ISC/18/SHARKWG-2/01

Estimation of initial equilibrium catch for North Pacific shortfin mako[1]

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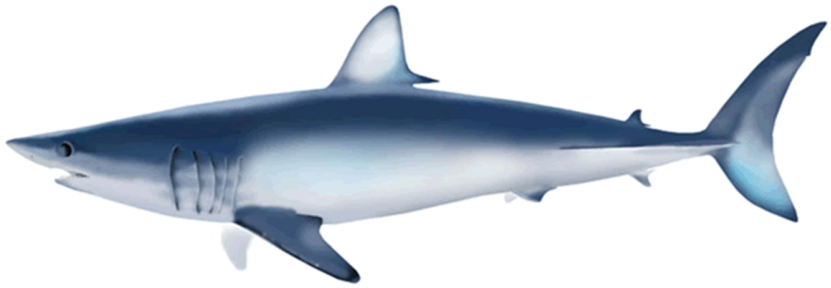

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Abstract

This working paper provides an estimate of initial equilibrium catch for North Pacific shortfin mako using an annual catch ratio of shortfin mako to North Pacific blue shark. We estimated the catches prior to 1994 for five fleets (1. Japanese shallow-set offshore and distant water longline (JPSSLL); 2. Japanese deep-set offshore and distant water longline (JPDSLL); 3. Japanese coastal longline (JPCOLL); 4. Japanese driftnet (JPDN); 5. Taiwanese small longline (TWSMLL)) and we combined them with the catches of other fleets. The average catch of shortfin mako from 1975 to 1993 was 4,813 tons. The catches of four fleets (1. US Hawaii shallow-set longline (HWSSLL); 2. US Hawaii deep-set longline (HWDSLL); 3. US recreational (USREC); 4. IATTC purse seine (IATTCPS)) were not included in the catch amount because the unit is number. Probably, the annual total catches of shortfin mako for the four fleets prior 1994 were not large amount due to the small number of catches compared to the catch of main fishery such as Japanese and Taiwanese fleets. We therefore recommend that the WG uses 5,000 tons as an initial equilibrium catch of shortfin mako in the stock assessment.

Introduction

Initial equilibrium catch is an essential quantity to estimate the initial fishing mortality and to grasp the stock depletion ratio throughout the stock assessment period. Initial equilibrium catch is commonly estimated from the actual landed catches before the initial year of the stock assessment. However, it is difficult for North Pacific shortfin mako (*Isurus oxyrinchus*) to calculate the initial catches because major countries fishing the shortfin mako such as Japan and Taiwan have no/little information about the species-specific data of sharks for earlier period. The objective of this document paper is to provide an estimate of initial equilibrium catch for North Pacific shortfin mako using an annual catch ratio of shortfin mako to North Pacific blue shark (*Prionace glauca*).

Materials and Methods

Data source

We used fleet specific catch time series of shortfin mako and blue shark from 1975 to 2015 and the data prior to 1975 were not used due to the lack of blue shark catch for JPDSLL (ISC 2017a,b). It is noted that Japan has no catch data of shortfin mako prior to 1994 except 1992 and 1993 for JPDSLL (Kai and Semba, 2018). It is also noted that TWSMLL has no catch data prior to 1989. In addition, catch data of Korea was not used in this analysis because there is no catch data of Korea throughout the stock assessment period and the catch amount of blue shark was small less than 220 tons (maximum value of annual total catch of all fleets was 87,805 tons in 1981) throughout the period from 1975 to 1993. Further, the catches of the following four fleets were not used in this analysis because the unit is number.

a) US Hawaii shallow-set longline (HWSSLL),
b) US Hawaii deep-set longline (HWDSLL),
c) US recreational (USREC),
d) IATTC purse seine (IATTCPS).

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Estimation of initial equilibrium catch

The procedures are as follows:

(1) Estimate the fleet specific average catch ratios of shortfin mako to blue shark using the catch data from 1994 to 2015 for the following major five fleets:
    e) Japanese shallow-set offshore and distant water longline (JPSSLL),
    f) Japanese deep-set offshore and distant water longline (JPDSLL),
    g) Japanese coastal longline (JPCOLL),
    h) Japanese driftnet (JPDN),
    i) Taiwanese small longline (TWSMLL).

(2) Estimate the fleet specific annual catches of shortfin mako from 1975-1993 (1975-1991 for JPDSLL, 1975-1988 for TWSLL) through multiplying the annual catches of blue shark by the average catch ratio of shortfin mako to blue shark.

(3) Calculate the fleet aggregated catches of shortfin mako by year from 1975 to 1993.

(4) Calculate an average catch of shortfin mako from 1975 to 1993.

Results and Discussion

The fleet specific average catch ratio of shortfin mako to blue shark for latter periods was 0.035 to 0.211 and the catch ratio of Japanese driftnet fishery was the highest (Table 1). As a result, the estimated catches of Japanese driftnet fishery for early periods were much higher than those of any other fleets because the catches of blue shark were high in 1980s. The annual catches of shortfin mako for early period were two or three times higher than those for latter period (Table 2; Fig. 1). The fleet aggregated average catch of shortfin mako from 1975 to 1993 was 4,813 tons. The catches of four fleets (HWSSLL; HWDSLL; USREC; IATTCPS) were not included in the total catches because the unit is number. Probably, the annual total catches of shortfin mako for the four fleets prior 1994 were not large due to the small number of catches compared to the catches of main fisheries such as Japanese and Taiwanese fleets. We therefore recommend that the WG uses 5,000 tons as an initial equilibrium catch of shortfin mako in the stock assessment.

Reference

ISC. 2017a. Report of the shark working group workshop. July12-17, 2017, Vancouver, Canada.

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Kaim, M. and Semba, Y. 2017. Estimation of catches for shortfin mako, *Isurus oxyrinchus*, caught by Japanese offshore and distant water fisheries. ISC/17/SHARKWG-1/03.

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Table 1. Fleet specific reported catches (tons) of shortfin mako (SFM) and blue shark (BSH), the catch ratio of shortfin mako to blue shark (orange), and estimated catches of shortfin mako (green) based on an average catch ratio.

	JPSSLL				JPDSLL				JPDN				JPNCOLL				TWSMLL			
	SFM (tons)	BSH (tons)	Ratio of SFM/ BSH	Estimates (tons)	SFM (tons)	BSH (tons)	Ratio of SFM/ BSH	Estimates (tons)	SFM (tons)	BSH (tons)	Ratio of SFM/ BSH	Estimates (tons)	SFM (tons)	BSH (tons)	Ratio of SFM/ BSH	Estimates (tons)	SFM (tons)	BSH (tons)	Ratio of SFM/ BSH	Estimates (tons)
1975		16,493		721		6,573		232		6,297		1329		914		75		9,192		396
1976		22,929		1002		12,262		433		6,297		1329		1,538		126		10,278		443
1977		30,925		1351		16,657		588		6,297		1329		1,265		103		9,997		431
1978		25,100		1097		15,595		550		6,297		1329		1,559		128		10,543		454
1979		27,465		1200		21,922		774		6,297		1329		1,510		123		12,346		532
1980		26,170		1144		26,013		918		6,297		1329		1,293		106		12,795		551
1981		23,173		1013		30,481		1076		19,628		4142		1,291		106		10,921		471
1982		14,585		637		21,941		774		19,628		4142		1,034		85		11,998		517
1983		11,661		510		23,847		842		19,258		4064		642		53		10,581		456
1984		9,087		397		23,682		836		18,059		3810		1,333		109		9,508		410
1985		8,054		352		21,778		769		17,095		3607		1,388		114		10,597		457
1986		9,517		416		15,996		565		17,412		3674		1,239		101		8,910		384
1987		7,630		333		13,769		486		17,322		3655		1,276		104		6,673		288
1988		6,850		299		18,280		645		17,039		3595		1,153		94		6,956		300
1989		6,261		274		21,163		747		23,730		5007		1,053		86	328	7,843	0.042	
1990		5,879		257		14,517		512		12,466		2630		1,070		88	365	8,669	0.042	
1991		7,619		333		14,313		505		12,466		2630		1,054		86	412	9,389	0.044	
1992		7,861		344	538	11,928	0.05			7,767		1639		1,099		90	443	7,540	0.059	
1993		9,859		431	775	15,101	0.05			661		139.4		1,047		86	338	6,859	0.049	
1994	326	10,180	0.03		364	21,863	0.02		123	577	0.21		76	1,899	0.04		262	5,458	0.05	
1995	408	10,396	0.04		521	26,158	0.02		103	483	0.21		69	1,440	0.05		268	9,462	0.03	
1996	383	10,801	0.04		421	17,509	0.02		101	474	0.21		362	1,059	0.34		707	9,642	0.07	
1997	388	13,877	0.03		309	18,170	0.02		127	598	0.21		196	632	0.31		390	13,453	0.03	
1998	400	12,868	0.03		249	16,926	0.01		130	611	0.21		30	1,217	0.02		325	11,303	0.03	
1999	507	14,970	0.03		348	11,809	0.03		176	828	0.21		209	772	0.27		592	13,495	0.04	
2000	568	20,883	0.03		362	7,345	0.05		156	730	0.21		103	1,970	0.05		498	19,707	0.03	
2001	457	22,390	0.02		488	7,535	0.06		156	731	0.21		201	1,084	0.19		543	8,847	0.06	
2002	385	19,725	0.02		312	5,478	0.06		122	768	0.16		111	1,515	0.07		592	10,225	0.06	
2003	477	19,360	0.02		356	6,326	0.06		229	1,350	0.17		22	1,624	0.01		782	9,467	0.08	
2004	491	16,711	0.03		406	8,138	0.05		134	1,202	0.11		23	1,234	0.02		917	11,479	0.08	
2005	587	20,048	0.03		302	7,039	0.04		155	1,321	0.12		92	2,521	0.04		418	13,563	0.03	
2006	736	16,667	0.04		252	6,236	0.04		178	1,204	0.15		14	2,419	0.01		444	13,291	0.03	
2007	802	13,161	0.06		205	7,850	0.03		244	1,323	0.18		48	2,801	0.02		525	13,030	0.04	
2008	632	12,640	0.05		239	5,071	0.05		212	944	0.23		111	2,547	0.04		334	14,144	0.02	
2009	718	13,796	0.05		204	3,436	0.06		294	1,208	0.24		280	2,248	0.12		316	16,081	0.02	
2010	633	11,735	0.05		164	9,061	0.02		272	963	0.28		140	1,910	0.07		518	13,015	0.04	
2011	469	6,694	0.07		131	12,615	0.01		163	765	0.21		59	934	0.06		489	15,857	0.03	
2012	522	8,344	0.06		185	3,960	0.05		229	1,076	0.21		11	1,596	0.01		392	15,857	0.02	
2013	554	6,763	0.08		99	8,694	0.01		345	1,103	0.31		57	1,759	0.03		320	6,983	0.05	
2014	578	7,690	0.08		199	7,416	0.03		263	1,060	0.25		11	1,141	0.01		345	11,156	0.03	
2015	466	7,670	0.06		85	3,862	0.02		334	1,080	0.31		14	1,498	0.01		440	8,856	0.05	
Average ratio			0.044				0.035				0.211				0.082				0.043	

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Table 2. Fleet specific annual catches (tons) of shortfin mako reported in the data preparatory meeting (blue) and newly added annual catches (yellow) estimated based on the catch ratio of shortfin mako to blue shark. Red denotes an average catch from 1975 to 1993.

Year	F1:CA-Com	F3:US-CAL-LL	F5:US-DR-OT	F7:TW-LA-LL-	F8:TW-LA-LL-S	F9:TW-SM-LL	F10:JP-OF-DW-	F11:JP-OF-DW-	F12:JP-COAST-	F13:JP-DRN	F14:JP-OTH	F15:MX-NORTH-	F16:MX-SOUTH-	F17: WCPFC-	Total	
1975	0	0	7	0	15	396	721	232	75	1329	0	0	0	0	2774	
1976	0	0	1	0	0	443	1002	433	126	1329	0	66	7	0	3407	
1977	0	1	12	3	2	431	1351	588	103	1329	0	64	8	0	3893	
1978	0	2	17	2	4	454	1097	550	128	1329	0	92	11	0	3685	
1979	0	10	13	0	1	532	1200	774	123	1329	0	43	21	0	4047	
1980	0	14	91	0	3	551	1144	918	106	1329	0	51	14	0	4221	
1981	0	19	168	0	3	471	1013	1076	106	4142	0	38	19	0	7054	
1982	0	6	354	0	0	517	637	774	85	4142	0	61	15	0	6592	
1983	0	1	223	0	0	456	510	842	53	4064	0	58	10	0	6214	
1984	0	2	162	0	0	410	397	836	109	3810	0	40	10	0	5776	
1985	0	0	153	0	8	457	352	769	114	3607	0	35	7	0	5501	
1986	0	1	319	0	10	384	416	565	101	3674	0	57	29	0	5556	
1987	0	4	410	0	4	288	333	486	104	3655	0	177	19	0	5480	
1988	0	156	174	0	1	300	299	645	94	3595	0	231	16	0	5512	
1989	0	5	258	0	4	328	274	747	86	5007	0	114	20	0	6842	
1990	0	15	368	0	16	365	257	512	88	2630	0	257	30	0	4539	
1991	0	23	201	0	17	412	333	505	86	2630	0	198	30	0	4436	
1992	0	2	144	0	6	443	344	538	90	1639	0	350	26	0	3581	Average
1993	0	1	125	0	4	338	431	775	86	139	0	354	89	0	2341	4813
1994	0	21	111	0	1	262	326	364	58	123	18	274	61	0	1618	
1995	0	0	91	84	7	268	408	521	56	103	13	276	58	0	1885	
1996	0	0	94	36	3	707	383	421	348	101	14	337	76	0	2520	
1997	0	0	133	23	13	390	388	309	181	127	15	328	73	0	1980	
1998	0	0	99	31	10	325	400	249	18	130	12	332	56	0	1662	
1999	0	0	58	76	9	592	507	348	196	176	13	353	85	0	2414	
2000	0	0	75	56	24	498	568	362	89	156	14	431	108	0	2381	
2001	0	0	41	21	62	543	457	488	187	156	14	422	70	0	2460	
2002	0	0	82	25	88	592	385	312	106	122	5	392	96	0	2204	
2003	0	0	68	31	42	782	477	356	17	229	6	348	124	1	2479	
2004	0	0	53	64	57	917	491	406	22	134	1	530	334	13	3022	
2005	0	0	33	36	39	418	587	302	49	155	43	388	220	6	2276	
2006	0	0	45	99	20	444	736	252	8	178	6	380	260	13	2441	
2007	0	0	43	57	16	525	802	205	34	244	15	344	345	11	2641	
2008	0	0	32	12	18	334	632	239	97	212	14	400	209	9	2208	
2009	0	0	30	10	16	316	718	204	278	294	1	438	214	12	2532	
2010	0	0	21	12	13	518	633	164	120	272	20	550	211	100	2632	
2011	0	0	17	36	35	489	469	131	48	163	11	520	238	246	2404	
2012	0	0	22	63	6	392	522	185	9	229	2	488	226	208	2352	
2013	0	0	29	116	9	320	554	99	47	345	9	478	234	49	2289	
2014	0	0	16	98	6	345	578	199	7	263	3	925	542	78	3061	
2015	0	0	13	147	9	440	466	85	2	334	11	1253	400	73	3233	
2016	0	0	26	145	5	360	314	66	33	448	26	401	259	76	2159	

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Table 3. Annual catches (tons) of blue shark (BSH) and shortfin mako (SFM) from 1975 to 2015 and the catch ratio (green and orange) of shortfin mako to blue shark. Red denotes the estimated catches based on the fleet specific catch rates of shortfin mako to blue shark. Blue denotes the catches estimated from an average catch ratio (0.08) of shortfin mako to blue shark.

Year	BSH (tons)	SFM (tons)	SFM (tons;	Ratio
1975	40153	2774		0.07
1976	53854	3407		0.06
1977	65861	3893		0.06
1978	60069	3685		0.06
1979	70368	4047		0.06
1980	74002	4221		0.06
1981	87805	7054		0.08
1982	71405	6592		0.09
1983	68554	6214		0.09
1984	63265	5776		0.09
1985	61054	5501		0.09
1986	57025	5556		0.10
1987	50758	5480		0.11
1988	55553	5512		0.10
1989	63407	6842		0.11
1990	47603	4539		0.10
1991	50098	4436		0.09
1992	41735	3581		0.09
1993	40881	2341		0.06
1994	44505	3634	1626	0.08
1995	53117	4338	1901	0.08
1996	45862	3745	2542	0.08
1997	53716	4386	1996	0.08
1998	50760	4145	1677	0.08
1999	48973	3999	2419	0.08
2000	57202	4671	2392	0.08
2001	45989	3755	2474	0.08
2002	44626	3644	2206	0.08
2003	43923	3587	2481	0.08
2004	50118	4093	3023	0.08
2005	51742	4225	2283	0.08
2006	46965	3835	2443	0.08
2007	46090	3764	2646	0.08
2008	42801	3495	2225	0.08
2009	44024	3595	2566	0.08
2010	44281	3616	2652	0.08
2011	45520	3717	2422	0.08
2012	39777	3248	2364	0.08
2013	33863	2765	2293	0.08
2014	37707	3079	3061	0.08
2015	32956	2691	3233	0.08

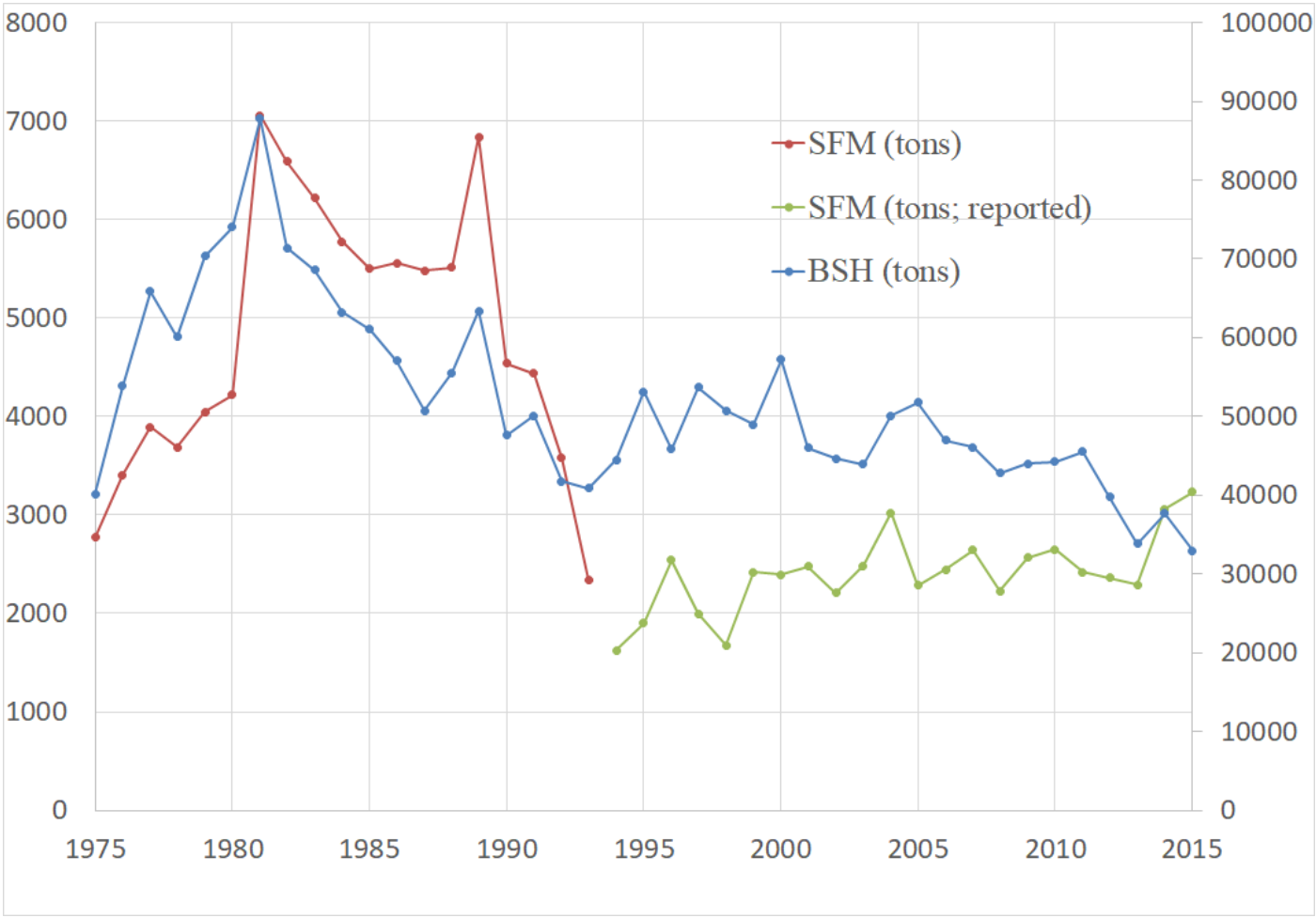

Figure 1. Yearly changes in total catch amount (tons) of shortfin mako and blue shark from 1975 to 2015. Blue line denotes the estimated catches of blue shark used in the stock assessment. Red line denotes the estimated catches of shortfin mako based on the catch ratio of shortfin mako to blue shark. Green line denotes the reported catches of shortfin mako in the data preparatory meeting.

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