15th Meeting of the
International Scientific Committee
for Tuna and Tuna-Like Species in the North Pacific Ocean
Kona, Hawaii, USA
15-20 July 2015

National Report of Mexico[1]
(Mexican Progress Report to the 15th ISC)

Michel Dreyfus-Leon[1], José Leonardo Castillo-Géniz[1], Javier Tovar-Ávila[2]
Luis Vicente González-Ania[3] José Ignacio Fernandez-Méndez[3]
Carlos Javier Godinez-Padilla[1] Hector Alejandro Ajás-Terriquez[1]
Oscar Sosa-Nishizaki5 Juan Fernando Márquez-Farías[6] David Corro-Espinosa[4]

Instituto Nacional de Pesca
(National Fisheries Institute)
[1]Centro Regional de Investigación Pesquera de
Ensenada, Baja California
[2]Centro Regional de Investigación Pesquera de
Bahía Banderas, Nayarit
[3]Dirección General Adjunta de Investigación Pesquera
en el Pacífico, Oficinas Centrales, D.F.
[4]Centro Regional de Investigación Pesquera
de Mazatlán, Sinaloa
[5]Laboratorio de Ecología Pesquera
Centro de Investigación Científica y Educación Superior de Ensenada
Ensenada, BC
[6]Facultad de Ciencias del Mar
Universidad Autónoma de Sinaloa
Mazatlán, Sinaloa

July 2015

[1]Prepared for the Fifteenth Meeting of the International Scientific committee on Tuna and Tuna-like Species in the North Pacific Ocean (ISC), 15-20 July, 2015, Kona, Hawaii, USA. Document should not be cited without permission of the authors.

INTRODUCTION

This national progress report describe the recent trends of the Mexican tuna fishery for the yellowfin, bluefin, albacore tunas, swordfish and sharks.

In Mexico, the National Institute of Aquaculture and Fisheries (Instituto Nacional de Acuacultura y Pesca, INAPESCA, Formerly INP), was created more that forty years ago to systematically conduct scientific work and fisheries research with the marine resources of Mexico. The INAPESCA is responsible of providing the scientific bases for the management advice to the fisheries authorities in México and has stablished along its coastal states, in both, Pacific and Gulf of Mexico, 14 regional fisheries centers (CRIPs) which are the centers and laboratories in charge of data collecting, sampling, monitoring and assesment of the main fisheries and aquaculture activities on a regional scale. Since 1992, the INAPESCA incorporated to this effort, the work of the National Tuna-Dolphin Program (Programa Nacional de Aprovechamiento del Atún y Protección del Delfín, PNAAPD), which closely monitored and study the tuna fishery of its purse seine and longline national fleets. The data here reported is based on the combined efforts from these different and unified groups.

Tunas

In this region the Mexican fleet concentrates mainly in the yellowfin (Thunnus albacares), which is the prime target tuna species. The Mexican tuna purse seine fishery is one of the largest in the (ETP) since the mid 1980’s. YFT represents for its large volumes the main component of the catch by Mexico. Other tuna species which are also caught, but contrastingly in lower proportions are: the skipjack, (Katsuwonus pelamis), the black skipjack (Euthynnus lineatus) and more recently, in northerly zones of the Mexican EEZ, the bluefin (Thunnus orientalis) which is targeted by some vessels and sporadically the albacore (Thunnus alalunga). The fishing operations of the Mexican purse seine fishery comprise a vast area in the EPO, (figure 1).

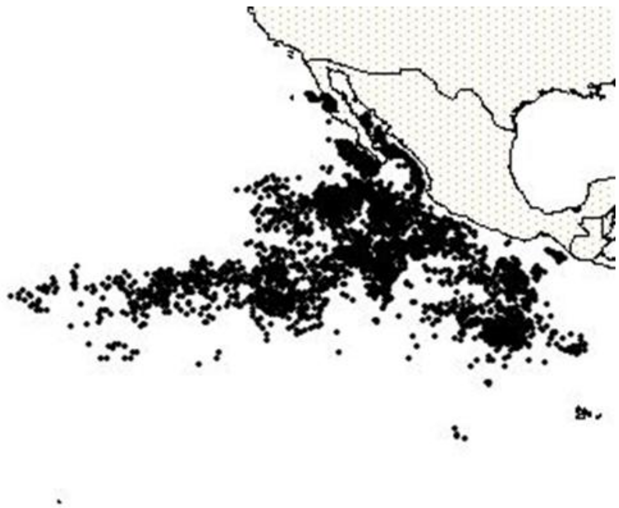

Figure 1. Fishing grounds of the Mexican purse seine. 2014

The recorded levels of tuna captures in the ETP zone by the Mexican fleet from 1980 till 2014 are shown in figure 2.

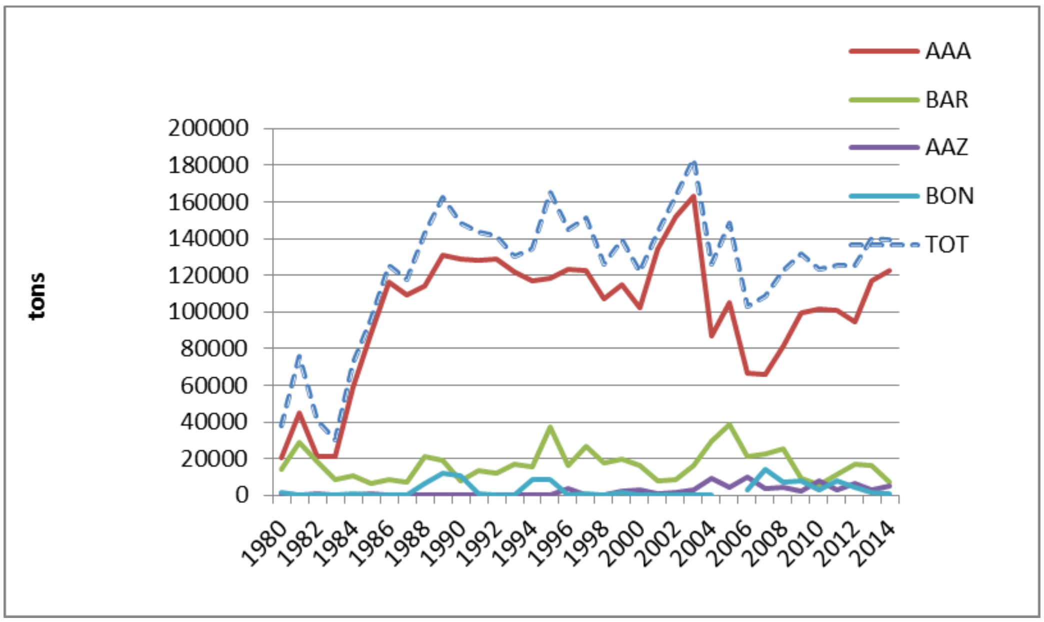

Figure 2. Mexican tuna catch of yellowfin tuna (YFT), skipjack (SKJ) and bluefin tuna (BFT), 1980-2014.

The total tuna landings of Mexico in 2003 were 183199 mt. Value which represents the highest historic record for this fishery. Comparatively, the lowest recorded capture in this fishery during recent years was in the 2006 season, with only 102472 mt., value which is closer to the 1980's development phase. During the last year catches of yellowfin tuna continue to increase slowly. The fleet has compensated partially its catches primarily with skipjack.

These high consistent reported catches are the result of the combination of the fishing experience and performance of the fleet as well as the effect of high recruitments in previous years and are not related with any significant increase in the fishing effort or a greater expansion of its carrying capacity during the corresponding years. Lower catches in 2006 and 2007 are probably related to a decrease in population levels of yellowfin tuna (lower recruitment) and excessive catches of juvenile tunas in coastal areas in the EPO.

The purse seine fleet is subdivided in purse seine vessels, most of them with observers on board all tuna fishing trips and a small quantity of pole and line vessels (Table I). The whole fleet is quite stable in number, composition and carrying capacity since the 1990´s.

Yellowfin tuna always has been the primary catch, and skipjack is always second in volume. Other tuna species have high values because the fleet has compensated lower yellowfin catches with other tunas, basically with skipjack but a slight increase is related also with Bluefin tuna catches (Table 2).

Table 1. Size, composition and carrying capacity of the active Mexican tuna fleet 2007 to 2014

YEAR	No. of active tuna boats	No. of m PSeiners > 400 m3	No. of PSeiners < 400 m3	No. of active Bait Boats
2007	55	42	11	2
2008	49	39	8	2
2009	46	38	6	2
2010	42	36	3	3
2011	43	38	3	2
2012	45	39	3	3
2013	43	37	3	3
2014	47	42	3	2

Table 2. Total tuna landings and the proportions of the different tuna species in the Mexican fishery from 2005-2014

YEAR	TOTAL LANDINGS All tuna species (mt.)	Yellowfin (mt	Skipjack (MT.)	Others Species (mt.)
2005	152364	113279	32985	6100
2006	102472	68644	18655	15173
2007	108351	65834	21970	20547
2008	122568	85517	21931	15111
2009	123750	99157	9310	15243
2010	120679	101523	6090	13066
2011	124902	102887	8600	13415
2012	126810	93686	18259	16865
2013	138214	113619	17185	7410
2014	139088	120996	8789	9303

1) Other species are: albacore (T. alalaunga), bluefin (T. orientalis), bigeye (T. obesus) and the black skipjack (Euthynnus lineatus). *2014 data is preliminary.

Bluefin tuna

All the fishing zones for bluefin tuna used by the Mexican fleet are located in the Northwest side of the Baja California peninsula, inside the ZEE of Mexico (figure 3), closer to the ranching locations. The fishing season usually runs five months, from May to September, which is the time in which the transpacific migration of this stock is closer to the Mexican Pacific coast, due to oceanographic factors. In 2006 the fishing season started earlier, in March. Sea conditions together with the presence of the specie permitted the development of this new fishery predominantly related to ranching activities in the Mexican

Northwestern coastal area. Temperature is an important factor defining areas were BFT is to be found.

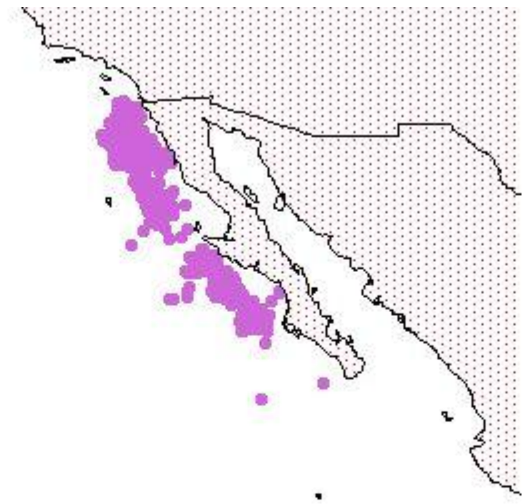

Figure 3. Fishing Zones for bluefin tuna in the Northwest region of Mexico, offshore the Baja California peninsula,

The time series of bluefin tuna captured by the Mexican tuna purse seine boats from 1995-2010 is presented respectively in Table 3 to see the period related to ranching activities that started in 1996 and fully developed since 1999. This catch represents only a very small proportion of the total tuna caught by the Mexican fleet with an average catch of 3612 mt for the entire period. This represents a small proportion of the Mexican tuna catch, although very valuable. The 3,700 mt. reported in 1996 was the first historic highest record for this fishery and the first year bluefin tuna has been targeted by the fleet. Again, in 2004 and 2006 new records were established for this tuna specie in Mexico. In 2007 the catch returned closer to the average. In 2009 due to the international economic crisis many companies did not operate and catches were below average. In 2010 catches increased and in 2011 catches are expected to be low. The catch in the Eastern Pacific nevertheless is below the historic highs observed in the 1960's and 1970's. The information provided makes clear that fishing for bluefin has not being a foremost significant activity in Mexico for many years. It also shows that even in some fishing seasons there were no captures on this stock, or those were only of low levels. Therefore, it is clear that fishing bluefin in Mexico was considered only incidental. However, more recently, in the years (1996-to present time) there has been a greater interest devoted to this species, mainly for the ranching activities developed in the Northwest region of Mexico.

Table 3. Bluefin tuna catch of Mexico, 1995-2014*. (*preliminary)

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
3025	863	1708	3211	8880	4542	9806	4147	4407	3019	7746	2731	6668	3154	4862

The catches of bluefin for ranching are performed only with commercial purse seiners (normally searching for YFT) with a deeper purse seine net. Bluefin tunas are transferred from the purse seine net to "transfer" nets then to the enclosures and fattening nets located in northern Baja California peninsula.

There is also a US sport fishery that operates in Mexican EEZ that is reported by the US.

Effort

There were 5 trips devoted to PBF catch in 2013 and 6 during 2014.

Ranching Activities

This new tuna fishery component or modality has been the trigger of higher proportional catches of bluefin. In 2005, the catch came down to 4542 from a high pick in 2004, increasing again in 2006 with very low catches this year, again making evident that oceanographic conditions and the eastern distribution of the specie are limiting factors for the Mexican bluefin fishery. Most of the catch is utilized for fattening. In 2005, 2006 an estimated 80% of the catch was transported to the ranching companies and the other 20% went to the Mexican market. In 2007, 2008 and 2009 almost all BFT was directed to ranching. This activity represents an economic incentive for the Mexican tuna fishery and has a regional economic impact especially in northwestern Mexico.

The ranching activities are limited in several ways. They depend on the fishing vessels already in the fishery, by the amount of area they have devoted for aquaculture purposes, by law the amount the companies can growth each year, oceanographic conditions and quotas stablished.

The size composition of the PBF catch for farming is obtained from stereoscopic cameras that are used during transfer operations. Information now available will be used to present size composition of the Mexican tuna fleet in next PBF meeting.

Albacore (T. alalunga)

The related Mexican information for this fishery has been reported constantly to ISC and IATTC. Catches are limited to a small area in northern Mexico. Table 4 shows the total catch reported for Mexico from 1980 to 2014.

Table 4. Mexican albacore tuna catches from 1980-2014 *2014 data is preliminary

YEAR	MEXICAN CATCH
1980	31
1981	8
1982	0
1983	0
1984	113
1985	49
1986	3
1987	7
1988	15
1989	2
1990	2
1991	2
1992	10
1993	11
1994	6
1995	5
1996	21
1997	53
1998	8
1999	57
2000	103

2001	**23**
2002	**28**
2003	**28**
2004	**104**
2005	**0**
2006	**109**
2007	**40**
2008	**10**
2009	**17**
2010	**25**
2011	**0**
2012	**0**
2013	**0**
2014	**0**

Bycatch

Billfishes and shark bycatch from the purse seine fishery is estimated and presented in table 5.

Table 5. Estimated billfish bycatch in the purse seine fishery in number of organisms for 2014.

Specie	**2013**	2014
Blue Marlin	**153**	159
Black Marlin	**88**	89
Stripped Marlin	**136**	165
Swordfish	**16**	18
Sail fish	**510**	464

Management

Management of the tuna fishery is done within the framework of the IATTC. In recent years a 62 day closure is applied for Mexican purse seiners from November 18 to January 18 the following year as a conservation measure for tropical tunas and a quota has been implemented for PBF since 2011. The catch of PBF is closely monitored by 100% scientific observer's coverage on board all the fishing activities (both a national and IATTC observer programs). All information is reported and shared weekly and based on the quota and catch amount information is reported daily to ensure a quick response from managers and timing of the closure season.

Research

Since 1998 the INAPESCA and the PNAAPD have also organized an annual scientific meeting in Mexico to review the research activities developed by Mexican and other scientists. These studies are related with tunas, large pelagic and other oceanic species. Available information of those scientific meetings could be obtained directly from the authors listed in the journal "El Vigia" of the PNAAPD (see www.fidemar.org) that lists the abstracts every year, or from the INP-PNAAPD sources. That information is not a complete list of all research performed in Mexico related to those fishes and fisheries.

Shark fisheries

Introduction

The management of Mexican shark fisheries over the past decade has seen significant progress towards the pursuit of sustainability. Among the main strategies implemented by the fisheries authorities highlights the publication in 2004 of Mexico's National Plan of Action (NPOA) for the Conservation and Management of Sharks (CONAPESCA-INAPESCA, 2004). The NPOA contains the guidelines and ongoing regulation, research, monitoring and education programs, to organize and optimize the use and conservation of sharks in Mexican federal waters. Among the most important guidelines is the improvement of catch and effort statistics by species or group of species, through fishing recording instruments such as new logbooks for commercial fishing fleets and the creation of a scientific observers program onboard the shark vessels.

The principal management tool that regulates shark and ray exploitation in Mexican waters is the Mexican Official Standard NOM-029-PESC-2006, Shark and Rays' Responsible Fisheries, Specifications for its exploitation. Published in February 14th 2007 in the Mexican Federal Government Gazette (SAGARPA, 2007), its purpose is to protect sharks and related species, as well as ensure their sustainable exploitation, in addition to fostering the conservation of elasmobranch species subject to special protection. The NOM-029-PESC-2006 is mandatory for holders of permits, concessions and authorizations that participate in targeted and by-catch shark and ray fisheries. The principal regulations that the NOM-029-PESC-2006 establishes are:

- A new system for collecting shark fisheries statistical information (catch and effort) by using logbooks.
- Delimitation of shark fishing zones for artisanal, semi-industrial and large commercial vessels on both Mexican littorals.
- Limits on dimensions and characteristics of shark fishing gears (longlines and gillnets) for each fishery and fishing area.
- The mandatory participation of the shark commercial boats (medium-size) in the Satellite Positioning System and Monitoring of fishing fleets (VMS, Vessel Monitoring System) (NOM-062-PESC-2007).
- Creation in 2006 of the Shark Scientific Observer Program (SSOP) operating onboard of shark commercial vessels (medium-size) from the fishery fleet of the northwest Mexican Pacific.
- Establishing of zones and periods of shark fishery closures based on studies conducted by the National Fisheries Institute.
- Restriction of shark fishing operations in front of marine turtle nesting areas (16 nesting beaches), sea lions colonies as well as in the Southern Baja California lagoon systems frequented by whales and calves and around coral reef areas.
- Mandatory use of circle hooks in shark longline fishing operations conducted by medium-size commercial vessels to reduce incidental catch of sea turtles
- Estabishing of a full protection scheme for the great white shark (*Carcharodon carcharias*), whale shark (*Rhincodon typus*), basking shark (*Cetorhinus maximus*), sawshark (*Pristiophorus schroederi*), sawfishes (*Pristis pectinata, P. perotteti,* and *P. microdon*), and the mantarays (*Manta birostris, Mobula japanica, M. thurstoni, M. munkiana, M. hypostoma* and *M. tarapacana*).

Recently, in 2012, a shark fishery closure in Mexico’s Pacific, Gulf of Mexico and Caribbean was included in the portafolio of Mexican shark regulatory measures.

The seasonal shark fishery ban includes targeted and by-catch shark fisheries conducted in national waters and its main objective is to protect the summer breeding season (May-July) of several sharks and ray species in the Pacific coast, and several sharks species in the Gulf of Mexico and Caribbean Sea (SAGARPA 2012 and 2013).

Another important management instrument for the Mexican shark fisheries is the National Fisheries Chart (CNP), published by the National Fisheries Institute (INAPESCA). The CNP a cartographic and written official document containing the summary of diagnostic information and a comprehensive assessments of the country’s fishing and aquaculture as well as indicators on the availability and conservation of fisheries and aquaculture resources in waters under federal jurisdiction are also included. Its content is of an informative nature for the productive sectors but has a binding character on the decision making process of the fisheries management authorities in the adoption and implementation of instruments and measures to control fishing effort in solving applications for licenses and permits for conducting fisheries and aquaculture, as well as the implementation and execution of actions and measures related to administrative actions of those activities.

The CNP present the information on fisheries and resources in the form of “cartographic fisheries cards”, with the most recent data on fisheries and biological knowledge. In the case of Mexican shark fisheries, INAPESCA had published three cards: "Coastal Sharks' for both oceans, and two cards exclusively for the Pacific: "Oceanic Sharks” and "Sharks of the Gulf of Tehuantepec". These cards provide detailed information on the specific composition of the shark commercial catches and landings, information about their areas and fishing seasons and gears. Also relevant information is included on the biology of the main exploited shark species and, if available, the results of stock assessments. Finally the is fisheries management regulations that are in force in shark fisheries and a final diagnosis of the resource are included. Considering all the scientific data available on these fisheries, INAPESCA has concluded that shark fisheries on both coasts of Mexico have reached their maximum sustainable yield, determining that is not possible conduct an additional expansion for shark fisheries in Mexico (SAGARPA, 2004, 2006 y 2010).

The Shark Observer Program (SOP)

The SOP was established in June 2006 in the Mexican Pacific waters as a research tool already considerate in the NOM-029-PESC-2006. The SSOP was designed by the INAPESCA and was implemented through the National Research Trust for the National Development Program of Tuna Utilization and Protection of Dolphin and Others Protected Aquatic Species (FIDEMAR). In the last two decades INAPESCA has systematically conducted surveys and monitored shark catches and landings in both artisanal and industrial fisheries, with the objective of providing scientific bases for management advice. FIDEMAR shark observers are trained by INAPESCA shark biologists and technicians, report on numerical catch by species and operational details (e.g., position, number of sets per trip, number of hooks per set, haul times, target species, bait type), and provide data on catch and by-catch composition and trends of several species. They also collect biometric (size and sex) and biological (maturity stage) data of the main shark target species. INAPESCA is responsible for analyzing data generated by SOP. Tovar-Avila et al. (2001) provided an initial comprehensive outline on the catch and effort data of pelagic sharks caught by the Mexican shark longline fishery in the North Pacific from data collected during the first years of SOP operations (2006-2014).

Mexico’s participation in the ISC Shark Working Group 2014-2015

During the 10th International Scientific Committee (ISC) Plenary, held in Victoria, B.C. Canada from July 21-26th 2010 the Plenary agreed to dissolve its By-catch Working Group and created a new Shark Working Group (SHARKWG), in order to implement the recommendations of its Shark Task Force Group (STFG). The STFG noted that ISC member countries seem to have enough information for the stock assessment of key shark species in the North Pacific Ocean, especially blue and shortfin mako sharks. The STFG also noted that there was sufficient interest and expertise to conduct these assessments.

Finally, the STFG prepared a list of key shark species captured in the Northern Pacific Ocean fisheries. The new SHARKWG would then be responsible for conducting stock assessment and other scientific studies as required, focusing on monitoring shark fisheries, particularly blue, shortfin mako, bigeye thresher, pelagic thresher, silky, oceanic whitetip, hammerhead and any other shark species for which stock assessment may be needed. So far efforts have concentrated mainly in the blue and shortfin mako. Shark specialists from INAPESCA participated in different research activities coordinated and conducted by the SHARKWG during 2013, 2014 and 2015. In response to the SHARKWG inquiry on fishery statistics and biological data for the blue shark stock assessment INAPESCA provided the available data on landings and size catch structure during 2013 and 2014.

Shark Workshop Puerto Vallarta, Mexico

In 2013 INAPESCA accepted the invitation of the ISC SHARKWG chair to organize the final data preparatory meeting for shortfin mako (*Isurus oxyrinchus*) in Puerto Vallarta, Mexico at the end of 2014. In order to assemble the best fishery and biological data on the shortfin mako caught in Mexican waters of the Pacific, INAPESCA invited several recognized academic shark experts from academia participate in the Mexican delegation: Mexico: Dr. Juan Fernando Márquez-Farias from the Marine Sciences Faculty of the Autonomous University of Sinaloa (FACIMAR-UAS), Dr. Oscar Sosa-Nishizaki from CICESE, Ensenada, Baja California and Dr. Felipe Galván-Magaña from CICIMAR, La Paz, BCS. For the integration and coordination of the different technical documents that the Mexican Delegation presented at the meeting of Puerto Vallarta, INAPESCA conducted two previous technical meetings during 2014, in Mazatlán, Sinaloa (Aril 7-8th) and Ensenada, BC (September 3rd). The joined effort with the specialists from academia allowed to submit five working documents at the meeting in Puerto Vallarta.

The SHARKWG held a 7-day meeting in Puerto Vallarta, Jalisco, Mexico, in November 19-26th 2014. The primary goal of the workshop was to review all shortfin mako fishery and biological information (data and abundance indices) and make plans for a shortfin mako assessment to be completed in the spring of 2015. Participant delegations included Chinese Taipei, Japan, United States of America (USA) and Mexico. Fifteen working papers and four information papers were distributed and numbered, (Mexico presented 6 working papers). Several oral presentations were also made during the meeting.

Shortfin mako Mexican landings

Until recently shark landings statistics in Mexico were recorded generically as “tiburón” (large sharks) and “cazón” (small sharks). With the publication of the shark regulations NOM-029-PESC-2006 in 2007, shark permit holders are required by law to report their catches by main species through the use of logbooks. Sosa-Nishizaki et al. (2014) estimated the shortfin mako catches landed in four states from northwestern Mexico (1976-2013) (Table 6). Shortfin mako catches were estimated using different sources of information, assuming different proportions of the species in total catches that have been published in the scientific literature or estimated using more detailed local statistics. Since 2006, reports with the species composition of the landings started to be published by the official Mexican fisheries agency, the National Commission for Fisheries and Aquaculture (CONAPESCA). Unfortunately, in these reports, a sizable portion of landings is reported as “un-categorized species” and in several states shortfin mako is included in this category.

In Mexico, shortfin makos are caught mainly by the artisanal and middle size long-line fisheries that target pelagic sharks or swordfish. Catches that were landed in the past by the large size vessel long-line fisheries and the drift gill net fisheries were taken into consideration to construct the historical time series. Shortfin mako was not an important species in the catch until the 1980s when catches increased from a level of around 60 metric tons to around 250 t. With the development of the longline fishery in Mazatlán, Sinaloa, during the second half of the 1990s today catches have reached a level of around 700 t (Fig. 4). Estimates indicate that shortfin makos are caught mainly in the western coast of the Peninsula of Baja California and the entrance of the Gulf of California.

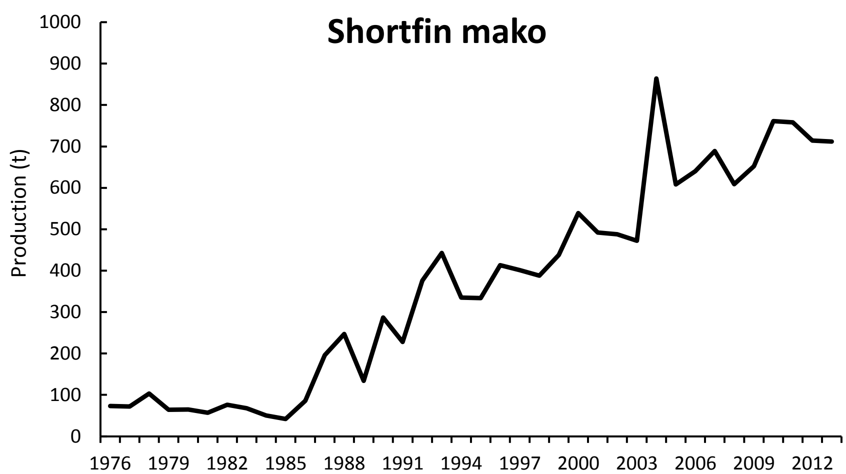

Figure 4. Pacific northern Mexican nominal shortfin mako catches estimated for the period 1976-2013. Source: Sosa-Nishizaki et al. 2014.

Table 6. Mexican shortfin mako shark landings estimations in metric tons (live weight) by state. BC= Baja California, BCS= Baja California Sur, SIN= Sinaloa, NAY= Nayarit, and COL= Colima

Year	BC	BCS	SIN	NAY	COL	TOTAL
1976	13	53	6	1	0	73
1977	7	57	6	2	0	72
1978	7	85	6	5	0	103
1979	8	35	8	13	0	65
1980	16	35	1	12	1	66
1981	22	16	5	13	1	56
1982	36	25	5	9	1	75
1983	32	26	4	5	1	67
1984	21	19	4	4	2	49
1985	7	28	3	3	1	43
1986	16	41	3	6	20	84
1987	128	49	3	3	13	197
1988	151	80	2	2	12	248
1989	83	31	2	4	14	135
1990	170	87	3	4	23	288
1991	120	78	3	4	23	228
1992	221	129	3	4	19	376
1993	205	149	65	3	21	442
1994	180	94	34	3	24	336
1995	125	151	22	4	32	333
1996	180	157	44	3	29	413
1997	202	126	55	2	16	401
1998	226	106	38	4	14	386
1999	144	209	68	4	13	439
2000	255	176	88	10	10	539
2001	293	129	53	7	10	491
2002	282	110	78	6	12	488
2003	263	85	111	5	8	471
2004	412	118	318	7	9	865
2005	258	130	208	4	8	609
2006	268	112	252	3	5	641
2007	207	137	335	3	7	689
2008	244	156	197	5	7	609
2009	284	154	201	7	6	653
2010	257	293	199	8	4	760
2011	211	309	219	8	11	758
2012	243	245	205	14	7	715
2013	258	220	211	17	6	711

Analysis of Shortfin mako data from the SSOP

Shortfin mako catch and size data analyzed were gathered by SSOP observers on 11,316 sets (73.9% longline and 26.1% driftnet sets) during 670 commercial fishing trips (longline 76.3% and driftnet 23.7%) from different fleets, during June 2006 through April 2014. The SSOP operated in the following fleets: Ensenada (EN), Mazatlán (MZ), San Carlos (SC), Puerto Peñasco (PP), Salina Cruz (SZ) and Topolobampo (TB) (Fig. 5). Most of the catch and effort data of the shortfin mako recorded by the observers came from the fishery operations of EN and MZ fleets (Fig. 6). From June 2006 through August 2009, both fleets used driftnets to catch swordfish and sharks so observers reported catches per set and species composition resulting from those trips. However, the NOM-029-PESC-2006 banned the use of driftnets in all commercial vessels >10 m length in August 2009. For that reason, the analysis of catch and size shortfin mako data was split by fishery gear.

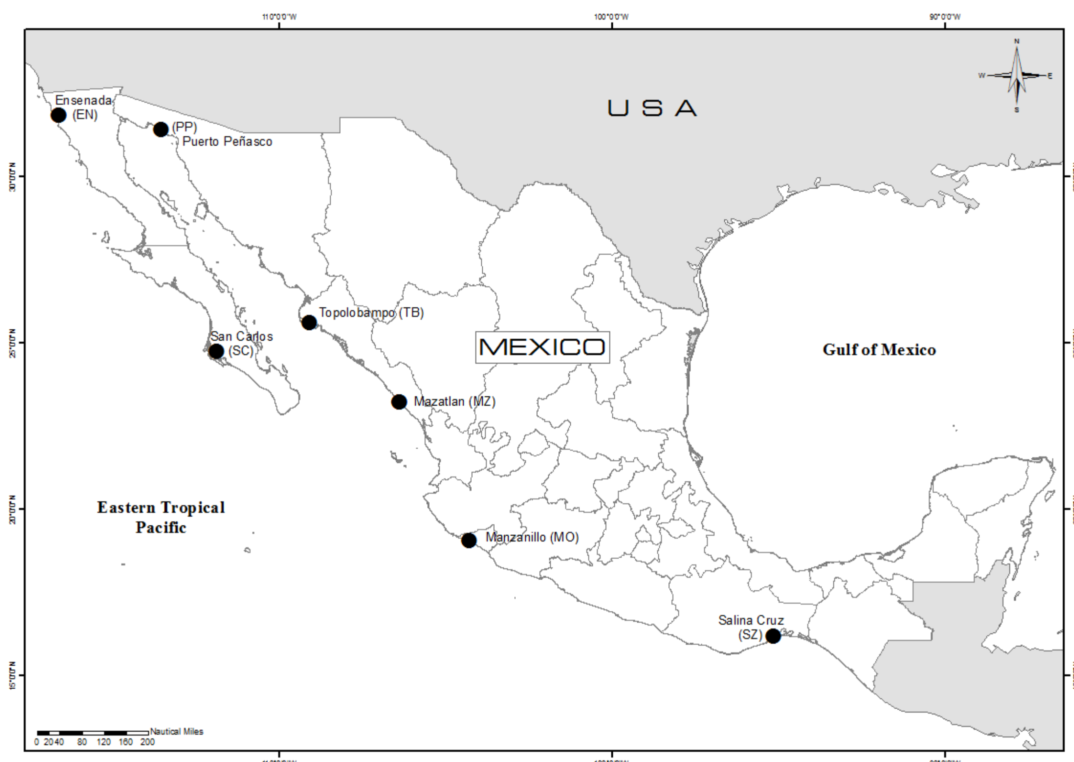

Figure 5. **G**eographical location of the port -based Mexican longline fishing fleets where SSOP operated during 2006-2014. Although Manzanillo's (MO) pelagic longline fishery was not included in the SSOP operations, it commonly targeted in a seasonal basis, blue and mako sharks.

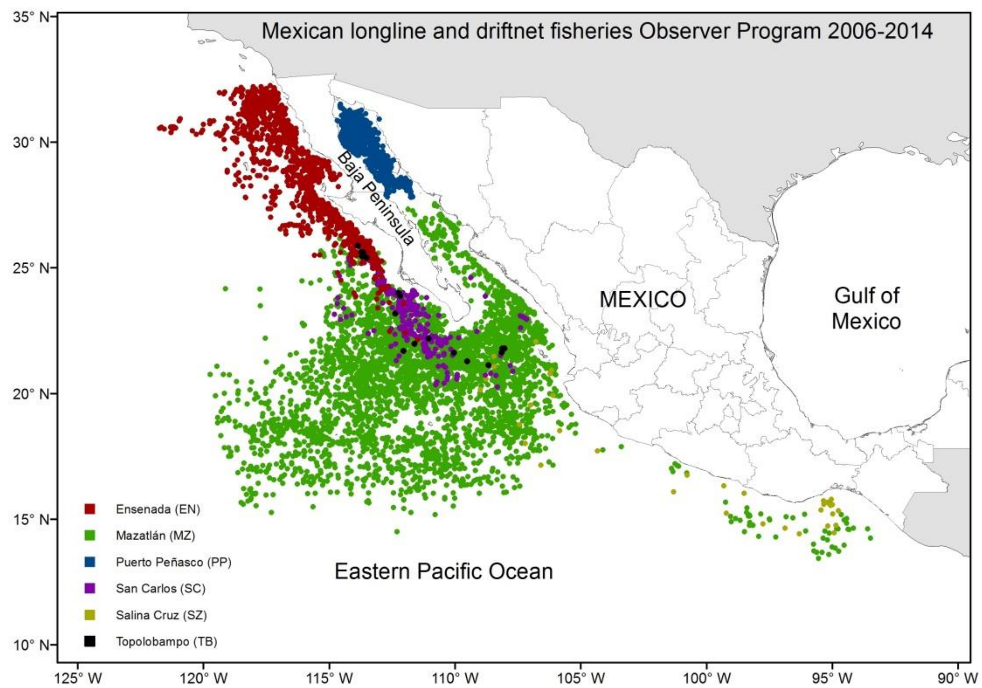

Figure 6. Observer effort conducted in the different Mexican pelagic and coastal fleets during 2006-2014.

Shortfin mako catch and catch/set indices

The observes reported a total numerical catch of 11,190 shortfin makos during 2006-2014, 73% from longline sets (8,357) and 27% was caught in driftnets (3,019). Shortfin makos were taken on 27.4% of the total observed longline sets and in 12% of the driftnet sets (Fig. 7). The catch data was ordered by quarters (Q) for each year separated by fishery gear (Table 3). Observed catch rates showed that Q3 and Q4 presented the higher longline shortfin mako catches. In contrast with the longline catch rates, the catch/set index in the observed driftnet fishing trips during the most representative years 2007 and 2008, were 2-6.5 shortfin makos per set between quarters. The percentage of sets with zero shortfin mako catches accounted 74.6. Most of the longline catches were concentrated in the interval of 1-5 and 6-10 sharks caught per set with 23.5% and 2.3%, respectively.

During the period examined were observed very few sets with numerical catches >10 sharks. A significant majority (72.6%) of observed sets caught zero makos. The decreasing trend in the number of set with zero shortfin mako catch along the years could be influenced by the gradual decrease of observed effort after 2008 (Table 7). Comparing the annually catch/set mean trend in the observed longline sets through the years, 2012 presented the higher mean, but this is caused by the lower observed level (111 sets) with a higher catch (416 shortfin makos). The data collected by the observers showed that Fall and Winter months had the higher catch/set indices for the longline sets through months and years during 2006-2014. This is congruent with the empiric knowledge of the

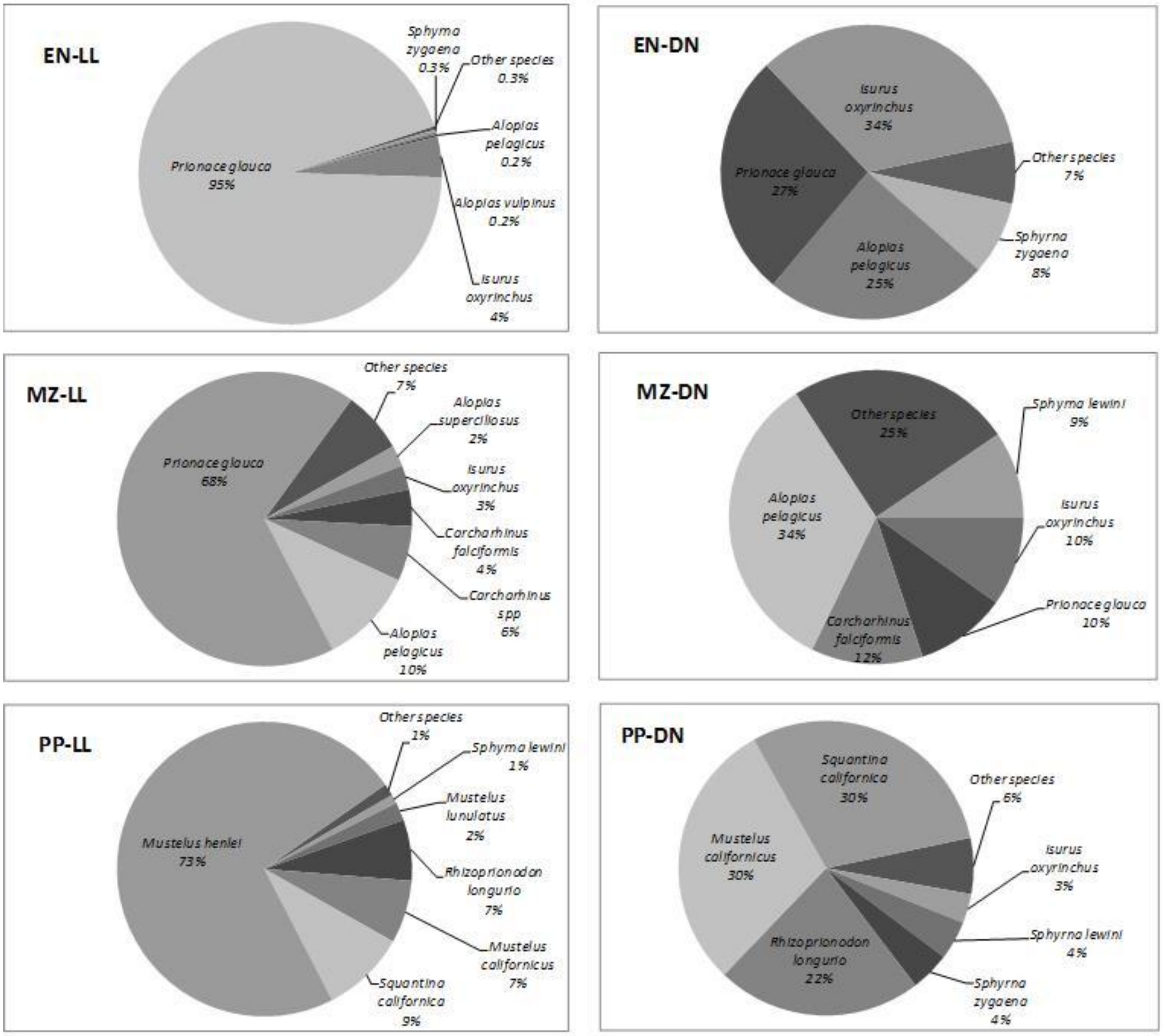

Figure 7. Observed shark species composition for the principal longline and driftnet fisheries in northern Mexican Pacific fisheries during 2006-2014. EN= Ensenada, MZ= Mazatlan and PP= Puerto Peñasco. Source: SOP, 2014.

commercial fishing crews that mentioned that the best season to catch shortfin makos is the end of the year (Q3 and Q4).

Analyzing by fleet and quarters the mako catch/set indices calculated for 2006-2014, it can be observed that the higher numerical catches were observed in the observer sets of the EN and MZ longline fleets with 1.7–4.9 sharks per set (Table 7) being Q3 and Q4 the periods with higher rates. The catch/set rates from the longline MZ-based fleet were lower than those observed in vessels from EN, its interval was 0.9-2.4 shark per set. In the vessels from SC, where SOP observers participated, catch data per set were also lower 0.3-1.3 sharks per set. Finally the observer effort at the PP based-fleet operating with longlines reported very few catches and its numbers were in average 0.2 shortfin mako sharks per set (Table 3). The observers reported larger catches of mako per set in the Ensenada fleet in comparison with the other fleets and fisheries zones. This is related to the highly productive waters of the west coast of the Peninsula of Baja California, which sustain diverse commercial fisheries for Mexico, such as lobster, squid and tuna fisheries. It should be mentioned that the MZ-based fleet operates in warmer waters and its fishing areas have been expanded toward the edge of the EEZ in the last decade.

During the years the observers collected data from the driftnet sets in both fleets (EN and MZ) the catch rates range between 0.3 and 7 shortfin makos per set. The driftnet sets were deployed at more coastal waters along the Peninsula of Baja California and in the Gulf of California. This highly productive semi-closed sea lured large numbers of top marine predators like shortfin makos and white sharks (*Carcharodon carcharias*). The observers catch data from PP-based fleet from 2006-2009 reported a total numerical catch 2,418 makos. In August 2009 the use of driftnets targeting sharks and other large pelagic fishes by medium-size commercial vessels was forbidden, affecting diverse fisheries including PP-based.

The observed fishery effort targeted shortfin makos in the northern Mexican Pacific coast was delimited between 15°N and 32°N and between 121°W and 104° W. The effort was concentrated around the tip of the peninsula of Baja California, considerate as a highly productive region. Mapping the fishery effort in terms of numerical catch per set two main regions stand out with higher catch sets, the above mentioned area between 20°N and 25°N and the west coast along the peninsula of Baja California between the tip and the upper area near the Baja California/USA border (Fig. 8).

Standardized catch rates for mako shark (Isurus oxyrinchus) in 2006-2014

For the shortfin mako data preparation workshop Gonzalez-Ania et al. (2014) presented a working paper on the standardization of the catch rate on the longline component of the shark fishery with medium size vessels in the northwest region of the Mexican Pacific. Driftnet operations were banned in 2009, while longline fishing has prevailed through the years of operation of the SOP, so the longline time series June 2006-April 2014 is complete. In particular, only data from the Ensenada longline fleet were used in the analysis, as it is the one with better observer coverage within the main mako shark

Table 7. Summary statistics for observed longline and driftnet shortfin mako shark catches by fleet and quarter in northern Mexican Pacific, period 2006-2014.

Longline

EN

Quarter	Total sets	Sets with catch	Catch	Catch/set	% Mako/set
Q1	372	187	631	1.7	50.3
Q2	292	154	644	2.2	52.7
Q3	328	224	1615	4.9	68.3
Q4	406	276	1520	3.7	68.0

MZ

Quarter	Total sets	Sets with catch	Catch	Catch/set	% Mako/set
Q1	823	334	668	1.2	40.6
Q2	1541	452	1628	0.9	29.3
Q3	945	184	453	2.1	19.5
Q4	660	190	278	2.4	28.8

SC

Quarter	Total sets	Sets with catch	Catch	Catch/set	% Mako/set
Q1	58	9	15	0.3	15.5
Q2	106	41	83	0.8	38.7
Q3	62	29	83	1.3	46.8
Q4	67	17	23	0.3	25.4

PP

Quarter	Total sets	Sets with catch	Catch	Catch/set	% Mako/set
Q1	172	4	8	0.0	2.3
Q2	1341	94	289	0.2	7.0
Q3	1106	81	226	0.2	7.3
Q4	26				

TB

Quarter	Total sets	Sets with catch	Catch	Catch/set	% Mako/set
Q1					
Q2					
Q3					
Q4	18	4	7	0.4	22.2

Driftnet

EN

Quarter	Total sets	Sets with catch	Catch	Catch/set	% Mako/set
Q1					
Q2					
Q3	30	19	110	3.7	63.3
Q4	37	22	47	1.3	59.5

MZ

Quarter	Total sets	Sets with catch	Catch	Catch/set	% Mako/set
Q1	78	15	92	0.8	19.2
Q2	291	113	835	0.3	38.8
Q3	231	23	33	7.0	10.0
Q4	27				

SC

Quarter	Total sets	Sets with catch	Catch	Catch/set	% Mako/set
Q1					
Q2					
Q3					
Q4					

PP

Quarter	Total sets	Sets with catch	Catch	Catch/set	% Mako/set
Q1	167				
Q2	1203	79	1244	1.0	6.6
Q3	845	77	651	0.8	9.1
Q4	20				

SZ

Quarter	Total sets	Sets with catch	Catch	Catch/set	% Mako/set
Q1					
Q2	34	4	7	0.2	11.8
Q3					
Q4					

distribution area in the Mexican Pacific. In this first stage, many zero-catch data –belonging to fleets operating outside this area or scarcely sampled– were excluded from the analysis. Then, data were subjected to a preliminary analysis, looking for missing values, incomplete information and inconsistencies. In this way, from an initial total of 8,389 longline sets, just 1,145 sets were retained to be used in the analysis. The proportion of zero-catch sets in this subsample was 41.5%, pointing to the use of a two-part, Delta model for the analysis, with a c log-log link for the binomial generalized linear model (GLM).

After an initial exploratory analysis, factors which were considered as having a possible influence on the response variables of the binomial or lognormal models (catch probability or logarithm of catch rate as number of makos per 100 hooks, respectively) were selected for the analyses, like mean sea surface temperature (MEANTEMP as a two-level factor) and time-area factors such as YEAR, QUARTER and fishing area (ZONE). Mean sea surface temperature (MEANTEMP) was calculated for each set as the average of temperature data measured *in situ*, at the beginning and the end of both gear setting and retrieval. MEANTEMP levels were defined as LOW (<=18.5°C), and HIGH (>18.5°C), on the basis of the mean sea surface temperature in which all validated sets of the Ensenada fleet were performed, and matching approximately the lower limit of the preferential range

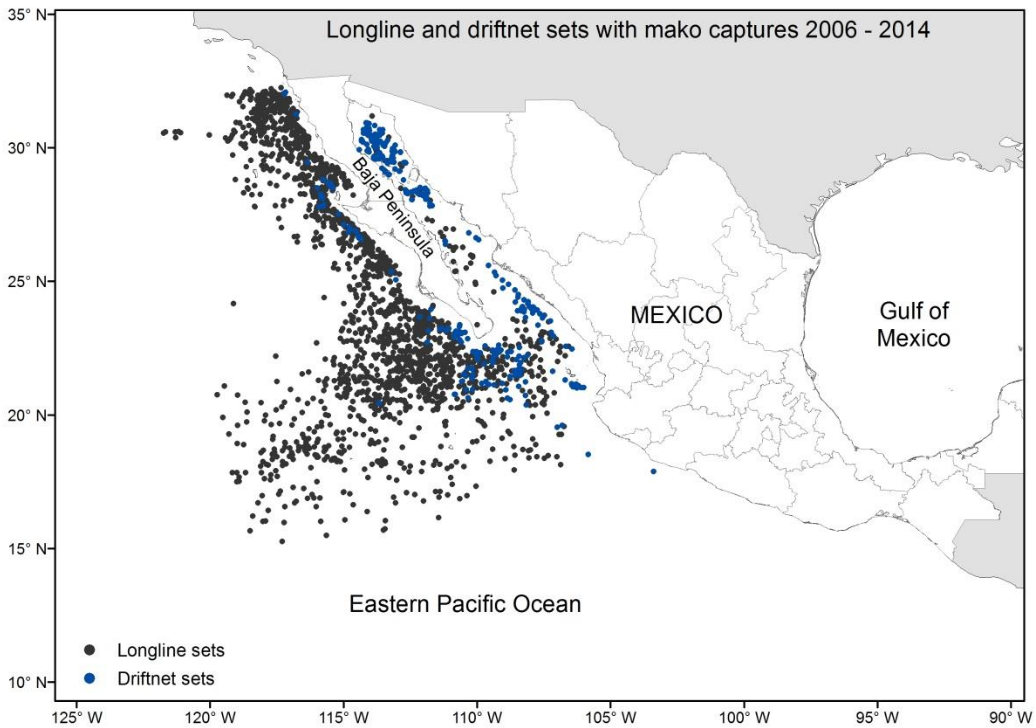

Figure 8. Observer fishery effort targeted shortfin mako in northern Mexican Pacific during 2006-2014. Black dots= longline sets; Blue dots= driftnet sets (2006-2009).

(18-21°C) of sea surface temperatures for shortfin makos (Castro 2011). Two fishing areas (ZONE) were defined as NORTH (>27° LN) and SOUTH (<=27° LN), based upon the central latitude of the fishing area (Figure 9). Catch probability and catch rates were modeled as a function of these factors. The quasi-binomial GLM presented a very small overdispersion (dispersion parameter = 1.020). The minimum adequate (final) model was:

RESPONSE ~ YEAR + QUARTER + MEANTEMP + ZONE + QUARTER:MEANTEMP + QUARTER:ZONE

The results of the tests of hypothesis (deletion tests) of the factors included in the positive GLM of the lognormal model are shown in Table 2. The final model was:

RESPONSE ~ YEAR + QUARTER + MEANTEMP + ZONE + QUARTER:MEANTEMP

It is possible that the biggest inter-annual differences observed in the abundance index result, at least in part, from inter-annual differences in sample sizes. Taking into account the uncertainty, the results of this analysis point at the abundance index trends being close to stability in the analyzed period (Fig. 10).

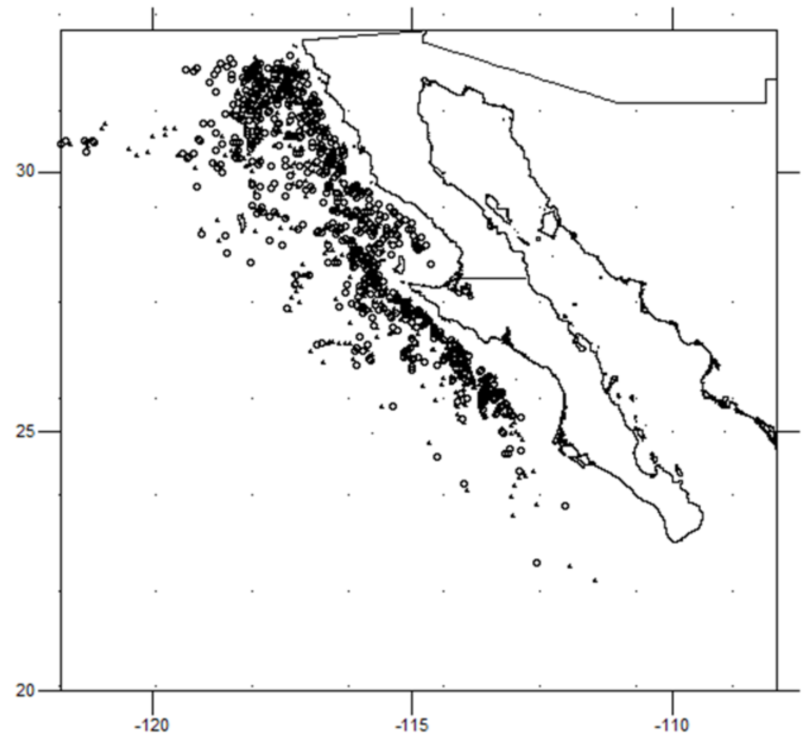

Figure 9. The zones used in the analyses. Sets positive for shortfin mako are shown with a circle. Negative sets are shown by small triangles.

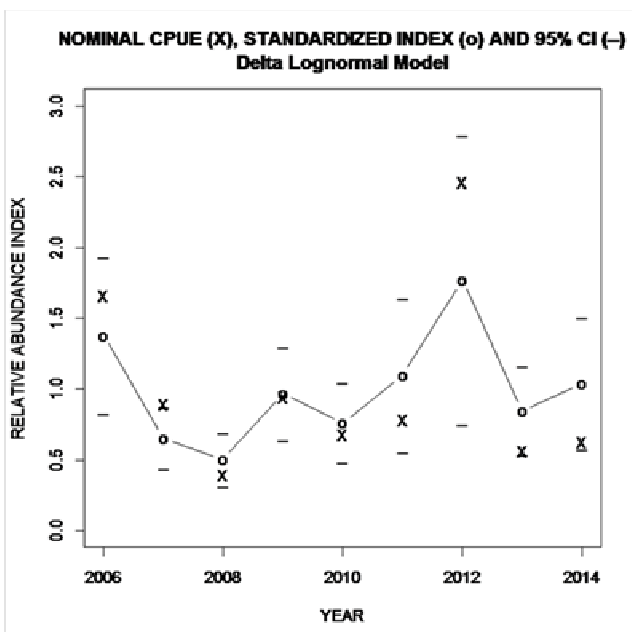

Figure 10. Relative abundance indices for shortfin mako with approximate 95% confidence intervals. Delta-lognormal model for years 2006-2014.

Contributions to the knowledge of the shortfin mako life history

Given the high degree of uncertainty on age estimations of shortfin makos and other pelagic sharks, the SHARKWG has highlighted the need to take action to standardize protocols for sampling collections, processing and data analysis. The SHARKWG has recommended conducting cross-validation studies that may be useful to derive a unified growth curve for shortfin mako in the North Pacific based on the vertebrae shared among laboratories (SHARKWG-ISC 2014).

Tovar-Avila et al. (2014) reported the results of an inter-research group crossed experiment of growth band counts, using vertebrae of shortfin makos caught in Mexican waters. The aim of such comparison was to determine the convenience of a standard, non-expensive and time consuming methodology that can ensure precise age estimates, in terms of repeatability of growth band counts. Precision estimates of vertebrae samples shared by other members of the SHARKWG, processed with the same methodology than the vertebrae from Mexican waters sharks, are presented as well in a preliminary way.

Shortfin mako vertebrae were collected from landings of the artisanal and industrial fleets operating along the North Pacific Mexican coast from 2007 to 2014. Due to de the difficulty to obtain vertebrae located below the first dorsal fin, particularly in the artisanal fishery, some samples were obtained from the cervical region once the shark was beheaded. The samples were preserved frozen until their preparation. The vertebrae were processed following a similar methodology by two independent research groups, the shark research group at FACIMAR-UAS and the shark group of INAPESCA (the counts corresponding to each research group are not identified purposely).

Vertebrae from different regions of the Pacific Ocean, shared by other members of the SHARKWG-ISC, were processed with the same methodology than the vertebrae of sharks from Mexican waters. Though some of these vertebrae were received already cleaned, it was assumed the cleaning process was similar having no influence in the section and observation process.

A total of 66 vertebrae from sharks caught in Mexican waters were processed and analyzed, of which 47 were collected by INAPESCA and 19 by FACIMAR-UAS. Vertebrae from 58 sharks provided by SHARKWG-ISC were also processed. Both research groups identified the same amount of hyaline and opaque edges, being the opaque the most common 98.6%. This indicated that the method used allowed for a good degree of consistency in the identification of the vertebral edge type. The age bias plots showed a high consistency of growth band counts with no systematic bias for counts of each research group. However, a slight systematic bias was detected in the comparison between the research groups counts. The first results proved that ageing sharks is a highly subjective process that needs a further inter-laboratory standardization of criteria to identify growth bands, despite the structure produce apparent and easy to identify growth bands.

Mexican swordfish fishery 2014-2015

Introduction

Swordfish (*Xiphias gladius*) is a high valuable resource for the Ensenada and Mazatlan medium size longline fishing fleets. It is the only species reserved by law for the sportfishing with commercial fishing permits in the northwest of the Mexican Pacific . Commercial fishing is conducted outside of the fifty miles along the west coast of the Baja California Peninsula. In 2012 had been operated 39 commercial fishing permits for the same number of commercial vessels based in the ports of Ensenada BC and San Carlos , BCS (INAPESCA , 2012). By the end of 2014 the number of permits and vessels was reduced to 29 in Ensenada (Rodriguez-Lorenzo , 2014). The longline fleets catching swordfish also capture other resources like diverse pelagic and coastal shark species, tunas, jacks, and dolphin fish.

With the entry into operation in August 2006 of the Shark Scientific Observer Program (SOP) onboard of medium-size commercial vessels targeting pelagic shark with surface longlines in the northwest Mexican Pacific, it has been gathering valuable information on swordfish catches. Another valuable source for statistical information on *X. gladius* catches have been the commercial fishing logbooks, whose use is mandatory since 2007.

Fishing logbooks

The data contained in 501 logbooks from the longline fleet of Ensenada , BC from de period 2011-2014 documented 5,506 fishing sets with a capture of 13,750 swordfish, representing 3% of the total catch reported . Sharks accounted for 94 % of the total longline catches (Fig . 11).

The swordfish fishery grounds are located along the west coast of the Peninsula of Baja California where the most abundant catches has been reported for the central and north regions of the Peninsula during the winter months (Fig. 12).

Apparenly the numbers of swordfish caught and reported in the logbooks of the Ensenada longline fleet has been increasing in recent years but we should be cautioned interpret this trend because the fishery effort have been gradually reduce. An unquantified number of commercial vessels had abandoned the fishery because of decreasing of economic revenues and recent hardening fishery regulations for longline fisheries.

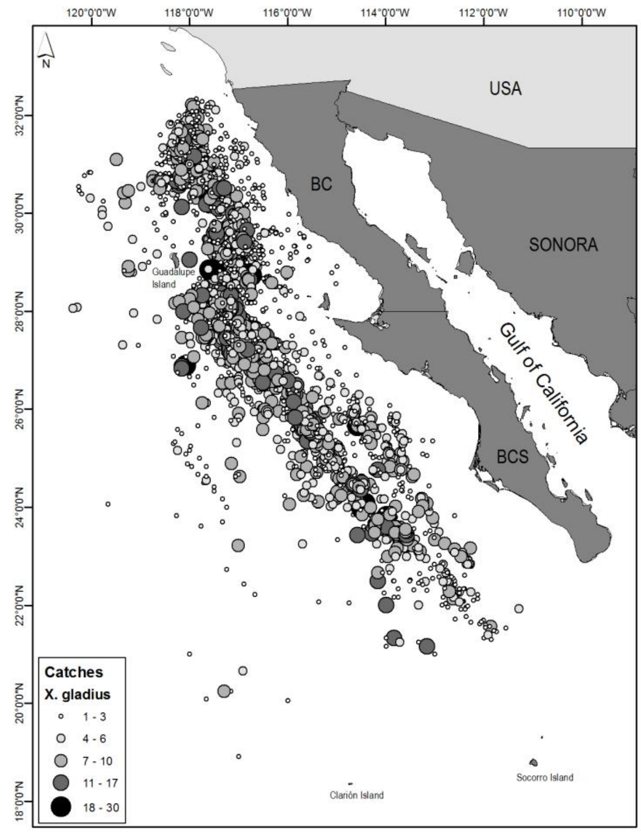

Figure 11. Fishery grounds and geographical distribution of swordfish numerical positive sets reported in the logbooks of the Ensenada's longline fleet. Source: fishery logbooks period 2011-2014 CONAPESCA.

Swordfish account for 0.43% of the total catches in weight of the Mazatlan's longline fleet reported in 750 logbooks for the period 2009-2012. Probably this fleet captured the southern population limit of the swordfish stock along the Mexican Pacific. Sharks were the principal target (85%) of this fleet.

Observer Shark Program

The SOP documented during 2006-2014 a total 1,693 longline sets along the west coast of the Baja Peninsula conducted by the Ensenada Fleet. A total number of 2,934 swordfish were caught in 661 sets (39% of total sets) (Table 8). The larger number of positive sets with swordfish catches were observed in the last quarter of the year (Q4, 43.1%) first (Q1, 23.8%) and third (22.2%) which encompassed the cold season in the region (Fig. 12). Same pattern was observed for the numerical swordfish catches. Swordfish positive observed sets were concentrated between 25° and 30° N along the Baja Peninsula, region considered as the swordfish fishery ground. Because the number of observed sets at the SOP has been decreasing annually since 2009, also the number of swordfish caught (Fig. 13).

Table 8. Numerical swordfish catches observed in the Ensenada's longline fleet from 2006-2014. Source: SOP INAPESCA-FIDEMAR, 2015.

Year	Q1	Q2	Q3	Q4	Total
2006			43	441	484
2007	247	61	32	695	1035
2008	50	34			84
2009			70	220	290
2010	10	5	132		147
2011		55	4	109	168
2012	5			90	95
2013	161		242	134	537
2014	94				94

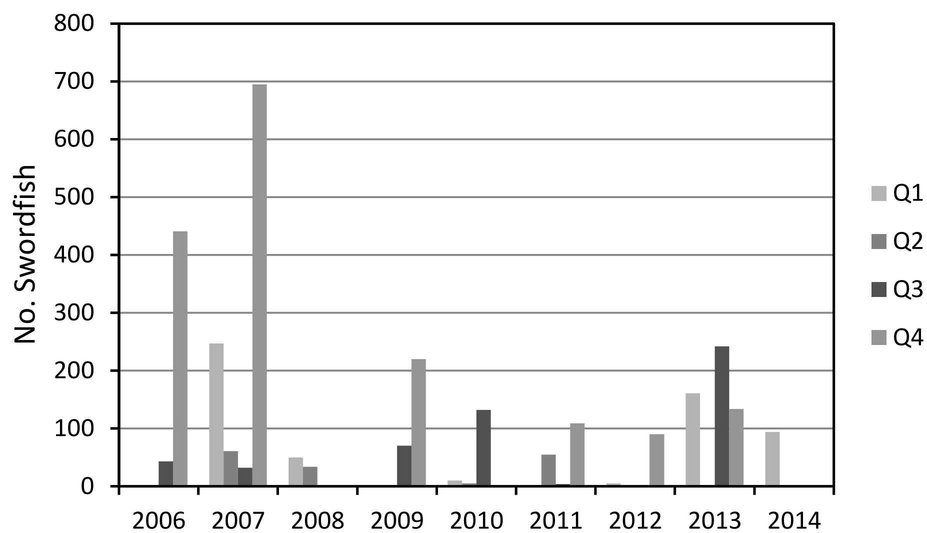

Figure 12. Quarterly distribution of the numerical swordfish catches of the Ensenada longline fleet during the period 2006-2014. For 2014 data was only available the first quarter. Source: SOP INAPESCA-FIDEMAR database.

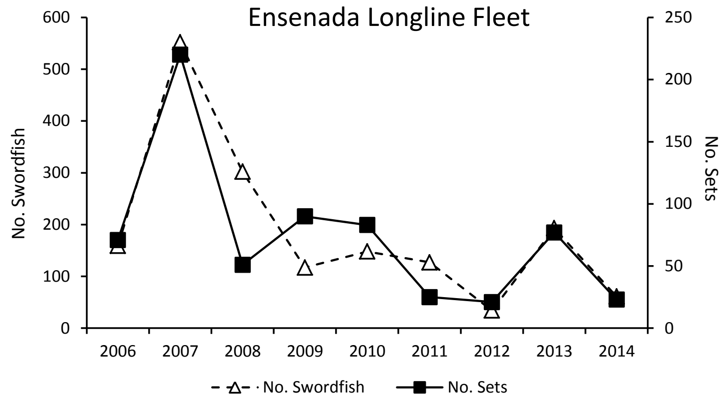

Figure 13. Number of sets and numerical swordfish catches observed by year in the Ensenada longline fleet during 2006-2014. Source: SOP INAPESCA-FIDEMAR database.

References

Castillo-Geniz, J.L., Godinez-Padilla, C.J., Ajás-Terriquez, H.A. y González-Ania, L.V. 2014. Catch data for shortfin mako shark reported by fishery observers in the Ensenada and Mazatlán longline fleets from Mexican Pacific in 2006-2014. Documento de Trabajo (Working paper) ISC/14/SHARKWG-3/. Taller del Grupo de Trabajo de Tiburones del Comité Científico Internacional para el Atún y Especies Afines del Pacífico Norte (ISC Shark Working Group Workshop), noviembre 19-26, 2014, Puerto Vallarta, Jalisco, México. 19 p.

Gonzalez-Ania, L.V., Fernández-Mendez, J.I. and Castillo-Géniz, J.L. 2014. Standardized catch rates for mako shark (*Isurus oxyrinchus*) in the 2006-2014 Mexican Pacific longline fishery based upon a shark scientific observer program. Documento de Trabajo (Working paper) ISC/14/SHARKWG-3/16, Taller del Grupo de Trabajo de Tiburones del Comité Científico Internacional para el Atún y Especies Afines del Pacífico Norte (ISC Shark Working Group Workshop), noviembre 19-26, 2014, Puerto Vallarta, Jalisco, México. 17 p

INAPESCA. 2012. Carta Nacional Pesquera. Ficha Pez Espada, Diario Oficial de la Federación, Viérnes 24 de agosto del 2012.

Norma Oficial Mexicana PROY-NOM-029-PESC-2006, Pesca Responsable de Tiburones y Rayas, Especificaciones para su Aprovechamiento, 14 de febrero del 2006, Diario Oficial de la Federación

SAGARPA. 2004. Carta Nacional Pesquera. Instituto Nacional de Pesca. Ficha “Tiburones Costeros”, Diario Oficial de la Federación, 15 de marzo del 2004.

SAGARPA. 2006. Carta Nacional Pesquera. Instituto Nacional de Pesca. Ficha “Tiburones del Golfo de Tehuantepec”, Diario Oficial de la Federación, 25 de agosto del 2006

SAGARPA. 2010. Carta Nacional Pesquera. Instituto Nacional de Pesca. Ficha “Tiburones Oceánicos”, Diario Oficial de la Federación, 2 de diciembre del 2010,

SAGARPA/CONAPESCA. 2007. Ley General de Pesca y Acuacultura Sustentables (LGPAS), 24 de julio del 2007, Diario Oficial de la Federación.

Tovar-Ávila, J., González-Ania, L.V., Liedo-Galindo, A., Márquez-Farías, J.F. 2011. Outline of new available catch and effort data of pelagic Shark caught by the Mexican longline fishery in the North Pacific. Working document submitted to the ISC Shark Working Group Workshop, 18-20 March 2011, National Research Institute of Far Sea Seas Fisheries, Fisheries Research Agency, Shimizu, Japan.

Sosa-Nishizaki, O., Saldaña-Ruiz, L.E., Corro-Espinosa, D., Tovar-Ávila, J., Castillo-Géniz, J.L., Santana-Hernández, H., Márquez-Farías, J.F. 2014. Estimations of the Shortfin Mako Shark (*Isurus oxyrinchus*) catches by Mexican Pacific fisheries (1976-2013). Documento de Trabajo (Working paper) ISC/14/SHARKWG-3/17, Taller del Grupo de Trabajo de Tiburones del Comité Científico Internacional para el Atún y Especies Afines del Pacífico Norte (ISC Shark Working Group Workshop), noviembre 19-26, 2014, Puerto Vallarta, Jalisco, México. 8 p.