

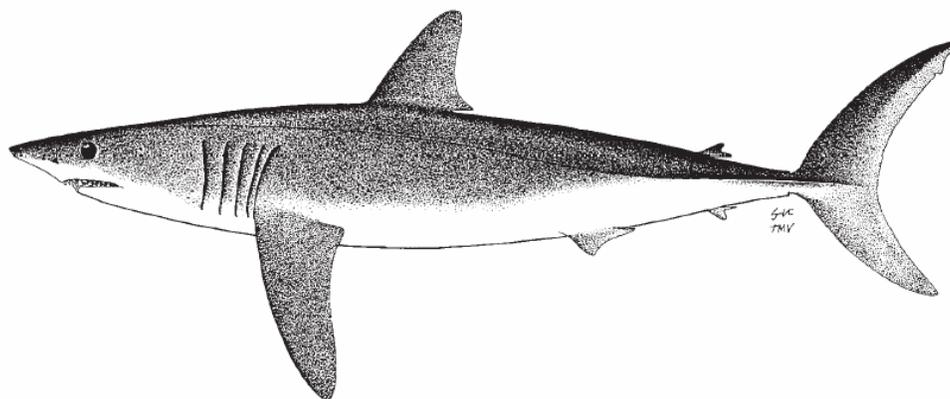
COSEWIC
Assessment and Status Report

on the

Shortfin Mako
Isurus oxyrinchus

Atlantic population

in Canada



THREATENED
2006

COSEWIC
COMMITTEE ON THE STATUS OF
ENDANGERED WILDLIFE
IN CANADA



COSEPAC
COMITÉ SUR LA SITUATION
DES ESPÈCES EN PÉRIL
AU CANADA

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

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Production note:

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Shortfin mako — Figure supplied by the author, from Compagne 2001.

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COSEWIC Assessment Summary

Assessment Summary – April 2006

Common name

Shortfin mako

Scientific name

Isurus oxyrinchus

Status

Threatened

Reason for designation

As a large (maximum length 4.2 m), relatively late-maturing (7-8 yrs) pelagic shark, the species has life-history characteristics making it particularly susceptible to increased mortality from all sources, including human activities. The species is circumglobal in temperate and tropical waters. Individuals found in Atlantic Canada are considered part of a larger North Atlantic population. There does not appear to be any reason to assume that the Canadian Atlantic "population" is demographically or genetically independent from the larger Atlantic population, so the status of the species in Atlantic Canada should reflect the status throughout the North Atlantic. Although there is no decline in an indicator of status for the portion of the species that is in Atlantic Canada, two analyses suggest recent declines in the North Atlantic as a whole (40% 1986-2001; 50% 1971-2003). The main causes of the species' decline (mortality due to bycatch in longline and other fisheries) are understood and potentially reversible, but these sources of mortality have not been adequately reduced.

Occurrence

Atlantic Ocean

Status history

Designated Threatened in April 2006. Assessment based on a new status report.



COSEWIC
Executive Summary

Shortfin Mako
Isurus oxyrinchus

Species information

Shortfin mako (*Isurus oxyrinchus*) is one of two species in the genus *Isurus*. In French this species is known as Requin - taupe bleu. Shortfin makos are identified by a pointed snout, a caudal keel, and a U-shaped mouth with teeth that extend outside of the mouth.

Distribution

Shortfin makos are distributed circumglobally in all tropical and temperate seas. In Canadian Atlantic waters the shortfin mako is typically associated with warm waters such as in and around the Gulf Stream. It has been recorded from Georges and Browns Bank, along the continental shelf of Nova Scotia, the Grand Banks and even into the Gulf of St. Lawrence. There is only one known record from Canada's Pacific waters. Shortfin makos are likely only occasional visitors to Canada's Pacific waters during periods of higher than normal ocean temperatures. Shortfin makos have been shown to be highly migratory as determined from conventional tagging studies.

Habitat

Shortfin makos prefer temperate to tropical waters and are seldom in waters less than 16°C. Preferred water temperature is between 17-22°C. In the Atlantic they are often associated with Gulf Stream waters. Canadian waters represent northern limits to their distribution in the western Atlantic Ocean. The typical offshore habitat of this species is not readily impacted by either anthropogenic or catastrophic natural events.

Biology

Shortfin makos are ovoviviparous and have a 15-18 month gestation period and an estimated 3 year parturition cycle. Typically, 4-25 young are born at about 70 cm in length. Females mature at lengths of 2.7-3.0 m and males at 2.0-2.2 m, corresponding to a minimum age at maturity of 7-8 years. Few mature individuals are found in Canadian waters. Longevity is estimated to be between 24-45 years. The instantaneous rate of natural mortality has been estimated at 0.16 and estimated generation length is 14 years. Shortfin makos are apex opportunistic predators with a wide prey base. They

have few natural predators due to their relatively large size and ability for high speed. Their body temperature is often 1-10°C above ambient water temperature. The greatest source of adult mortality is from commercial fisheries.

Population sizes and trends

There are no reliable population-level stock assessments available for shortfin mako anywhere in the North Atlantic or Pacific. As there is only one known record of shortfin mako in Pacific waters, little can be said about the status off Canada's west coast and it is not considered eligible for COSEWIC assessment. The status of the population in Atlantic waters reflects that of the larger North Atlantic population. Population size is not estimated in this report. Trend information based on declines in catch rates in the entire northwest Atlantic suggests that shortfin mako populations may have decreased by up to 50% in the past 15-30 years. There is some evidence of decline in the median size of shortfin mako landed in Atlantic waters, which may be an indicator of fishing pressure. It has been estimated that mortality in Canada's Atlantic waters accounts for less than 2% of the mortality in the entire North Atlantic.

Limiting factors and threats

Shortfin makos are caught as bycatch in pelagic fisheries worldwide. Poor catch accounting over several decades has complicated efforts to produce a population-level stock assessment. Fishing is the single largest threat to their populations.

Special significance of the species

The shortfin mako is an opportunistic apex predator with a wide prey base and as such is likely important in structuring marine ecosystems. Their palatable meat combined with energetic behaviour make them a prized game fish. Shortfin makos are also commercially traded due to their high value meat.

Existing protection

In Canada, shortfin makos receive some protection through fisheries management regulations. There is a non-restrictive catch guideline of 250 t quota for directed fisheries only. In Canadian waters all catch is non-directed (bycatch) and therefore has no catch limits, so the catch guideline has little or no practical conservation benefit. Removal of fins and discarding of the shark at sea has been prohibited in Canada and the US for several years, and recently ICCAT imposed a regulation to prohibit finning on the high seas. The IUCN assessed shortfin mako in 2000 and listed it as *lower risk/near threatened* (LR/nt).



COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5th 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

DEFINITIONS (2006)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and it is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

** Formerly described as "Not In Any Category", or "No Designation Required."

*** Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.



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The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.

COSEWIC Status Report

on the

Shortfin Mako *Isurus oxyrinchus*

in Canada

2006

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SPECIES INFORMATION

Name and classification

Shortfin mako (*Isurus oxyrinchus*) is one of two species in the genus *Isurus* (the other being the longfin mako, *Isurus paucus*) and one of five species in the family Lamnidae or mackerel sharks. Other lamnid sharks found in Canada include the white shark (*Carcharodon carcharias*), salmon shark (*Lamna ditropis*), and the porbeagle shark (*Lamna nasus*). There are no recognized sub-populations of shortfin mako, although there is some genetic variability within the species. Based on colouration it has been suggested that a population around the Azores may represent a distinct local population worthy of 'population variant' status (Compagno 2001). Molecular work is required to confirm this possibility. In French this species is known as Requin - taupe bleu.

Morphological description

Description modified from Compagno (2001). Shortfin makos are identified by a pointed snout, relatively small eyes, and a U-shaped mouth (Figure 1). The lower anterior teeth protrude horizontally on jaws even when mouth is closed. The body is moderately slender but more fusiform than the closely related *Isurus paucus*. Pectoral fins are slightly curved with tips relatively narrow, anterior margins about 16 to 22% of total length and shorter than head length (the pectoral fins of the longfin makos are equal to or longer than the head length). Origin of first dorsal fin over or just behind the pectoral free rear tip; first dorsal-fin apex broadly rounded in young but more angular and narrowly rounded in large juveniles and adults; first dorsal-fin height greater than base length in large individuals but equal or smaller in young below 185 cm. The dorsolateral colouration is brilliant blue or purplish, with white below the underside of snout in young and adults. The head is dark in colour and partially covering the gill septa. The dark colour of their flanks does not extend ventrally onto the abdomen; the pelvic fins are dark on anterior halves, white on posterior halves, with the undersides white.

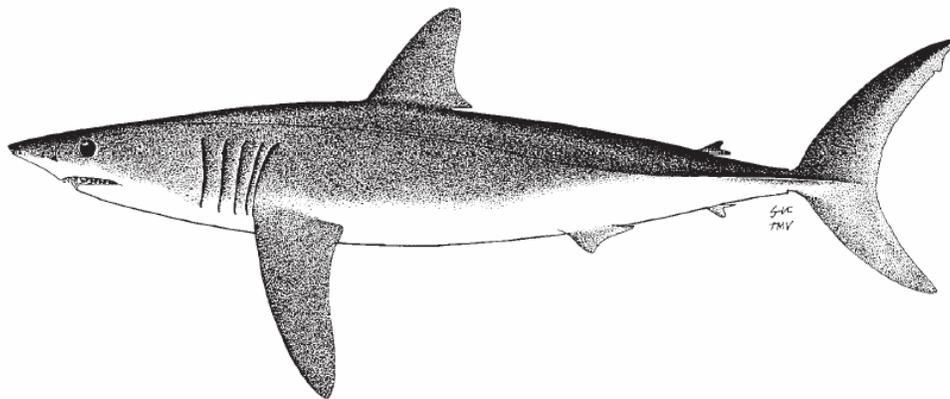


Figure 1. Shortfin mako (*Isurus oxyrinchus*). Figure from Compagno 2001.

In the field, shortfin makos are identified by a spindle-shaped body, a long, acutely conical snout, large blade-like teeth, narrow-tipped pectoral fins, a large first dorsal fin and minute, pivoting second dorsal, a crescentic caudal fin, and ventral surface of body that is usually white.

Misidentifications have occurred in warmer waters where the two mako species ranges commonly overlap; however, in Canada where longfin makos are extremely rare, misidentification between the two species is not believed to be a problem. In Atlantic Canada, shortfin makos have been misidentified as porbeagle shark (Campana *et al.* 2004).

Genetic description

Heist *et al.* (1996) used mitochondrial DNA (mtDNA) to analyze population structure in shortfin mako from both the Atlantic and Pacific. They found that the north Atlantic samples differed substantially from samples from the south Atlantic and north and south Pacific (overall $F_{ST} = 0.15$), and the authors concluded that the north Atlantic samples experience very restricted gene flow from other areas and therefore may warrant separate management consideration. Schrey and Heist (2003) investigated microsatellite (nuclear) DNA of shortfin mako at four loci using 433 samples from the North Atlantic, South Atlantic, North Pacific, South Pacific, and the Atlantic and Pacific coasts of South Africa. This latter study found very low levels of differentiation even among the major ocean basins (global $F_{ST} < 0.003$) and only a weak basis for rejecting the hypothesis that shortfin mako comprise a single global population; under one mutation model the P value was slightly less than 0.05, whereas under another mutation model the P value was slightly above 0.05. Power analysis indicated very high power to detect population structure at the level indicated by the mtDNA study. Schrey and Heist (2003) suggested that one way to explain both datasets is that females are strongly philopatric (hence the strong differences at the maternally inherited mtDNA) but males are good dispersers (hence at best weak differentiation at nuclear DNA makers). This pattern has been reported in other shark species.

Tagging studies indicate that individuals are capable of transoceanic migrations. A small Canadian tagging program applied a total of 110 tags to shortfin makos between 1961-1980 (Burnett *et al.* 1987). There were only 5 recaptures from this study, which showed that some of the sharks migrate between continental shelf and offshore (non-shelf) waters, and between Canadian and U.S. waters (Figure 2). The U.S. National Marine Fisheries Service (NMFS) between 1962-1993 applied 3,457 tags to shortfin makos in U.S. and international waters, of which 320 tags were recovered (Figure 3, Kohler *et al.* 1998). Most of the recaptures were made in U.S. waters, where fishing effort is highest, but it was also shown that many of the shortfin makos migrated over long distances (>500 km). For the purposes of this report the Atlantic Canada population is considered to be part of the entire North Atlantic population.

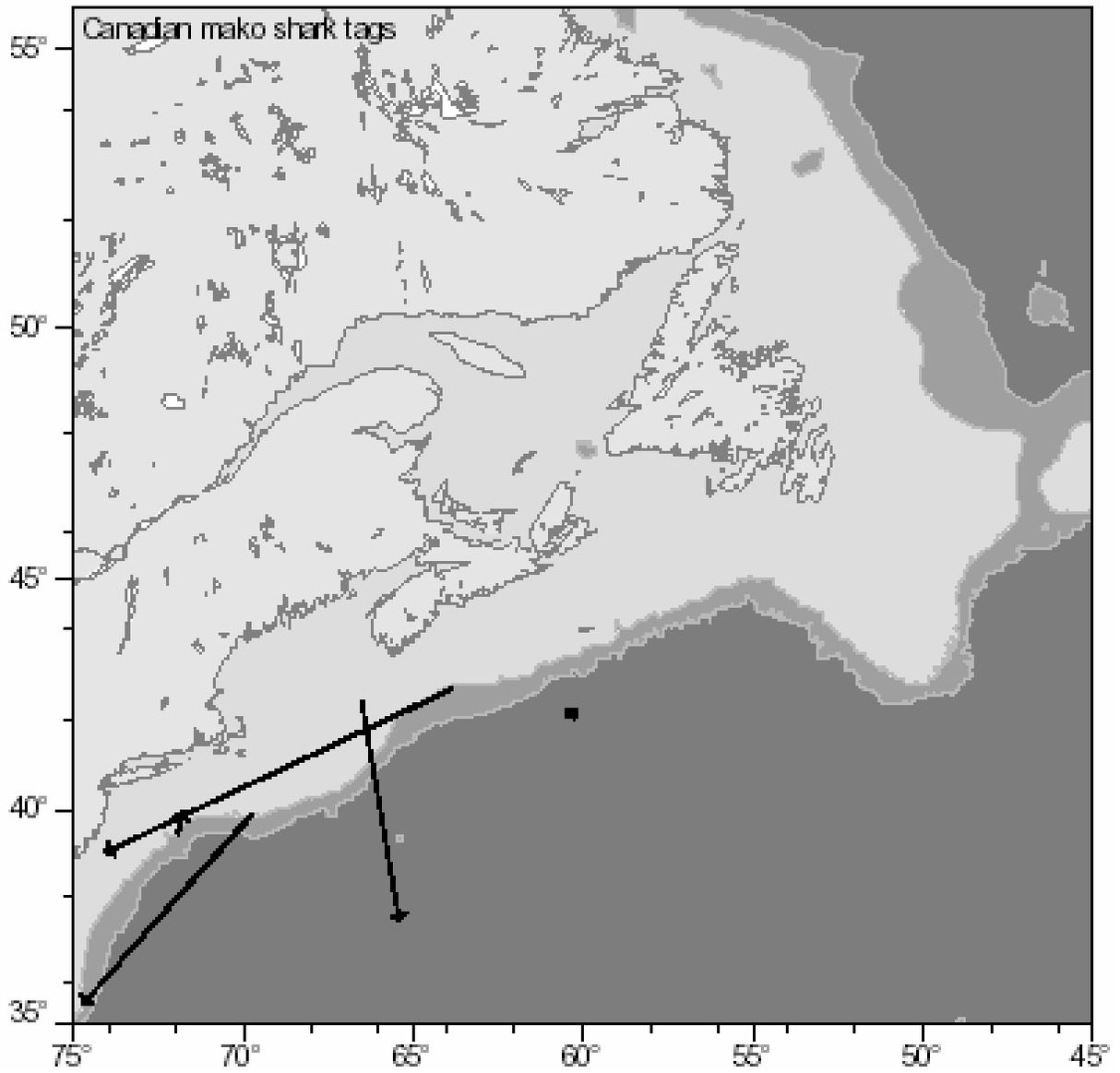


Figure 2. Shortfin mako sharks tagged between 1961-1972 in the Canadian tagging program. From Campana *et al.* 2004.

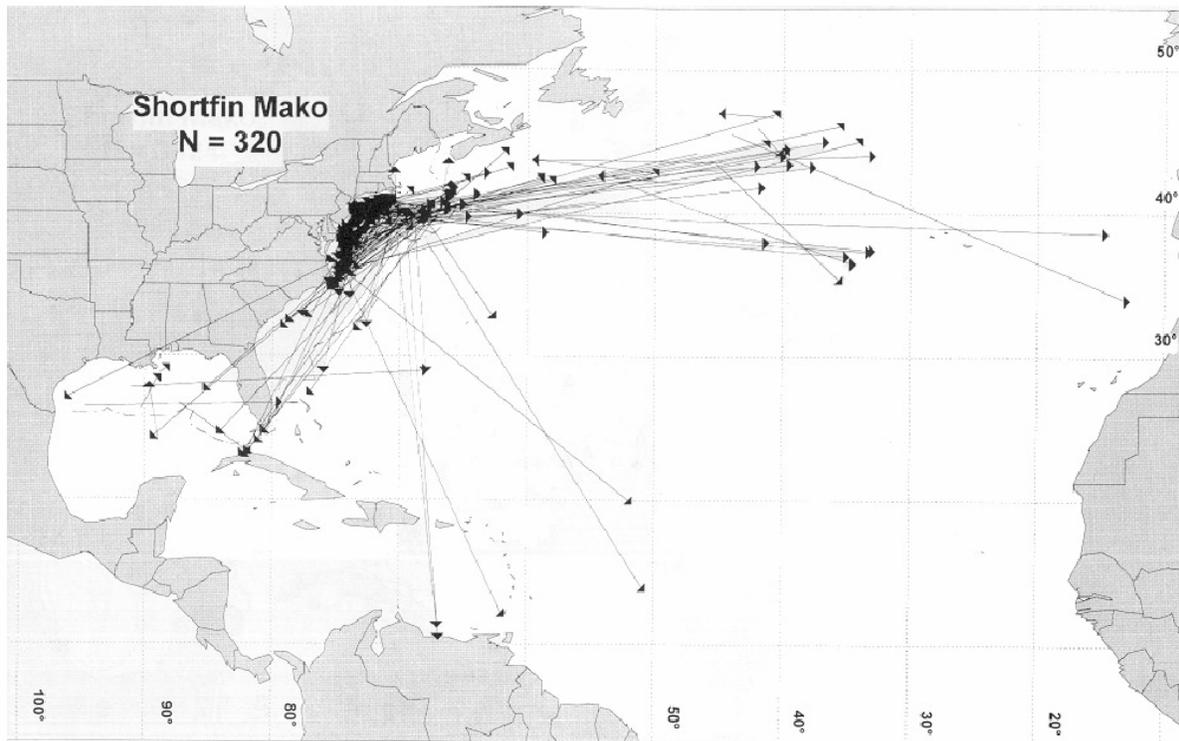


Figure 3. Recaptures of shortfin makos tagged by the NMFS Shark Tagging Program. Figure adapted from Fig. 38 of Kohler *et al.* 1998.

Designatable units

Based on biogeographical separation and genetic differences, Shortfin mako populations in Canada's Atlantic and Pacific should not be considered part of the same designatable unit. From a biogeographical perspective, the continental landmass of North and South America combined with the shortfin mako's preference for subtropical and tropical waters limits the amount of exchange between ocean basins. Based on a single genetic study by Schrey and Heist (2003) (described above), there is some level of differentiation between the North Atlantic and North Pacific.

Although Canadian waters are near the periphery of the species' range in the North Atlantic, shortfin mako are commonly encountered in the Canadian Atlantic and represent a designatable unit. In the Pacific, the species is represented by a single observation near the periphery of Canadian waters, which suggests that the population should not be considered eligible for assessment by COSEWIC. Since most records of this species are associated with pelagic longline fisheries, which are currently absent in waters of the Canadian Pacific, it is possible that the species is more abundant in Canadian waters than the record indicates; however, there are regular records of other large pelagic sharks (e.g. blue shark) in Canada's Pacific waters.

DISTRIBUTION

Global range

Shortfin makos are distributed circumglobally in all tropical and temperate seas (Figure 4). There are no data indicating that their global range has changed. Compagno (2001) describes shortfin mako range in the northwestern Atlantic as being from the Gulf of Maine to Bermuda.

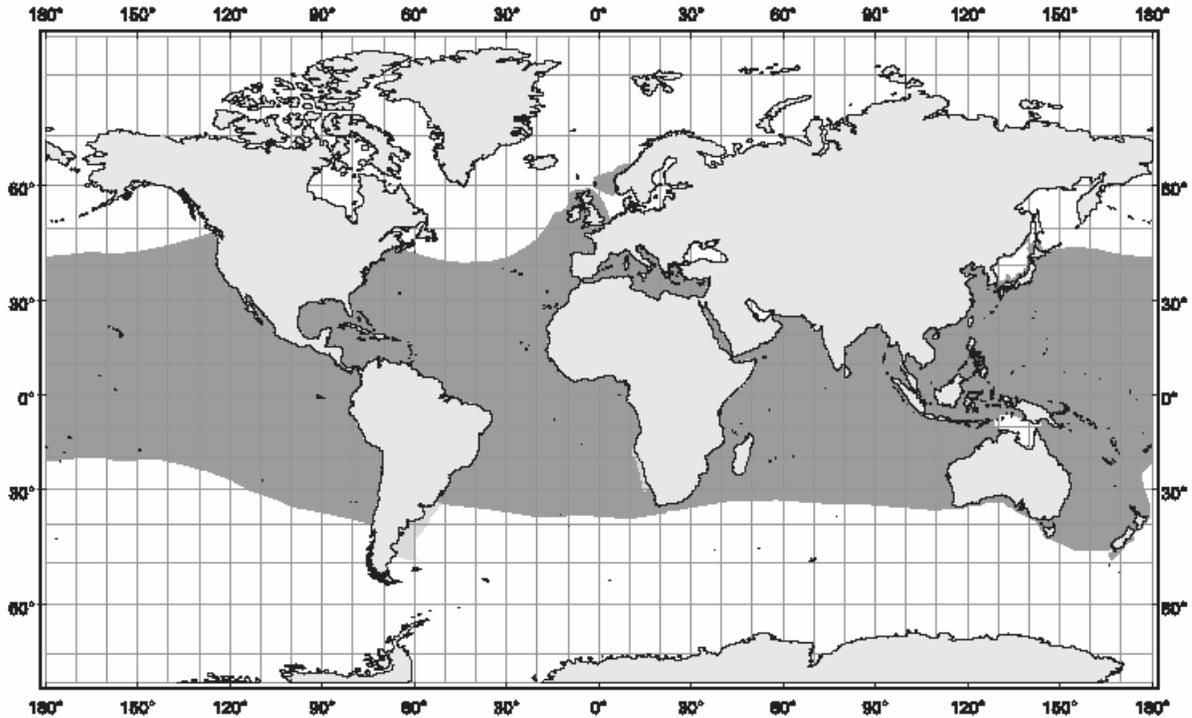


Figure 4. Global distribution of shortfin mako. Source: Compagno 2001.

Canadian range

Atlantic Coast: In Canadian waters the shortfin mako is typically associated with warm waters such as in and around the Gulf Stream. It has been recorded from Georges and Browns Bank, along the continental shelf of Nova Scotia, the Grand Banks and even into the Gulf of St. Lawrence (Templeman 1963). Observer data from Canadian, Faroese, and Japanese vessels indicate that makos are caught both in inshore waters and offshore waters between 39°-50°N (Figure 5). This species is a highly migratory seasonal visitor (late summer and fall) to Canada's Atlantic coast. The population in Canadian waters represents the northern extension of the North Atlantic-wide population and likely only represents a small portion of the total population. There are no data to indicate either an expansion or reduction in shortfin mako range within Atlantic Canadian waters.

All Divisions SHORTFIN MAKO , Jan-Dec 1986-2004, total catch from Observer Data

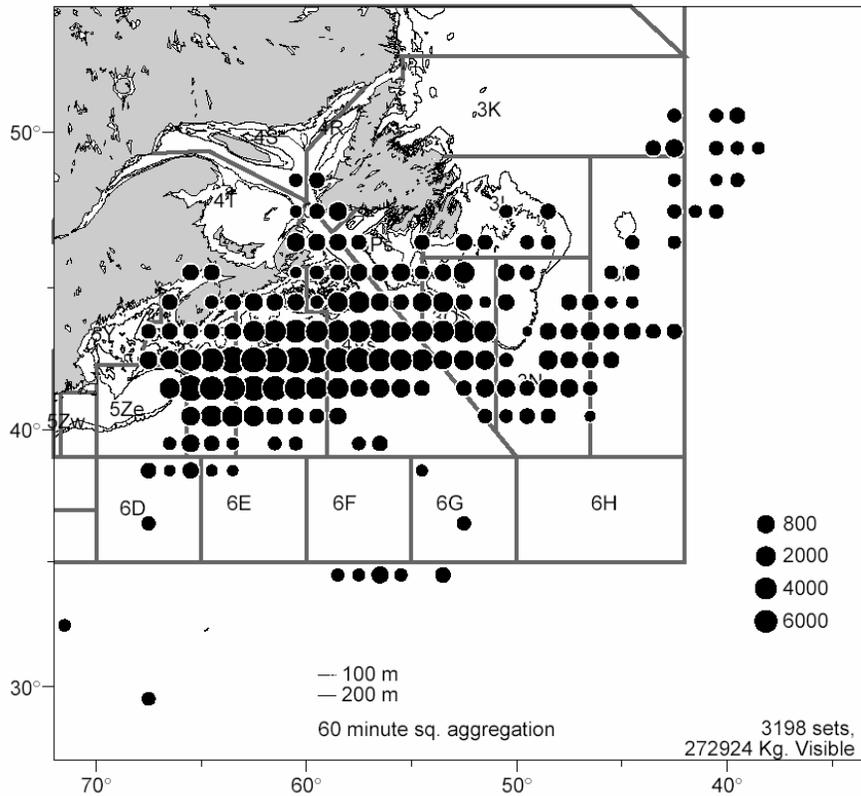


Figure 5. Distribution of shortfin mako in Atlantic Canada based on all recorded catch (kg) from the International Observer Program database between 1986-2004. Source: Campana *et al.* 2004.

Pacific Coast: Compagno (2001) describes the range in the central Pacific as being from south of the Aleutian Islands to the Society Islands, and the Hawaiian Islands and in the eastern Pacific from Washington State to central Chile. There has been only one confirmed shortfin mako caught in Canada's Pacific waters (360 km due west of Cape St. James) (Gillespie and Saunders 1994). Shortfin makos are probably only occasional visitors to Canada's Pacific waters during periods of higher than normal ocean temperatures. The lack of confirmed records in Pacific Canadian waters indicates that they are either rare in those waters and/or do not overlap with human activities. Databases searched include the International Halibut Commission survey data, PacTrawl, GFBio, all DFO groundfish survey reports, and National Marine Fisheries Service Triennial Survey.

Pelagic longlining is the primary fishing gear responsible for the bycatch of shortfin mako sharks worldwide. Presently in Canada's Pacific waters, this type of fishing practice does not exist, whereas on Canada's Atlantic coast this practice is very common. The absence of records from Canada's Pacific waters may reflect the absence of pelagic longline fishing methods and not the absence of this species.

However, there are regular records of other large pelagic sharks (e.g. blue shark) in other gears in Canada's Pacific, so most likely the shortfin mako is genuinely rare and vagrant.

Because of the single record, this species does not meet COSEWIC's criteria for eligibility for assessment – it can be considered a vagrant in Canadian waters. Accordingly this status report does not provide further information on shortfin mako in Canada's Pacific waters.

HABITAT

Habitat requirements

Specific habitat requirements have not been well described. Temperature appears to be a critical component defining shortfin mako distribution. They prefer temperate to tropical waters and are rarely found in waters less than 16°C. Preferred water temperature is between 17-22°C and consequently, in the Atlantic, they are often associated with Gulf Stream waters (Compagno 2001). They occur from the surface to 500 m depths. Typically they occur well offshore but have occasionally been observed in littoral zones. In the western North Atlantic they move onto the continental shelf when surface temperatures exceed 17°C. In the eastern North Pacific juveniles range into southern California waters and tend to stay near the surface, with little tendency to descend into cold subsurface waters. Off California, small sharks were found to stay near the surface above 20 m depth and in waters near 21°C (Holts and Bedford, 1992). Recent data from eight juvenile shortfin makos radio tagged off southern California confirms previous studies that juveniles spend most of their time (~80%) within 12 m of the surface (Sepulveda *et al.* 2004).

Habitat trends

The typical offshore habitat of this species is not readily affected by either anthropogenic or catastrophic natural events. Anthropogenic shifts in ocean temperatures (i.e., global climate change) could influence the distribution and habitat of this species, but this has not yet been investigated.

Habitat protection/ownership

Much of the preferred habitat of the shortfin mako lies outside of any nation's exclusive economic zone. There are no agreements for the protection of their habitat, nor have any other protective measures such as fishing exclusion zones been established. Likewise, in Canadian waters there are no habitat-related protective measures for shortfin mako.

BIOLOGY

Unless otherwise noted, biological information is from Compagno (2001).

Life cycle and reproduction

The life cycle of shortfin mako is incompletely known. Shortfin makos are ovoviviparous. Developing embryos feed on unfertilized eggs during the 15-18 month gestation period. After parturition it is thought that females may rest for 18 months and therefore the breeding cycle may be three years (Mollet *et al.* 2000). Birth can occur from late winter to mid-summer with typically 4-25 free-swimming young born at about 70 cm in length. Females mature at total lengths of 2.7-3.0 m and males at 2.0-2.2 m corresponding to a minimum age of 7-8 for both sexes. Size is a better indicator of reproductive maturity than age. In the northwest Atlantic it was found that females up to 272 cm fork length were immature despite being between 7-18 years old (Campana *et al.* 2004). Maximum size is about 4.2 m.

Based on length frequency data collected in Canadian waters by the International Observer Program (IOP), it is clear that mature animals are either rare in Canada or do not encounter commercial fishing gear. A coarse approximation of the percentage of mature males and females encountered by the commercial fishing fleet is estimated at 10-23% (n=1054) and 0.2-0.6% (n=850) respectively based on length data collected by the IOP from 1980-2003. Of the 1904 observations, only five were mature females. The range of percentages was calculated assuming a length of maturity (total length) of 200-220 cm for males and 270-300 cm females. Size frequency distributions of commercially caught males and females from waters around Newfoundland and Nova Scotia (1979-2002) are shown in Figure 6 (Campana *et al.* 2004).

Longevity of shortfin makos in Northwest Atlantic based on vertebral cross-sections has been estimated by Campana *et al.* (2002) to be at least 24 years, with a theoretical maximum age using von Bertalanffy's growth equation of 28 years (Smith *et al.* 1998), and 45 years (Cailliet and Bedford 1983). The instantaneous rate of natural mortality has been estimated at 0.16 (Smith *et al.* 1998). Using the combination of natural mortality rate and age of first reproduction (8 years), a conservative (minimum) generation length of 14 years is estimated ($GL=8+1/0.16=14$).

Predation

Shortfin mako have few natural predators due to their relatively large size and ability for high speed. Evidence of predation by white sharks has been observed off California, in the Mediterranean Sea and off South Africa. Makos have been caught with visible scars and injuries from interactions with sailfish and swordfish. The primary predator of shortfin makos are humans in the form of directed and incidental fishing mortality.

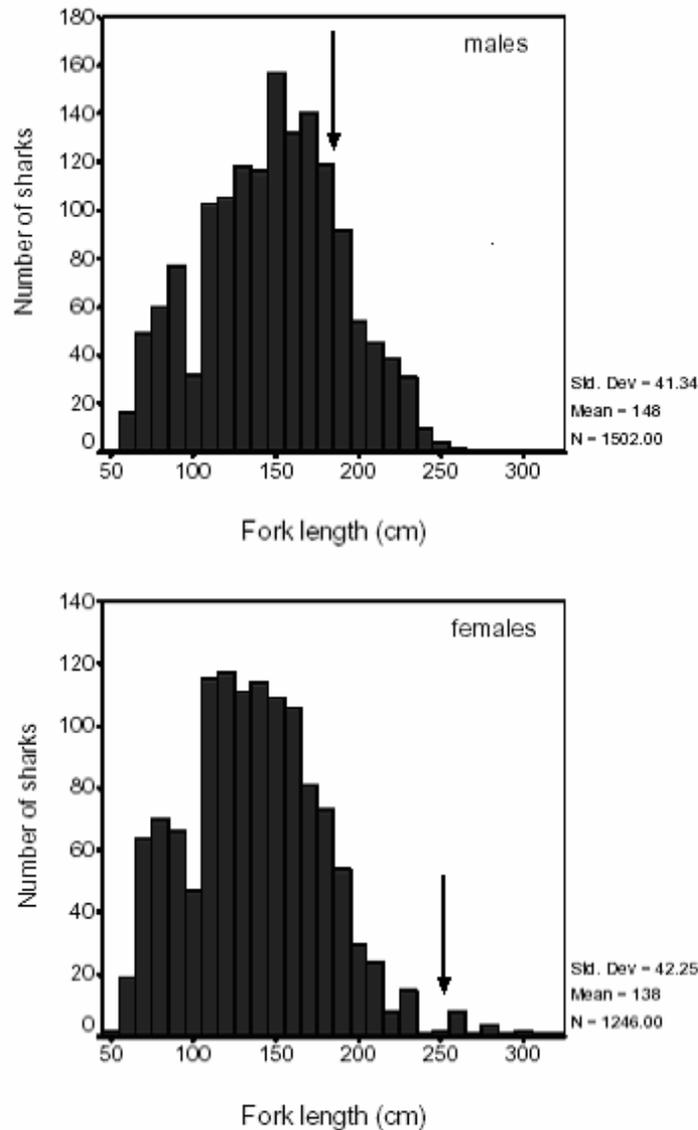


Figure 6. Length frequency histograms of male and female shortfin mako sharks (year, area and season combined) from observer data collected from 1979-2002 from the waters around Newfoundland, the Scotian Shelf, and off southern Nova Scotia. Length at maturity (fork length) for females is between 250-280 cm and males 185-205 cm. Arrow represents minimum length at maturity. Figure from Campana *et al.* 2004.

Physiology

Shortfin makos are endothermic, with body temperatures 1-10°C above ambient water temperature. This adaptation is advantageous in maintaining elevated swimming, visual, central nervous system and digestive functions when the makos are in cooler waters in higher latitudes, as is the case with those in Canadian waters, or when diving below the thermocline in warm waters.

Dispersal/migration

Shortfin makos have been shown to be highly migratory as determined from conventional tagging studies (Kohler *et al.* 1998) and more recently from genetic evidence (Schrey and Heist 2003). Based on both thermal preference and highly mobile behaviour, it is unlikely that shortfin makos have extended residency in Canadian waters. Shortfin makos ($N_{\text{tagged}}=3457$, $N_{\text{returned}}=320$) tagged and recaptured between 1962-1993 in the northwestern Atlantic coast demonstrated a wide range of movement patterns (Figure 3). Individuals show potential for considerable movement at the scale of ocean basins but most tag recoveries were within 500 km of the tagging location.

Interspecific interactions

Shortfin makos prey upon a wide variety of species, primarily fish including tunas, mackerels, bonitos, and swordfish. Squid are also an important component of their diet. Prey items are typically 10-35% of the size of the predator. There is some suggestion that larger makos shift towards consuming larger prey including other sharks, small cetaceans and turtles. In the western North Atlantic, bluefish are considered to be the most important prey, comprising 78% of their diet (Stillwell and Kohler 1982).

Adaptability

This species is likely well adapted to withstand natural changes in its environment (i.e., change in prey type or temperature), as it can readily move long distances and prey upon a wide variety of species. Furthermore, the species is distributed over a large area, thereby reducing its susceptibility to small stochastic events. Their endothermic physiology allows the animal to remain highly active in cooler waters.

POPULATION SIZES AND TRENDS

Information sources

Atlantic population: All catch information, including distribution of fishing effort, is from the Maritimes Region and Newfoundland International Observer Programs (IOP), sport fishing derby data, the International Commission for the Conservation of Atlantic Tunas (ICCAT), and the Department of Fisheries and Oceans (DFO) catch statistics databases. Data used to develop a catch rate model is from observer and logbook data. There has been no effort to specifically survey for shortfin mako in Canadian waters; therefore all population and trend data are derived from fisheries data.

Abundance

There are no reliable population-level stock assessments available for shortfin mako anywhere in the North Atlantic due to severe limitations in the quantity and quality of data available (ICCAT 2005a). Shortfin makos are considered bycatch in pelagic

longline fisheries with the swordfish fishery being the main source. An analysis of observed sets in the Maritimes Region between 1990-2003 indicates that mako typically make up less than 2-3% of the catch by weight (Campana *et al.* 2004; Campana *et al.* 2005). Due to the high value of the meat, discard rates are very low and therefore landings are similar to the nominal catch.

In Canada, landings reported from Canadian vessels have declined since 1994 from 142 t to about 66 t in 2003 (Figure 7; Table 1). However, this decline is almost certainly a result of misreporting porbeagle as shortfin mako prior to 1996 due to a data coding issue, where porbeagle and shortfin mako were coded together under the heading of mackerel sharks. Since 1996 landings have been relatively constant but total effort is unknown. In addition to Canadian landings, between 1980 and 1999 there was a small international fishery operating in Canada's Atlantic waters, comprised of Japanese and Faroese vessels with total landings of 163 t (~8.1 t/yr) (Table 1). Since 1999, there have been no international fisheries reporting shortfin mako in Canadian waters. Derby/recreational catches of shortfin makos are minor with only a few sharks landed per year (Campana *et al.* 2004).

Landings in the entire North Atlantic are from ICCAT (2005b) representing all nations and all regions. Nominal annual recorded catches/landings have averaged approximately 2,800 t since 1997 (Table 1). Landings prior to 1997 are underreported, primarily due to the absence of data from the Spanish fleets (ICCAT 2005b). In the northwest Atlantic (north of Florida), average landings since 1997 have been 1,100 t (Table 1).

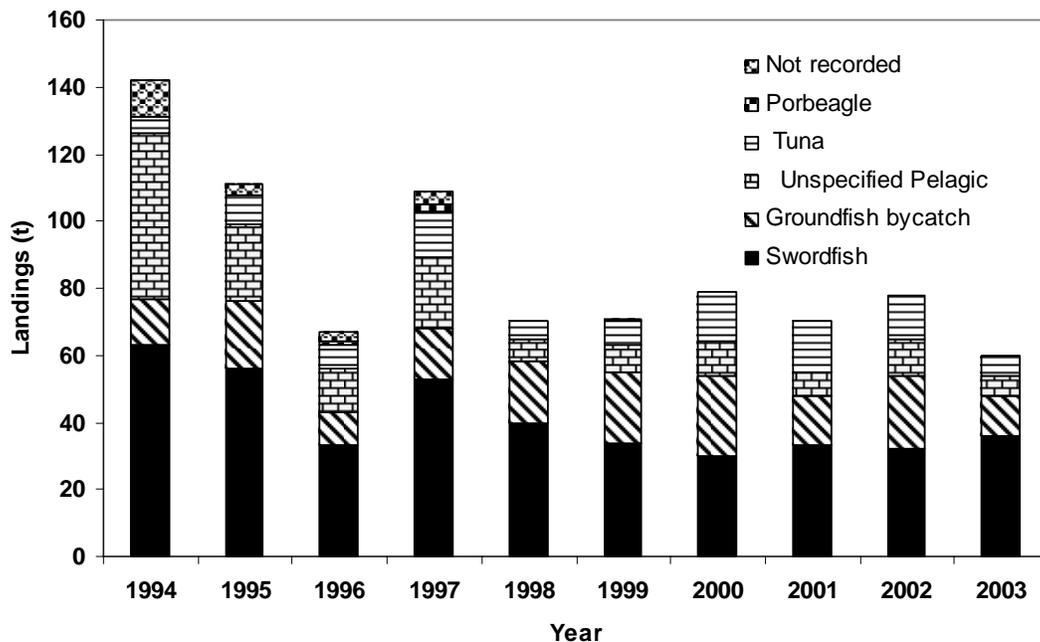


Figure 7. Atlantic Canada landings of shortfin mako by fishery between 1994-2003. Data from DFO Zonal Statistics File except for 2003 which is from MARFIS.

Table 1. Reported shortfin mako shark landings (t) by country in the North Atlantic.

Year	Canadian Atlantic (NAFO Areas 2-5)					Northwest Atlantic				North Atlantic
	Canada	Faroe Is	Japan	Other	Total	Japan	USA	Other	Total	Total
1979			0		0					
1980		2	0		2					
1981			1		1					
1982			0		0	226			226	
1983			5		5	85			85	
1984			1		1	213			213	
1985						214			214	
1986			2		2	231			231	
1987			10		10	232			232	
1988		0	17		18	168			168	
1989		1	13		14	176			176	
1990		5	8		13	140			140	193
1991		2	14		16	198			198	314
1992		2	29		31	345			345	246
1993	4	0	16		20	553	236		789	1094
1994	142		21		164	450	273		723	978
1995	111		4		115	397	230		627	1088
1996	67		5		72	238	181	72	491	1136
1997	110		2		111	99	213	808	1120	3307
1998	71		1	0	72	107	0	999	1106	2586
1999	70		2		72	123	0	969	1092	2439
2000	79				79	83	0	785	868	2144
2001	70				70	116	160	637	913	2360
2002	79			1	79		154	1066	1220	2918
2003	66				66		128	1277	1405	3801

Canadian Atlantic landings: from DFO Zonal Statistics File, except for 2003 which is from MARFIS; Japan, Faroes, other countries in Canadian Atlantic are from Maritimes Region & NF IOP (excludes discards).

NW Atlantic landings: Japan in NW Atlantic represents nominal catch of unspecified sharks and rays from FAO Statistics (2001). U.S. and other countries are from ICCAT statistics for Areas 1 (NW Atlantic) and 39 (Northwest Central Atlantic). Note, some countries do not report at a regional scale.

Total North Atlantic landings from ICCAT statistics for nominal catches of sharks (1990-2003). Includes all countries with reported landings from the North Atlantic including Canada (ICCAT 2005b). ICCAT Areas: ATL, ATMED, AZOR, GOFM, MEDI, NE, NW, NWC, WTRO

Campana *et al.* (2004) report that international landing statistics for shortfin makos are probably underreported. If this is true, and if it is also true that the estimates of Canadian catch are more accurate, then estimates of the fraction of total catches that are taken in Canadian waters are too high. Since 1997, total reported catch in Canadian Atlantic waters has been 549 t compared to 7,724 t in the northwest Atlantic (~7%) and 19,554 t in the entire North Atlantic (2.8%). Because some countries do not report catches by regional areas, the most accurate comparison of landings between countries is at the scale of the entire North Atlantic.

Although an estimate of the proportions of mature animals in Canada's Atlantic waters has been derived (see Lifecycle and Reproduction section), there are no reliable

means for estimating the total abundance of mature individuals in the Atlantic Ocean, as the total population in Canadian Atlantic waters is unknown.

Fluctuations and trends

There are no surveys specifically designed to assess shortfin mako trends in the North Atlantic or elsewhere in Canada.. Despite the general lack of shortfin mako research, there have been some attempts to examine trends based on data collected from various pelagic fisheries. In the following paragraphs, four of the most recent and relevant analyses are summarized to provide insight into the current trend.

Baum *et al.* (2003), using U.S. pelagic longline logbook data, found that the catch rates of makos (thought to be mostly shortfin mako) in the northwest Atlantic had declined by 40.7% over the time series (Figure 8). The Baum *et al.* (2003) analysis was based on 65,795 makos caught by 214,234 longline sets (mean of 550 hooks/set) between 1986 and 2000. Data prior to 1986 did not accurately account for individual shark species and therefore was not used in their analysis. The index of abundance was based on a standardized catch per unit effort (CPUE) time series for area, season, fishery variables, and year. Aspects of the analysis by Baum *et al.* (2003) were recently questioned by several U.S. shark scientists who suggested that the trend observed for the shortfin mako should be considered preliminary without the full benefit of data from multiple international sources and a complete stock assessment (Burgess *et al.* 2005).

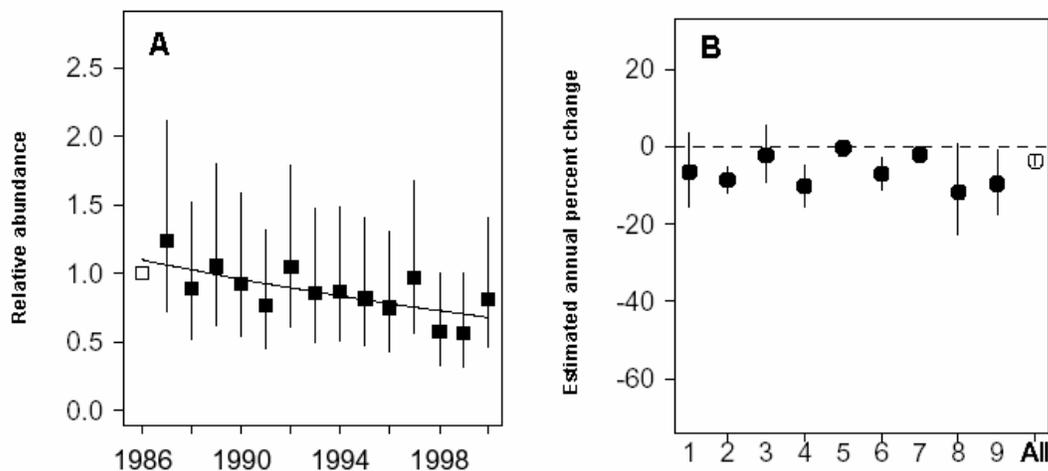


Figure 8. A. Relative abundance of shortfin mako in the entire west Atlantic indicated by an analysis of U.S. commercial longline fishery logbook data from 1986-2000 (decline of 40.7%); (B) estimated annual rate of change for nine assessment areas and total. From Baum *et al.* 2003.

A large-scale investigation into shortfin mako trends in the North Atlantic was recently undertaken by ICCAT (ICCAT 2005a). This study concluded that shortfin mako have likely experienced some level of stock depletion in the North Atlantic based on declines in catch rates of 50% or more from 1971-2003 (Figure 9). Catch rates used in the analysis were from the Japanese longline (1971-2003) and U.S. longline logbook data (1986-2003).

Modelling results from the same report indicate that the ratio of the current level of spawning stock biomass relative to virgin conditions (SSB/SSB_0) is 0.31-0.33 (ICCAT 2005a). Due to limitations on quantity and quality of the information available for the stock assessment of shortfin mako, the assessment is described as very preliminary (ICCAT 2005a). It should be noted that catch rates from the U.S. longline logbook data used in the ICCAT analysis suggest a small upswing between 2000-2003 (Figure 9).

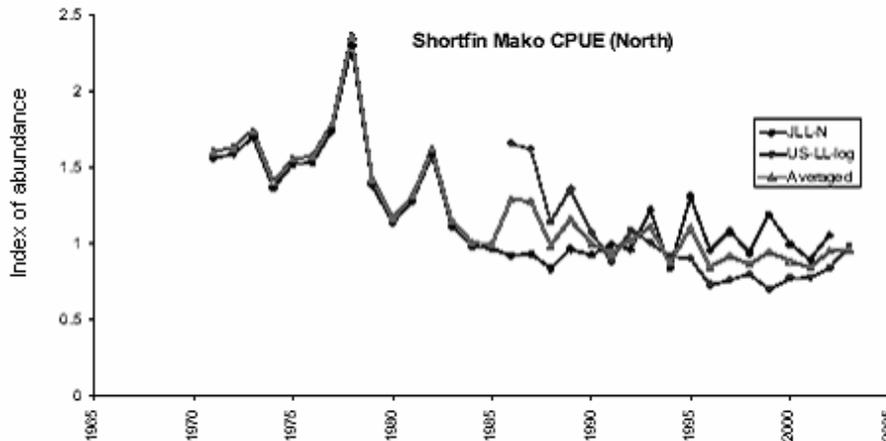


Figure 9. Indexed CPUE of shortfin mako in the North Atlantic from the Japanese longline fleet (JLL) and United States longline fleet (USLL). Index achieved by identifying the years common to all indices, calculating the mean within each series for those common years, and expressing all values in each series as a proportion of the calculated mean for that series. Figure from ICCAT 2005a.

Research into shortfin mako trends in exclusively Canadian Atlantic waters is limited to a single study by Campana *et al.* (2004). In this study the authors developed a catch rate model using logbook data representing longline sets between 1988 and 2003 where at least one mako was recorded in a trip. There was no observed decline in catch rates over the time series (Figure 10). However, due to small sample sizes and large variances, the analysis was of low statistical power and would have been unable to detect anything other than a severe decline (or increase); in addition this index represents part of the overall population found in Canadian Atlantic waters and could have been affected by factors related to migration rate into this area.

The median size of shortfin mako in the Canadian Atlantic catch was used as an additional indicator of population status, where a long-term change in the median size may signal the degree of exploitation (Campana *et al.* 2004; 2005). A plot of median fork length against year of collection indicated a gradually increasing trend in the Japanese fishery until 1996 (Figure 11). However, median size in the Canadian Atlantic fishery declined between 1998 and 2003. Since there is no overlap in the time series of the two countries (due to insufficient or absent observer effort in some years), it is difficult to determine if the disparate trends reflect targeting of different groups of shortfin mako or a real change in trend. However, the recent decline in the mean size in the Canadian fishery suggests a decline in abundance of larger shortfin makos (since there is no evidence of an increase in abundance of smaller sharks based on length frequency data).

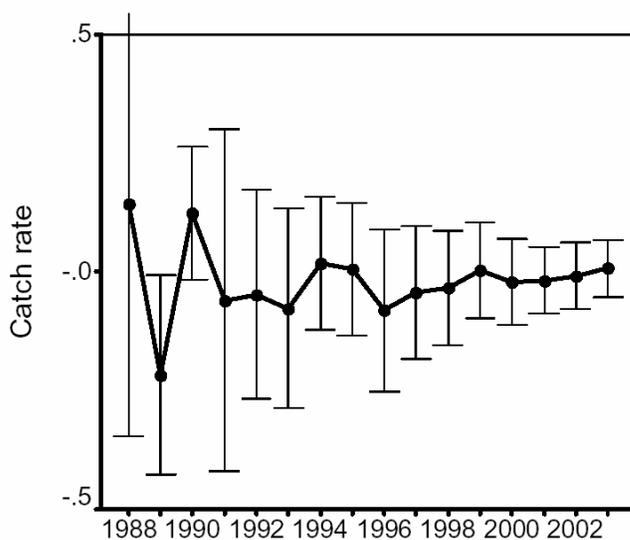


Figure 10. Standardized trip-level catch rate of the weight of shortfin mako sharks caught by pelagic longliners on the Scotian Shelf between 1988 and 2003. Data were restricted to Japanese longliners targeting bigeye tuna between Oct-Dec of 1987-99 and Canadian longliners targeting swordfish between July-Sept of 1996-2003. The GLM model was fit to non-zero trips using a gamma error distribution and with Year and Vessel as factors. Error bars represent 1 SE around the mean. There was no trend in catch rate through the time series. Source: Campana *et al.* 2004.

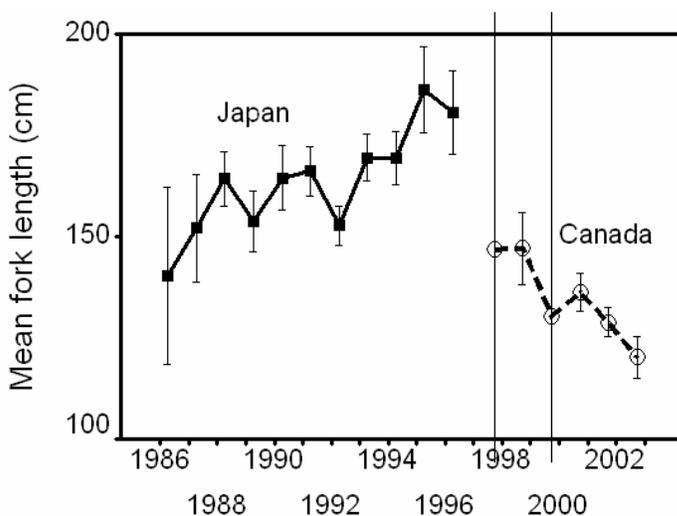


Figure 11. Long-term changes in the mean fork length of shortfin makos caught by Japanese (solid squares) and Canadian Atlantic (open circles) pelagic longliners. Error bars represent 95% confidence intervals around the mean. In both the Japanese and Atlantic Canadian fishery, observer coverage was sporadic in some years, resulting in fewer than 10 length measurements per year; these data are not presented, resulting in non-overlap of the two time series.

In summary, four indices of population trends are shown, two from international waters and two from Canadian waters. Both studies from international waters suggest

shortfin mako populations in the North Atlantic have likely undergone some level of depletion based on declines in catch rates. The trend presented by Baum *et al.* (2003) is the most reliable trend presently available to assess the status of shortfin mako at a large spatial scale because of its use of a single consistent data set (US longline fleet logbooks) and analytical methods. Confidence in the ICCAT series is weaker because of possible misidentification issues in years prior to 1995. Canadian indices consist of a catch rate model and a trend in median fork length. The catch rate time series from Canadian waters does not indicate any trend. Interpretation of biological data collected in Canadian waters is constrained by years of insufficient or absent data, but a recent decline in median fork length is apparent.

Because shortfin mako in Canadian Atlantic waters represent the margins of their distribution, trends derived from these data may be influenced by several ecological factors (e.g., ocean temperatures, prey abundance) that may naturally shift the abundance in Canadian waters over varying temporal and spatial scales. For this reason, analyses representing a larger spatial scale present a more accurate picture of the population as a whole.

Rescue effect

Canada's Atlantic waters represent a small portion of shortfin mako habitat. Population status and rescue effect at any given time in Canadian Atlantic waters depends heavily on the status of the population as a whole. If the ocean basin-wide population increases, so should the relative abundance in Canadian Atlantic waters and *vice versa*. Furthermore, this species distribution is largely influenced by temperature and therefore one would expect thermal oceanographic patterns to influence the relative abundance in Canadian Atlantic waters.

LIMITING FACTORS AND THREATS

Mortality from fishing, both directed and incidental, is the principal threat facing shortfin makos. Their slow intrinsic growth rate and low fecundity mean that even low levels of additional mortality could lead to population decline. Internationally there has been insufficient monitoring effort resulting in severe limitations in the quantity and quality of the data used in stock assessments (ICCAT 2005a). The resulting inability to monitor trends in population increases the uncertainty surrounding shortfin mako status. Longline effort in the Atlantic has steadily increased beginning in 1955, indicating that the potential for fishing mortality on shortfin makos has also increased (Figure 12). Under present fishing practices (i.e., gear type, seasons), decreasing catch on this species is only possible by lowering fishing effort for targeted pelagic species (i.e., tunas, swordfish) worldwide. Other threats such as pollution or contamination have not been investigated, but given that shortfin mako feed at a high trophic level, pollution could have long-term health effects on the population.

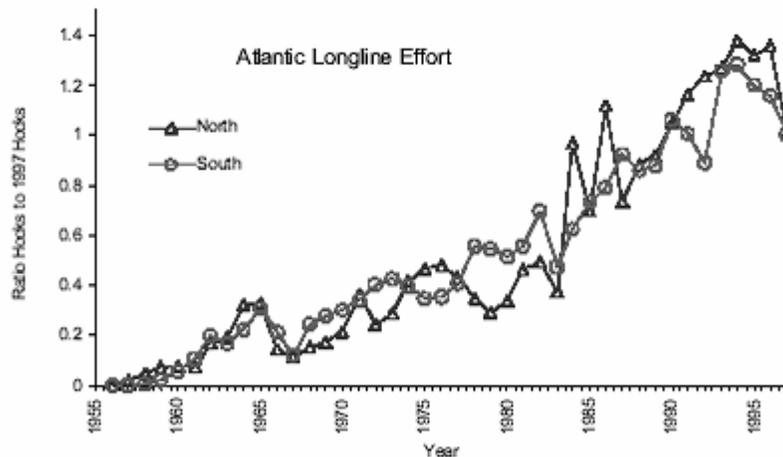


Figure 12. Trend in effort for the North Atlantic longline fleet (1956-1997). Source: ICCAT 2005a.

SPECIAL SIGNIFICANCE OF THE SPECIES

Although this species is not directly targeted in Canada, it is traded commercially in Atlantic Canada because of its high quality meat. Due to its energetic displays and edibility, it is highly prized by sport anglers as a game fish. The meat is utilized fresh, frozen, smoked and dried salted for human consumption; the oil is extracted for vitamins; the fins used for shark-fin soup; the hides processed into leather and the jaws and teeth used for ornaments. The shortfin mako is an opportunistic apex predator with a wide prey base and as such is likely important in structuring marine ecosystems.

EXISTING PROTECTION OR OTHER STATUS DESIGNATIONS

Protection of shortfin mako is limited to fisheries management regulations. In Atlantic Canada there is a non-restrictive catch guideline of 250 t for directed fisheries; however, there are no directed fisheries at the present time. There is no quota for bycatch in the Atlantic pelagic fisheries, which at present accounts for all the reported landings. Recreational fishing is restricted to catch and release. Removal of fins and discarding of the shark carcass at sea has been prohibited in Canada and the US for several years, and recently ICCAT imposed a regulation to prohibit finning on the high seas. Although on paper there appears to be some protection, in reality the shortfin mako in Atlantic Canada is not protected by catch limits because the catch guidelines apply only to directed catch, whereas all reported landings are actually bycatch (on which there is no limit). On Canada's Pacific coast, longlining fleets are prohibited from retaining any shark species (with the exception of dogfish), thereby protecting shortfin mako from a directed fishery in the event of an increase in abundance in Canada's Pacific waters. The IUCN assessed shortfin mako in 2000 and listed it as *lower risk/near threatened* (LR/nt).

TECHNICAL SUMMARY

Isurus oxyrinchus

Shortfin mako – Atlantic population

requin - taupe bleu

Range of Occurrence in Canada: Atlantic Ocean - Georges and Browns Bank, along the continental shelf of Nova Scotia, the Grand Banks and into the Gulf of St. Lawrence

Extent and Area Information	
<ul style="list-style-type: none"> • <i>Extent of occurrence (EO)(km²)</i> Sum across the annual Canadian distributional range determined from catches 	1,200,000 km ²
<ul style="list-style-type: none"> • <i>Specify trend in EO</i> 	Unknown
<ul style="list-style-type: none"> • <i>Are there extreme fluctuations in EO?</i> 	Unknown
<ul style="list-style-type: none"> • <i>Area of occupancy (AO) (km²)</i> Represents Canadian area of frequent and regular sightings (catches). 	800,000 km ²
<ul style="list-style-type: none"> • <i>Specify trend in AO</i> 	Unknown
<ul style="list-style-type: none"> • <i>Are there extreme fluctuations in AO?</i> 	Unknown
<ul style="list-style-type: none"> • <i>Number of known or inferred current locations</i> 	Widespread, non localized.
<ul style="list-style-type: none"> • <i>Specify trend in #</i> 	Not Applicable
<ul style="list-style-type: none"> • <i>Are there extreme fluctuations in number of locations?</i> 	Not Applicable
<ul style="list-style-type: none"> • <i>Specify trend in area, extent or quality of habitat</i> 	Habitat not considered to have changed
Population Information	
<ul style="list-style-type: none"> • <i>Generation time (average age of parents in the population)</i> 	14 years (minimum)
<ul style="list-style-type: none"> • <i>Number of mature individuals</i> 	Unknown
<ul style="list-style-type: none"> • <i>Total population trend: North Atlantic</i> 1. US longline 1986-2000 (Baum) 2. Japan and US longline 1971-2003 (ICCAT) 	1. 40% decline 2. 50% decline
<ul style="list-style-type: none"> • <i>Total population trend: Canadian North Atlantic</i> 1. Canada and Japan longline Scotian shelf 1988-2003 (Campana) 	1. No trend
<ul style="list-style-type: none"> • <i>Are there extreme fluctuations in number of mature individuals?</i> 	No
<ul style="list-style-type: none"> • <i>Is the total population severely fragmented?</i> 	No
<ul style="list-style-type: none"> • <i>Specify trend in number of populations</i> 	Considered one North Atlantic population
<ul style="list-style-type: none"> • <i>Are there extreme fluctuations in number of populations?</i> 	No
<ul style="list-style-type: none"> • List populations with number of mature individuals in each: Not Applicable 	
Threats (actual or imminent threats to populations or habitats)	
The primary threat is mortality from fishing operations where shortfin makos are taken as bycatch.	
Rescue Effect (immigration from an outside source)	
<ul style="list-style-type: none"> • <i>Status of outside population(s)?</i> Shortfin mako throughout the North Atlantic are considered to be a single population. Status in Canada is a reflection of the population as a whole. Indices of abundance indicate a decline in the North Atlantic population. 	
<ul style="list-style-type: none"> • <i>Is immigration known or possible?</i> 	Yes
<ul style="list-style-type: none"> • <i>Would immigrants be adapted to survive in Canada?</i> 	Yes (seasonal)
<ul style="list-style-type: none"> • <i>Is there sufficient habitat for immigrants in Canada?</i> 	Yes
<ul style="list-style-type: none"> • <i>Is rescue from outside populations likely?</i> 	Yes, but N. Atlantic source population is apparently in decline

Quantitative Analysis	Not undertaken
Current Status	
COSEWIC: Threatened IUCN: lower risk/ near threatened	

Status and Reasons for Designation

Status: Threatened	Alpha-numeric code: A2b
<p>Reasons for Designation: As a large (maximum length 4.2 m), relatively late-maturing (7-8 yrs) pelagic shark, the species has life-history characteristics making it particularly susceptible to increased mortality from all sources, including human activities. The species is circumglobal in temperate and tropical waters. Individuals found in Canada are considered part of a larger North Atlantic population. There does not appear to be any reason to assume that the Canadian Atlantic “population” is demographically or genetically independent from the larger Atlantic population, so the status of the species in Atlantic Canada should reflect the status throughout the North Atlantic. Although there is no decline in an indicator of status for the portion of the species that is in Atlantic Canada, two analyses suggest recent declines in the North Atlantic as a whole (40% 1986-2001; 50% 1971-2003). The main causes of the species’ decline (mortality due to bycatch in longline and other fisheries) are understood and potentially reversible, but these sources of mortality have not been adequately reduced.</p>	
<p>Applicability of Criteria</p> <p>Criterion A: (Declining Total Population): CPUE in the US longline fleet declined 41% between 1986 and 2000, while ICCAT analysis of longline data from Japan and US fleets showed a 50% decline from 1971-2003 (meets Threatened A2b). Very preliminary ICCAT estimates suggesting that the current Atlantic population is at approximately 31-33% of virgin biomass was given lower weight than the abundance trends. Analysis of longline CPUE in Canada (1988-2003) shows no trend but this index was given lower weight due to high variability and because it only represents part of the population (animals entering Canada).</p> <p>Criterion B: (Small Distribution, and Decline or Fluctuation): Not applicable</p> <p>Criterion C: (Small Total Population Size and Decline): Not applicable</p> <p>Criterion D: (Very Small Population or Restricted Distribution): Not applicable</p> <p>Criterion E: (Quantitative Analysis): Not applicable.</p>	

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