ISC/21/SHARKWG-1/05

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

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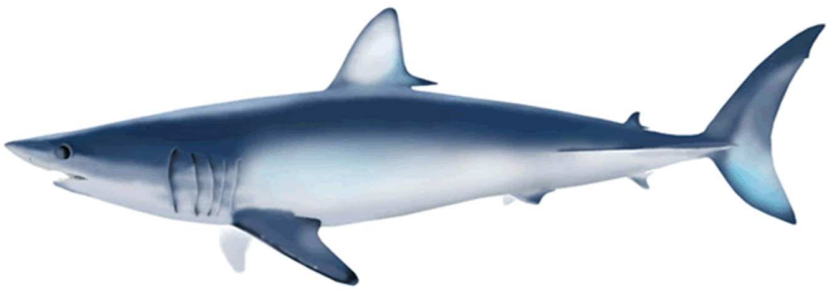

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Abstract

This working paper provides with estimation of catches for shortfin mako caught by Japanese offshore (1994 and 2019) and distant-water longline fishery (during 1992 and 2019) 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 swordfish, total catches including retained and discard/released catches were estimated using a product of the annual standardized CPUEs and the fishing effort. Two annual catch data in number of shortfin mako caught by shallow-set (1994 and 2019) and deep-set (1992 and 2019) fisheries were used. The catch number was 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 1144 tons, and then it had gradually decreased due to the continuous reduction of total fishing effort.

Introduction

Shortfin mako (*Isurus oxyrinchus*) in the North Pacific is frequently caught as bycatch by pelagic longline fisheries targeting tuna and billfish. 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 2019.

Materials and Methods

Data source

We used two standardized CPUEs of shortfin mako in the North Pacific from 1992 to 2019 (**Table 1**). One is a standardized CPUE of Japanese commercial fishery from 1994 to 2019 (Kai 2021a). The other is a standardized CPUE of Japanese research and training vessel from 1992 to 2016 (Kai 2021b). 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

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logbook data of Japanese offshore and distant water longline fishery from 1992 and 2019 were used to calculate the total number of hooks by year (1992-2019), quarter (1:Jan.-Mar.; 2:Apr.-Jun.; 3:Jul.-Sep.; 4:Oct.-Dec.), area (1: west of dateline (≤ 180°E) and ≥ 30°N; 2: west of dateline (≤ 180°E) and < 30°N; 3: east of dateline (> 180°E) and > 30°N; 4: east of dateline (> 180°E) and < 30°N) and depth (i.e. shallow-set or deep-set). The set by set data was also used to calculate the annual landed catches of shortfin mako from 1994 to 2019. The logbook data of commercial fishery before 1994 had no information about the shortfin mako catch. The average round weight (kg) of the shortfin mako by area and quarter was calculated using the port-sampling data of shortfin mako caught by Japanese longline fishery in the North Pacific.

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) Annual catch number was estimated through multiplying the annual CPUE by annual fishing effort (number of hooks).

(2) Annual catch number was allocated into four area and quarter using the proportion of the fishing effort by area and quarter.

(3) Total catch weight by area and quarter was calculated through multiplying the catch number by the mean body weight by area and quarter (**Table 2**).

(4) If the annual landed catch is larger than the annual estimated catch, the annual landed catch was used as the updated 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 1144 tons in 2007, and then it had gradually decreased (**Fig. 1**). The estimated catches of shallow-set longline fishery showed an increasing trend from 1992 and 2007, and then it had decreased until 2017 (**Table 1** and **Fig. 1**). The estimated catches of deep-set longline fishery showed a continuous decreasing trend since 1992 (**Table 1** and **Fig. 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 (**Fig. 2**). The estimated catches in recent five years varied between 651 and 955 tons (**Table 3**).

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Reference

Kai, M. 2021a. Updated CPUE of shortfin mako, *Isurus oxyrinchus*, caught by Japanese shallow-set longliner in the northwestern Pacific. ISC/20/SHARKWG-1/XX.

Kai, M. 2021b. Updated CPUE of shortfin mako, *Isurus oxyrinchus*, caught by Japanese research and training vessels in the western and centralNorth Pacific. ISC/20/SHARKWG-1/XX.

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

Year	Deep-set (RTV)	Shallow-set (Commercial)
1992	0.051	
1993	0.082	
1994	0.078	0.276
1995	0.063	0.337
1996	0.052	0.385
1997	0.070	0.382
1998	0.073	0.395
1999	0.097	0.455
2000	0.070	0.496
2001	0.077	0.417
2002	0.079	0.372
2003	0.088	0.522
2004	0.085	0.533
2005	0.079	0.733
2006	0.080	0.825
2007	0.099	0.825
2008	0.084	0.730
2009	0.064	0.951
2010	0.075	0.861
2011	0.058	1.227
2012	0.068	1.112
2013	0.050	1.055
2014	0.077	1.131
2015	0.128	1.090
2016	0.131	1.686
2017	0.080	1.089
2018	0.144	1.200
2019	0.182	1.216

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Table 2. Average body weight (kg) of shortfin mako by area and quarter.

Area	Quartor	Number of sample	Mean body weight (kg)
1	1	87,696	42.12
1	2	61,105	39.64
1	3	54,398	49.90
1	4	89,646	51.60
2	1	6,300	55.82
2	2	15,076	63.09
2	3	670	59.66
2	4	509	56.07
3	1	3,800	67.98
3	2	1,593	58.40
3	3	2,386	75.71
3	4	7,434	75.05
4	1	13,378	65.19
4	2	7,172	60.29
4	3	6,128	64.00
4	4	15,313	66.77

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Table 3. Annual 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 fishing effort (number of hooks in millions) from 1992 to 2019. Red figures indicates that the landed catch is higher than the estimated catch.

Year	Number of catch		Number of landed catch		Weight of estimated catch (tons)		Weight of landed catch (tons)		Numer of hooks (millions)	
	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep
1992	0	8,809	0	0	0	521	0	0	0.0	172.7
1993	0	14,139	0	0	0	839	0	0	0.0	172.4
1994	7,150	9,137	3,205	8,392	374	546	160	524	25.9	117.1
1995	8,309	7,114	3,694	12,514	438	433	187	807	24.7	112.9
1996	8,861	5,002	5,663	5,946	454	303	283	376	23.0	96.2
1997	8,648	6,270	7,187	5,784	440	381	346	360	22.6	89.6
1998	9,266	6,490	7,729	4,402	472	394	378	282	23.5	88.9
1999	10,601	9,601	9,766	4,763	527	586	472	305	23.3	99.0
2000	12,949	6,187	12,780	2,838	621	376	588	174	26.1	88.4
2001	10,811	7,043	11,013	2,693	514	430	508	171	25.9	91.5
2002	8,777	6,541	9,605	1,821	428	397	456	112	23.6	82.8
2003	10,653	7,063	10,002	2,243	518	429	470	136	20.4	80.3
2004	11,364	5,862	10,690	1,459	576	354	520	86	21.3	69.0
2005	13,910	4,789	12,798	1,688	677	291	608	105	19.0	60.6
2006	15,653	4,554	13,544	2,065	776	277	645	122	19.0	56.9
2007	17,950	4,487	15,742	1,627	874	270	748	91	21.8	45.3
2008	14,460	3,516	13,065	1,483	686	213	604	86	19.8	41.9
2009	16,108	2,082	16,344	598	770	125	751	38	16.9	32.5
2010	13,914	2,539	13,987	742	685	151	638	45	16.2	33.9
2011	10,955	2,402	9,415	934	545	141	455	54	8.9	41.4
2012	11,841	2,437	11,203	531	568	142	514	28	10.6	35.8
2013	11,810	1,692	8,499	523	610	99	421	27	11.2	33.8
2014	12,003	2,731	12,607	672	606	160	609	35	10.6	35.5
2015	9,744	4,153	13,143	348	470	242	605	18	8.9	32.4
2016	15,097	3,177	16,939	491	713	182	784	25	9.0	24.3
2017	9,127	1,723	12,015	197	439	99	564	10	8.4	21.5
2018	10,259	3,212	13,506	252	494	186	638	14	8.5	22.3
2019	9,770	3,734	11,791	105	486	215	571	6	8.0	20.5

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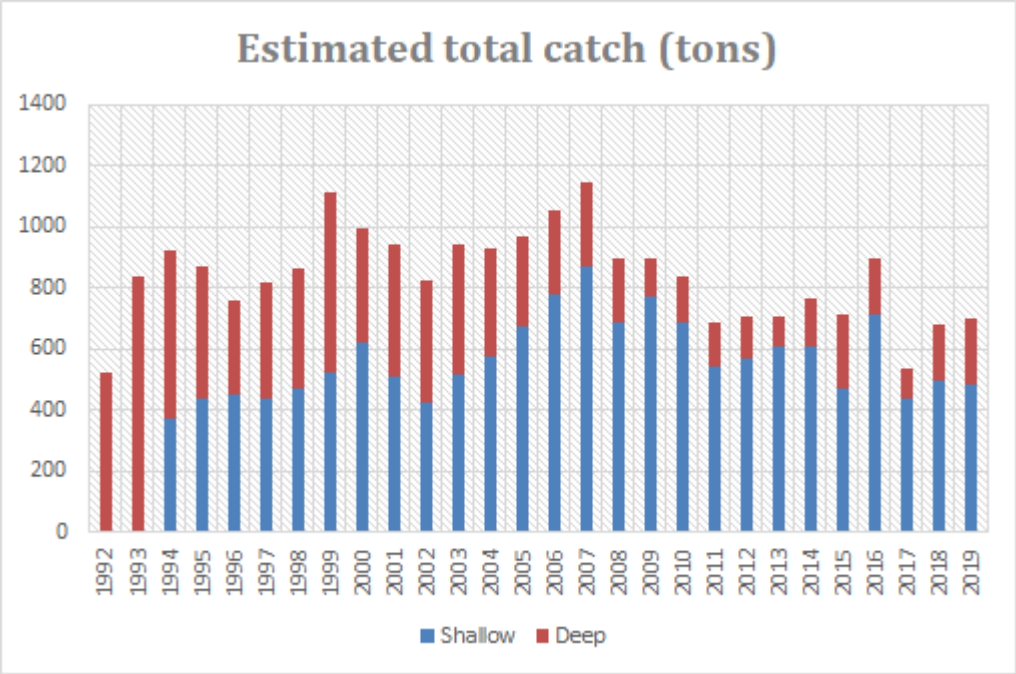

Figure 1. Annual estimated total catches (tons) for shallow and deep-set fishery from 1992 to 2019.

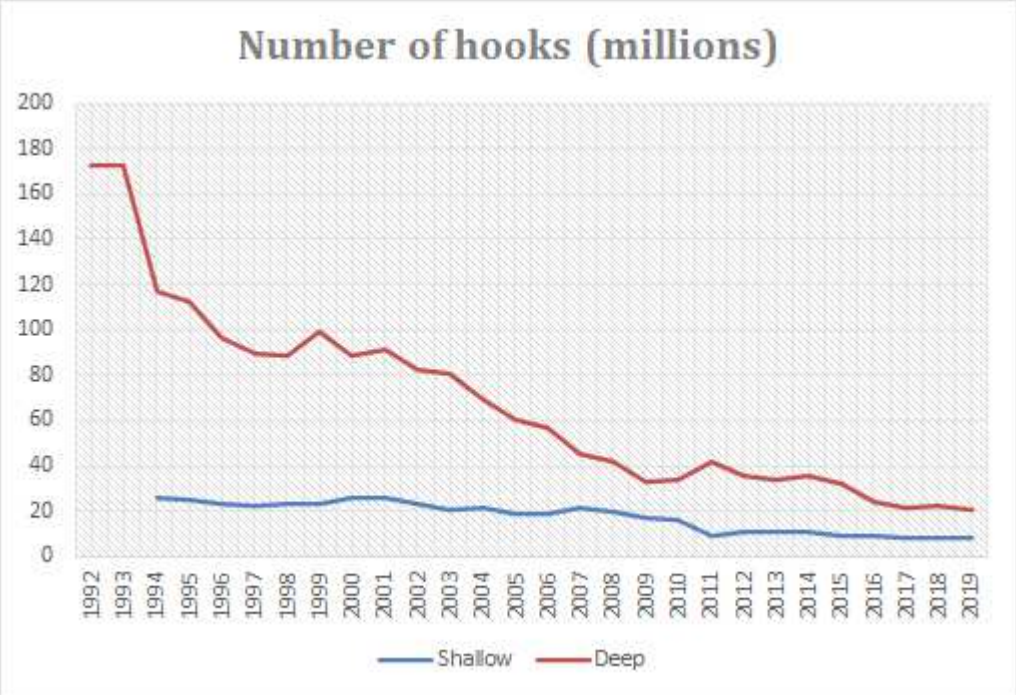

Figure 2. Annual fishing effort (number of hooks in millions) for shallow and deep-set fishery from 1992 to 2019.

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