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Updated annual catches of shortfin mako caught by Japanese coastal fisheries in the North Pacific Ocean from 1994 to 2022[1]

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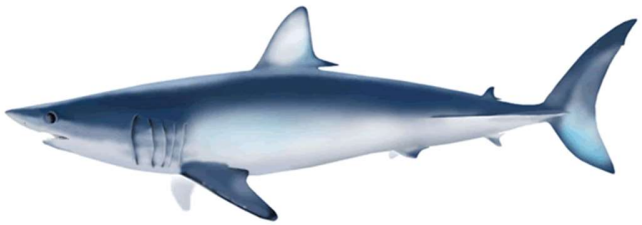

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Abstract

This working paper provides update of Japanese annual catch of shortfin mako (SMA), *Isurus oxyrinchus*, caught by Japanese coastal fisheries in the North Pacific Ocean for 1994-2022. We used the same estimation methods as those used in the previous analysis in 2017. Since the species-specific shark's data was not included in Japanese official coastal landing data, the catch amounts of SMA caught by multiple coastal fisheries were estimated using several available species-specific data. The proportion of estimated total catch of SMA for both longline fisheries and large-mesh driftnet fishery accounted for more than 89 % of annual total catch amounts except the catches in 2005 (83%) and 2022 (76%). The annual total catch of SMA largely fluctuated between 151 and 638 *t* throughout the period. After 2016, it had continuously decreased until 2022 due to the reduction of catch for large mesh driftnet fishery. The annual trends of catch amounts of SMA for 1994-2016 were almost similar between previous and updated estimates.

Introduction

Shortfin mako, *Isurus oxyrinchus*, is incidentally caught by multiple Japanese coastal fisheries such as Japanese coastal longline, Japanese other longline, Japanese large-mesh drift net, Japanese trap-net, Japanese bait fishing, and the other fisheries. Most of the Japanese coastal catch for pelagic sharks were occupied by the longline fisheries as well as large-mesh drift net fishery (Kimoto et al., 2012). Large-mesh drift net fishery was banned in the open sea area in 1993 (Fujinami et al., 2021), while Japanese large-mesh drift net fishery has been operating in the coastal waters within the economic excusive zone (EEZ) of northeastern Japan thereafter. Kai and Yano (2017) updated the annual catch amount of SMA caught by multiple Japanese coastal fisheries until 2015 using the same methods as used in the previous analyses, and the annual catch estimated in 2017 was applied to the stock assessment for North Pacific SMA (ISC, 2018). This document paper updates annual catch amounts of SMA caught by multiple Japanese coastal fisheries until 2022.

Materials and Methods

In the previous stock assessment in 2018 (ISC, 2018), annual catch amounts of Japanese coastal fisheries were comprised of six types of fisheries: (1) Japanese coastal longline, (2) Japanese other longline, (3) Japanese large-mesh drift net, (4) Japanese trap net, (5) Japanese bait fishing, and (6) Japanese other fisheries. Since Japanese official coastal landing data have no information about the species for pelagic sharks, annual catch amounts of SMA for the coastal fisheries were estimated using several other sources including species-specific shark's data (i.e., a ratio of SMA to the sharks including major pelagic sharks such as blue shark, SMA, salmon shark, thresher sharks, hammerhead shark, silky shark, and oceanic whitetip sharks etc.). We used three types of other data sources from 1994 to 2022; (i) Japanese statistical yearbook ("Nourin-toukei"), (ii) Research project on Japanese

Bluefin tuna ("RJB"), (iii) Logbook data ("Gyoseki"). The details of these data were summarized in the **Appendix**.

First, the annual catch amounts of North Pacific spiny dogfish (*Squalus suckleyi*) caught by four fleets (Other longline, Trap net, Bait fishing, and Other fisheries) were excluded from the total catch amounts of sharks in "Norin-toukei" because the catch amounts of spiny dogfish were not included in the other two data sources. Then, the catch amounts of SMA caught by multiple Japanese coastal fisheries were estimated using the following equations:

(1) Japanese coastal longline

Catch of SMA = Catch of sharks ("Norin-toukei") * Catch ratio of SMA to sharks ("Gyoseki")

(2) Japanese other longline

Catch of SMA = Catch of sharks ("Norin-toukei") * Catch ratio of SMA to sharks ("Gyoseki")

(3) Japanese large-mesh drift net

Catch of SMA = Catch of sharks ("Norin-toukei") * Catch ratio of SMA to sharks ("RJB")

(4) Japanese trap net

Catch of SMA = Catch of sharks ("Norin-toukei") * Catch ratio of SMA to sharks ("RJB")

The ratios were calculated using the data for a large-scale trap net fishery (S2) in RJB data. If there was no annual catch for SMA, we used a mean catch ratio of SMA to sharks between 1994 and 2022.

(5) Japanese bait fishing

Catch of shortfin mako caught by this fishery was not estimated because we have no information about the ratio of shortfin mako to all sharks.

(6) Japanese other fisheries

Catch of SMA = Catch of sharks ("Norin-toukei") * Catch ratio of SMA to sharks ("RJB"). The catch ratios of SMA were calculated using the data for other fisheries (O1 and O2) in RJB data.

Finally, the annual catch amounts of SMA caught by "Coastal longline" and "Other longline", and "Trap net" and "Other fisheries" were combined respectively.

Results

The proportion of estimated total catch of SMA for longline fisheries and large-mesh driftnet fishery accounted for more than 87 % of annual total catch amounts except the catches in 2005 (83%) and 2022 (76%) (**Table 1**, **Fig. 1**). In contrast, the estimated total catch amounts of SMA caught by the remaining fisheries were considerably small (**Table 1**). The estimated annual total catch of SMA had largely fluctuated between 151 and 638 *t* throughout the period, and it reached to the peak in 2009. After 2016, it had continuously decreased until 2022 due to the reduction of catch for large-mesh driftnet fishery. As of them, the estimated annual catch amounts for large-mesh drift net fishery had

accounted for more than approximately 74% since 2014. The annual trends of catch amounts of SMA for 1994-2016 were almost similar between previous and updated estimates (**Fig. 2**).

Discussions

Annual catch amounts of SMA caught by multiple Japanese coastal fisheries in the North Pacific Ocean were estimated based on the Japanese statistical yearbook from 1994 to 2022. The estimated annual catch amounts were dominated by the coastal and other longline fisheries as well as large mesh drift net fishery, but the catch amount of the large-mesh drift net fishery largely accounted for the coastal catches in recent years (**Table 1**, **Fig. 1**). The estimated annual catch of SMA had largely fluctuated depending on the annual catches of coastal- and other- longline fishery during 1994 and 2011. Thereafter the estimated annual catch of SMA was dominated by the catch of large-mesh drift net fishery. The estimated annual catch amount of SMA caught by Japanese coastal longline fishery suddenly decreased in 2011 because the fishing operation was halted due to the influence of the huge earthquake of the Pacific coast of Tohoku. The recent decline of SMA caught by the coastal longline fishery was caused by the decrease of the fishing effort. The estimated annual total catches of SMA may be underestimated due to the discard or release of the SMA through the lower values compared to tunas and swordfishes. In future work, it is important to estimate the discard/released catch amounts for Japanese coastal longline fisheries through developments of the standardized CPUE.

Reference

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ISC. 2018. Stock assessment of shortfin mako shark in the North Pacific Ocean through 2016. Report of the shark working group. ISC18/Annex15.

Kai, M., and Yano, T. 2017. Estimation of catches of shortfin mako, *Isurus oxyrinchus*, caught by Japanese coastal fisheries. ISC/17/SHARKWG-1/02.

Kimoto, A. Yano, T., and Yokawa, K. 2012. Historical catch amount of blue shark caught by Japanese coastal fisheries. ISC/12/SHARKWG-1/11.

Table 1. Estimated annual catch amounts (*t*) of shortfin mako caught by multiple Japanese coastal fisheries from 1994 to 2022. The values in 2022 is preliminary estimates.

Year	Coastal longline (*t*)	Other longline (*t*)	Large mesh drift net (*t*)	Trap net (*t*)	Other fisheries (*t*)	Total (*t*)
1994	44.6	24.4	110.5	13.9	7.8	201.1
1995	37.2	28.2	92.5	11.1	4.3	173.4
1996	253.7	145.0	90.8	10.4	7.6	507.4
1997	138.2	67.7	114.5	13.4	3.2	337.1
1998	15.1	5.9	117.0	11.1	2.0	151.2
1999	160.0	58.9	158.4	11.6	2.7	391.6
2000	71.7	32.7	139.7	11.6	4.3	260.0
2001	156.8	53.4	139.9	11.8	3.8	365.7
2002	88.4	32.0	121.9	4.1	0.6	247.0
2003	13.7	5.6	228.7	5.2	0.5	253.7
2004	19.2	7.1	133.5	0.4	0.3	160.6
2005	45.6	15.7	154.9	41.7	1.2	259.1
2006	7.1	2.4	177.9	5.4	0.3	193.1
2007	30.8	12.3	243.8	12.2	2.4	301.6
2008	79.9	41.2	212.5	12.5	1.2	347.2
2009	225.3	116.6	294.2	1.0	0.5	637.5
2010	85.3	65.6	272.0	18.4	1.3	442.5
2011	3.3	44.4	146.4	11.3	0.0	205.5
2012	5.0	4.6	206.1	1.0	0.9	217.4
2013	30.1	16.7	344.7	7.3	2.0	400.8
2014	3.4	3.8	263.2	3.3	0.0	273.6
2015	1.3	0.9	334.1	11.1	0.3	347.7
2016	20.2	12.1	445.7	15.4	0.3	493.7
2017	14.4	8.9	271.1	8.9	0.9	304.2
2018	12.0	7.3	223.2	27.9	0.4	270.7
2019	8.7	6.8	213.6	2.5	0.8	232.4
2020	1.4	2.6	194.3	14.5	1.3	214.2
2021	10.5	5.9	133.5	22.2	0.8	172.8
2022	3.1	1.6	159.7	52.1	0.2	216.8

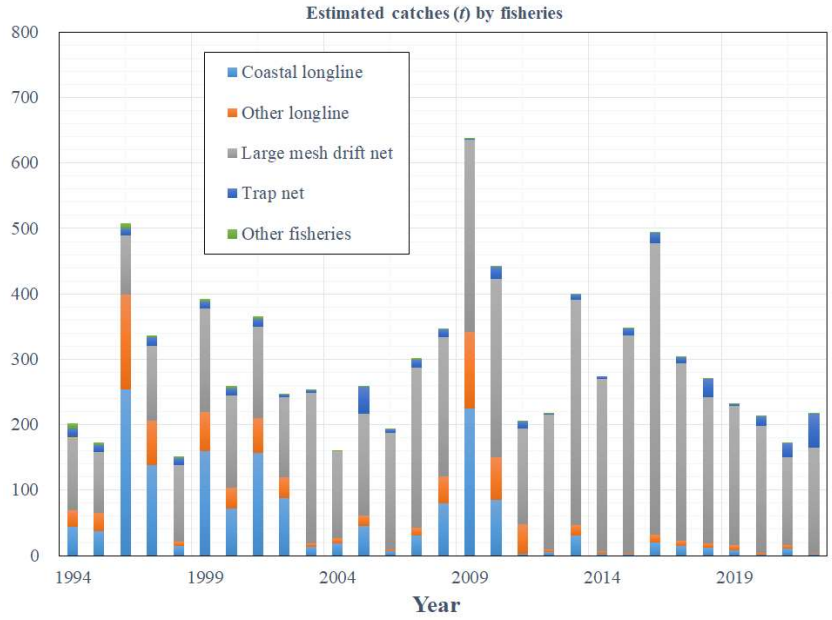

Figure 1. Estimated annual catch amounts (*t*) of shortfin mako caught by multiple Japanese coastal fisheries from 1994 to 2022. The values in 2022 is preliminary estimates.

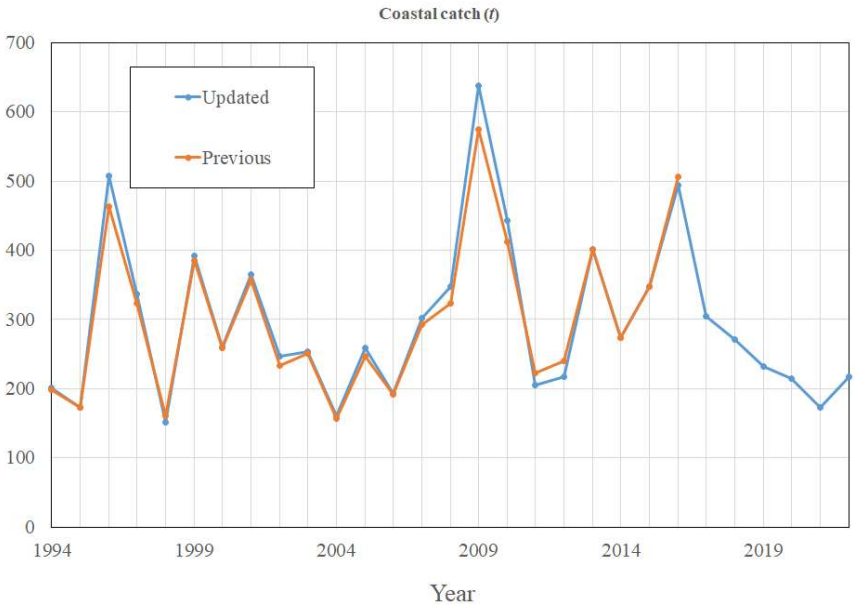

Figure 2. Updated annual total catch of shortfin mako caught by multiple Japanese coastal fisheries from 1994 to 2022 compared with previous one until 2016. The values in 2022 is preliminary estimates.

Appendix

Information about Japanese major statistical data sources

Three kinds of Japanese major statistical data sources were used to estimate the annual catch amount of SMA in the North Pacific Ocean.

(i) Japanese statistical yearbook ("Nourin-toukei")

Japan Fishery Agency (JFA) compiles this year book and opens the data to the public every year through Ministry of Agriculture, Forestry and Fisheries. This yearbook covers wide areas in Japan and long term from 1951 to 2022, however, it has a one or two-year time lag and the catch of last year is preliminary value. In addition, shark species are aggregated into one category "sharks" after 1967. The statistics includes total catch amounts of sharks caught by multiple fishing gears, species, and prefecture. Gear-specific annual catch amounts of pelagic sharks from 1994 to 2022 are shown in **Table A1**. In addition, gear-specific annual catch amounts of North Pacific spiny dogfish from 1994 to 2022 are shown in **Table A2**. Those were also estimated using annual catch of sharks in "Nourin-toukei" and the catch ratio of spiny dogfish to all shark from 1964 to 1967.

(ii) Research project on Japanese bluefin tuna ("RJB")

National Research Institute of Far Seas Fisheries (NRIFSF) commenced the survey program since 1992 to gather information about Pacific bluefin tuna landings from Japanese coastal and offshore fisheries. The data includes information about landed prefecture, landed local market, landed dates, fishing area, fishing gear, catch weight (Sales slips) for Pacific bluefin tuna as well as those of other species including pelagic sharks such as a blue shark etc., while the compilation of the data for pelagic sharks had started in 2002. Catch ratios of SMA to all pelagic sharks caught by three types of fisheries during 1994 and 2022 are shown in **Table A3**. "Kesennuma" is a major fishing port located in the eastern part of Japan where many blue sharks are landed by Japanese longline fisheries as well as large-mesh drift net fishery.

(iii) Logbook data ("Gyoseki")

NRIFSF compiles the logbook data collected from Japanese coastal longline fisheries. The set by set data from 1994 to 2022 includes information on species of sharks, catch number, and catch weight etc.. Annual retained catches (t) of SMA, all sharks, and the catch ratio of SMA to all sharks caught by coastal and other longline fisheries are shown in **Table A4**.

Appendix tables

Table A1. Gear-specific annual catch amounts (*t*) of sharks from Japanese statistical yearbook ("Nourin-toukei") during 1994 and 2022.

Year	Coastal longline (*t*)	Other longline (*t*)	Large mesh drift net (*t*)	Bait fishing (*t*)	Trap net (*t*)	Other fisheries (*t*)
1994	2052	1783	1480	119	117	65
1995	1683	2030	1240	118	107	37
1996	1954	1775	1216	119	103	64
1997	2128	1658	1534	187	114	28
1998	2551	1592	1567	122	99	19
1999	2345	1373	2123	63	92	25
2000	2031	1472	1872	41	99	41
2001	2633	1425	1874	72	117	34
2002	2007	1155	2037	43	87	27
2003	1516	983	3000	66	86	20
2004	1552	912	2438	85	91	19
2005	2313	1263	2278	65	101	29
2006	2176	1180	2558	65	84	11
2007	2185	1385	2583	49	78	69
2008	1900	1556	2881	37	117	44
2009	1984	1632	3300	30	96	29
2010	1292	1579	3215	30	120	29
2011	70	1498	1961	88	100	6
2012	965	1405	2761	76	67	7
2013	1538	1352	3310	70	98	25
2014	741	1309	3867	46	90	0
2015	985	1098	3581	70	105	3
2016	845	804	3082	47	153	5
2017	1023	1008	3463	44	129	4
2018	571	550	3592	34	127	2
2019	502	622	3497	41	109	3
2020	173	505	3267	36	109	5
2021	567	503	3742	29	126	5
2022	600	500	3900	29*	200	5*

*The same values as those in 2021 were given

Table A2. Gear-specific annual catch (*t*) of North Pacific spiny dogfish from Japanese statistical yearbook ("Nourin-toukei") during 1994 and 2022.

Year	Other longline (tons)	Other bait fishing (tons)	Trap net (tons)	Other fishery (tons)
1994	661	25	58	4
1995	753	25	60	3
1996	658	25	59	4
1997	615	40	57	3
1998	590	26	52	3
1999	509	13	43	4
2000	546	9	50	7
2001	528	15	67	4
2002	428	9	44	3
2003	365	14	40	3
2004	338	19	42	3
2005	468	14	58	3
2006	438	14	51	3
2007	514	10	48	4
2008	577	8	66	3
2009	605	6	56	3
2010	586	6	62	2
2011	556	19	52	1
2012	521	16	53	0
2013	501	15	67	1
2014	485	10	76	1
2015	407	15	58	1
2016	298	10	80	2
2017	374	9	72	2
2018	204	7	52	1
2019	231	9	49	1
2020	187	8	33	1
2021	187	6	45	1
2022	185	0	52	0

Table A3. Catch ratios of shortfin mako to all pelagic sharks caught by three types of fisheries during 1994 and 2022. The ratios were estimated using RJB data.

Year	Trap net	Other fisheries	Large mesh drift net in Kesennuma
1994	0.24	0.13	0.07
1995	0.24	0.13	0.07
1996	0.24	0.13	0.07
1997	0.24	0.13	0.07
1998	0.24	0.13	0.07
1999	0.24	0.13	0.07
2000	0.24	0.13	0.07
2001	0.24	0.13	0.07
2002	0.09	0.03	0.06
2003	0.11	0.03	0.08
2004	0.01	0.02	0.05
2005	0.97	0.05	0.07
2006	0.16	0.03	0.07
2007	0.41	0.04	0.09
2008	0.24	0.03	0.07
2009	0.03	0.02	0.09
2010	0.32	0.05	0.08
2011	0.24	0.01	0.07
2012	0.07	0.12	0.07
2013	0.24	0.08	0.10
2014	0.24	0.15	0.07
2015	0.24	0.13	0.09
2016	0.21	0.10	0.14
2017	0.16	0.43	0.08
2018	0.37	0.38	0.06
2019	0.04	0.42	0.06
2020	0.19	0.32	0.06
2021	0.27	0.20	0.04
2022	0.35	0.05	0.04

Table A4. Retained annual catches (*t*) of shortfin mako, all sharks, and the catch ratio of shortfin mako to all sharks caught by coastal and other longline fisheries and the data come from logbook data ("Gyoseki") during 1994 and 2022.

Year	Shortfin mako (kg)	Sharks (kg)	Ratio of shortfin mako
1994	7,213	332,188	0.022
1995	17,747	802,804	0.022
1996	173,819	1,338,926	0.130
1997	65,829	1,013,575	0.065
1998	2,915	491,354	0.006
1999	1,791	26,252	0.068
2000	1,565	44,339	0.035
2001	2,673	44,882	0.060
2002	2,986	67,813	0.044
2003	667	73,767	0.009
2004	2,319	187,704	0.012
2005	1,398	70,857	0.020
2006	419	127,914	0.003
2007	1,129	80,080	0.014
2008	19,991	475,389	0.042
2009	46,410	408,773	0.114
2010	26,409	399,968	0.066
2011	23,783	504,113	0.047
2012	3,128	606,798	0.005
2013	20,534	1,049,041	0.020
2014	4,680	1,013,403	0.005
2015	1,183	881,543	0.001
2016	51,623	2,158,076	0.024
2017	58,975	4,189,246	0.014
2018	78,138	3,716,377	0.021
2019	67,151	3,872,341	0.017
2020	20,529	2,465,269	0.008
2021	53,518	2,886,348	0.019
2022	12,021	2,363,471	0.005