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Shortfin mako (*Isurus paucus*) incidental catch statistics in Canadian fisheries[1]

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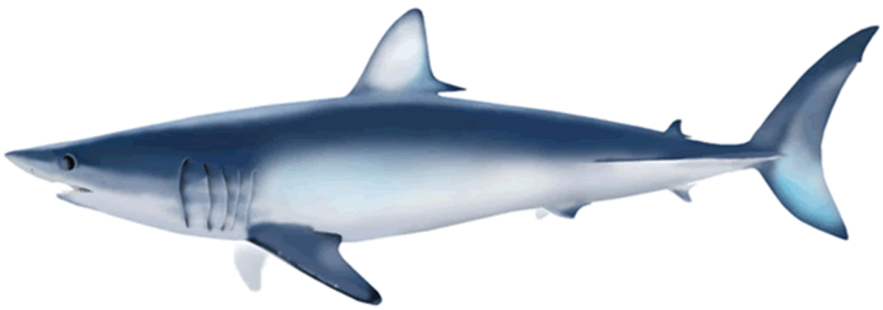

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Introduction

There are no directed Shortfin Mako Shark (*Isurus paucus*) fisheries conducted within Canadian waters; as such, all catch statistics are incidental encounters. Fishery encounters with Shortfin Mako Sharks are rare within Canadian waters. All commercial fisheries in Canada are covered by a dockside monitoring program which provides validated landings. There are no landings of incidentally encountered Shortfin Mako Shark. Currently, the groundfish trawl and longline fisheries have 100% observer coverage, with either an at-sea observer program or electronic monitoring to record discards of incidental catches at sea. Discards at sea of incidental catches by other commercial fisheries are based solely on fisher logbook data. There are historic records of discarded Shortfin Mako Sharks in the short-lived experimental squid fishery that operated outside and within Canadian waters during the 1980s.

Methods

Data were obtained from Fisheries and Oceans Canada (DFO) research staff at the Pacific Biological Station, from a variety of databases maintained by the Fishery and Assessment Data Section, (DFO Pacific Region) and the Regional Catch Statistics Unit (DFO Pacific Region), as well as from the literature. All data sources included details of individual fishing trips or catch offloading events associated with a date (capture date or offload date), fishing gear, species code, catch weight and/or count, and catch utilization (whether the catch was landed or discarded). Fishing gear types were categorized as "trawl" (bottom trawl, midwater trawl, surface trawl, and unknown trawl), "line" (longline, handline, and jig gear e.g. squid experimental fishery gear), and "other" (troll, trap, seine, gillnet). For non-trawl gears where the gear type was not specified, gear type was assumed to be "line" unless the vessel's fishing history indicated an alternative gear type. Commercial catches were either retained on the vessel and landed for sale, or discarded/released at sea. Landed catch for most commercial fisheries is validated by a third party at the landing port through dockside monitoring programs (DMP) and recorded on sales slips, while discarded catch is generally based on observer log books for observed fisheries, or on fisher log books for non-observed fisheries. Discard information varies in quality depending on the data source and time period. As requested by the ISC Shark Working Group, Canadian Shortfin Mako Shark catch statistics are compiled for 1979-2016.

<u>Groundfish Fisheries</u>

Trawl data from 1945 – 1995 are archived in the GFCatch database (Fishery and Assessment Data Section, DFO Pacific Region); however, discard information is considered unreliable for this time period, and no Shortfin Mako Sharks were recorded. Post-1995, commercial catch data for the groundfish trawl fishery were obtained from the PacHarvTrawl database for 1996 – 2006 and the GFFOS database for 2007 – 2016 (Fishery and Assessment Data Section, DFO Pacific Region). Trawl data from 1996 is based on 100% observer coverage of the fishery, consisting of tow-by-tow information including georeferenced capture location, as well as estimates of discarded weight (kg), and is generally considered reliable. Landings are based on validation records from the dockside monitoring program. There were no Shortfin Mako Shark encounters in this fishery.

Prior to 1997, discard information for groundfish line fisheries is not available. Landings from 1982 – 1995 are available from sales slip data archived in the PacHarv3 database (Fisheries and Oceans Canada, Pacific Region, Regional Data Services Unit); however there were no Shortfin Mako Sharks landed by the groundfish line fisheries during this period. From 1997 onwards, commercial catch data for the groundfish line fisheries were obtained by fishery from the PacHarvHL database (1997 – 2005), PacHarvSable database (2000 – 2005) and the GFFOS database for 2006 – 2016 (Fishery and Assessment Data Section, DFO Pacific Region). Line data include landings based on validation records from the dockside monitoring program, as well as records of retained and discarded catch from fisher logbooks when available. Landings based on validation records are considered reliable (catch is weighed at the dock). Logbooks provide tow-by-tow information including georeferenced capture location, retained catch, and discarded catch, but retained and discarded catch may be visual estimates, and are often only available as piece counts. The quality and completeness of logbook records prior to 2005 is variable, and may be poor; from 2006 onwards, data from logbook records including discard information may be more reliable due to electronic monitoring. There were no Shortfin Mako Shark encounters in this fishery.

Salmon Fishery

Data on incidental catches of sharks in the commercial salmon troll, gillnet, and seine fisheries for 2001 – 2015 were provided by the Salmon Data Unit (S. Hamilton, DFO Pacific Region, pers. comm) and include landing date, area of capture, landings, and discards. Catches are reported in pieces and are based on daily phoned-in catch reports and annual fisher logbook submissions. The quality and completeness of the information is unknown. There were no Shortfin Mako Shark encounters in this fishery.

Sardine Fishery

The Canadian Pacific Sardine fishery is an opportunistic fishery dependent on the migration of Pacific Sardine into British Columbia waters. Pacific Sardine was absent from much of the west coast of North America from the late 1940s to the early 1980s , and commercial harvest of Pacific Sardine in British Columbia did not resume until 2002 (DFO 2012). A purse seine fishery for Pacific Sardine operated in British Columbia from 2002 – 2012; from 2013 onwards, Pacific Sardine have again been absent from British Columbia waters (DFO 2015). Data on incidental catches of sharks in the sardine fishery in 2002 – 2012 were provided by L. Flostrand (DFO Pacific Region, pers. comm) and include landing date, area of capture, validated landings, and discards based on fisher logbooks. The quality and completeness of discard information is unknown. There were no Shortfin Mako Shark encounters in this fishery.

Albacore Tuna Fishery

The North Pacific Albacore Tuna troll fishery is operated under a treaty between the governments of Canada and the United States (US) which allows Canadian and US vessels to fish inside

both Canadian and US waters. Data on incidental catches of sharks in Canadian waters by Canadian vessels in the tuna troll fishery in 1995 – 2016 were provided by J. Holmes (DFO Pacific Region, pers. comm) and include capture date, georeferenced capture location, and discards (pieces) based on fisher logbooks. The quality and completeness of the discard information is unknown, although the quality is thought to increase from about 2006 onwards (J. Holmes, DFO Pacific Region, pers. comm). One single Shortfin Mako Shark encounter was recorded in each of 1992 (Gillespie and Saunders, 1994) and in 2014.

Squid Experimental Commercial Fisheries

Experimental fishing for Neon Flying Squid (*Ommastrephes bartrami*) was conducted using drift gillnets on 12 commercial trips in 1979, 1980, 1983, and 1985 - 1987 off the west coast of British Columbia. Experimental fishing trips were conducted with an observer on board whose duties included accurately identifying bycatch species, including sharks. Data from each trip are available in six reports (Bernard 1980 , Bernard 1981, Sloan 1984, Robinson and Jamieson 1984, Jamieson and Heritage 1987, Jamieson and Heritage 1988) and consist of tow by tow information, including georeferenced fishing locations and incidental catches recorded as weights (kg) and/or counts (pieces). Data are considered reliable, and Shortfin Mako Shark encounters were recorded as occurring in this fishery.

Experimental fishing for flying squid using jig gear occurred in 1987 and 1990 – 1991. Experimental fishing trips were conducted with an observer on board whose duties included accurately identifying bycatch species, including sharks. Data from each trip are summarized in two reports (Jamieson and Heritage 1988; Shaw and Smith 1995) and include total catch weight of incidental species by trip for catches within and outside Canadian waters; no detailed catch locations are available. Data are considered reliable, and Shortfin Mako Shark encounters were recorded as occurring in this fishery.

Pilot commercial jig fisheries were conducted in 1996 – 1998 (Gillespie and Shaw 1997; Campagna et al. 2000). A portion of the commercial trips were observed; however, even on observed trips, bycatch reporting may have been incomplete (Campagna et al. 2000). No sharks were reported.

Joint Venture / Foreign Fisheries

Foreign trawl fisheries for Pacific Hake (*Merluccius productus*) in Canadian waters occurred from 1966 – 1992 off the west coast of Vancouver Island (Hicks et al. 2013); data on incidental catches from foreign "national" fisheries are available from the Groundfish Biological Samples (GFBio) database (Fishery and Assessment Data Section, DFO Pacific Region) for 1977 – 1992, and include shark catches recorded as weights or as piece counts; the quality and completeness of the data is unknown. There were no Shortfin Mako Shark encounters in this fishery.

From 1978 – 2011, Canadian and foreign vessels participated in a joint venture trawl fishery for Pacific Hake, whereby Canadian catcher vessels delivered Pacific Hake and incidental species to foreign processing vessels in cooperative fishing arrangements. In addition, foreign processing vessels involved in the joint venture fishery at times fished directly (supplemental fishing) when Canadian domestic vessels could not supply sufficient quantities of Pacific Hake. Data on incidental catches in the joint-

venture and foreign "supplemental" fisheries are available from the Groundfish Biological Samples (GFBio) database (Fishery and Assessment Data Section, DFO Pacific Region) and include shark catches recorded as weights or as piece counts. All joint venture catches are monitored by at-sea observers; therefore the quality of the data is assumed to be reliable. There were no Shortfin Mako Shark encounters in this fishery.

Results and Discussion

The only Canadian commercial fisheries with recorded Shortfin Mako Shark are the short-lived experimental squid fishery that operated in the 1980s and the albacore tuna fishery. Catch estimates are all less than 0.1 tonnes (Table 1) and Shortfin Mako Sharks are rarely encountered, with only 5 years from 1979-2016 with incidental catches. While it is possible that fisheries with reliance on fisher logbooks have unreported Shortfin Mako Shark encounters, it should be noted that this species has never been encountered within Canadian waters in any research survey – indicating the rarity of occurrence of this species in Canadian waters. If underreporting has occurred, the changes to catch estimates provided in Table 1 would likely be nominal.

It is also possible that Shortfin Mako Sharks have been unidentified, and reported within the category Mackerel Sharks (family Lamnidae). Catches of unidentified Mackerel Sharks have been recorded in the groundfish trawl fishery, the groundfish line fishery and salmon fisheries. All Mackerel Shark catches recorded are less than 1.0 tonnes, typically less than 0.20 tonnes, and are discarded (Table 2). A common Mackerel Shark in Canadian waters is Salmon Shark (*Lamna ditropis*) and it is likely that sharks recorded within this Mackerel Shark category are mainly that species. However, the catches may include Shortfin Mako Shark or Great White Shark (*Carcharodon carcharias*) which also occurs rarely in Canadian waters.

Table 1. Catches (tonnes) of Shortfin Mako Shark (*Isurus paucus*) from Canadian commercial fisheries in 1979 – 2016. Shortfin Mako Sharks were only encountered in the short-lived (1979-80, 1983, 1985 - 1987, 1990-91) experimental squid fishery and in the albacore tuna fishery. All catches were discarded. Years without recorded catch can be assumed to be zero.

	Fishery		
Year	**Squid**	**Tuna**	**Total**
1979			
1980	0.09		0.09
1981			
1982			
1983			
1984			
1985			
1986	0.04		0.04
1987	0.10		0.10
1988			
1989			
1990			
1991			
1992		0.04	0.04
1993			
1994			
1995			
1996			
1997			
1998			
1999			
2000			
2001			
2002			
2003			
2004			
2005			
2006			
2007			
2008			
2009			
2010			
2011			
2012			
2013			
2014		0.04	0.04
2015			
2016			

Table 2. Catches (tonnes) by fishery of unidentified Mackerel Sharks (family Lamnidae) from Canadian commercial fisheries 1979-2016. These sharks likely represent catches of Salmon Shark (*Lamna ditropis*) but may include Great White Shark (*Carcharodon carcharias*) and/or Shortfin Mako (*Isurus oxyrinchus*). Catches were reported in the groundfish trawl fishery, the groundfish line fishery and in salmon fisheries. All catches were discarded. Years without recorded catch can be assumed to be zero.

	Fishery			
Year	**Trawl**	**Line**	**Salmon**	**Total**
1979				
1980				
1981				
1982				
1983				
1984				
1985				
1986				
1987				
1988				
1989				
1990				
1991				
1992				
1993				
1994				
1995				
1996				
1997				
1998				
1999				
2000	0.73			0.73
2001	0.04		0.86	0.90
2002			0.15	0.15
2003				
2004				
2005	0.04		0.05	0.09
2006		0.10	0.30	0.41
2007	0.09	0.10		0.19
2008				
2009		0.10		0.10
2010			0.36	0.36
2011		0.05		0.05
2012		0.20		0.20
2013		0.20		0.20
2014	0.07			0.07
2015				
2016				

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