Catch and size data of striped marlin (*Kajikia audax*) by the Taiwanese fisheries in the western and central North Pacific Ocean during 1958-2017

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Abstract

Catch data of striped marlin by the fisheries of Taiwan during 1958-2017 were obtained from the Oversea Fisheries Development Council (OFDC) of Taiwan. Recent five-years, the total catches of striped marlin in the western central North Pacific Ocean (WCNPO) showed a decreasing and slightly increasing trend overtime. Lower jaw-to-fork length (LJFL, cm) and round weight (Kg) data of striped marlin collected from the Taiwanese distant-water longline fishery in the WCNPO were summarized using violin plots during 1981-2017 and 2014-2017, respectively. For consistency of size data among various fleets for the stock assessment model, LJFL and weight were converted into eye-to-fork length (EFL).

Introduction

The boundary of the Western and Central North Pacific (WCNPO) stock is of striped marlin defined to be the waters of the Pacific Ocean west of 150°W and north of the equator, as well as analyses of fisheries data from longline fisheries (ISC, 2015). This paper aims to provide updated available fishery data for striped marlin in the areas of WCNPO caught by Taiwanese fisheries, including catch estimates by fisheries and size frequency data.

Materials and methods

Nominal catch data of striped marlin caught by the fisheries of Taiwan were obtained from the logbook dataset provided by the Oversea Fisheries Development Council (OFDC) of Taiwan. Time-series of catch statistic of three major fisheries: distant-water tuna longline

(DWLL), small scale tuna longline (STLL), and others (including coastal longline, offshore gillnet, coastal gillnet and catches from offshore and coastal other fisheries or unknown) were summarized in this working paper. Distant-water tuna longline (DWLL) fishing vessels refer to those whose gross register ton (GRT) are larger than or equal to 100 GRT, which mostly operate in the high seas or in the EEZs of Pacific Island countries under access agreements. The small-scale tuna longline (STLL) vessels generally refer to those vessels smaller than 100 GRT (mostly 50-70 GRT).

Lower jaw-to-fork length data (cm) and round weight (Kg) of striped marlin collected from the Taiwanese distant-water longline fishery (first 30 fishes caught each set) in the WCNPO were summarized using violin plot during 1981-2017 and 2014-2017, respectively. For consistency of size data among various fleets for the stock assessment model, LJFL and weight were converted into eye-to-fork length (EFL) using the equation (Hsu, 2010):

$$\mathrm{LJFL} = 1.12\mathrm{EFL} + 7.33$$

$$\mathrm{W} = 4.68 \times 10^{-6}\mathrm{EFL}^{3.16}$$

Results and discussion

Time-series catches of striped marlin in the WNCPO caught by the fisheries of Taiwan were shown in **Table 1**. The catches fluctuated around 600 mt during 1958-1983, however, the catch reached a peak of 1,295 mt in 1984 (**Fig. 1**). The catch during 1986-2002 was relatively low at around 300 mt, and then increased around 900 mt during 2003-2006. Thereafter, the catch declined around 250 mt in 2014-2016 and increased to 435 mt in 2017. The majority of striped marlin catch in WCNPO was contributed by the small-scale tuna longline fishery (STLL) and only a small amount of striped marlin catch was reported for the "DWLL" in WCNPO. LJFL and weight compositions of striped marlin harvested by the Taiwanese distant-water longline fishery in the areas of WCNPO were shown in **Fig. 2** and **tables 2-3**. The LJFL-converted and weight-converted EFL was shown in **Fig. 3** and **tables 4-5.**

The results indicated the mean lengths and mean weights of measured fishes were relatively stable during 2004-2017 (from 156 to 175 cm LJFL or 131-153 cm LJFL-converted EFL) and

2014-2017 (from 53 to 54 kg or 163-170 cm round weight-converted EFL), respectively **(Tables 2-5)**. Although both LJFL-converted EFL and round weight-converted EFL were available during 2014-2017, there is an uncertainty that the semi-dress weight may record as round weight in the logbook. For the higher data quality (larger sample size) and the data consistency, we recommend using the LJFL-convert EFL data from 2004 to 2017 as the input data of stock assessment.

Reference

ISC (2015). Report of the Billfish Working Group Workshop. International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean. 15-20 July 2015, Kona, Hawaii, U.S.A.

Hsu, W. C. (2010). Age and growth of striped marlin (*Kajikia audax*) in waters off Taiwan. MS. Thesis, National Taiwan University, Taipei, Taiwan. 104 pp. [In Chinese.]

Table 1. Catch estimates (metric ton, mt) of striped marlin caught by the fisheries of Taiwan in the western and central North Pacific Ocean (WCNPO) during 1958-2017. DWLL= distant-water tuna longline; STLL= small scale tuna longline; Others = coastal longline, offshore gillnet, coastal gillnet and catches from offshore and coastal other fisheries or unknown. New stock and old stock denotes the waters of the Pacific Ocean west of 150°W and 140°W, respectively.

Year	DWLL			STLL	Others	Total	Year	DWLL			STLL	Others	Total
	New stock	Old stock	% diff					New stock	Old stock	% diff			
1958				543	387.4	930.41	1988	7	7	0	457	169	633
1959				391	353.5	744.51	1989	6	6	0	184	157	347
1960				398	350.4	748.45	1990	2	2	0	137	256	395
1961				306	342	647.98	1991	36	36	0	254	286	576
1962				332	211.1	543.1	1992	1	1	0	219	197	417
1963				560	199	759.05	1993	5	5	0	221	142	368
1964				392	174.8	566.8	1994	1	1	0	137	196	334
1965				355	156.8	511.8	1995	27	27	0	83	82	192
1966				370	180.4	550.4	1996	26	26	0	162	47	235
1967	2	2	0	385	204	591	1997	59	59	0	290	47	396
1968	1	1	0	332	208	541	1998	90	90	0	205	50	345
1969	2	2	0	571	192	765	1999	66	66	0	128	42	236
1970	0	0	0	495	189	684	2000	90	127	0.29134	161	55	343
1971	0	0	0	449	135	584	2001	21	32.7	0.3578	129	51	212.73
1972	9	9	0	380	126	515	2002	51	133.8	0.61883	226	29	388.79
1973	1	1	0	568	139	708	2003	172	195.7	0.1211	681	43	919.72
1974	24	24	0	650	117.5	791.5	2004	228	243.9	0.06519	261	24	528.87
1975	64	64	0	732	96	892	2005	176	189.9	0.0732	584	32	805.93
1976	32	32	0	347	140	519	2006	134	173.4	0.22722	537	147	857.4
1977	17	17	0	524	219	760	2007	89	98.7	0.09828	199	170	467.71
1978	0	0	0	618	78	696	2008	72	75.2	0.04255	192	213	480.21
1979	26	26	0	432	122	580	2009	30	35.7	0.15966	225	138	398.72
1980	61	61	0	223	131.5	415.5	2010	32	45.3	0.2936	200	176	421.29
1981	16	16	0	491	95	602	2011	53	72	0.26389	269	127	468.03
1982	7	7	0	397	138	542	2012	73	87	0.16092	352	150	588.91
1983	0	0	0	555	214	769	2013	67	87	0.22989	285	220	592.35
1984	0	0	0	965	330	1295	2014	16.8	25	0.328	115	69.8	209.83
1985	0	0	0	513	181	694	2015	33.3	40.6	0.1798	181	32.9	254.47
1986	0	0	0	179	148	327	2016	58	78	0.25641	135	24.3	237.29
1987	31	31	0	383	151	565	2017	72	96	0.25	291	48.3	435.3

Table 2. Summary statistics of length composition data (lower jaw-to-fork length, cm) collected from the Taiwanese distant-water longline fishery in the western and central North Pacific Ocean (WCNPO).

Year	Mean	Median	Min	Max	Sample size
1981	165.88	170	120	256	216
1982	213.95	212.5	160	285	94
1983					0
1984	252.50	252	238	270	8
1985					0
1986					0
1987					0
1988					0
1989	176.48	182.5	110	198	42
1990	144.64	131	50	239	149
1991	150.90	152	125	165	20
1992					0
1993	245.60	251	230	251	5
1994					0
1995	139.68	142	129	146	56
1996	136.53	136	73	210	32
1997	133.67	132	97	162	396
1998	98.50	98.5	72	125	2
1999	112.72	113.5	89	127	18
2000	101.24	107	60	160	33
2001	201.50	184.5	127	295	24
2002	146.38	138	89	243	186
2003	158.41	151	102	284	17
2004	155.59	158	60	241	1444
2005	166.02	169	62	282	1284
2006	175.30	176	90	260	522
2007	170.13	168	87	237	395
2008	163.90	166	82	232	303
2009	160.77	159	75	224	162
2010	164.65	162	122	280	369
2011	163.49	165	71	248	610
2012	164.42	165	93	253	925
2013	170.71	171	112	247	411
2014	173.57	175	87	228	133
2015	168.40	168	114	238	166
2016	172.07	174	110	231	189
2017	167.88	170	102	238	348

Table 3. Summary statistics of length composition data (LJFL-converted EFL, cm) collected from the Taiwanese distant-water longline fishery in the western and central North Pacific Ocean (WCNPO).

Year	Mean	Median	Min	Max	Sample Size
1981	141.57	145.24	100.60	222.03	216
1982	184.48	183.19	136.31	247.92	94
1983					0
1984	218.90	218.46	205.96	234.53	8
1985					0
1986					0
1987					0
1988					0
1989	150.15	152.38	104.17	164.88	14
1990	123.01	109.53	38.10	206.85	121
1991	126.87	127.38	118.46	132.74	7
1992					0
1993	212.74	217.56	198.81	217.56	5
1994					0
1995	117.86	118.46	108.63	123.81	45
1996	115.36	114.88	58.63	180.96	32
1997	112.81	111.31	80.06	138.10	396
1998	81.40	81.40	57.74	105.06	2
1999	94.46	94.79	72.92	106.85	16
2000	87.28	92.56	51.49	106.85	24
2001	179.02	168.46	129.17	256.85	6
2002	122.31	114.88	82.74	210.42	96
2003	135.31	132.29	84.53	247.03	16
2004	131.13	132.74	47.03	208.63	1245
2005	140.38	144.35	48.81	238.99	1072
2006	151.58	152.38	73.81	225.60	324
2007	143.07	140.78	71.13	199.71	276
2008	139.25	141.22	66.67	200.60	282
2009	135.52	133.19	60.42	180.96	152
2010	135.32	132.29	102.38	243.46	282
2011	139.14	141.67	56.85	214.88	390
2012	140.33	140.78	76.49	219.35	882
2013	145.13	146.13	93.46	213.99	382
2014	146.03	146.58	71.13	197.03	102
2015	142.91	141.67	95.24	205.96	145
2016	144.65	147.03	91.67	191.67	128
2017	141.66	142.12	84.53	205.96	244

Table 4. Summary statistics of weight composition data (round weight, Kg) collected from the Taiwanese distant-water longline fishery in the western and central North Pacific Ocean (WCNPO).

Year	Mean	Median	Min	Max	Sample Size
2014	52.82	52	27	110	221
2015	47.52	46	15	113	295
2016	53.61	52	23	110	250
2017	54.15	53	20	108	398

Table 5. Summary statistics of round weight-converted EFL (cm) collected from the Taiwanese distant-water longline fishery in the western and central North Pacific Ocean (WCNPO).

Year	Mean	Median	Min	Max	Sample Size
2014	169.58	169.70	137.91	215.10	221
2015	163.05	163.24	114.50	216.94	295
2016	170.08	169.70	131.09	215.10	250
2017	170.27	170.72	125.41	213.86	398

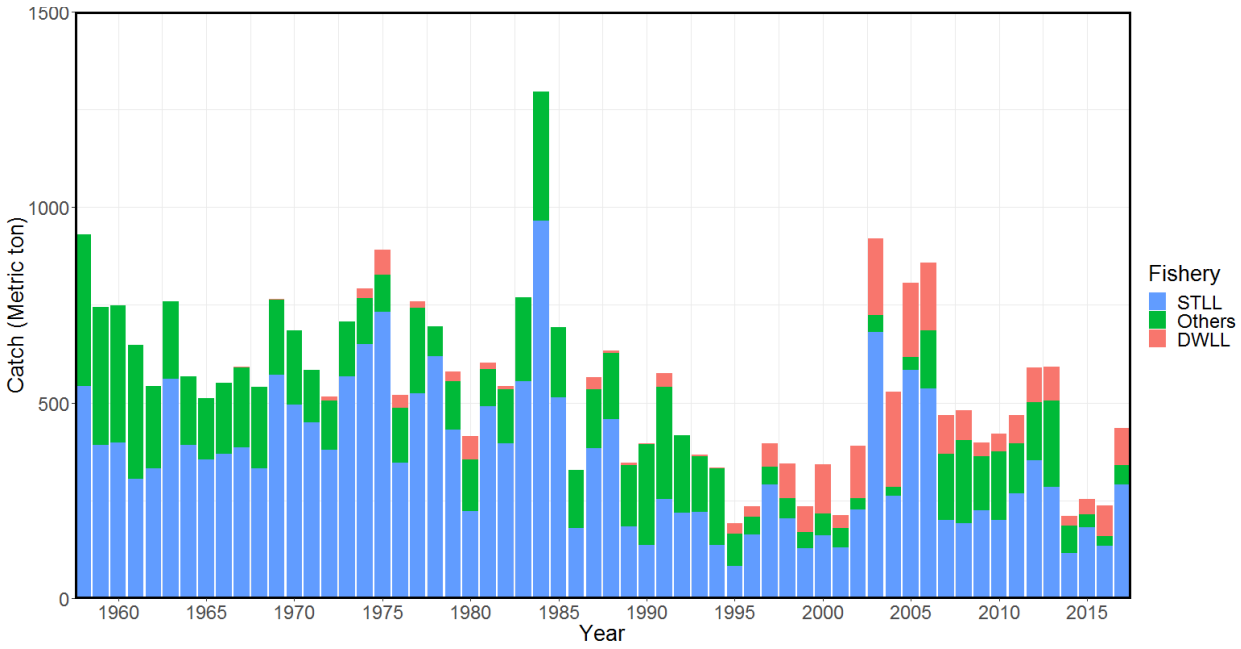

Figure 1. Time-series of striped marlin catches caught by the fisheries of Taiwan in the western central North Pacific Ocean (WCNPO). DWLL= distant-water tuna longline; STLL= small scale tuna longline; Others = coastal longline, offshore gillnet, coastal gillnet and catches from offshore and coastal other fisheries or unknown.

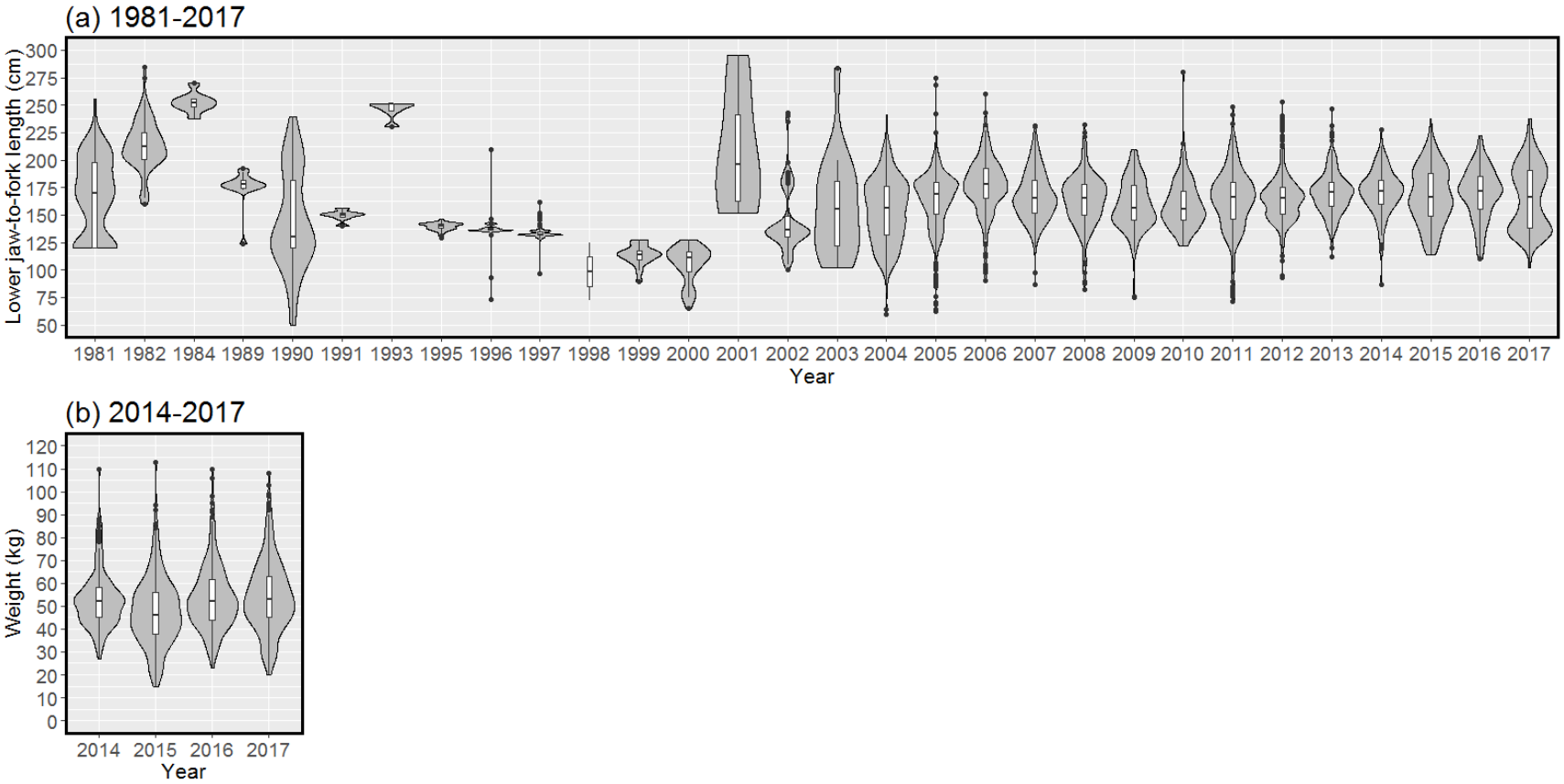

Figure 2. (a) Lower jaw-to-fork length frequency distributions during 1981-2017 and (b) weight frequency distributions during 2014-2017 of striped marlin caught by the Taiwanese distant-water longline fishery in the western central North Pacific Ocean (WCNPO).

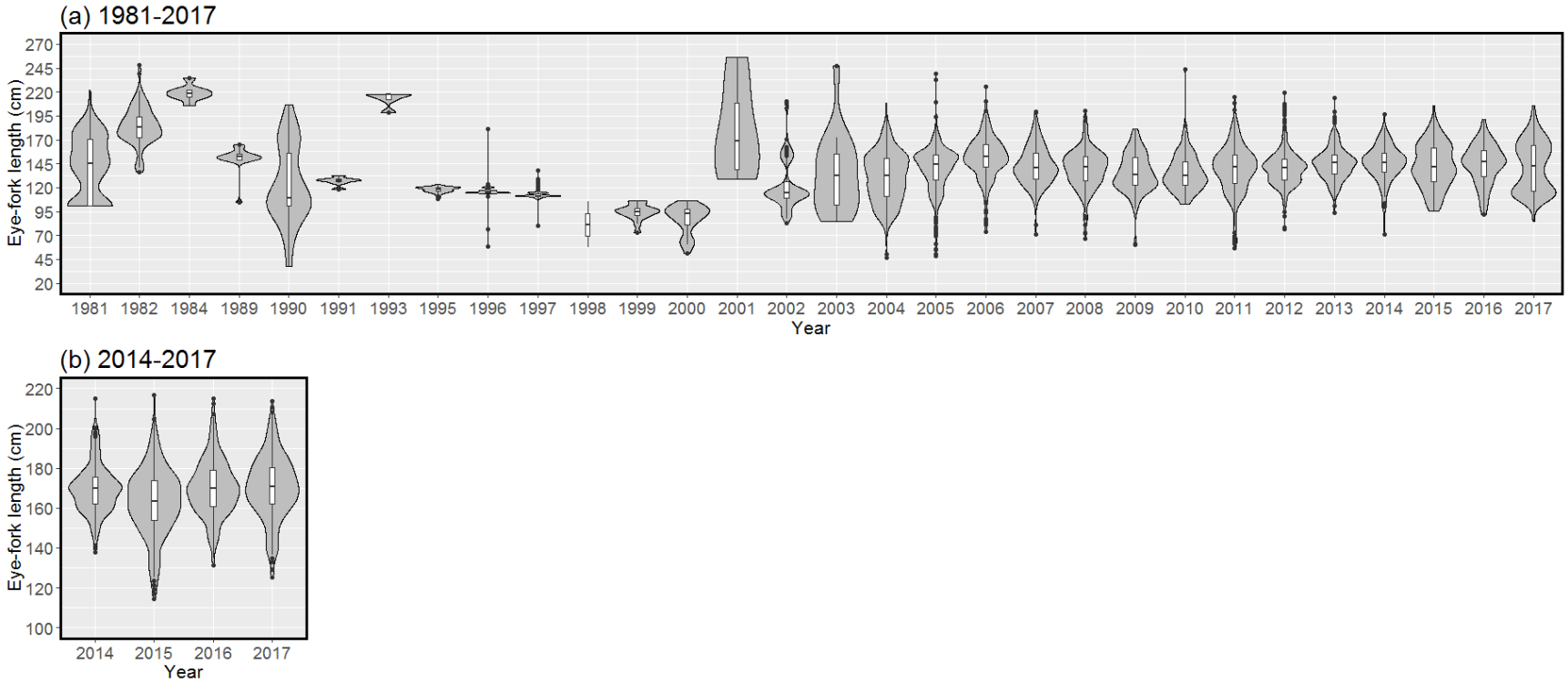

Figure 3. (a) LJFL-converted EFL (cm) frequency distributions during 1981-2017 and (b) weight-converted EFL frequency distributions during 2014-2017 of striped marlin caught by the Taiwanese distant-water longline fishery in the western central North Pacific Ocean (WCNPO).