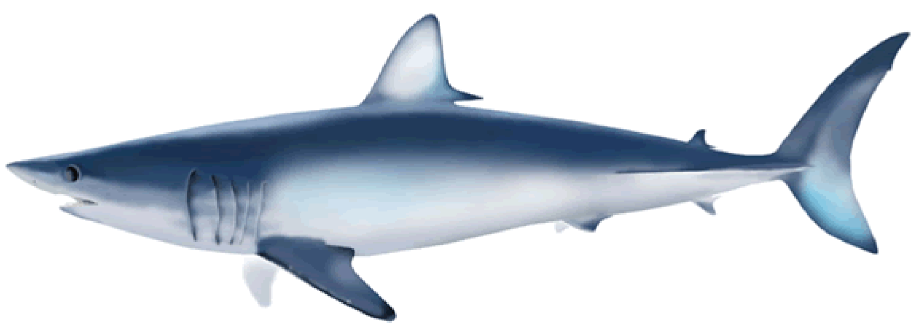
ISC/11/SHARKWG-2/07

Preliminary estimated catches of blue and mako sharks from US West Coast fisheries[1]

Steven L. H. Teo, Vardis Tsontos, and Suzanne Kohin

NOAA/NMFS
Southwest Fisheries Science Center
8604 La Jolla Shores Dr.
La Jolla, CA 92037 USA

Email: steve.teo@noaa.gov



[1]Working document submitted to the ISC Shark Working Group Workshop, 28 November – 3 December, NOAA Southwest Fisheries Science Center, La Jolla, California U.S.A.
Document not to be cited without author's permission.

.

ABSTRACT

Blue and mako sharks are not primary target species for US West Coast fisheries. However, the pelagic drift gillnet and longline fisheries based on the US West Coast do catch non-negligible numbers of blue and mako sharks. Since these shark species are not the targets of these fisheries, the representativeness of commercial landings and logbook records for these species is mixed, depending on the species and fishery. In this paper, we detail the methods used to estimate catches of these species by both fisheries, primarily based on recorded logbook and observer data. For the gillnet fishery, the catch (numbers of fish retained or discarded dead) and effort (in km of net) information associated with 240 strata (20 years x 4 seasons x 3 areas) were extracted from observer data and the catch-per-unit-effort (CPUE) in each stratum was calculated. For the longline fishery, the catch (numbers of fish retained or discarded dead) and effort (in thousands of hooks) information were extracted from observer data and the average CPUE was calculated. The catches for a given year for the fisheries were then calculated from the CPUEs and effort recorded in logbooks. A comparison of estimated catches and recorded landings for mako sharks by the gillnet fishery showed that the methods described produced relatively representative estimates. It is recommended that the described methods be used to estimate catches of blue shark by the drift gillnet fishery and both species by the longline fishery. However, it is recommended that the reported landings for mako sharks from the drift gillnet fishery be used because those recorded landings are relatively representative due to the high retention rate (95.2%).

INTRODUCTION

Blue and mako sharks are not primary target species for US West Coast fisheries. However, the pelagic drift gillnet and longline fisheries based on the US West Coast do catch non-negligible numbers of blue and mako sharks. In this paper, we detail the methods used to estimate catches (numbers of fish retained or discarded dead) of these species by both fisheries.

The pelagic drift gillnet fishery primarily targets swordfish and thresher sharks within the EEZ while the US West Coast longline fishery primarily targeted swordfish with shallow-set longlines on the high seas (beyond the EEZ). Blue shark is considered a low value species and is generally discarded (both dead and alive) by both fisheries. In contrast, mako shark is considered to be of higher economic value and is often retained by the fisheries. In addition, regulations in 2004 disallowed shallow-set longline gear for targeting swordfish off the US West Coast, which resulted in only one vessel continuing to use longline gear off the US West Coast after 2004. The one remaining vessel switched to deep-set longlines targeting tuna after 2004. Details on these fisheries may be found in the 2011 Stock Assessment and Fishery Evaluation Report (PFMC 2011; http://www.pcouncil.org/highly-migratory-species/stock-assessment-and-fishery-evaluation-safe-documents/).

Since these shark species are not the targets of these fisheries, the representativeness of commercial landings and logbook records for these species is mixed, depending on the species and fishery. Preliminary analysis comparing vessel logbooks with observer records indicated that commercial landings and logbook records of blue sharks were not representative of the fishing impacts of both fisheries. In contrast, commercial landings and logbook records of mako sharks appeared to be representative for the pelagic drift gillnet fishery but less so for the longline fishery.

In order to estimate representative catches of blue and mako sharks from these fisheries, we calculate catch-per-unit-effort of time-area strata based on observer data and combine that with the recorded effort from logbooks. In addition, we use observer data to correct for the proportion of sharks released alive and non-submission of logbooks.

MATERIALS AND METHODS

Pelagic drift gillnet

Three main sources of data are used to estimate the catch of blue and mako sharks by the pelagic drift gillnet fishery: 1) commercial landings in the PacFIN database; 2) vessel logbooks; and 3) onboard observers. Commercial landings of blue and mako sharks on the US West Coast are collected by individual states through a fish ticket system and compiled in the PacFIN database. Seasonal landings data on these two shark species are available from 1981. Based on PacFIN, the gillnet fishery has landed negligible amounts of blue shark (generally 1 t or less in a single season) and small amounts of mako shark (up to 181 t in a single season). Logbooks, which record the time, location, catch by species, and net length (as well as other information) of each set, are submitted by individual vessels in the fishery. Logbook data for the gillnet fishery are available from 1981. Onboard observers have been mandatory for this fishery since 1990 and observer coverage for this fishery ranges from 4.4% in 1990 to 22.9% in 2000. Observer data provide accurate records of time, location, catch by species, net length, and length of fish caught (as well as other information) of each observed set. In addition, it is mandatory for vessels to call in each trip before the start of the trip so that an observer may be assigned to the trip. Therefore the Southwest Regional Office of the National Marine Fisheries Service is able to provide estimates of the annual number of sets for the fishery.

The observer and logbook data from the pelagic drift gillnet fishery were divided into 240 strata (20 years x 4 seasons x 3 areas). For this study, we divided the fishing area into 3 strata: 1) <35 °N; 2) 35-39 °N; and 3) >40 °N. These latitudinal boundaries were chosen due to landmarks (Point Conception at approximately 35 °N and Cape Mendocino at approximately 40 °N), which are associated with important changes in the oceanography along the US West Coast. No longitudinal boundaries were used because this fishery is highly coastal and limited to the US EEZ. Each year was divided into 4 seasons (Jan-Mar, Apr-Jun, Jul-Sep, Oct-Dec) and the time series for this paper extends from 1990 to 2009. Observer and logbook records with missing information on the time, area and length of the net used in the set were eliminated from the dataset prior to further analysis. The proportion of eliminated logbook records was calculated.

The catch (numbers of fish retained or discarded dead) and effort (in km of net) information associated with each stratum were extracted from the observer data and the catch-per-unit-effort (CPUE) in each stratum was calculated. If a discarded fish was of unknown status, we assumed that the fish was a dead discard because this assumption is more conservative. If no observer data were available for a particular stratum, the average CPUE for the particular year was used for that stratum. The total catch C of each species in year t was then calculated as:

$$C_t = \sum_i \sum_j CPUE_{i,j,t} \times E_{i,j,t} \times \frac{1}{1-p} \times \frac{1}{1-q_t} \times w_t$$

where $CPUE_{i,j,t}$ is the observed CPUE in area $_i$, season $_j$, and year $_t$; $E_{i,j,t}$ is the logbook-recorded total effort (km of net) in the same stratum; p is the proportion of eliminated logbook sets due to missing information; q_t is the estimated proportion of sets that were not recorded or submitted in logbooks in year t; and w_t is the estimated average weight of the species from observer records in year *t*. Onboard observers measure the length of the fish caught in each observed set. These lengths were converted into weights using the following relationships for blue and mako sharks, which were derived from sharks measured and weighed during NOAA juvenile shark surveys (blue sharks: $weight$ (kg) $= 5.00857 \times 10^{-6} \times fork\ length$ (cm)$^{3.0541}$, N = 138, R^2 = 0.8847; mako sharks: $weight$ (kg) $= 1.1025 \times 10^{-5} \times fork\ length$ (cm)$^{3.0091}$, N = 244, R^2 = 0.9718). These length-weight relationships are highly similar to those found in a study on sharks from the western North Atlantic (Kohler et al. 1995).

Since the landings of mako sharks recorded in PacFIN were considered to be relatively representative of catches due to the high retention rate (95.2%) as seen in the observer data, we compared the estimated catches of mako sharks to the commercial landings of mako sharks recorded in PacFIN.

Pelagic longline

Two main sources of data are used to estimate the catch of blue and mako sharks by the pelagic longline fishery: 1) vessel logbooks; and 2) onboard observers. Logbooks, which record the time, location, catch by species, and number of hooks set (as well as other information) of each set, are submitted by individual vessels in the fishery. Logbook data for the longline fishery are available from 1991. Onboard observers were present for this fishery from 2001 to 2004. Observer data provide accurate records of time, location, catch by species, number of hooks set, and length of fish caught (as well as other information) of each observed set. Due to the relatively low retention rate of blue and mako sharks by the pelagic longline fishery, and the fact that US West Coast mako landings data include some landings made by Hawaii-based longline vessels, the commercial landings of blue and mako sharks recorded in the PacFIN database were considered to be unrepresentative of catches by the US West Coast-based longline fishery.

Due to the relatively small number of trips (n=23) and short observation period (4 years) recorded by observers, we did not subset the observer data into finer strata like the gillnet fishery. Instead, we assumed that the average observed CPUE was representative throughout the time-series of the fishery. The catch (numbers of fish retained or discarded dead) and effort (in thousands of hooks) information were extracted from the observer data and the average catch-per-unit-effort (CPUE) was calculated. If a discarded fish was of unknown status, we assumed that the fish was a dead discard because this assumption is more conservative. The total catch of each species in year t was then calculated as:

$$C_t = \overline{CPUE} \times E_t \times \overline{w}$$

where $\overline{CPUE}$ is the average observed CPUE; E_t is the logbook-recorded total effort (thousands of hooks) in year *t*; and $\overline{w}$ is the estimated average weight of the species from observer records. Onboard observers measure the length of fish caught in each set, which were converted into weights using the same length-weight relationships as the gillnet fishery (see above). No correction was made for logbook records with missing data because only 20 out of 11594 logbook records had missing data rendering them unusable. No correction was made for non-submission of logbooks due to the high reporting compliance (>95%) for this fishery.

RESULTS AND DISCUSSION

The size of blue and mako sharks caught during observed trips in the US West Coast drift gillnet and longline fisheries are shown in Table 1. Because of the low number of observed sets in the longline fishery, few sharks were measured and the sizes for all years are combined.

Larger sharks are caught in the high seas longline fishery than in the pelagic drift gillnet fishery, on average.

The preliminary estimated catches for blue and mako sharks for the drift gillnet and longline fisheries are shown in Tables 2 and 3, respectively. Due to confidentiality requirements, estimated catches after 2004 cannot be presented for the longline fishery (less than 3 vessels remained in the fishery after 2004). However, for assessment and accounting of total US catch, data for this fishery will be combined with the longline fishery data from Hawaii.

A comparison of estimated catches of mako sharks with recorded commercial landings from the gillnet fishery showed that the estimated catches were relatively representative. The estimated catch of mako sharks were highly similar to ($R^2 = 0.811$) and significantly correlated with ($R = 0.930$, $p = 3.02E-9$) the PacFIN landings of the gillnet fishery (Table 2). An alternative preliminary analysis using a delta-lognormal model with full interactions, produced estimated catches that were less representative ($R^2 = 0.772$) than the method presented here. This comparison shows that the method presented here produced representative estimated catches for this fishery. We could not perform a similar comparison for the longline fishery because recorded landings in PacFIN are not representative of the catches.

In general, we recommend that the methods described above be used to estimate catches of blue shark by the drift gillnet fishery and both species by the longline fishery. However, we recommend using the reported landings for mako sharks from the drift gillnet fishery because the retention rate for this species and fishery is very high (95.2%).

REFERENCES

Kohler, NE, JG Casey, and PA Turner. 1995. Length-weight relationships for 13 species of sharks from the western North Atlantic. Fishery Bulletin 93:412-418.

Pacific Fishery Management Council. 2011. Status of the US West Coast Fisheries for Highly Migratory Species through 2010. Pacific Fishery Management Council, Portland, Oregon.

TABLES

Table 1. Observer measured average size of blue and mako sharks caught in the US West Coast pelagic drift gillnet fishery (left columns) and pelagic longline fishery (right columns).

Year	Blue shark average size (kg)	Number of Blue sharks measured	Mako shark average size (kg)	Number of Mako sharks measured	Years	Blue shark average size (kg)	Number of Blue sharks measured	Mako shark average size (kg)	Number of Mako sharks measured
1990	16.9	229	31.1	193	**2001-2004**	19.7	38	40.1	87
1991	19.5	148	30.7	357					
1992	12.0	815	36.5	368					
1993	12.3	693	32.0	244					
1994	10.2	590	27.5	332					
1995	12.8	1312	27.0	444					
1996	11.4	640	25.2	337					
1997	10.8	1553	26.2	947					
1998	12.8	1663	30.8	366					
1999	10.8	1461	23.7	322					
2000	9.1	863	18.9	427					
2001	11.0	320	15.0	265					
2002	10.4	355	17.1	641					
2003	12.2	253	18.3	458					
2004	11.2	172	18.6	235					
2005	9.2	66	21.5	128					
2006	19.6	49	23.4	274					
2007	18.7	321	26.2	240					
2008	16.0	211	25.4	105					
2009	28.2	57	28.9	86					
2010	28.8	22	21.1	42					

Table 2. Preliminary estimated catch (retained and dead discards) and effort of blue and mako sharks of the pelagic drift gillnet fishery of the US West Coast. *Mako landings were extracted from the PacFIN database.

Year	Effort (km of net)	Number of sets	Estimated Mako catch (number of fish)	Estimated Mako catch (tons)	Mako landings (tons)*	Estimated Blue shark catch (number of fish)	Estimated Blue shark catch (tons)
1990	7158	4078	6514	202.8	229	20238	343.0
1991	8484	4778	5479	168.1	125	5205	101.4
1992	7725	4379	4509	164.4	118	12848	154.0
1993	9574	5442	2671	85.5	87	9871	121.3
1994	7508	4248	2226	61.2	80	3929	40.0
1995	6496	3673	3959	106.9	79	13816	176.4
1996	5983	3392	4949	124.9	85	8769	100.3
1997	5315	3039	5230	136.9	119	7425	80.3
1998	5803	3353	2814	86.7	88	9174	117.1
1999	4535	2634	2221	52.6	52	6496	70.2
2000	3528	1936	3231	61.1	64	4103	37.4
2001	2735	1665	2149	32.2	31	2178	24.0
2002	2657	1630	4904	84.1	69	1752	18.2
2003	2443	1467	2832	51.8	57	1541	18.8
2004	1777	1084	1492	27.8	38	1230	13.7
2005	1731	1075	946	20.3	25	388	3.6
2006	2375	1433	2008	47.0	38	219	4.3
2007	2048	1241	2031	53.3	37	1858	34.7
2008	1815	1103	1046	26.5	27	1159	18.5
2009	1261	761	756	21.9	25	222	6.3

Table 3. Preliminary estimated catch (retained and dead discards) and effort of blue and mako sharks of the pelagic longline fishery of the US West Coast. Catches after 2004 are not provided due to confidentiality requirements.

Year	Effort (thousands of hooks)	Estimated Mako catch (number of fish)	Estimated Mako catch (tons)	Estimated Blue shark catch (number of fish)	Estimated Blue shark catch (tons)
1991	10.7	4	0.2	55	1.1
1992	71.2	28	1.1	363	7.2
1993	15.2	6	0.2	77	1.5
1994	48.0	19	0.7	244	4.8
1995	254.5	98	3.9	1296	25.6
1996	561.0	217	8.7	2857	56.4
1997	605.9	234	9.4	3086	60.9
1998	746.0	289	11.6	3799	74.9
1999	1099.3	425	17.1	5599	110.4
2000	1620.0	627	25.1	8251	162.7
2001	1450.4	561	22.5	7387	145.7
2002	945.6	366	14.7	4816	95.0
2003	867.9	336	13.5	4420	87.2
2004	367.3	142	5.7	1871	36.9