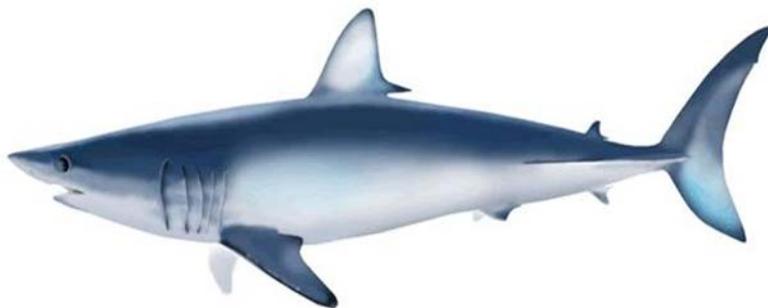


Unofficial blue shark catch estimations for the Mexican Pacific (1976-2011)¹

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Abstract

This document presents estimates for the blue shark catches landed at ports or fishing camps along the coasts of five Mexican states, located in the Pacific, for the period of 1976 to 2011. Mexican shark catch statistics by species were not available until 2006, so past blue shark catches have to be estimated. Here an unofficial estimate using different sources of information is suggested to the ISC SHARKWG. This estimate assumes that blue shark has been represented in total catches with different proportions through time. The values of the proportions were obtained from published papers in the scientific literature or by using more detailed local statistics. In Mexico, blue sharks are caught mainly by the artisanal and mid-size long-line fisheries, which target pelagic sharks or swordfish. Catches that were landed in the past by the former large size vessel long-line fisheries and the drift gill net fisheries were taken into consideration to construct the historical series. Historically, blue shark was not an important species in catches; however, catches have increased from levels of less than 500 t in the 1970s to around 1,000 in the 1990s, and to around 4,000 t in the second half of the 2000s. Estimates indicate that blue sharks are caught mainly in the western coast of the Peninsula of Baja California. Also, in order to facilitate the assessment by the ISC SHARKWG, information on blue shark size frequencies in the catches is added, from information of studies analyzing mainly the artisanal fisheries in the region. The results of these studies suggest that a large proportion of the catch is represented by juvenile sharks.

Introduction

Pelagic sharks have been targeted within the exclusive economic zone off Mexico's Pacific Coast by the artisanal fishery, the pelagic long-line fishery, and the former drift gillnet fishery (Holts et al. 1998; Sosa-Nishizaki et al. 2008). In the catch compositions of these fisheries, blue shark has become an important species, and even more, has become a target species off the west coast of the Baja California peninsula.

Until recently, shark landings in Mexico were not reported by species, but were divided into two groups based on the length. Sharks larger than 150 cm total length (TL) were reported as "Tiburón", while shark less than 150 cm TL were reported as "Cazón". Since 2006, reports with the species composition of the landings began to be published (http://www.conapesca.sagarpa.gob.mx/wb/cona/consulta_especifica_por_produccion) by the official Mexican fisheries agency, the National Commission for Fisheries and Aquaculture (CONAPESCA, based in its name in Spanish). Unfortunately, in these reports, landings categorized as "Species not specified" are still listed, showing possible misreporting. However, the level of classification into species has shown an improvement during time for some of the state's catch statistics.

The objective of this document is to detail how Mexican blue shark landings from 1976-2011 can be estimated, based on a time series without species composition, using the "Tiburón" or shark category only. Also, in order to facilitate the assessment of the species, the blue shark size frequency distributions in the catches is included, based on information from several published papers that describe Mexican shark fisheries in the Pacific. This report was categorized as an unofficial estimation, because the author is not part of the Mexican delegation of the ISC SHARKWG.

Material and Methods

Catch data

Aggregated shark catches from Mexico's Pacific waters were provided by the Mexican National Institute of Fisheries and Aquaculture (INAPESCA, based on its name in Spanish) for each state, for the period of 1976-2010. Blue shark is primarily landed at the Baja California, Baja California Sur, Sinaloa, Nayarit and Colima states and the estimations are based on the reported total shark catches for these states. The states of Oaxaca and Guerrero have very few reports, with catches less than 0.2 t, so they were not included. For the period of 2007 to 2011, blue shark catches by state are reported as reported by CONAPESCA on its web page (see above), except for the state of Baja California. The estimated blue shark catches for each of the states, followed different assumptions for the proportion that blue sharks represented in the total shark catch.

Baja California

In Baja California sharks are fished by the artisanal fishery (1976-2011) that targets primarily sharks. The mid-size vessels (10-17 m size) drift gillnet fishery started in 1986 targeting sharks and swordfish. In the beginning blue sharks were not landed, except for their fins, because of the lack of market or low value. Blue shark started to be landed in 1993. This fishery was halted by federal regulations in 2010. In the middle of the 1990s, some of the drift gill net fishing vessels started to switch fishing gear to long-lines, but still targeting swordfish, intensifying their search for pelagic sharks, mainly blue shark and short fin mako shark (Holts et al. 1998; Sosa-Nishizaki et al. 2008).

The state of Baja California has two coasts, one facing the Pacific Ocean and the other the Gulf of California. Available official statistics were pooled, so shark landing statistics have to be separated by coast first. Because blue shark is only landed in the Pacific side, the proportion of the total shark landings that come from the Pacific coast was obtained using statistics from the Mexican fisheries agency office at the port of Ensenada. These statistics contained shark landings classified by coast for the period of 1992 to 2010, and since 2002 blue shark landings, in weight, were specified for some of the years.

Based in the information reported in Sosa-Nishizaki et al. (2002), Sosa-Nishizaki et al. 2008, and Cartamil et al. (2011), the proportion of blue shark caught by the artisanal fishery was estimated to be 5% of the total yearly catch of sharks caught in the Pacific side. During the 1976 to 1989 period the total blue shark catches were assumed to be landed by the artisanal fishery only, and yearly blue shark catches were estimated using this proportion.

By 1990 the number of artisanal boats targeting blue shark increased, and some of the mid-size boats started to land blue shark, instead of finning them at sea. In order to reflect this increment, for the period of 1990 to 1992 I assumed that a proportion of 15% of the shark catches were represented by blue shark catch. Since 1993, most of the mid-size vessels started to land blue shark, and local landing statistics started to be classified to identify blue shark catches, and a proportion of 55% of the total shark catches was estimated for the period of 1993 to 2007. However, the proportion increased during the period of 2008 to 2011, and blue shark landings represented a mean of 60% and this proportion was used in the shark catches landed in the Pacific side.

For the case of Baja California, I decided to not use the blue shark catches reported by CONAPESCA in its web page since 2006, because statistics were very different when compared with my own estimations based on field observations and the catch statistics available by species locally. Nonetheless, I used CONAPESCA web page blue shark catch statistics for the other states.

Baja California Sur

In Baja California Sur, most of the blue shark catches come from the artisanal long-line fishery at both coasts in the Pacific side and Gulf of California (Bizzarro et al. 2009b; Ramirez-Amaro 2011). Although, at Puerto San Carlos in Magdalena Bay of the Pacific coast, a mid-size fleet of small number of vessels (4-8 depending the year), have been fishing with drift gillnet and long-line since the middle of 1990s (Ramirez-Gonzales 2002), and was considered in these estimations.

The proportion of blue sharks in the total shark catches of Baja California Sur were estimated for different periods. From 1976 to 1984, 11% was considered to be the proportion that represents the blue shark catches, based on the information reported by Bizzarro et al. (2009b), and considering that fishing in the Pacific coast was less developed. From 1985 to 1989, 20% was used by considering the development of the artisanal fishery in the Pacific coast and the continuation of the fishery in the Gulf of California (Bizzarro et al. 2009b; Ramirez-Amaro 2011). For the period of 1990 to 2000, the proportion was raised to 31% to include the participation of the mid-size vessels based in Puerto San Carlos. And for the period 2001 to 2006 the proportion was raised once more, to 35% to reflect the continuity of the increment of the blue shark catches in recent years, suggested by Ramirez-Amaro (2011). From 2007 to 2011, the catches of blue shark reported by CONAPESCA on its web page were used. These catches represented an average of 49% of the total shark catch in the state for that period.

Sinaloa

Bizzarro et al. (2009a) described the artisanal catches of elasmobranchs in the state of Sinaloa, during 1998-1999, and found only one blue shark among 2,390 sharks analyzed. However, in the port of Mazatlan blue sharks are usually landed by the mid-size vessel long-line fishery that is based there. This fishery is one of the less known shark fisheries in the country. The blue shark catch estimations for this state were done considering only the proportion of the total sharks landed in Mazatlan.

For the period of 1976 to 1993, because of the lack of information, I assumed that 50% of the sharks landed in Sinaloa were landed in Mazatlan. For the period of 1994 to 2011 we have access to data reporting the proportion of sharks landed in Mazatlan in yearly bases, with values varying from 47% to 94%. These values were used to estimate shark catches landed at Mazatlan.

Knowing the total shark catches landed in Mazatlan, for the period of 1976 to 1992 a 5% value was used as the proportion of blue sharks caught by the local artisanal fishery, assuming that it was the only fishery during those years and taking into consideration the artisanal catches of the neighboring state of Nayarit (see below). The assumption was supported knowing that during those years, mid-size boats of Sinaloa were concentrated

mainly on fishing shrimp in the Gulf of California. To estimate the following years, first, the proportion of blue sharks landed in Mazatlan during 2007 to 2011 was estimated, based on the reports for Sinaloa by CONAPESCA in its web page (http://www.conapescasagarpa.gob.mx/wb/cona/consulta_especifica_por_produccion). A value of 12% was obtained, and this proportion was used to estimate the blue shark catch for the 1993 to 2006. The year of 1993 was assumed to be the first year when catches of blue shark started to increase, taking into consideration what happened in Baja California. For the period of 2007 to 2011, blue shark catches are here reported with values reported in CONAPESCA yearly report, published in his web page.

Nayarit

Since 2003 the Nayarit state has almost double its “tiburón” and “cazón” landings from a level of 843 t to 1,594 t in 2011 (CONAPESCA 2011). In this state, sharks are landed only by the artisanal fishery. Pérez-Jiménez et al. (2005) estimated that blue shark represented 5% of the catches in fishing operations at the most important fishing areas of Nayarit. I used this proportion to estimate the blue shark catches for this state, during the period of 1976 to 2006. Then catches reported by CONAPESCA web page were used.

Colima

Blue shark catches in the state of Colima are landed mainly in the port of Manzanillo, where a large size vessel long-line fishery operated during the period of 1986 to 2002 (Mendizabal y Oriza et al., 2002). Before that period most of the fishing was carried out by the artisanal fishery. Since 2003, a middle size vessels (10-14 m long) long line fishery, started to operate targeting sharks from the costal pelagic waters (Vögler et al., 2012).

Yearly blue shark catches for the Colima state were estimated, assuming artisanal fishing operations only, for the period of 1976 to 1986, using a proportion of 5% similar to Nayarit. Then for the period of 1986 to 2002, I used the yearly proportions of blue shark reported by Mendizabal y Oriza et al., (2002). Then a proportion of 19% was used to reflect the catches of blue shark by the coastal middle size vessels (Santana-Hernández personal communication), for the 2003 to 2006 period. Finally, I used the reported blue shark catches for the state by CONAPESCA.

Blue shark size data

In order to show the known size frequency distribution in the blue shark catches in Mexico, a compilation of figures from the different published papers was carried out (Sosa-Nishizaki et al. 2002; Pérez-Jiménez et al. 2005; Bizarro et al. 2009b; Cartamil et al. 2011; and Ramirez-Amaro et al. In press).

Results and Discussion

Catch data

Blue shark catch estimations are shown in Table 1. Catches show a constant increasing trend since 1990, from a level of 1,130 t to 4,469 t in 2010, to decrease to 3,719 t in 2011. Baja California seems to be the most important landing place for the species, followed by Baja California Sur.

In order to test the quality of these estimations, the catches reported by CONAPESCA for the period of 2007 to 2011, were compared with the estimated catches for the same period, using the empirical proportion assumed to estimate the catches for the periods between 2000 and 2006. On average, the difference between estimated catches with those reported were less than $\pm 10\%$ for all the states except in Baja California. And these results confirm the decision for the states of Baja California Sur, Sinaloa, Nayarit and Colima to use of reported blue shark data by CONAPESCA's web page, and are suggested to be use in the assessment. In the case of Baja California, an overestimation was constantly seen when comparing estimated data with reported data. However, estimated catches were based on local information and observations done in ports by observers of the Fisheries Ecology Laboratory of CICESE. For Baja California, it is suggested that estimated catches for the entire time series be used, and they are included in Table 1. Finally, these estimations, are unofficial, and they were based on information publicly available, so an official version might include information not available to the author, and possible differences might occur when Mexican official data are available for the assessment.

Blue shark size data

Sosa-Nishizaki et al. (2002) published length frequencies distributions of blue sharks sampled from catches of the artisanal and drift gillnet fisheries based in Ensenada, during July 1999 to May 2000 (Figure 1). The catch of the small size vessels had a sex ratio (F:M) of 1.05:1, with specimens between 69 to 250 cm of total length, although the mode was in the 100-109 cm bin. While the catch of the mid-size vessels had a sex ratio of 1.3:1, with specimens between 87-280 cm of total length with a modes one at 160 cm and other in 210 cm. In both fisheries the majority of the specimens were considered juveniles.

Perez-Jimenez et al. (2005) reported the length frequency distribution of 505 blue sharks caught in waters off Nayarit by the local artisanal long-line fishery, during 1996-1996 and 2001. Sharks had a size range of 165 to 205 cm in total length, with a sex ratio of 1.95:1 (F:M) (Figure 2).

During 1998-1999, Bizzarro et al. (2009b) sampled 83 artisanal fishery landing sites in the Gulf of California coast of Baja California Sur. They recorded 111 blue sharks, but only 92 were sampled, dominated by males, representing 73.9% of the total. Specimens ranged from 133–275 cm stretched total length (STL) (Fig. 3), and average size of males (199.1 ± 22.5 cm STL) and females (201.7 ± 23.0 cm STL) was similar within the landings ($t = 0.4901$, $P = 0.625$).

Cartamil et al. (2011) sampled 1068 blue shark at Laguna Manuela artisanal landing site fished with long-line in Vizcaino Bay of the Baja California's Pacific coast, during 2006 to 2008. Female blue sharks (150.5 ± 29.1 cm TL) were significantly larger than males (132.7 ± 22.2 cm TL) (Fig. 4), and were also present in significantly larger proportion ($n = 679$) than males ($n = 348$). The size range of blue sharks suggested juvenile status.

Ramírez-Amaro et al. (In press), examined a total of 3,351 individuals from artisanal fishery observed landings. Female and male blue sharks averaged 135.6 ± 1.0 cm TL and 144.5 ± 0.92 cm TL, respectively (Fig. 5). Males ($n=1993$) were captured more frequently

than females (n=1358), therefore the sex ratio differed significantly from the ratio 1:1 ($\chi^2_{0.05, 1} = 120.33$; $P < 0.001$) and the catches were dominated by juveniles in this study.

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Table 1. Mexican blue shark landing estimations in tons (live weight) for the main states with blue shark landings. BC= Baja California, BCS= Baja California Sur, SIN= Sinaloa, NAY= Nayarit, and COL= Colima.

Year	BC	BCS	SIN	NAY	COL	TOTAL
1976	25	291	28	7	22	374
1977	14	315	28	9	19	386
1978	14	467	31	25	25	561
1979	17	194	41	64	23	338
1980	32	193	7	61	44	336
1981	44	87	24	66	35	256
1982	71	139	23	43	29	306
1983	63	143	18	27	42	293
1984	41	105	20	18	79	263
1985	15	140	16	17	40	227
1986	31	203	13	28	131	407
1987	54	244	16	14	23	351
1988	63	402	12	12	20	509
1989	34	157	12	22	55	280
1990	212	450	17	22	429	1,130
1991	149	404	16	22	424	1,016
1992	276	668	15	19	659	1,636
1993	938	770	141	15	676	2,540
1994	827	486	74	17	352	1,758
1995	572	778	48	19	682	2,100
1996	825	813	96	16	1,367	3,117
1997	925	651	120	11	1,241	2,948
1998	1,241	546	82	19	1,247	3,134
1999	792	1,082	149	21	218	2,261
2000	1,404	908	193	48	166	2,719
2001	1,612	665	116	33	162	2,587
2002	1,552	566	170	28	207	2,524
2003	1,445	438	242	23	158	2,307
2004	2,265	611	694	37	175	3,781
2005	1,420	670	455	21	155	2,721
2006	1,474	622	551	17	102	2,765
2007	1,774	776	554	13	207	3,324
2008	2,088	1,171	812	57	227	4,355
2009	2,438	949	779	48	209	4,423
2010	2,206	1,523	540	93	107	4,469
2011	1,810	1,228	477	47	157	3,719

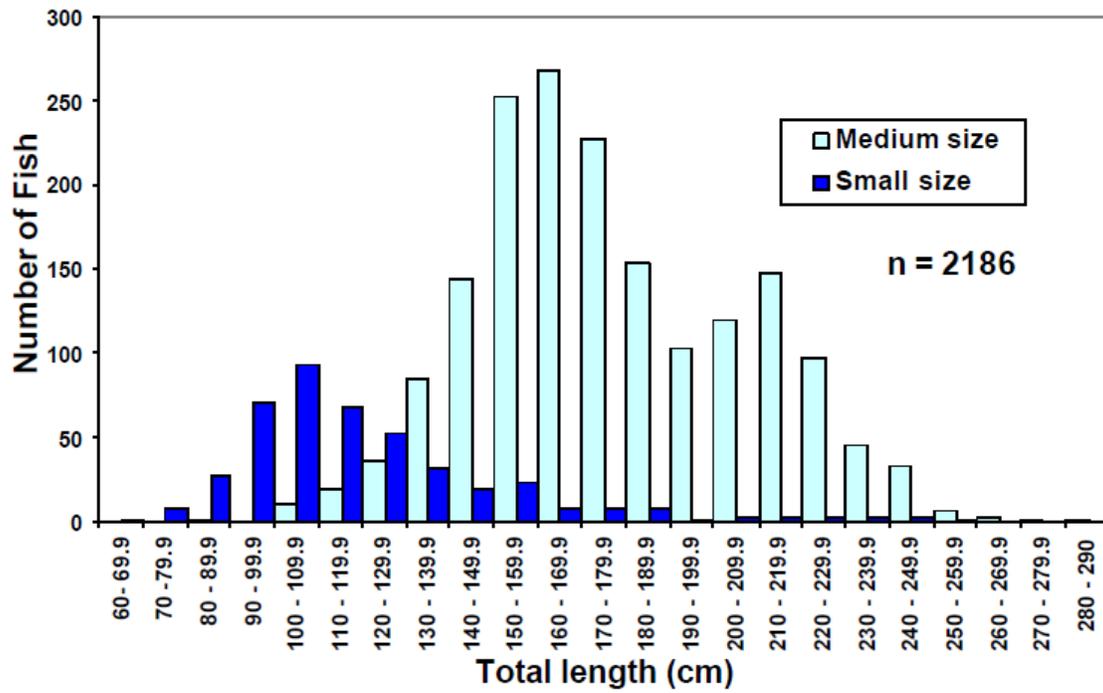


Figure 1. Blue shark total length frequencies distributions by middle scale and small scale (artisanal) fisheries (Sosa-Nishizaki et al. 2002), landed at Ensenada in Baja California.

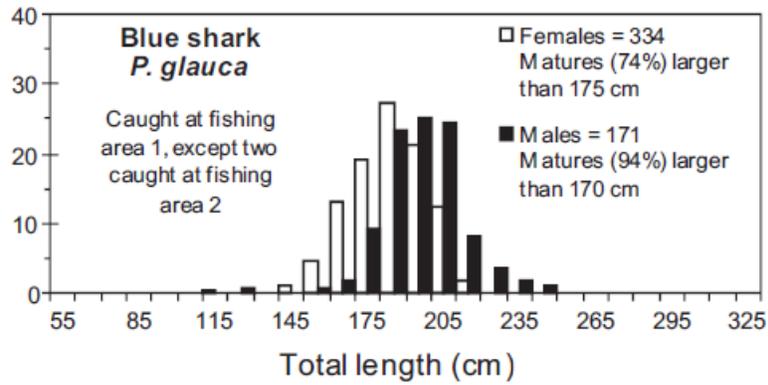


Figure 2. Size frequency distribution of blue sharks by sex sampled in waters off Nayarit by the local long-line artisanal fishery (Pérez-Jiménez et al. 2005).

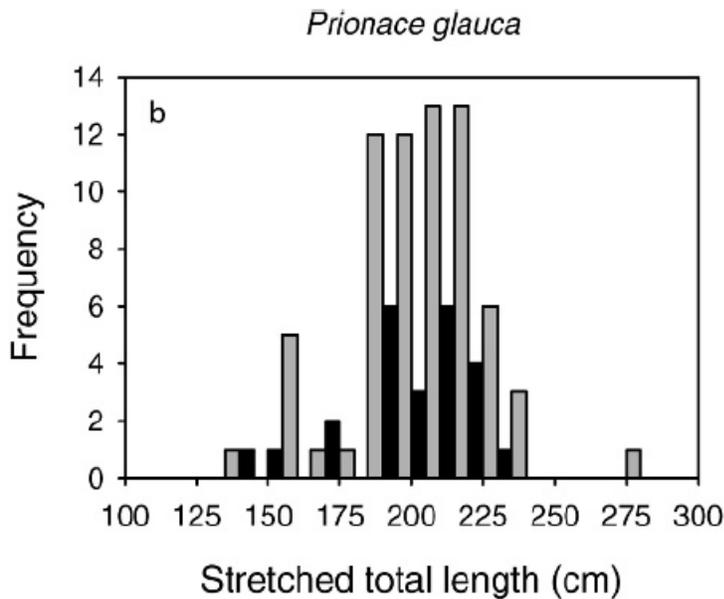


Figure 3. Size frequency distribution of blue sharks by sex sampled in waters of the Gulf of California off Baja California Sur by the local long-line artisanal fishery (Bizzarro et al. 2009b). Females (n= 25) are depicted in black, and males (n=68) in grey.

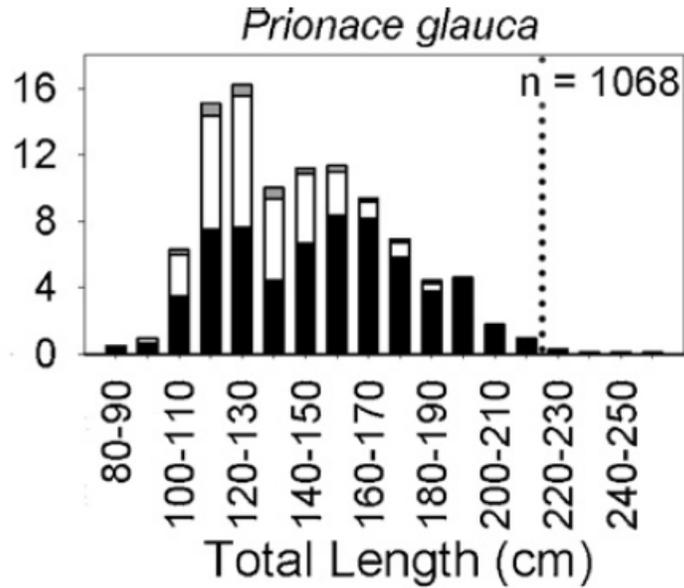


Figure 4. Size frequency (%) distribution by sex, of blue sharks sampled at Laguna Manuela in Vizcaino Bay, Baja California, from the local long-line artisanal fishery (Cartamil et al. 2011). Females are depicted in black, males in white, and sex unknown in grey.

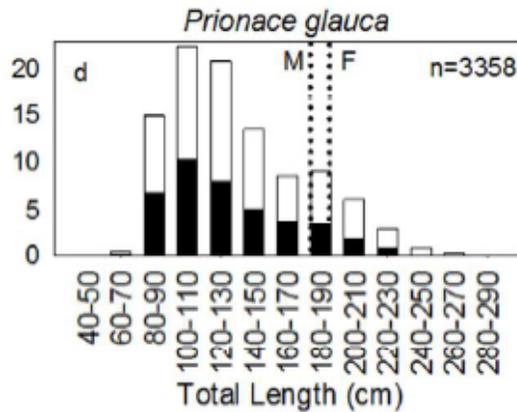


Figure 5. Size frequency (%) distribution by sex, of blue sharks sampled at 60 artisanal fishing camps located in the Pacific coast of Baja California Sur, during 2000 to 2010 (Ramírez-Amaro et al., In press). Sharks were fished by artisanal long-line. Females are depicted in black, and males in white. Dotted lines indicate size at maturity.