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Estimation of catches for shortfin mako, *Isurus oxyrinchus*, caught by Japanese offshore and distant water fisheries[1]

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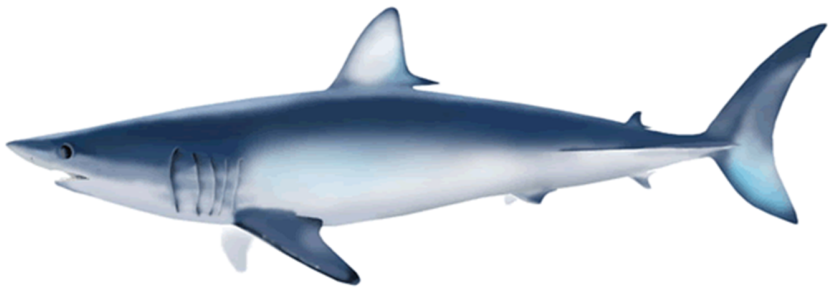

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Abstract

This working paper provides the estimated catches of shortfin mako caught by Japanese offshore (1994 and 2016) and distant-water longline fishery (during 1992 and 2016) in the North Pacific. Since the landings of sharks is frequently underestimated due to the lower value than any other teleost species such as tunas and billfishes, total catches including retained and discard/released catches were estimated using a product of the yearly changes in standardized CPUEs and the fishing effort. Two time series of catch number for shortfin mako caught by shallow-set (1994 and 2016) and deep-set (1992 and 2016) fisheries were calculated. The catch numbers were converted into the catch weight using the average weight of shortfin mako by area and season. The results showed that the total catches of shortfin mako in the North Pacific caught by Japanese offshore and distant-water longline fishery had gradually increased since 1992 until 2007 and reached at 1007 tons, and then it had gradually decreased until 2016 due to the continuous reduction of fishing effort.

Introduction

Shortfin mako (*Isurus oxyrinchus*) in the North Pacific is frequently caught as bycatch by pelagic longline fisheries targeting tuna and billfish (Kai et al. 2017). Since the market value of shortfin mako is lower than any other species such as tunas and billfishes, total catches (retained and discarded/released catches) for shortfin mako landed in Japan is frequently underestimated. Therefore, the total catches (in number) of shortfin mako caught by Japanese offshore and distant-water longline fishery in the North Pacific were estimated by multiplying the time series of the abundance indices by those of fishing effort.

This document paper provides with total catches (in weight) of shortfin mako caught by Japanese offshore and distant-water longline fishery in the North Pacific from 1992 to 2016.

Materials and Methods

Data source

We used two standardized CPUEs of shortfin mako in the North Pacific from 1992 to 2016 (**Table 1**). One is a standardized CPUE of Japanese commercial fishery from 1994 to 2016 (Kai 2017a). The other is a standardized CPUE of Japanese research and training vessel fishery from 1992 to 2016 (Kai 2017b). The former CPUE was estimated using shallow-set data (the number of hooks between float < 6). The latter CPUE was estimated using deep-set data (the number of hooks between float > 5).

Set by set logbook data of Japanese offshore and distant water longline fishery from 1992 and 2016 are used to calculate the total number of hooks by year (1992-2016), quarter (1:Jan-Mar; 2:Apr-Jun; 3:Jul-Sep; 4:Oct-Dec), area (1: west of dateline ($\leq 180^{o}$E) and $\geq 30^{o}$N; 2: west of dateline ($\leq 180^{o}$E) and $< 30^{o}$N; 3: east of dateline ($> 180^{o}$E) and $> 30^{o}$N; 4: east of dateline ($> 180^{o}$E) and $< 30^{o}$N) and depth (i.e. shallow-set or deep-set). The set by set data is also used to calculate the annual landed catches of shortfin mako from 1994 to 2016. The logbook data before 1994 has no information about the shortfin mako catch.

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The average processed weight (kg) of the shortfin mako by area and quarter is calculated using the port-sampling data of shortfin mako caught by Japanese longline offshore fishery and coastal fishery (including gillnet fishery) in the North Pacific. In the fishing port, the sharks are landed without head and gut (fins attached). The round weight of shortfin mako was estimated based on the conversion factor by multiplying the processed weight by 1.3428.

Estimation of total catch

Two time series of catches for shallow-set and deep-set were estimated using the total number of hooks in the North Pacific as well as the standardized CPUEs for both fisheries. The procedures are as follows:

(1) Year specific total catch number is estimated through multiplying the year specific CPUE by year specific total number of hooks.

(2) Total catch number is allocated into each area and quarter using the proportion of the fishing effort by area and quarter.

(3) Total catch weight by area and quarter is calculated through multiplying the catch number by the average of processed weight by area and quarter and then multiplying each component by 1.3428 (**Table 2**).

(4) If the annual landed catch is larger than the annual estimated catch, we use the annual landed catch.

Results and Discussion

The results showed that the total catches of shortfin mako in the North Pacific caught by Japanese offshore and distant-water longline fishery had gradually increased since 1992 and reached at 1007 tons in 2007, and then it had gradually decreased until 2016 (**Figure 1**). The estimated catches of shallow-set longline fishery showed an increasing trends from 1992 and 2007, and then it had decreased until 2016 (**Figure 1**). The estimated catches of deep-set longline fishery showed a continuous decreasing trends since 1992 (**Figure 1**). The reductions of the catches after 2007 were caused by the reduction in the fishing effort (i.e. total number of hooks) for both shallow and deep-sets fisheries (**Figure 2**). The estimated catches in recent five years varied between 380 and 777 tons (**Table 3**).

Reference

Kai, M., Thorson, J. T., Piner, K. R. and Maunder, M. N. (2017) Predicting the spatio-temporal distributions of pelagic sharks in the western and central North Pacific. *Fish. Oceanogra.* doi:10.1111/fog-12217

Kai, M. 2017a. Updated CPUE of shortfin mako, *Isurus oxyrinchus*, caught by Japanese shallow-set longliner in the North Pacific. ISC/17/SHARKWG-1/XX.

Kai, M. 2017b. CPUE of shortfin mako, *Isurus oxyrinchus*, caught by Japanese research and trining vessels in the North Pacific. ISC/17/SHARKWG-1/XX.

Table 1. Standardized CPUE of shortfin mako caught by Japanese research and training vessel fishery (deep-set) and Japanese commercial fisheries (shallow-set) respectively.

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Year	Deep-set (RTV)	Shallow-set (Commercial)
1992	0.06635326	
1993	0.09627061	
1994	0.09289341	0.30890930
1995	0.07235065	0.40626430
1996	0.05840557	0.41574480
1997	0.07371481	0.43092250
1998	0.08521190	0.42949540
1999	0.11078712	0.56034030
2000	0.07800176	0.57103350
2001	0.09239361	0.46673030
2002	0.12260229	0.42686080
2003	0.10330809	0.61132280
2004	0.09216961	0.58319050
2005	0.09614763	0.80978850
2006	0.12001761	0.99641360
2007	0.13265372	0.96544390
2008	0.10355233	0.84582320
2009	0.06857815	1.12596920
2010	0.11365596	1.00979830
2011	0.06367903	1.38331960
2012	0.12205958	1.29387850
2013	0.05728252	1.24160250
2014	0.08452771	1.39348930
2015	0.13873181	1.41132600
2016	0.13179846	1.80877950

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Table 2. Average body weight (kg) of shortfin mako by area and quarter. The shades denote the interpolated average values. Remarks denotes the area and quarter used for the calculation of the average weights.

Area	Quartor	Number of sample	Body weight (kg)	Remarks (Area-Quarter)
1	1	28967	31.55	
1	2	14077	37.28	
1	3	14076	39.31	
1	4	12627	39.23	
2	1	1027	39.94	
2	2	3627	49.52	
2	3	0	46.55	1-3;2-2;2-4;3-3
2	4	60	45.05	
3	1	2286	49.78	
3	2	4311	44.39	
3	3	6984	52.30	
3	4	10465	51.73	
4	1	823	50.22	
4	2	2947	53.41	
4	3	0	52.85	3-3;4-2
4	4	0	52.57	3-4;4-2

Table 3. Annual changes in estimated catch (number and tons) and landed catch (number and tons) of North Pacific shortfin mako caught by Japanese shallow and deep-sets longline fishery and the number of hooks (millions) from 1992 to 2016. Red figures indicates that the landed catch is higher than the estimated catch.

Year	Number of catch		Number of landed catch		Weight of catch (tons)		Weight of landed catch (tons)		Numer of hooks (millions)	
	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep
1992		11,686				538				172.7
1993		16,743				775				172.4
1994	8,003	7,773	3,205	8,392	326	364	126	414	25.9	117.1
1995	10,017	10,871	3,694	12,514	408	521	143	638	24.7	112.9
1996	9,568	8,936	5,663	5,946	383	421	222	286	23.0	96.2
1997	9,756	6,481	7,187	5,784	388	309	274	282	22.6	89.6
1998	10,075	5,193	7,729	4,402	400	249	295	219	23.5	88.9
1999	13,055	7,297	9,766	4,763	507	348	366	236	23.3	99.0
2000	14,908	7,532	12,780	2,838	568	362	473	136	26.1	88.4
2001	12,100	10,134	11,013	2,693	457	488	408	128	25.9	91.5
2002	10,072	6,458	9,605	1,821	385	312	356	87	23.6	82.8
2003	12,476	7,415	10,002	2,243	477	356	376	106	20.4	80.3
2004	12,434	8,456	10,690	1,459	491	406	407	67	21.3	69.0
2005	15,368	6,263	12,798	1,688	587	302	482	81	19.0	60.6
2006	18,905	5,246	13,544	2,065	736	252	519	95	19.0	56.9
2007	21,006	4,357	15,742	1,627	802	205	589	71	21.8	45.3
2008	16,754	5,023	13,065	1,483	632	239	486	66	19.8	41.9
2009	19,072	4,316	16,344	598	718	204	603	29	16.9	32.5
2010	16,319	3,506	13,987	742	633	164	520	35	16.2	33.9
2011	12,351	2,840	9,415	934	469	131	350	43	8.9	41.4
2012	13,777	4,073	11,203	531	522	185	418	21	10.6	35.8
2013	13,899	2,156	8,499	523	554	99	323	21	11.2	33.8
2014	14,789	4,329	12,607	672	578	199	473	27	10.6	35.5
2015	12,379	1,850	13,112	347	466	85	482	14	8.8	32.3
2016	8,751	1,412	9,524	160	314	66	337	6	4.8	16.7

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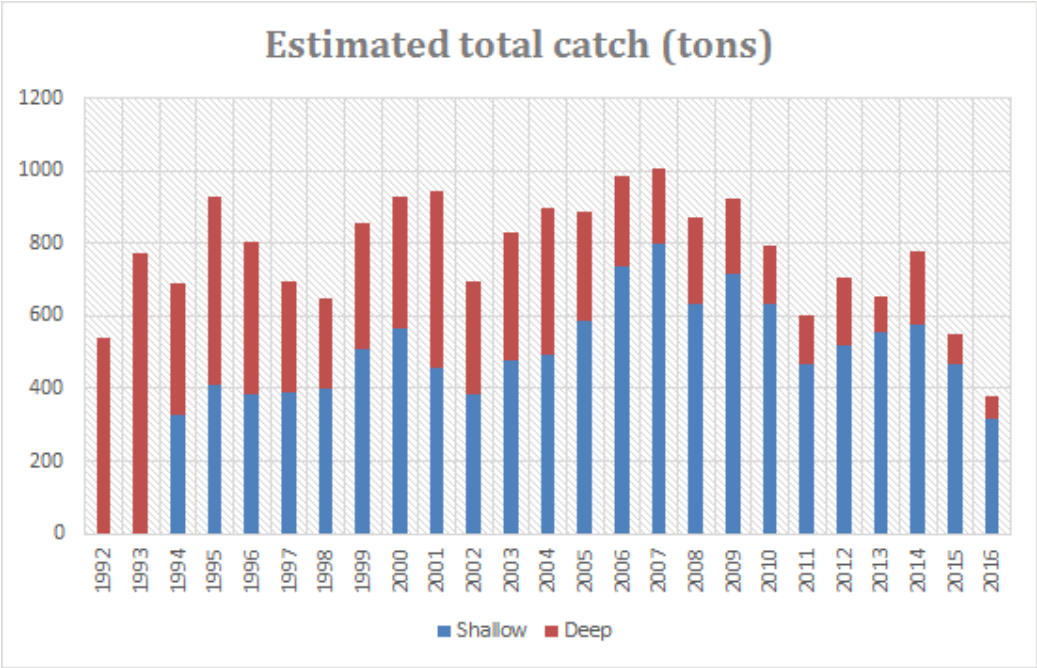

Figure 1. Yearly changes in estimated total catches (tons) for shallow and deep-set fishery from 1992 to 2016.

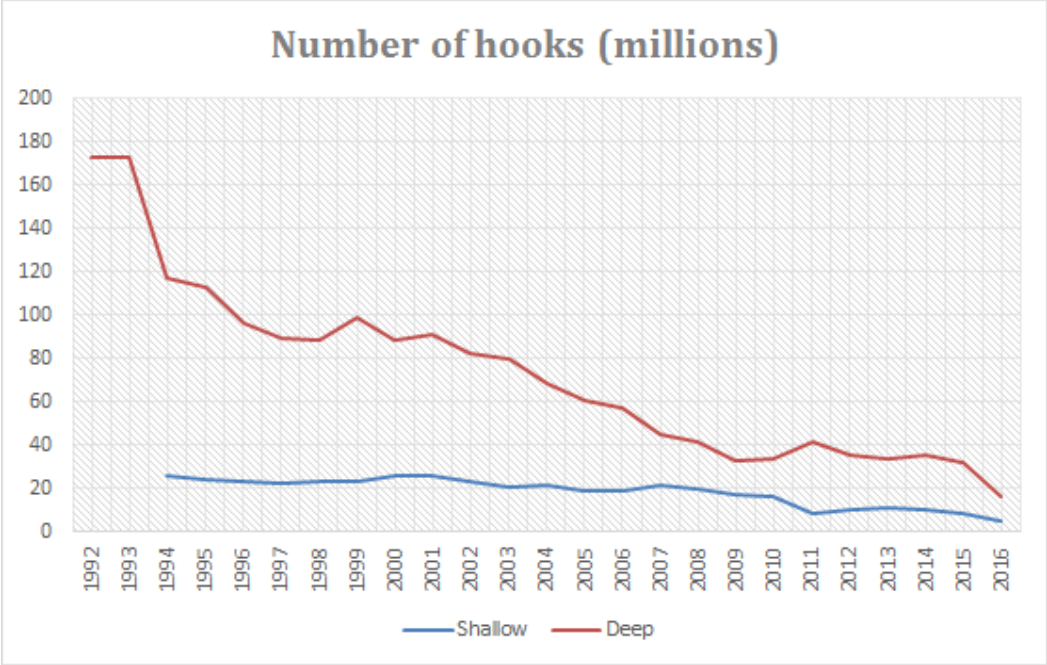

Figure 2. Yearly changes in number of hooks (millions) for shallow and deep-set fishery from 1992 to 2016.

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