute to the achievement of international goals.

The NPOA -Sharks was reviewed and revised in 2013 (MPI 2013, MPI 2014). It adopts a risk-based approach to prioritising management actions so that resources can be directed to those shark populations most in need of active management, whether that is through absolute protection, catch limits, measures to reduce incidental catches, or other methods such as spatial or temporal closures (MPI 2014). An expert panel made a qualitative assessment of the risk to the 112 chondrichthyan taxa in New Zealand waters was undertaken in 2014 (Ford et al. 2015), and then updated in 2017 for 50 taxa at higher risk, including all 11 taxa included in the Quota Management System and three of the seven protected species (Ford et al. 2018). The risk assessment involved scoring the risk to each species from commercial fishing on a national (EEZ) scale taking into consideration its biological productivity.

In 2014, the shortfin mako shark had a risk score of 15, derived from an intensity score of 5 out of 6 and a consequence score of 3 out of 6, which placed it 8th= of the 11 QMS species, and higher than any non-QMS species or protected species. Its intensity score was relatively high because it is vulnerable to fishing across more than 60% of its range and across most of the year. Two factors that reduced the consequence score were that adult females do not appear to be caught by the New Zealand fishery and the CPUE has been increasing in recent years (Ford et al. 2015). The 2017 assessment came up with the same score and ranking for shortfin mako among the 11 QMS species, but 13 non-QMS chondrichthyan species were ranked at higher risk (Ford et al. 2018). For both assessments, data was described as 'exist and sound' but confidence in the data was low due to the lack of data on adult stock size.

One of the most significant objectives in the 2013 NPOA-Sharks (and revised through an announcement by the Minister for Primary Industries in August 2014) was the elimination of shark-finning from 1 October 2014 (2015 fishing year). After that date, almost all shark species had to be landed with their fins naturally attached, though an exemption was made for shortfin mako and six other QMS species for which fins must be landed in the appropriate ratio to the weight of shark trunks (currently set at 1:59 for wet fins or 1:142 for dried fins (Fisheries (Conversion Factors) Notice 2011

(No.F607)), and fins for each species must be separately stored and landed. With this domestic requirement for mako sharks to be landed in a prescribed ratio relative to the whole weight (i.e. fishers have to land mako trunks if they want to land mako fins), there will be more incentive to release live mako sharks rather than fill freezer space with their carcasses.

4.2 Quota Management System

Because of concerns over the sustainability of shortfin mako bycatch in the tuna longline fishery, they were introduced to the Quota Management System (QMS with a single Quota Management Area, MAK 1, incorporating the entire EEZ) in October 2004 (at the start of the 2005 fishing year), with individual transferable quota. This move brought with it the requirement that the weight of all processed and discarded or released mako be recorded on fishing returns.

The total allowable catch (TAC) was intended to allow for only historical bycatch rather than any target fishing. It was initially set in 2004 at 512 tonnes per year, including a total allowable commercial catch (TACC) of 406 tonnes, a recreational allowance (RA) of 50 tonnes, a customary non-commercial allowance (CNCA) of 10 tonnes and an allowance for other sources of fishing-related mortality of 46 tonnes. This TAC was based on historical levels of landings rather than on any scientific analysis of the maximum sustainable yield, which would have been complicated by shortfin mako being a highly migratory species with only part of the stock being found at any one time in New Zealand fisheries waters.

The TAC was reviewed in 2012. Because of ongoing sustainability concerns related to the slow growth, late maturity and low fecundity of shortfin mako and to maintain apparent trends of increasing abundance, the allocation and allowances were reduced to a TAC of 276 tonnes, a TACC of 200 tonnes, RA of 30 tonnes, CNCA of 10 tonnes, and an allowance of 36 tonnes for other sources of fishing-related mortality. The new quota was again based on historical catch rates being well under the existing 2004 quota, as well precaution based on concerns about the vulnerability of shortfin mako to overfishing.

Since the TACCs were set, the total commercial landings of shortfin mako have been consistently well below the quota limits. The actual landings have been 13% (26 tonnes reported by licenced fish receivers against a quota of 200 tonnes in 2019) to 40.5% (81 tonnes reported in 2013) of the TACC. The appropriateness of the quota limits for maintaining a sustainable fishery has not really been tested, and the time series is still quite short.

4.3 Fisheries Act 1996

When mako shark was added to the QMS, it was also added to the Schedule 6 of the Fisheries Act 1996 with the provision that:

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

This encourages commercial fishers to return live mako sharks to the sea and not count them against their allocated quota, nor against the entire TAC.

4.4 Observer programme

Since the early 1990s, there has been an independent fishery observer programme in place within the New Zealand EEZ. There was good coverage of chartered Japanese longline vessels that took a reasonable percentage of the mako shark catch before the fishery finished in 2015, but there has been a low, but steadily increasing coverage of domestic longline vessels (Figure 4) and midwater trawl vessels (Griggs & Baird 2013, Francis & Finucci 2019).

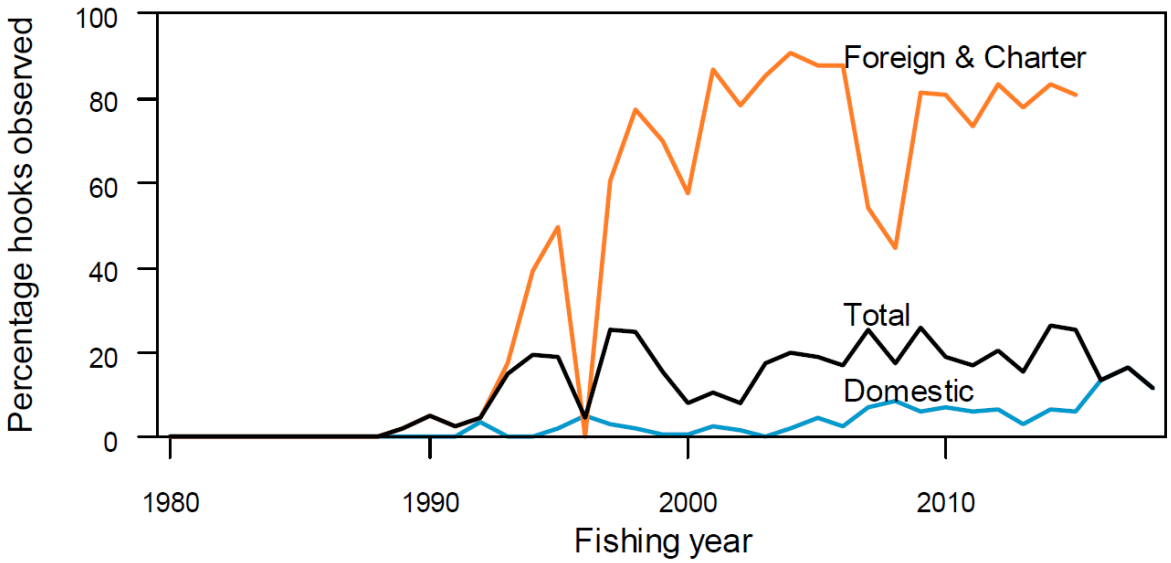


Figure 4: Percentage of hooks observed on foreign/charter and New Zealand domestic vessels (from Francis & Finucci 2019).

4.5 Regional Fisheries Management

New Zealand has an obligation to provide estimates of the numbers of non-target fish species taken in the tuna longline fishery as part of its contribution to the Ecologically Related Species Working Group under the Commission for the Conservation of Southern Bluefin Tuna (CCSBT), and to the Western and Central Pacific Fisheries Commission (WCPFC), which covers most of the New Zealand EEZ.

Management of shortfin mako in the western and central Pacific Ocean is the responsibility of the WCPFC. In 2008, shortfin mako was one of seven shark species designated as 'key species' within their jurisdiction (Clarke et al. 2014). Designation as a key species requires WCPFC members to provide catch and effort data, and stock status, indicator-based or other population analyses are to be conducted by the Secretariat of the Pacific Community (SPC), the WCPFC's scientific services provider. The two species of mako sharks (*Isurus* spp.) in the Pacific Ocean were the subject of an indicator-based analysis by Clarke et al. (2013) and this was updated by Rice et al. (2015). A stock assessment of the shortfin mako population in the North Pacific was conducted in 2017 (ISC Shark Working Group 2018). The listing of shortfin mako in the CITES Appendices, together with a wealth of materials to aid species identification, should lead to improved quality of identification, and the recording of mako catches to the species level in the South Pacific.

New Zealand is also a member of the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), but its area of interest, south of the Antarctic Convergence, is beyond the southern limit of shortfin mako distribution.

4.6 Regional context

In the Oceania region, generally covered by WCPFC, shortfin mako are known to be caught as bycatch in the EEZ of many nations and are likely taken in the high seas in the Tasman, immediately north of New Zealand and to the northwest of the Chatham Islands.

Although mainly juvenile shortfin mako tagged in New Zealand waters spent most of their time in the New Zealand EEZ, the majority were highly mobile for part of their year and visit the EEZs of many other Oceania nations (Francis et al. 2019). Little is known about the regional distribution and movements of adult mako sharks, especially for females that are rarely caught in commercial fisheries in New Zealand waters. Because stocks are shared, both a local and a regional approach to mako shark fisheries management is required, and a formal stock assessment of the entire southwestern Pacific mako shark population is required to better elucidate its current status (Francis et al 2019).

5 Conclusion

New Zealand and southwestern Pacific stocks of shortfin mako have never been specifically targeted as a fishery, except for a small targeted sports fishery. Shortfin mako have been caught as a valuable secondary bycatch mainly in the tuna longline fishery. There are no reliable historical data available about the trends in the mako shark population in the New Zealand EEZ before 1995, but available data suggests that their current stocks are still strong and well balanced.

It is likely that many mako sharks were taken as bycatch at the peak of foreign tuna longline fisheries in the New Zealand EEZ in the 1970s and 1980s, when over 25 million longline hooks were set each year, but since the decline in the longline fishing effort to less than 4 million hooks set per year, and with their inclusion in the QMS since 2004, the stocks are stable or starting to recover. The recent population increases, shown by various fisheries indicators, are likely to continue because retention rates have declined further due to increasing restrictions on the ability of fishers to land and trade in shark fins.

Overall, the evidence shows that shortfin mako are being sustainably managed under the QMS. The levels of tuna longline fishing effort have declined substantially over the past 40 years and therefore it is likely that fewer shortfin mako are now being captured as bycatch. In recent years, many shortfin mako have been released alive rather than landed or discarded dead. Fisheries indicators, such as the proportion of zero captures and catch per unit effort, show that the New Zealand population has been stable or increasing in recent decades. It should be noted that the landings have never been close to the actual TACC set under the QMS, and although the recreational and customary take has not been accurately quantified or estimated, both are believed to be well below quota limits.

The evidence suggests it is reasonable to **allow exports of shortfin mako shark products that were legally obtained within the New Zealand EEZ under the Quota Management System** on the basis that the recent level of take is sustainable and unlikely to lead to stock decline.

The high seas take of shortfin mako that is landed in New Zealand is understood to be very small, but New Zealand flagged vessels may land their high seas catch in other jurisdictions. Given that shortfin mako move freely in and out of the New Zealand EEZ, the suggestion that the recent take on tuna longlines within the New Zealand EEZ has probably resulted in an increase in stock size suggests that the overall recent southwest Pacific fishery, including a small take on the nearby high seas, has

not been detrimental to the New Zealand part of the stock nor to the regional stock as a whole. This suggests that **20 tonnes of shortfin mako can be sustainably introduced to New Zealand if it was taken from the high seas within 500 nautical miles of the New Zealand EEZ**. This quantity is arbitrarily set at half of the combined recreational take and customary take (40 tonnes) allowed within the EEZ under the QMS, on the basis that it appears that these two allowances are nowhere near reached each year.

6. Recommendations to improve the NDF process

These recommendations are made to the fishing industry, fisheries managers, and scientists supporting fisheries management in New Zealand and the southwest Pacific.

1. Species-specific data should continue to be collected on fishing effort; the number, weight, sex, age, and total and/or fork length of all shortfin mako landed and, wherever possible, those discarded dead and released alive.

2. The recreational and customary take under the QMS is estimated through survey of recreational and customary fishers, especially to gather information on customary take for which there is a lack of data.

3. Increase observer coverage of domestic longline vessels, midwater trawl vessels and New Zealand-flagged high seas vessels, especially those operating in areas where shortfin mako are often caught. There are discrepancies between observer records and fisher records, but it is unclear if this is due to misreporting by fishers, or due to observer coverage not being truly representative of the fishery.

4. The type of indicator-based analysis performed by Francis et al. (2014) and Francis & Finucci (2019) should be repeated at 3-5 yearly intervals, and the models improved with more data and testing.

5. Further efforts should be made to satellite tag adult shortfin mako, especially females in the New Zealand EEZ and in waters of neighbouring Pacific countries to better determine within-region movements of adults.

6. New Zealand should collaborate with Oceania neighbours, and especially with WCPFC, to conduct a formal quantitative stock assessment of shortfin mako in the southwestern Pacific and, if necessary, establish quota for high seas fisheries in the southwest Pacific. Now that shortfin mako are listed on Appendix II of CITES, all catches on the high seas will require a positive non-detriment finding before they can be landed, so there is scope for regional players to determine what harvest is sustainable in the high seas of the southwest Pacific.

7. Review, research and implement best practice mitigation methods to minimise captures of shortfin mako in each fishery.

8. Research, develop and implement specific methods for handling and releasing shortfin mako, and investigate the fate of those released alive while still in the water (cut free) versus those that have been brought on board and then released.

9. The volumes of shortfin mako product introduced from the high seas to New Zealand or by New Zealand flagged vessels to foreign ports should be monitored closely, and expert advice be sought before the 20-tonne limit given above is allowed to be exceeded.

7. References

Bishop, S.D.; Francis, M.P.; Duffy, C.; Montgomery, J.C. (2006). Age, growth, maturity, longevity and natural mortality of the shortfin mako shark *Isurus oxyrinchus* in New Zealand waters. *Marine & Freshwater Research* 57: 143-154.

Cailliet, G.M.; Cavanagh, R.D.; Kulka, D.W.; Stevens, J.D.; Soldo, A.; Clo, S.; Macias, D.; Baum, J.; Kohin, S.; Duarte, A.; Holtzhausen, J.A.; Acuña, E.; Amorim, A.; Domingo, A. (2009). *Isurus oxyrinchus*. The IUCN Red List of Threatened Species 2009: e.T39341A10207466. http://dx.doi.org/10.2305/IUCN.UK.2009-2.RLTS.T39341A10207466.en.

Compagno, L.J.V. (2001). Sharks of the World: An annotated and illustrated catalogue of shark species known to date. Vol. 2. Bullhead, mackerel and carpet sharks (Heterodontiformes, Lamniformes and Orectolobiformes). FAO, Rome. 269 p.

Clarke, S.C.; Harley, S.J.; Hoyle, S.D.; Rice, J.S. (2013). Population trends in Pacific Ocean sharks and the utility of regulations on shark finning. *Conservation Biology* 27: 197-209.

Clarke, S.; Manarangi-Trott, L.; Brouwer, S. (2014). Issues for t-RFMOs in relation to the listing of shark and ray species by the Convention on International Trade in Endangered Species (CITES). Paper WCPFC-SC10-2014/EB-IP-05 for the tenth regular session of the Scientific Committee of the Western and Central Pacific Fisheries Commission.

Duffy, C.A.J. (2015). Family Lamnidae. Pp. 70-73 in Roberts, C.D.; Stewart, A.L.; Struthers, C.D. (eds.). *The Fishes of New Zealand*, Vol. 2: Systematic Accounts. Te Papa Press, Wellington. 576 p.

Duffy, C.A.J.; Francis, M.P. (2001). Evidence of summer parturition in shortfin mako (*Isurus oxyrinchus*) sharks from New Zealand waters. *New Zealand Journal of Marine and Freshwater Research*, 35: 319 – 324.

Duffy, C.; Francis, M.; Dunn, M.; Finucci, B.; Ford, R. Hitchmough, R.; Rolfe, J. (2018). Conservation status of New Zealand chondrichthyans (chimaeras, sharks and rays), 2016. New Zealand Threat Classification Series 23. Department of Conservation, Wellington. 13 p.

Fisheries New Zealand (2018) Mako shark (MAK) (*Isurus oxyrinchus)*. Pp 176-189 in Fisheries Assessment Plenary, November 2018: stock assessment and stock status. Fisheries Science and Information Group, Fisheries New Zealand, Ministry for Primary Industries, Wellington. 526p.

Ford, R.B.; Francis, M.P.; Holland, L.; Clark, M.R.; Duffy, C.A.J.; Dunn, M.R.; Jones, E.; Wells, R. (2018). Quantitative (Level 1) risk assessment of the impact of commercial fishing on New Zealand chondrichthyans: an update for 2017. New Zealand Aquatic Environment and Biodiversity Report No. 201. Fisheries New Zealand, Wellington. 109 p.

Ford, R.B.; Galland, A.; Clark, M.R.; Crozier, P.; Duffy, C.A.J.; Dunn, M.; Francis, M.P.; Wells, R. (2015). Quantitative (Level 1) risk assessment of the impact of commercial fishing on New Zealand chondrichthyans. New Zealand Aquatic Environment and Biodiversity Report No. 157. Ministry for Primary Industries, Wellington. 117 p.

Francis, M.P. (1998). New Zealand shark fisheries: development, size and management. *Marine & Freshwater Research* 49: 579-591.

Francis, M.P. (2013). Commercial catch composition of highly migratory elasmobranchs. New Zealand Fisheries Assessment Report 2013/68. Ministry for Primary Industries, Wellington.

Francis, M.P. (2019). Pelagic shark fishery characterisation. New Zealand Fisheries Assessment Report 2019/50. Fisheries New Zealand, Ministry for Primary Industries, Wellington.

Francis, M.P.; Clarke, S.C.; Griggs, L.H.; Hoyle, S.D. (2014). Indicator-based analysis of the status of New Zealand blue, mako and porbeagle sharks. New Zealand Fisheries Assessment Report 2014/69. Ministry for Primary Industries, Wellington. 109p.

Francis, M.P.; Duffy, C. (2005). Length at maturity in three pelagic sharks (*Lamna nasus*, *Isurus oxyrinchus* and *Prionace glauca*) from New Zealand. *Fishery Bulletin* 103: 489-500.

Francis, M.P.; Finucci, B. (2019). Indicator-based analysis of the status of New Zealand blue, mako and porbeagle sharks in 2018. New Zealand Fisheries Assessment Report 2019/51. Fisheries new Zealand, Ministry for Primary Industries, Wellington. 105p.

Francis, M.P.; Griggs, L.H.; Baird, S.J. (2001). Pelagic shark bycatch in the New Zealand tuna longline fishery. *Marine and Freshwater Research* 52: 165-178.

Francis, M.P.; Shivji, M.S.; Duffy, C.A.J.; Rogers, P.J.; Byrne, M.E.; Wetherbee, B.M.; Tindale, S.C.; Lyon, W.S.; Meyres, M.M. (2019). Oceanic nomad or coastal resident? Behavioural switching in the shortfin mako shark (*Isurus oxyrinchus*). Marine Biology 166:5 https://doi.org/10.1007/s00227-018-3453-5

Griggs, L.H.; Baird, S.J. (2013). Fish bycatch in New Zealand tuna longline fisheries 2006-07 to 2009-10. New Zealand Fisheries Assessment Report 2012/13. Ministry for Primary Industries, Wellington.

Holdsworth, J.C.; Saul, P.J. (2014). New Zealand billfish and gamefish tagging, 2012-2013. New Zealand Fisheries Assessment Report 2014/11. Ministry for Primary Industries, Wellington. 26p.

Holdsworth, J.C.; Saul, P.J. (2017). New Zealand billfish and gamefish tagging, 2013-14 to 2015-16. New Zealand Fisheries Assessment Report 2017/14. Ministry for Primary Industries, Wellington. 28p.

Horn, P.L.; Ballara, S.L.; Sutton, P.J.H.; Griggs, L.H. (2013). Evaluation of the diets of highly migratory species in New Zealand waters. New Zealand Aquatic Environment and Biodiversity Report No. 116. Ministry for Primary Industries, Wellington.

ISC (International Scientific Committee for Tuna and Tuna-like species in the North Pacific Ocean) Shark Working Group (2018). Stock Assessment of Shortfin Mako Shark in the North Pacific Ocean through 2016. Paper WCPFC-SC14-2018/SA-WP-11 for the 14th regular session of the Scientific Committee of the Western and Central Pacific Fisheries Commission.

Lack, M.; Meere, F. (2009). Pacific Islands Regional Plan of Action for Sharks: Guidance for Pacific Island Countries and Territories on the Conservation and Management of Sharks. Forum Fisheries Agency, Secretariat of the Pacific Community and the South Pacific Regional Environment Programme.

Ministry of Fisheries (2008). New Zealand National Plan of Action for the Conservation and Management of Sharks. Ministry of Fisheries, Wellington.

Ministry for Primary Industries (2013). Review of progress against actions identified in the New Zealand NPOA-Sharks 2008. MPI Technical Paper No. 2013/22. Ministry for Primary Industries, Wellington.

Ministry for Primary Industries (2014). National Plan of Action for the Conservation and Management of Sharks 2013. Ministry for Primary Industries, Wellington.

Rice, J.; Tremblay-Boyer, L.; Scott, R.; Hare, S.; Tidd, A. 2015. Analysis of stock status and related indicators for key shark species of the Western Central Pacific Fisheries Commission. Paper WCPFC-SC11-2015/EB-WP-04-Rev 1 for the 11th regular session of the Scientific Committee of the Western and Central Pacific Fisheries Commission.

Rigby, C.L.; Barreto, R.; Carlson, J.; Fernando, D.; Fordham, S.; Francis, M.P.; Jabado, R.W.; Liu, K.M.; Marshall, A.; Pacoureau, N.; Romanov, E.; Sherley, R.B.; Winker, H. (2019). *Isurus oxyrinchus*. The IUCN Red List of Threatened Species 2019: e.T39341A2903170. http://dx.doi.org/10.2305/IUCN.UK.2019-1.RLTS.T39341A2903170.en.

Sims, D. (2015). Mako: Atlantic hotspot. Save our Seas Foundation Project news. https://saveourseas.com/update/Mako-atlantic-hotspot/

Stevens, J.D. (2008) The Biology and Ecology of Shortfin Mako Shark, *Isurus oxyrinchus*. Pp 87-xx in Camhi, M.D.; Pikitch, E.K.; Babcock, E.A. (eds). Sharks of the Open Ocean: Biology, Fisheries and Conservation. Blackwell Publishing Ltd, Oxford.