Catch estimates and size compositions of blue marlin (*Makaira nigricans*) from the Taiwanese fisheries in the Pacific Ocean*

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Abstract

Most of blue marlin catches was from the domestic-based offshore longline fishery in Taiwan, varying between 3,000 mt to 4,500 mt from 1992 to 2014. Catch information for the foreign-based offshore tuna longline fishery has been collected since 2000. This shows a catch amount of 3,066-4,375 mt in the early 2000s with a decreasing trend to about 2000 mt after 2006. The catch of blue marlin from the distant-water tuna longline fishery has increased to more than 1,000 mt since 2003, except for a 910 mt in 2008. In contrast, a small proportion of blue marlin catch was reported for the offshore and coastal gillnet, set-net, and all the other fisheries in the Pacific Ocean. Data for eye fork length of blue marlin were collected from the Taiwanese distant-water tuna longline fishery in the Pacific Ocean, with sample sizes ranging from 620 for the first quarter of 2014, to 17,705 for the whole year of 2005 (with an average sample size more than 8,000 for 2005-2013). Although the smallest and largest blue marlin measured from this fishery varied among years, the mean lengths of measured fish remain relatively stable (from 171.9 to 179.0 cm in EFL) during 2005-2012, but show an increasing trend to near 180 cm for 2013.

Keywords: fishery information, catch and length data, blue marlin, Taiwan

Introduction

Blue marlin (*Makaira nigricans*) is a highly migratory species distributed throughout tropical and temperate waters of the Pacific Ocean (Su et al., 2011). A single stock of blue marlin in the Pacific Ocean has been assumed based on genetic analyses (Graves and McDowell, 2003) and fishery-dependent catch-rate data (Kleiber et al., 2003). This assumption is also supported by the results of tagging experiments that have demonstrated that blue marlin migrate long distances (>8,000 km in some instances) and throughout the Pacific basin (Hinton, 2001).

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Blue marlin are the largest of the billfishes, attaining up to 450 cm in length and over 900 kg in weight, and are the most popular game fish because of their size and fighting ability (Molony, 2008). They exhibit, however, sexual dimorphism in size, with males reaching a maximum size of 200 cm in length while females can grow to much more than this (Wilson et al., 1991). The sizes-at-maturity of blue marlin also differ between males and females, with estimated size at about 130 and 180 cm EFL (eye fork length) respectively (Sun et al., 2009). Therefore, the assessment method for blue marlin in the Pacific Ocean need to take account of sex structure to improve the stock assessment, as suggested by previous studies (e.g., Su et al., 2012).

This paper aims to provide available fishery data for blue marlin caught in the Taiwanese fisheries and update the data to 2014, including catch estimates by fishery and size compositions in eye fork length by quarter and by year in the Pacific Ocean.

Materials and methods

Nominal catch data of blue marlin by fishery in the Pacific Ocean were obtained from the Oversea Fisheries Development Council (OFDC) of Taiwan, as well as the Taiwan Fisheries Yearbooks provided by Fisheries Agency (FA) of Taiwan. For the Taiwanese distant-water tuna longline fishery, the blue marlin catches were estimated based on logbook information. Catch information from the offshore and coastal fisheries such as gillnets, set-nets, and harpoons that operated in waters near Taiwan were based on the Fisheries Yearbooks of FA. Due to the availability of sufficient information reported, blue marlin landings in foreign ports for the offshore longline fishery have been estimated annually since 2000 (Su et al., 2014).

Data for eye fork length in cm of blue marlin were collected from the Taiwanese distant-water tuna longline fishery in the Pacific Ocean, and summarized with the smallest and largest observations and length frequencies by quarter and by year. Size data of blue marlin were collected through on-board sampling that the measurement is carried out by fishermen on the initial 30 fishes caught from each operation.

Results and discussion

Catch estimates of blue marlin from the fisheries in Taiwan were summarized in Table 1. Most of blue marlin catches was from the domestic-based offshore longline fishery in Taiwan, varying between 3,000 mt to 4,500 mt from 1992 to 2014, and the catches from the distant-water longline fishery in the Pacific Ocean were lower than those from the offshore longline fishery (Fig. 1).

Catch information for the foreign-based offshore tuna longline fishery has been collected since 2000. This shows a catch amount of 3,066-4,375 mt in the early 2000s with a decreasing trend to about 2000 mt after 2006 (Table 1). The catch of blue marlin from the distant-water tuna longline fishery has increased to more than 1,000 mt since 2003, except for a 910 mt in 2008. In contrast, a small proportion of blue marlin catch was reported for the offshore and coastal gillnet, set-net, and all the other fisheries in the Pacific Ocean (Fig. 1).

Eye fork length of blue marlin collected from the Taiwanese distant-water tuna longline fishery in the Pacific Ocean were summarized in Table 2, with sample sizes ranging from 620 for the first quarter of 2014 to 17,705 for whole year of 2005. Although the smallest and largest blue marlin measured from this fishery varied among years, the mean lengths of measured fish remain relatively stable (from 171.9 to 179.0 cm EFL) during 2005-2012, but show an increasing trend to >180 cm for 2013 and 2014, probably due to large size samples (about 200 cm) collected in the third and fourth quarters of 2013 and a small sample sizes for 2014 (Figs. 2-3). Size compositions of blue marlin by quarter were showed in Fig. 3 with mean lengths and sample sizes for each quarter. Note that size data of blue marlin were only showed for the first quarter of 2014 and will be updated when size data become available (Fig. 3). However, due to the small sample sizes in recent years (particularly incomplete data set for 2014), the geographic range for sampling the size of blue marlin is very limited within the central Pacific Ocean, comparing the spatial coverage for previous years from 2005 to 2013 (Fig. 4).

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Table 1. Catch estimates of blue marlin by fishery for Taiwan. DWLL: distant-water longline; DOLL: domestic-based offshore longline; FOLL: foreign-based offshore longline; OSGN: offshore gillnet; OSOT: offshore others; CTHP: coastal harpoon; CTSN: coastal set-net; CTGN: coastal gillnet; CTOT: coastal other fisheries.

Year	DWLL	DOLL	FOLL	OSGN	OSOT	CTHP	CTSN	CTGN	CTOT	Total
1955										
1956										
1957										
1958		887								887
1959		781								781
1960		948								948
1961		703								703
1962		628								628
1963		691								691
1964	19	934								953
1965	40	1,016								1,056
1966	52	957								1,009
1967	113	898		-	167	-	-	317	-	1,495
1968	193	1,433		30	120	-	-	649	-	2,425
1969	160	1,230		58	103	-	-	465	-	2,016
1970	163	1,385		21	70	-	1	604	-	2,244
1971	104	1,331		13	118	-	-	473	-	2,039
1972	203	1,205		14	50	-	-	490	-	1,962
1973	225	1,650		12	265	-	-	275	-	2,427
1974	161	2,139		6	146	-	1	355	3	2,811
1975	148	2,628		3	207	-	-	421	-	3,407
1976	176	1,291		9	162	-	-	511	-	2,149
1977	145	1,175		11	110	-	-	391	-	1,832
1978	63	1,633		15	7	-	1	364	-	2,083
1979	422	1,626		19	164	-	3	362	-	2,596
1980	490	1,134		35	170	-	-	444	-	2,273
1981	463	1,813		35	69	-	-	313	1	2,694
1982	304	2,129		7	120	-	-	306	-	2,866
1983	272	2,121		26	127	-	-	741	-	3,287
1984	382	1,789		22	111	-	-	960	-	3,264
1985	212	1,187		11	43	-	9	747	-	2,209
1986	184	1,723		90	107	-	4	839	-	2,947
1987	198	4,617		9	1	-	12	973	1	5,811
1988	320	2,822		8	589	-	20	658	-	4,417
1989	445	2,644		13	8	1	10	640	1	3,762
1990	437	1,730		24	143	-	3	427	-	2,764
1991	720	2,152		48	152	2	4	338	-	3,416
1992	122	3,771		34	110	6	25	432	2	4,502
1993	449	3,876		38	81	3	44	400	1	4,892
1994	603	3,007		30	7	-	12	206	-	3,865
1995	326	3,820		33	5	3	15	895	-	5,097
1996	187	3,298		33	10	2	13	270	-	3,813
1997	104	3,625		44	-	4	5	194	38	4,014
1998	209	3,603		58	-	1	8	91	1	3,971
1999	131	3,362		30	-	2	21	135	2	3,683
2000	114	4,056	3,681	40	2	-	24	186	-	8,103
2001	585	4,524	4,202	56	-	1	18	229	-	9,615
2002	495	4,310	4,375	52	6	11	13	32	-	9,294
2003	1,207	4,289	3,288	89	4	18	20	52	-	8,967
2004	1,456	3,354	3,066	84	5	9	14	36	4	8,028
2005	1,506	3,949	3,454	55	16	10	8	48	-	9,046
2006	1,678	3,842	1,909	-	-	15	12	30	-	7,486
2007	1,271	3,230	1,891	6	-	11	3	20	-	6,432
2008	910	3,347	2,134	1	1	15	10	15	-	6,433
2009	1,338	3,210	1,546	3	1	9	9	9	-	6,125
2010	1,490	3,553	2,141	5	-	22	5	15	1	7,232
2011	1,331	3,257	1,808	2	9	16	3	17	-	6,443
2012	1,284	3,152	1,746	1	-	12	6	16	7	6,224
2013	1,055	3,255	2,352	-	-	6	2	16	-	6,686
2014	1,225	3,995	1,667	-	5	11	4	124	-	7,031

Table 2. Summary of blue marlin eye fork length (EFL in cm) data collected from the Taiwanese distant-water tuna longline fishery in the Pacific Ocean.

Year	Min	Median	Max	Mean	*n*
2005	66	170	330	171.9	17,705
2006	63	174	298	176.6	9,807
2007	69	171	297	173.4	6,612
2008	65	173	297	176.3	6,741
2009	75	174	299	175.9	7,006
2010	60	175	298	176.2	10,215
2011	75	173	296	175.3	8,354
2012	70	178	297	179.0	7,530
2013	67	181	299	182.6	5,833
2014	127	199	266	197.1	620

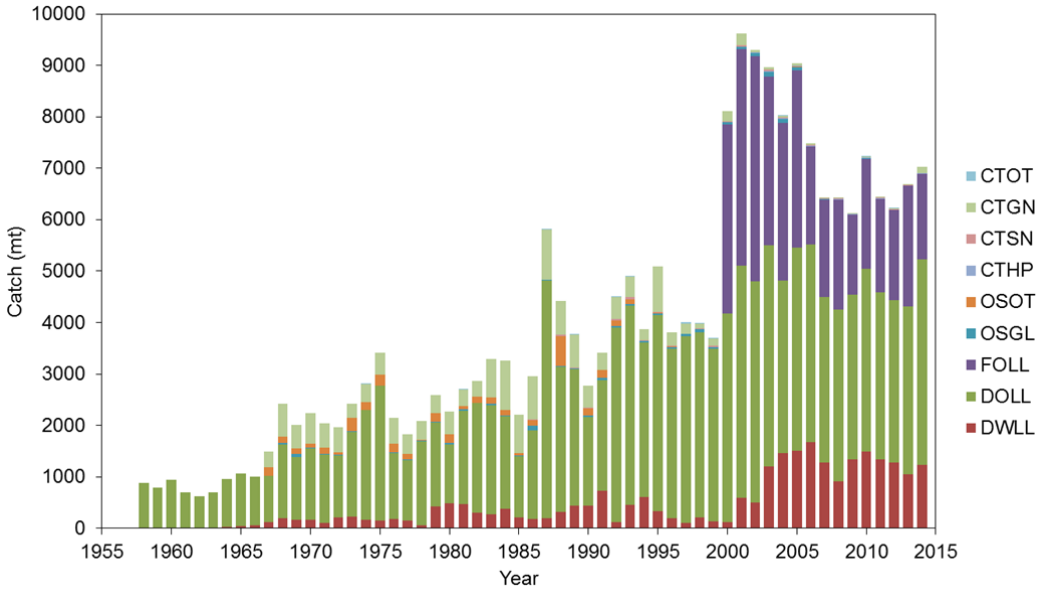


Fig. 1. Catch estimates of blue marlin by fishery for Taiwan. DWLL: distant-water longline; DOLL: domestic-based offshore longline; FOLL: foreign-based offshore longline; OSGN: offshore gillnet; OSOT: offshore others; CTHP: coastal harpoon; CTSN: coastal set-net; CTGN: coastal gillnet; CTOT: coastal other fisheries.

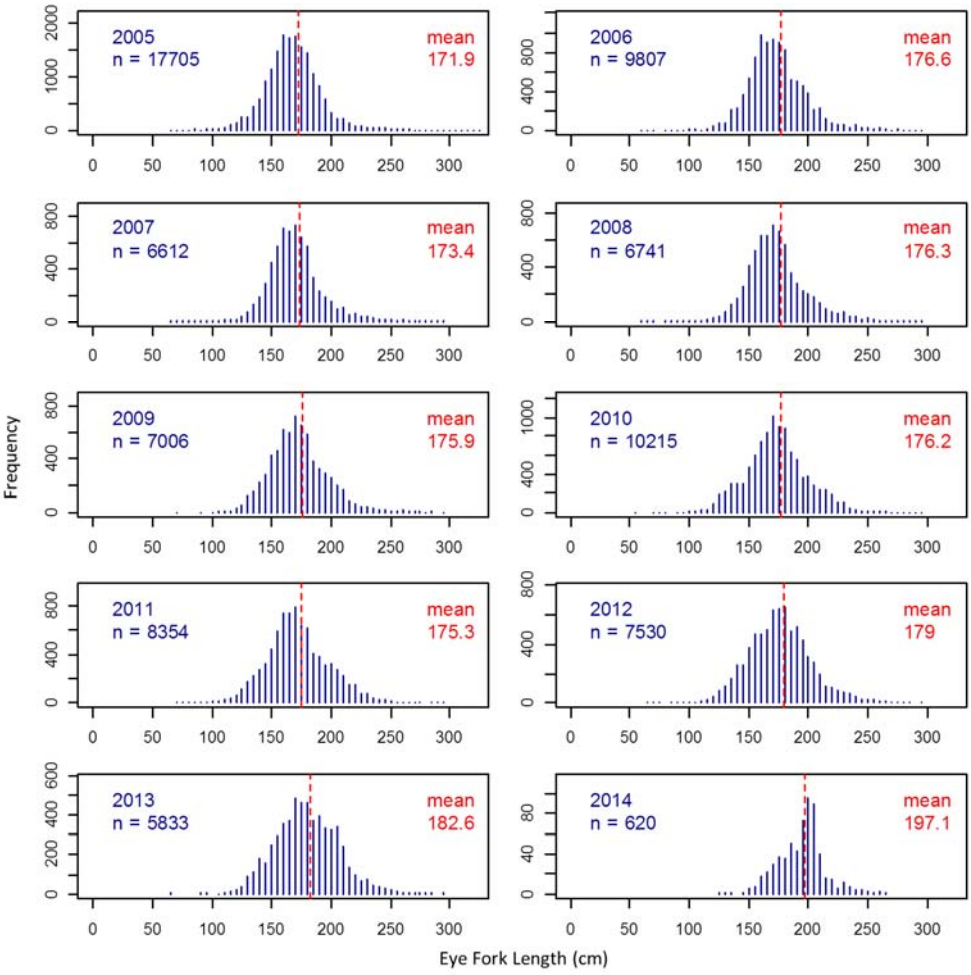


Fig. 2. Length frequency distributions by year for blue marlin caught in the Taiwanese distant-water tuna longline fishery in the Pacific Ocean.

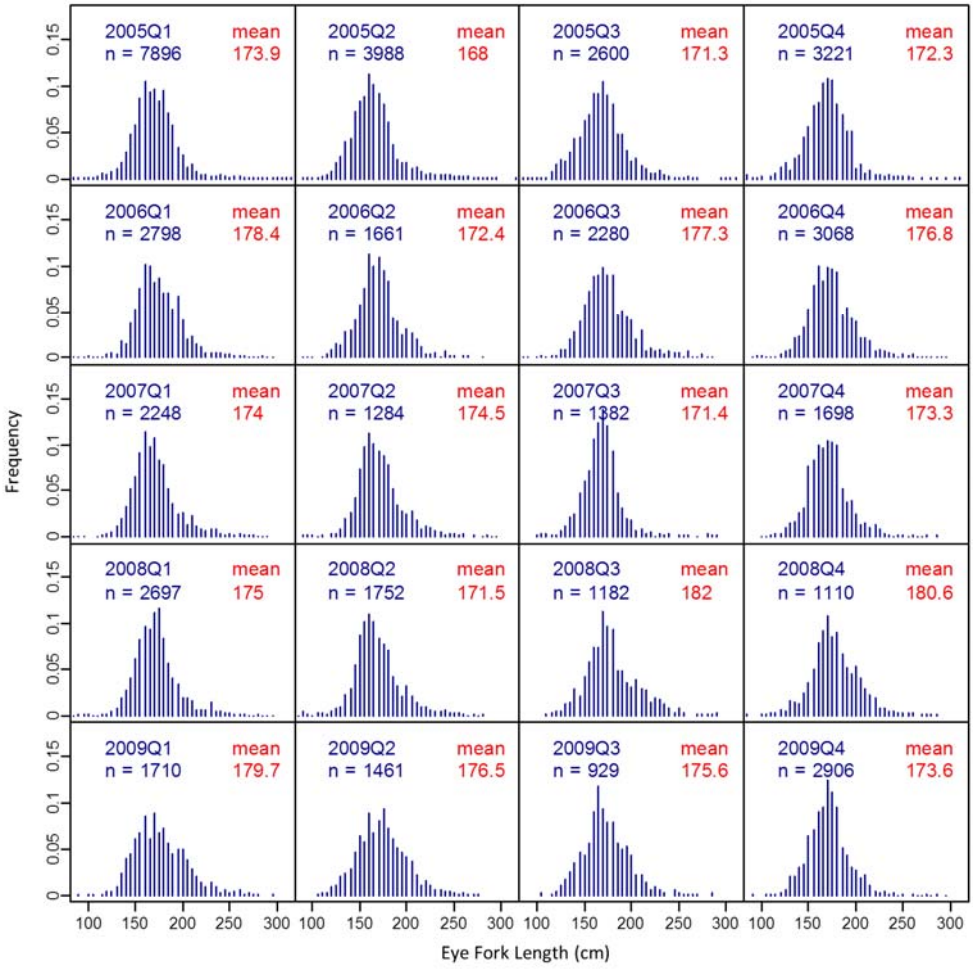
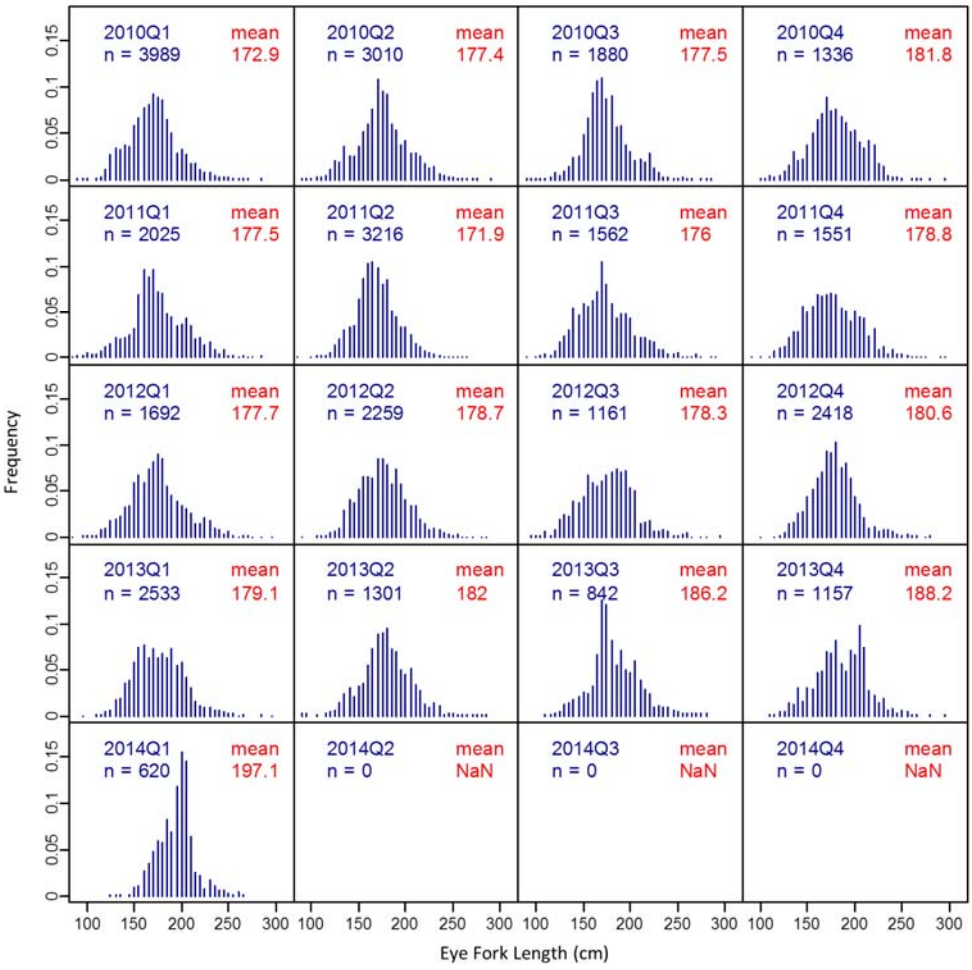


Fig. 3. Length frequency distributions by quarter for blue marlin caught in the Taiwanese distant-water tuna longline fishery in the Pacific Ocean.



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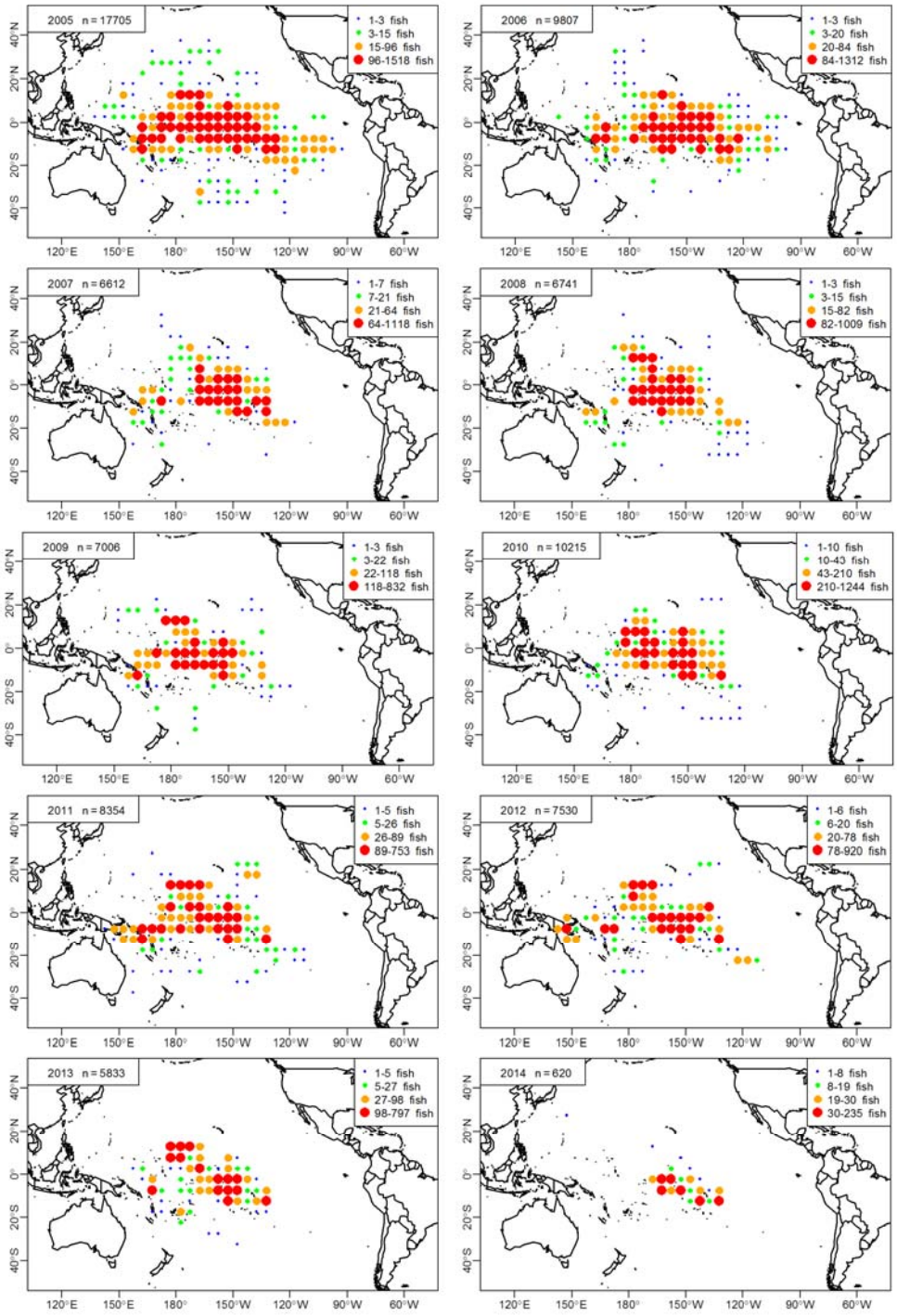

Fig. 4. Maps showing the sample sizes of length data (by color) and the locations where blue marlin were caught in the Taiwanese distant-water tuna longline fishery in the Pacific Ocean.