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Updated annual catches of blue shark caught by Japanese coastal fisheries in the North Pacific Ocean from 1994 to 2019[1]

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Abstract

This working paper provides update of Japanese annual catch of blue shark (BSH), *Prionace glauca*, caught by Japanese coastal fisheries in the North Pacific Ocean for 1994-2019. We used the same estimation methods as those used in the previous analysis in 2016. Since the species-specific shark's data was not included in Japanese official coastal landing data, the catch amounts of BSH caught by multiple coastal fisheries were estimated using several available species-specific data. The proportion of estimated total catch of BSH for both longline fisheries and large-mesh driftnet fishery accounted for more than 97 % of annual total catch amounts. The annual total catch of BSH had increased in 2000s and reached at peak in 2007, and then it gradually decreased until 2019 due to the reduction of catch amounts for longline fisheries. The total catch amounts of BSH were largely fluctuated between 1041 and 4064 MT during 1994 and 2019. The annual trends of catch amounts of BSH were almost similar between previous and updated analyses.

Introduction

Blue shark (BSH), *Prionace glauca*, 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. Historical Japanese coastal catches of BSH from 1951 to 2010 were estimated by Kimoto *et al*. (2012). Most of the Japanese coastal catch for pelagic sharks were occupied by the longline fisheries as well as large-mesh drift net. 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 (2016, 2019) updated the annual catch amount of BSH caught by multiple Japanese coastal fisheries until 2014 and 2017 using the same methods as used in the previous analyses, and the annual catch estimated in 2014 was applied to the stock assessment for North Pacific BSH (ISC, 2017). This document paper updates annual catch amounts of BSH caught by multiple Japanese coastal fisheries until 2019.

Materials and Methods

In the previous stock assessment in 2017 (ISC, 2017), 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 BSH for the coastal fisheries were estimated using several other sources including species-specific shark's data (i.e., a ratio of BSH to the sharks including major pelagic sharks such as BSH, shortfin mako, salmon shark, thresher sharks, hammerhead shark, silky shark, and oceanic whitetip sharks etc.). We used three types of other data sources from 1994 to

2019; (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*) 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 BSH caught by multiple Japanese coastal fisheries were estimated using the following equations:

(1) Japanese coastal longline

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

(2) Japanese other longline

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

(3) Japanese large-mesh drift net

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

(4) Japanese trap net

Catch of BSH = Catch of sharks ("Norin-toukei") * Catch ratio of BSH 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 BSH, we used a mean catch ratio of BSH to sharks between 1994 and 2019.

(5) Japanese bait fishing

Catch of BSH = Catch of sharks ("Norin-toukei") * Catch ratio of BSH to sharks ("Nourin-toukei"), where a catch ratio of BSH in "Norin-toukei" from 1965 to 1967 (0.042) was used because RJB data have no information about the catch of BSH for this fishery.

(6) Japanese other fisheries

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

Since the annual catch amounts of BSH caught by Japanese bait fishing were much smaller than those caught by the other major fisheries, we combined the catch amounts with those of "Other fisheries".

Results

The proportion of estimated total catch of BSH for longline fisheries and large-mesh driftnet fishery accounted for more than 97 % of annual total catch amounts (**Table 1**, **Fig. 1**). In contrast, the estimated total catch amounts of BSH caught by the remaining fisheries were very small (**Table 1**). The estimated annual total catch of BSH had increased in 2000s and reached to peak at 4,064 MT in 2007. Thereafter, it gradually decreased until 2019 due to the reduction of catch amounts for longline fisheries (**Fig. 1**). The total catch amounts of BSH were largely fluctuated between 1041 and 4064 MT during 1994 and 2019. As of them, the estimated annual catch amounts for large-mesh drift net fishery had accounted

for more than approximately 70% since 2016.

Discussions

Annual catch amounts of BSH caught by multiple Japanese coastal fisheries in the North Pacific Ocean were estimated based on the Japanese statistical yearbook from 1994 to 2019. The estimated annual catch amounts were dominated by the coastal and other longline fisheries as well as large mesh drift net fishery (**Table 1**, **Fig. 1**). The estimated annual catch amounts of BSH had remarkably increased in the middle of 2000s (**Fig. 1**) due to the increase in the catch ratio of BSH to sharks (**Table A4**). These results were almost the same as those shown by Kai and Yano (2016). However, the estimated annual catch amounts of BSH in this study were slightly lower than those by Kai and Yano (2016) (**Fig. 2**) because they used incorrect conversion factor from processed weight into round weight in the previous estimation. The estimated annual catch amount of BSH 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 BSH caught by the coastal longline fishery was caused by the decrease of the fishing effort. The estimated annual total catches of BSH may be underestimated due to the discard or release of the BSH through the lower values compared to tunas and swordfishes. In future work, it is important to explore the estimation of the discard/released catch amounts for Japanese coastal fisheries.

Reference

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ISC. 2017. Stock assessment and future projections of blue shark in the North Pacific Ocean through 2015. Report of the shark working group. ISC17/Annex13.

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Table 1. Estimated annual catch amounts (MT) of blue shark caught by multiple Japanese coastal fisheries from 1994 to 2019. Last year in 2020 was removed due to the preliminary values.

Year	Coastal longline (MT)	Other longline (MT)	Large mesh drift net (MT)	Trap net (MT)	Other fisheries (MT)	Total (MT)
1994	856.7	468.4	581.7	14.5	21.7	1943.0
1995	575.4	436.6	487.4	11.6	13.8	1524.8
1996	448.6	256.5	478.0	10.8	21.4	1215.4
1997	275.7	135.1	603.0	14.0	13.5	1041.3
1998	585.9	230.1	615.9	11.6	8.7	1452.2
1999	358.4	132.0	834.5	12.0	8.2	1345.2
2000	921.1	419.9	735.8	12.0	11.3	2100.1
2001	515.3	175.5	736.6	12.3	11.1	1450.8
2002	718.4	260.2	767.7	10.6	14.7	1771.5
2003	776.7	316.6	1350.3	11.3	13.7	2468.6
2004	610.0	225.6	1202.4	12.0	10.2	2060.3
2005	1782.6	612.7	1321.2	0.0	15.0	3731.7
2006	1642.9	560.2	1204.1	5.0	4.2	3416.4
2007	1941.0	773.7	1322.6	5.2	20.9	4063.5
2008	1586.6	817.5	943.7	0.2	15.1	3363.3
2009	1382.4	715.6	1207.7	0.3	5.3	3311.1
2010	1024.3	787.3	962.5	4.1	9.9	2788.0
2011	63.8	858.1	770.8	11.8	4.3	1708.8
2012	829.4	759.8	1085.3	1.9	5.1	2681.4
2013	1125.5	622.8	1103.4	6.1	6.7	2864.5
2014	538.9	599.3	1059.6	3.8	1.4	2203.0
2015	573.0	402.0	697.4	20.6	2.5	1695.4
2016	375.5	224.8	1832.3	25.6	2.2	2460.4
2017	342.8	212.4	1365.7	3.6	1.8	1926.4
2018	263.1	159.4	1235.8	39.8	1.4	1699.6
2019	208.6	162.5	1149.3	35.1	1.5	1557.0

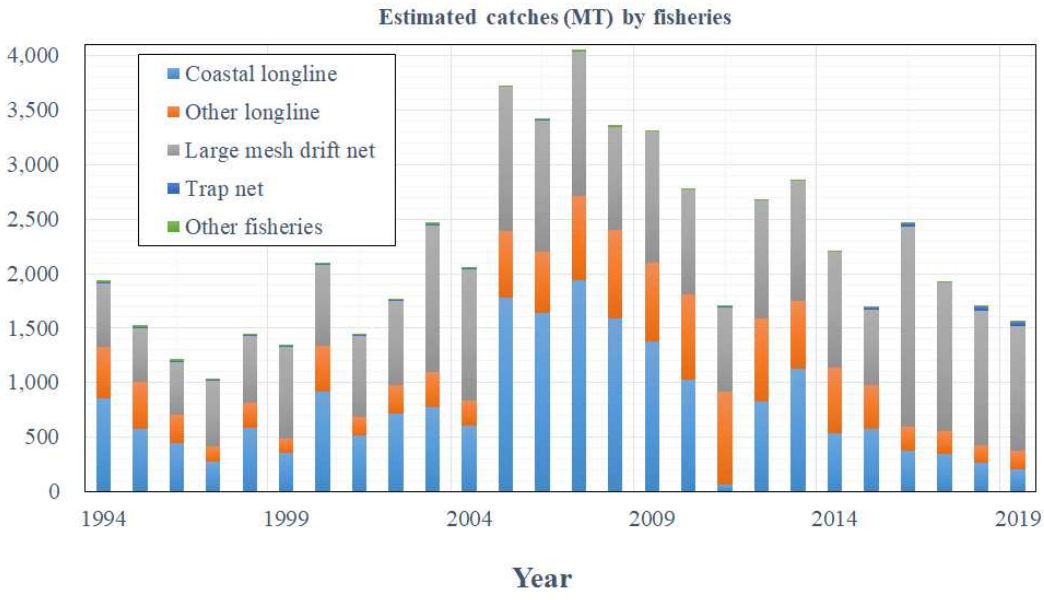

Figure 1. Estimated annual catch amounts (MT) of blue shark caught by multiple Japanese coastal fisheries from 1994 to 2019. Last year in 2020 was removed due to the preliminary analysis.

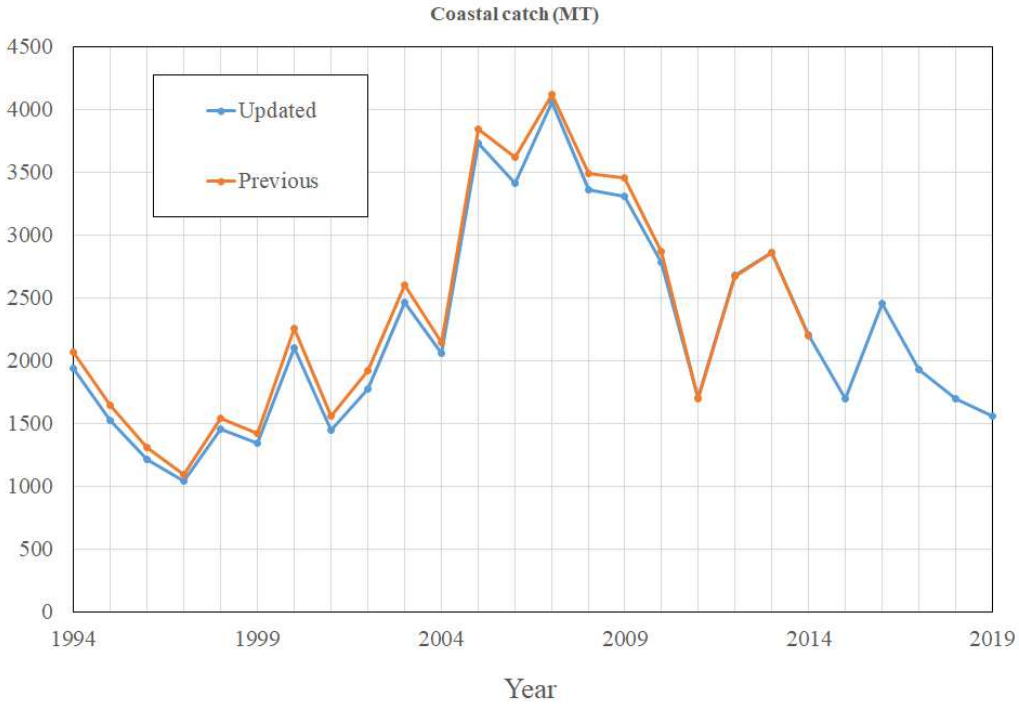

Figure 2. Updated annual total catch of blue shark caught by multiple Japanese coastal fisheries from 1994 to 2019 compared with previous one until 2016.

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 BSH 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 2019, however, it has a two-year time lag and 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 2020 are shown in **Table A1**. In addition, gear-specific annual catch amounts of North Pacific spiny dogfish from 1994 to 2020 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 BSH etc., while the compilation of the data for pelagic sharks had started in 2002. Catch ratios of BSH to all pelagic sharks caught by three types of fisheries during 1994 and 2020 are shown in **Table A3**. "Kesennuma" is a major fishing port located in the eastern part of Japan where many BSHs 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 2020 includes information on species of sharks, catch number, and catch weight etc.. Annual retained catches (MT) of BSH, all sharks, and the catch ratio of BSH to all sharks caught by coastal and other longline fisheries are shown in **Table A4**.

Appendix tables

Table A1. Gear-specific annual catch amounts (MT) of sharks from Japanese statistical yearbook ("Nourin-toukei") during 1994 and 2020.

Year	Coastal longline (MT)	Other longline (MT)	Large mesh drift net (MT)	Bait fishing (MT)	Trap net (MT)	Other fisheries (MT)
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*	502	622	3497	41	109	3

* The same values as those in 2019 were given.

Table A2. Gear-specific annual catch (MT) of North Pacific spiny dogfish from Japanese statistical yearbook ("Nourin-toukei") during 1994 and 2020.

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*	185	0	26	0

* Preliminary values.

Table A3. Catch ratios of blue shark to all pelagic sharks caught by three types of fisheries during 1994 and 2020. The ratios were estimated using RJB data.

Year	Trap net	Other fisheries	Large mesh drift net in Kesennuma
1994	0.25	0.29	0.39
1995	0.25	0.29	0.39
1996	0.25	0.29	0.39
1997	0.25	0.29	0.39
1998	0.25	0.29	0.39
1999	0.25	0.29	0.39
2000	0.25	0.29	0.39
2001	0.25	0.29	0.39
2002	0.25	0.55	0.38
2003	0.25	0.68	0.45
2004	0.25	0.47	0.49
2005	0.00	0.50	0.58
2006	0.15	0.25	0.47
2007	0.17	0.30	0.51
2008	0.00	0.34	0.33
2009	0.01	0.16	0.37
2010	0.07	0.33	0.30
2011	0.25	0.27	0.39
2012	0.14	0.36	0.39
2013	0.20	0.18	0.33
2014	0.27	0.14	0.27
2015	0.44	0.11	0.19
2016	0.35	0.20	0.59
2017	0.06	0.18	0.39
2018	0.53	0.25	0.34
2019	0.58	0.09	0.33
2020	0.71	0.18	0.34

Table A4. Retained annual catches (MT) of blue shark, all sharks, and the catch ratio of blue shark to all sharks caught by coastal and other longline fisheries and the data come from logbook data ("Gyoseki") during 1994 and 2020.

Year	Blue shark (kg)	Sharks (kg)	Ratio
1994	138,679	332,188	0.42
1995	274,475	802,804	0.34
1996	307,424	1,338,926	0.23
1997	131,329	1,013,575	0.13
1998	112,854	491,354	0.23
1999	4,012	26,252	0.15
2000	20,108	44,339	0.45
2001	8,783	44,882	0.20
2002	24,273	67,813	0.36
2003	37,794	73,767	0.51
2004	73,779	187,704	0.39
2005	54,610	70,857	0.77
2006	96,575	127,914	0.75
2007	71,137	80,080	0.89
2008	396,987	475,389	0.84
2009	284,817	408,773	0.70
2010	317,100	399,968	0.79
2011	459,236	504,113	0.91
2012	521,523	606,798	0.86
2013	767,713	1,049,041	0.73
2014	737,013	1,013,403	0.73
2015	512,795	881,543	0.58
2016	958,949	2,158,076	0.44
2017	1,403,736	4,189,246	0.34
2018	1,712,633	3,716,377	0.46
2019	1,609,294	3,872,341	0.42
2020	1,045,117	2,465,269	0.42