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Estimates of Mexico's blue shark catch from 1976 - 2010[1]

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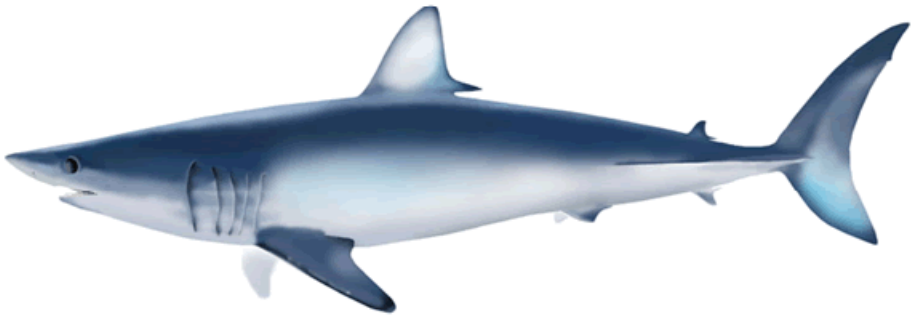

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Executive Summary

The purpose of this document is to detail how blue shark catches have been estimated for Mexico from 1976-2010, using a combination of catch statistics from INAPESCA (Mexico) and publicly available information. Catch is estimated from three vessel size classes: small (artisanal: shark target); medium (drift gillnet and longline: swordfish and shark target); and large (longline: tuna target). While there are many assumptions and uncertainties about these data, these estimates are the only ones currently available to the ISC Shark Working Group (SHARKWG) about the magnitude of blue shark catch from Mexico's fisheries.

Introduction

The ISC SHARKWG is conducting an assessment of blue sharks in the North Pacific Ocean in 2013. The purpose of this document is to detail how blue shark catches have been estimated for Mexico from 1976-2010, using a combination of catch statistics from INAPESCA (Mexico) and publicly available information. Artisanal fisheries began targeting blue sharks in the early 1990's when a market developed for the species (Sosa-Nishizaki et al. 2002). Mid-sized vessels (approximately 35 ft) targeting swordfish with longline and drift gillnet gear (DGN) are known to catch significant blue shark as bycatch. Blue sharks are known to be an important bycatch species by longliners targeting tunas (bigeye and yellowfin) worldwide, and Mexico has a tuna longline fleet. Catches are estimated for three vessel categories: small (artisanal DGN and longline: shark target), medium (DGN and longline: swordfish and shark target), large (longline: tuna target).

Materials and Methods

Catch data

Aggregated shark catches from Mexico's Pacific waters were provided by INAPESCA for each state from 1976-2010. Pacific states are Baja California, Baja California Sur, Sonora, Sinaloa, Nayarit, Jalisco, Colima, Michoacan, Guerrero, Oaxaca, and Chiapas (Figure 1). However, INAPESCA scientists indicated blue sharks are landed in Baja California, Baja California Sur, Sinaloa and Colima.

Weighting catch data – geographically

Blue sharks occur in temperature and tropical waters, but relative abundance is known to be lower in tropical waters (Kleiber et al. 2009). The Pacific coast of Mexico spans tropical to temperate, and it is known that they are not as abundant in southern Mexican waters as they are in northern Mexican waters. It is also known that blue shark abundance is lower on the Gulf of California side of the Baja Peninsula than on the Pacific side. It is therefore assumed that the abundance of blue sharks is not equal across all Mexican states, and relative weighting factors (high=1.0, medium=0.5 and low=0.25) are used to account for this. INAPESCA catches were multiplied by these factors for each state to adjust for assumed differences in relative abundance. The states given high weights were Baja California and Baja California-Sur; medium

weights for Sinaloa; and low weights in Colima, with all other states assumed to have zero catch of blue sharks.

Catch composition information

INAPESCA shark catches are categorized as 'Cazon' and 'Tiburon', meaning sharks shorter than 1.5m or under 5kg, and greater than or equal to 1.5m long or heavier than 5kg, respectively. Blue sharks are assumed to be primarily part of the 'Tiburon' category, based on input from Mexican scientists and IATTC staff. Three fisheries were identified based on vessel size and target species. Catch compositions by vessel sizes and species were determined from multiple information sources. Sosa-Nishizaki et al. (2002) estimated catches by vessel size (small-artisanal and medium sized vessels) from Pacific states during 1990-1999 (proportions were visually estimated from Figure 3 of their report).

Species composition from artisanal fishing camps where fishing effort comes from small 'pangas' was taken from Santana-Morales (2008) (page 15, Table 2). Catch compositions (including shark bycatch) from medium-sized vessels during 2006-2007 were derived from Dreyfus et al. (2008) (page 18, Figure 13). Ratios of longline target species (tunas, swordfish, mahi mahi) to bycatch species (including blue shark) and catch rates of bycatch in different Pacific fisheries (Western Pacific, Central Pacific, Eastern Pacific) were found in Bartram and Kaneko (2004) (page 23, Table 14).

Large vessel (tuna longline) effort was extracted from IATTC fishery status reports (FSR) (http://iattc.org/FisheryStatusReportsENG.htm). In the 2002 and 2006 FSR, Mexico's total longline effort and tuna catch are estimated, but in the 2012 FSR they are combined in the 'Other' category in which nations with 3 or fewer vessels operating are aggregated to prevent identification of individual vessel data (a rule agreed upon by nations sharing their EPO data with IATTC). When looking at overlapping years of Mexico data in 2002 & 2006 FSR, marked changes in reported effort and catch are apparent. For example, effort reported for 1983 in the 2002 FSR report is 950,000 hooks, but in the 2006 FSR the 1983 effort reported is only 1000 hooks. It is assumed that catch and effort initially reported included small and/or medium sized vessels in the early FSR's, but were adjusted to only include large vessel information in the 2006 FSR (thus removing small and medium vessels). As the number of vessel decreased through time, there were eventually 3 or fewer vessels in the fishery, thus were aggregated in 'Other' in the 2012 report. Anecdotal information from personal communications with Mexican shark experts and IATTC staff suggests this could be a reasonable assumption. Thus, large vessel catches are estimated from 1983-2004 by multiplying tuna effort from the 2006 FSR by blue shark by the average bycatch rates tuna fisheries (0.055 blue sharks per 1000 hooks) from Bartram and Kaneko (2004) (page 23, Table 14). While FSR tables include catch and effort for the entire EPO (north and south of equator), it's assumed here that Mexican tuna fishing effort occurs north of the equator.

Estimating missing data

Sosa-Nishizaki et al. (2002) assumed the majority of Mexican blue shark catch during 1990-1999 came from small and medium vessels, and partitioned catch estimates between these fisheries.

Since INAPESCA data were available from 1976-2010, it was necessary to extrapolate the 1990-1999 proportions to the entire period shark catch data were available. A general linear model (glm) implemented in R was used to predict proportions:

glm (small vessel proportion ~ weighted Tiburon catch : Year)

Results and Discussion

The effect of weighting factors vs. unweighted catches on the proportion of Tiburon to total shark catch for the 4 states with blue shark landings was examined. The weighted vs. unweighted proportions had similar trajectories through time, with the weighted proportions being roughly half the unweighted (Figure 2). Estimated total Mexican Pacific blue shark catch ranged from 903-4764 mt during 1976-2010. This resulted in blue sharks comprising from 6-18% of total Mexican shark catch on the Pacific Coast (Figure 3). Catches from 1976-1999 trended fairly flat (although variable), but from 1990-2010 catches trended upwards, and the proportion of blue sharks of the total shark catch increased over this period as well. This is consistent with the emergence of new markets for Mexico's sharks in 1990 (Sosa-Nishizaki et al. 2002).

Sosa-Nishisaki et al (2002) showed size and sex composition data for small and medium vessel size landings, with mean sizes and sex ratios (F:M) from artisanal fisheries of 119 cm (TL) and 1.05:1 respectively, and from medium sized vessels at 177.2 cm (TL) and 1.3:1 respectively.

These estimates are based on numerous assumptions:

- Blue sharks are indeed only included in the 'Tiburon' statistics. It is not known if smaller blue sharks might actually be included in the 'Cazon' category, and thus not represented in these estimates.
- The nature of catch and effort reported to IATTC and shown in the FSR reports is highly uncertain, and the reasons for reporting patterns are still uncertain.
- While reasonable efforts were made to weight shark catches by state based on what is known about their relative geographic distribution, further investigation could probably improve upon assumptions of relative abundance.
- Reporting of artisanal catches is particularly uncertain, and potentially under-reported in official data.
- Bycatch ratios of target to bycatch used to estimate large vessel blue shark catch from IATTC reports are potentially not representative of the Mexico large vessel longline fisheries.
- Proportions of small:medium vessel catches were extrapolated based on relatively few data and uncertain relationships for the glm prediction. Although exploration of residuals did not show substantial skewness, there were not a lot of data to make

predictions from. Some of the glm predictions were quite different from observed values, indicating important factors were not accounted for.

- INAPESCA catches were apportioned to small and medium vessels based on a single, apparently non-peer reviewed source of information. Large vessel catches (bycatch from longliners) were estimated separately and then combined with the INAPESCA data. Estimated large vessel catches were negligible and a very minor portion of total blue shark catches.

Artisanal fisheries commonly target sharks, and probably keep almost all blue sharks they catch. Thus, it is assumed that artisanal fishery discard mortality is insignificant. Swordfish is a higher value species than blue sharks, so there is potentially a significant amount of blue shark bycatch discarded in the medium vessel fisheries. However, Sosa-Nishizaki et al (2002) indicates much of this catch is retained for sale in markets. Mortality of discarded sharks from gillnets would probably be significant and is not accounted for here. Large vessel catches are likely to be the smallest contributor to blue shark fishing mortality in Mexico. However, it is expected that most blue shark bycatch in tuna fisheries would be discarded.

While there are many assumptions and uncertainties about these data, these estimates are the only information currently available to the ISC SHARKWG about the magnitude of blue shark catch from Mexico's fisheries. The ISC blue shark assessment will be based on catch time-series starting in 1971, but information to make these estimates for Mexico was available only back to 1976. One option for extending the time-series back to 1971 could be using the average estimates over the last 5 years of this time-series (1976-1980), or other alternatives the Shark WG has agreed to for other incomplete catch time-series.

Literature cited

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States	Area in sq.km	Population (Est. 1992)	State Capital
1a Baja California Sur (B.C.S.)	72,465	500,000	La Paz
1b Baja California Norte (B.C.)	71,627	2,000,000	Mexicali
2 Sonora (Son.)	182,553	1,900,000	Hermosillo
3 Chihuahua (Chih.)	245,612	2,700,000	Chihuahua
4 Sinaloa (Sin.)	58,488	2,400,000	Culiacán
5 Durango (Dgo.)	123,520	1,600,000	Durango
6 Coahuila (Coah.)	150,395	2,100,000	Saltillo
7 Nuevo León (N.L.)	65,103	4,000,000	Monterrey
8 Zacatecas (Zac.)	73,454	1,300,000	Zacatecas
9 San Luis Potosí (S.L.P.)	63,231	2,000,000	San Luis Potosí
10 Tamaulipas (Tamps.)	79,602	2,400,000	Ciudad Victoria
11 Nayarit (Nay.)	27,053	850,000	Tepic
12 Aguascalientes (Ags.)	5,586	800,000	Aguascalientes
13 Jalisco (Jal.)	81,058	5,800,000	Guadalajara
14 Guanajuato (Gto.)	30,575	4,200,000	Guanajuato
15 Querétaro	11,480	1,200,000	Querétaro
16 Hidalgo (Hgo.)	20,870	2,000,000	Pachuca
17 Colima (Col.)	5,205	500,000	Colima
18 Michoacán (Mich.)	60,093	3,600,000	Morelia
19 México (Mex.)	21,414	11,500,000	Toluca
20 Morelos (Mor.)	4,964	1,400,000	Cuernavaca
21 Tlaxcala (Tlax.)	4,027	780,000	Tlaxcala
22 Puebla (Pue.)	33,995	4,300,000	Puebla
23 Veracruz (Ver.)	71,896	6,500,000	Jalapa
24 Guerrero (Gro.)	64,458	2,800,000	Chilpancingo
25 Oaxaca (Oax.)	94,211	3,000,000	Oaxaca
26 Chiapas (Chis.)	74,415	3,500,000	Tuxtla Gutiérrez
27 Tabasco (Tab.)	25,337	1,550,000	Villahermosa
28 Campeche (Camp.)	50,952	600,000	Campeche
29 Yucatán (Yuc.)	38,508	1,350,000	Mérida
30 Quintana Roo (Q.R.)	50,350	550,000	Chetumal
D.F. Distrito Federal (Federal District)	1,483	10,500,000	Ciudad de México
Mexican Republic	1,972,547	90,180,000	

www.PlanetWare.com

Figure 1. A map of Mexican states (http://www.planetware.com/map/mexico-mexico-mexican-states-map-mex-mex1.htm)

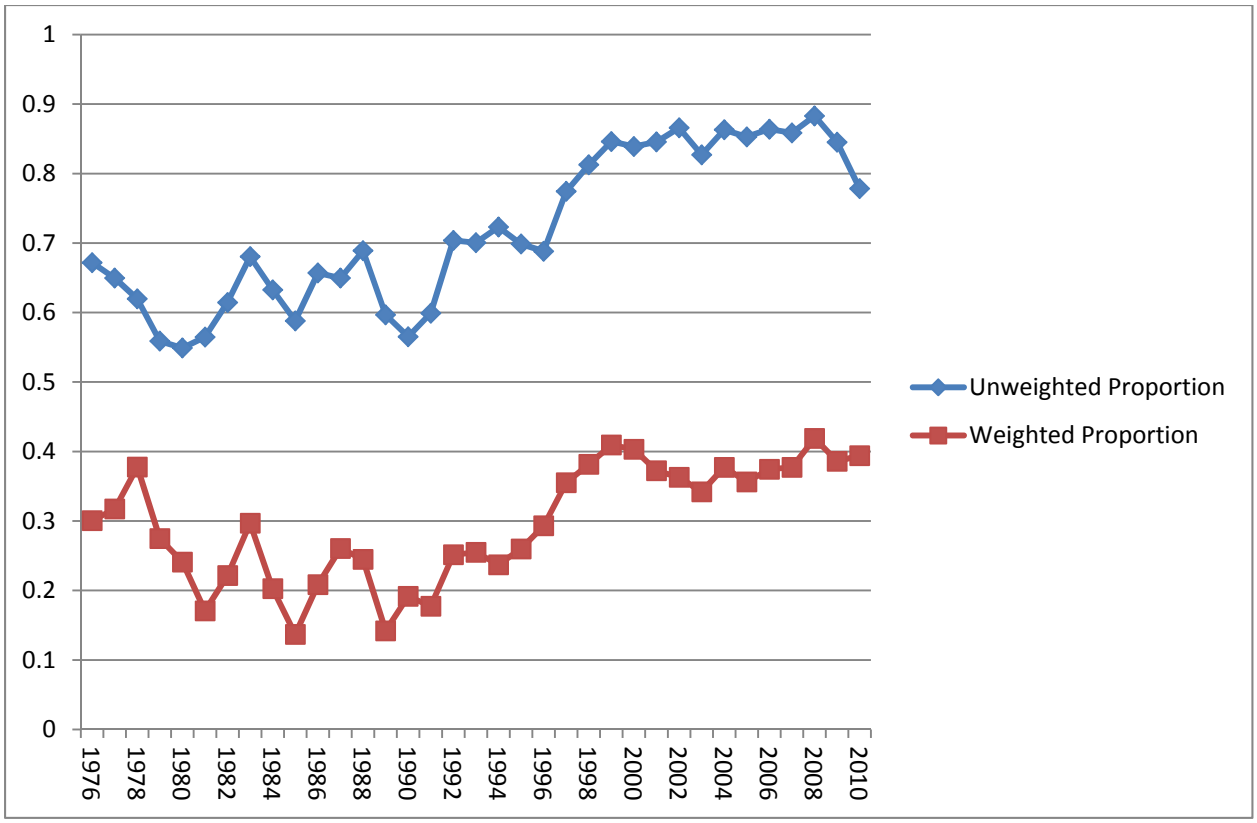

Figure 2. Effect of weighting Pacific states shark catch by area to demonstrate the amount of Tiburon catch scaled in this analysis. Comparison of the proportion of area weighted Tiburon catch to area weighted total shark catch vs. unweighted Tiburon catch to unweighted total shark catch through time in Pacific states.

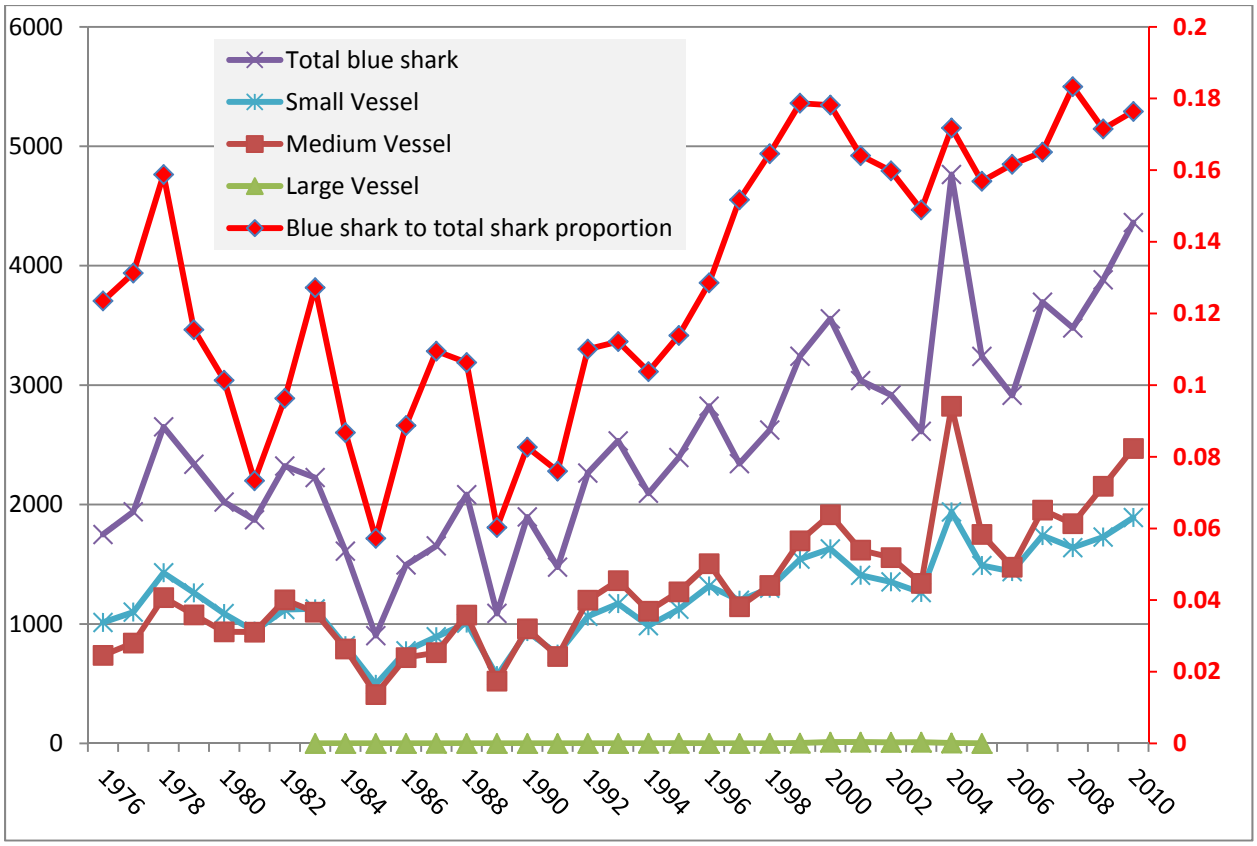

Figure 3. Estimated blue shark catch (mt) during 1976-2010 in Pacific Mexican states for small (blue), medium (brown), large (green) vessels, total blue shark catch (purple), and proportion of blue shark to total Pacific shark catch (red, scaled on secondary x-axis).

Table 1. Estimated blue shark catches (mt) by vessel size.

Year	Small Vessel	Medium Vessel	Large Vessel	Total blue shark
1976	1013	737		1750
1977	1099	841		1940
1978	1428	1222		2650
1979	1261	1077		2337
1980	1087	934		2021
1981	940	932		1872
1982	1120	1202		2323
1983	1126	1100	0.1	2226
1984	818	792	0.0	1610
1985	493	410	0.0	903
1986	775	719	0.2	1494
1987	893	760	0.3	1654
1988	1007	1076	0.2	2083
1989	567	521	0.0	1089
1990	936	960	0.0	1897
1991	747	729	0.0	1476
1992	1065	1200	0.0	2264
1993	1170	1363	0.2	2533
1994	986	1108	0.8	2094
1995	1123	1269	1.5	2394
1996	1318	1505	0.0	2823
1997	1198	1145	0.0	2343
1998	1299	1324	0.7	2623
1999	1543	1696	2.6	3242
2000	1629	1916	10.6	3555
2001	1408	1619	10.8	3038
2002	1353	1557	8.3	2918
2003	1262	1341	9.8	2613
2004	1938	2823	3.0	4764
2005	1489	1750	0.1	3240
2006	1438	1476		2915
2007	1740	1954		3695
2008	1639	1840		3479
2009	1728	2154		3882
2010	1891	2470		4361