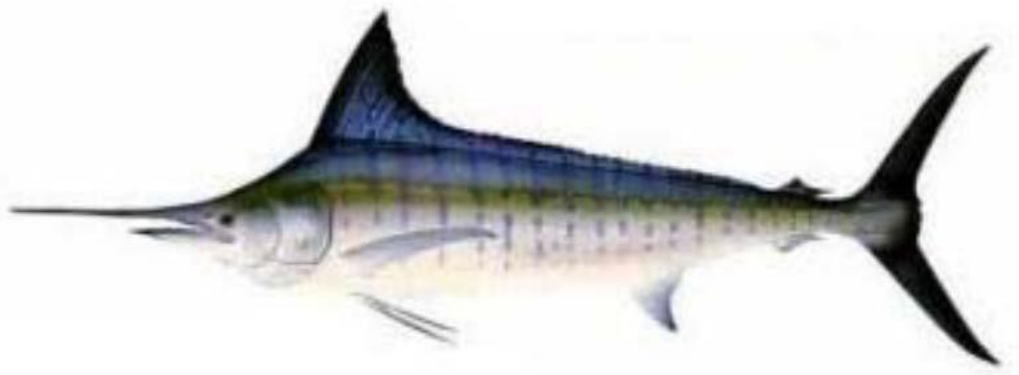




SUMMARY OF STRIPED MARLIN (*Kajikia audax*) CATCH AND SIZE DATA FROM THE WESTERN AND CENTRAL PACIFIC FISHERIES COMMISSION



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ABSTRACT

Data on striped marlin (*Kajikia audax*) catch and length frequency data were provided by the Western and Central Pacific Fisheries Commission (WCPFC) to the ISC Billfish Working Group for the purposes of conducting a 2015 stock assessment update. The results of Category 1 data from 1950-2013 (annual total catch by fleet) and Category 3 data from 1992-2013 (size frequency aggregated by month and spatial 5° grids) are summed up here for visualization and exploration purposes. Striped marlin catches peaked in 1971 at 12,093 tonnes, and in 2013 there were 2,070 tonnes caught. Japan has historically and recently caught a large proportion of the total striped marlin catches, with Taiwan, the United States, and Korea catching the next highest proportions. The reported lengths of striped marlin varied between 40 cm and 315 cm, assumed to be eye to fork length (EFL), with an overall average and standard deviation of 140.09 cm \pm 26.51 cm. The average size of striped marlin varied by country, and also through time by year and quarter.

INTRODUCTION

In 2011, the Billfish Working Group members of the ISC completed a benchmark stock assessment of striped marlin in the Western and Central North Pacific Ocean (ISC, 2012). In that assessment, data provided by member countries to the Western and Central Pacific Fisheries Commission (WCPFC) were included. Here we summarize the data provided by the WCPFC for the purposes of completing a 2015 stock assessment of striped marlin in the Western Pacific North Pacific Ocean stock of striped marlin (**Figure 1**).

This working paper summarizes two types of data provided by the WCPFC. Category 1 data is the annual total catch by fleet and was provided for 1950-2013. Category 3 data is size frequency aggregated by month and spatial 5° grids for each country and was provided for 1992-2013. Another working paper by Tagami et al. (2015) from this session summarizes Category 2 data on catch and effort aggregated by month and spatial 5° grids for each country.

RESULTS

The striped marlin (*Kajikia audax*) catch by country is reported in **Figure 2**. Catch by fleet is reported in **Figure 3** and **Table 2**. Catches began in 1958 at 543 tonnes caught by Taiwan. The lowest amount of catch reported was 306 tonnes in 1961, also caught by Taiwan. Japan has caught a substantial amount of striped marlin, both historically and also present-day. Catches peaked in 1971 at 12,093 tonnes, with Japan catching 11,632 tonnes. Total catch in the most recent year, 2013, was 2,070 tonnes. China's catch of striped marlin has increased in recent years. The striped marlin catch from China peaked in 2012 at 911 tonnes. In 2013, Japan reported catching 1,136 tonnes; the United States caught 391 tonnes, Taiwan caught 227 tonnes; and China caught 190 tonnes.

Category 3 size data was summed up in several ways. Belize and Guam did not report Category 1 catch data but reported Category 3 size data. The reported lengths of striped marlin varied between 40 cm and 315 cm, assumed to be eye to fork length (EFL), with an overall average and standard deviation of 140.09 cm \pm 26.51 cm. **Table 3** provides the mean length and CV of striped marlin caught by each country across all years. Mean length varied between 130.03 cm (USA) to 191.05 cm (Marshall Islands), with most countries catching mean lengths between 150-170 cm.

When averaged annually across all countries, the highest average annual size of 176.6 cm occurred in 2013, and the lowest average annual size of 124.4 cm occurred in 2003 (**Table 4**, **Figure 4A**). The average striped marlin size has fluctuated over time. There appears to be a shift in the average annual size caught starting in 2006; however this pattern is not apparent when the data are plotted by quarter instead of by year (see **Figure 4B**).

Quarterly calculation of average size (**Figure 4B**) indicates a slightly different pattern than the annual calculation of average size (**Figure 4A**), with the highest average quarterly size of 185.4 cm occurring in Quarter 4 of 2010, and the lowest average quarterly size of 121.6 cm occurring in Quarter 1 of 2004. Specification of quarters follows the system from the last stock assessment

(ISC, 2012): Quarter 1 = Jan-Mar, Quarter 2 = Apr-Jun, Quarter 3 = Jul-Sep, and Quarter 4 = Oct-Dec.

Bubble plots indicating size frequency data from catch in each quarter for individual countries with major catches are provided in **Figures 5-10**. For each country, size frequencies and average sizes fluctuated through time. The availability of size data from the WCPFC for each country varies through time, and it's likely that individual countries have more comprehensive size data available.

Spatial distribution of average size across all years by country is illustrated in **Figures 11-16**. In the Western part of the stock, Japan, Taiwan, Korea, China, and the Federated States of Micronesia, caught striped marlin near the Equator between 0° and 15° latitude, and generally west of 180° longitude. The average size caught varied with each 5° by 5° grid and by country. The average size of individuals caught was generally largest closest to the Equator. The United States caught striped marlin around the Hawaiian Islands in the Eastern part of the stock up to 45° latitude, but also caught a few striped marlin (small sample size) near the Equator, west of 175° longitude (**Figure 13**). The availability of size data from the WCPFC for each country varies spatially, and it's likely that individual countries have more comprehensive size data available since the spatial distribution of effort is much larger than the distribution indicated by the size data.

DISCUSSION

The authors note that there is likely more data available from each individual country. For example, the catch data provided by the WCPFC begins in 1958, but the previous assessment (ISC, 2012) indicated that catch starting in 1950 was used for several fleets. In the previous assessment, countries reported multiple fleets, but in the WCPFC database there are only two countries that reported multiple fleets: Taiwan and the United States. This may be a consequence of the WCPFC data reporting structure or other unknown factors. Similarly, there is likely more size data available from individual countries (temporally and spatially) than the WCPFC is able to provide.

ACKNOWLEDGMENTS

We sincerely thank the member countries of the WCPFC and the WCPFC staff for their help in preparing and providing this data for the purposes of a 2015 Striped marlin stock assessment update.

REFERENCES

ISC (2012) Stock assessment of striped marlin in the Western and Central North Pacific Ocean in 2011, Report of the Billfish Working Group Stock Assessment Workshop. July, Sapporo,

Japan. ISC/SAR/MLS/2012. Available at: http://isc.ac.affrc.go.jp/pdf/stock_assessment/isc-billwg%202011%20stock%20assessment%20of%20striped%20marlin.pdf

Table 1. ISO country codes and fleet codes used by the WCPFC and throughout this document.

Country Code	Country	Fleet code	Fleet name
BZ	Belize		
CN	China		
FM	Federated States of Micronesia		
JP	Japan		
KI	Kiribati		
KR	Korea		
MH	Marshall Islands		
PH	Philippines		
TW	Taiwan	DW	Distant water
		OD	Offshore
US	United States of America	HW	Hawaii
		MP	Northern Mariana
VU	Vanuatu		

Table 2. Striped marlin (*Kajikia audax*) catch in tonnes in the Western and Central North Pacific Ocean stock by fleet. Catch data provided by the WCPFC.

Year	China	Micronesia	Japan	Kiribati	Korea	Marshall Islands	Philippines	Taiwan, distant water	Taiwan, offshore	USA, Hawaii	USA, Northern Mariana	Vanuatu
1950			0							0		
1951			0							0		
1952			0							0		
1953			0							0		
1954			0						0	0		
1955			0						0	0		
1956			0						0	0		
1957			0						0	0		
1958			0						543	0		
1959			0						391	0		
1960			0						398	0		
1961			0						306	0		
1962			0						332	0		
1963			0						560	0		
1964			0					0	392	0		
1965			0					0	355	0		
1966			0					0	340	0		
1967			0					0	385	0		
1968			0					0	332	0		
1969			600					0	571	0		
1970			690				11	0	495	0		
1971			11632				12	0	449	0		
1972			7843				13	0	380	0		
1973			6931				15	0	568	0		
1974			6952				17	0	487	0		
1975			5479		0		18	0	732	0		
1976			5240		0		15	0	347	0		
1977			2978		0		21	0	524	0		
1978			2707		0		13	0	618	0		
1979			5264		0		17	0	432	0		
1980			6479		0		22	0	223	105		
1981			4216		0		30	0	491	94		
1982			5481		0		35	0	397	140		
1983			3895		0		52	0	555	114		
1984			3721		0		23	0	965	91		
1985			4409		0		33	0	513	75		
1986			6079		0		44		179	191		
1987			6626		0		69		383	273		
1988			6520		0		58	0	457	500		
1989			5663		0		63	0	184	591		
1990			3423		0		10	0	137	500		
1991		0	3874		0		10	0	254	524		
1992		0	4004		0	0	10	0	219	545		
1993		1	8684		0	0	10	0	221	632		
1994		1	3990		0	0	10	0	137	384		
1995		5	5094	0	0	0	10	0	83	727		
1996		2	3567	0	0	0	10	0	136	524		
1997		1	3428	0	0	0	10	0	267	352		
1998		5	3660	0	0	0	10	0	183	379		
1999		4	2999	0	0	0	10	0	106	364		
2000	2	7	2172	0	629	0	10	0	141	200		
2001	4	5	2191	0	558	0	10	0	141	356		
2002	7	5	1486	0	139	0	10	0	141	228		
2003	8	5	1743	0	347	0	10	0	131	547		
2004	3	4	1620	0	391	0	10	0	143	380		70

2005	3	1	1161	0	345	0	10	0	205	511		78
2006	2	2	977	0	245	0	10	0	165	611		45
2007	2	10	996	0	129	0	10	102	150	276		46
2008	125	1	999	0	67	1	10	78	175	426		19
2009	33	0	617	0	47	0	10	37	213	256		13
2010	256	0	1019	0	59	0	10	53	188	152		13
2011	153	3	1239	0	62	0	0	74	255	362		95
2012	911	3	1290	1	77	0	0	91	339	282		39
2013	190	0	1136	1	65	0	0	87	140	391	45	15

Table 3. Striped marlin (*Kajikia audax*) mean length (in cm, assumed to be eye to fork length) caught in the Western and Central North Pacific Ocean stock by country, along with coefficient of variation (CV) and sample size (*n*). Data provided by the WCPFC.

Country	Country Code	Mean length (cm)	CV	<i>n</i>
Belize	BZ	160.60	0.20	5
China	CN	156.83	0.17	851
Federated States of Micronesia	FM	146.82	0.12	694
Guam	GU	155.81	0.20	16
Japan	JP	158.62	0.14	739
Kiribati	KI	189.60	0.19	25
Korea	KR	167.75	0.23	64
Marshall Islands	MH	191.05	0.24	19
Taiwan	TW	162.30	0.15	4132
USA	US	130.03	0.16	12779

Table 4. Striped marlin (*Kajikia audax*) mean length (in cm, assumed to be eye to fork) caught in the Western and Central North Pacific Ocean stock by year, along with coefficient of variation (CV) and sample size (n). Data provided by the WCPFC.

Year	Mean length (cm)	CV	n
1992	158.11	0.10	9
1993	158.00	0.15	68
1994	149.10	0.15	570
1995	140.69	0.16	992
1996	141.93	0.14	1382
1997	147.76	0.17	784
1998	145.15	0.18	767
1999	139.36	0.17	495
2000	141.96	0.14	848
2001	128.50	0.16	2257
2002	155.63	0.14	70
2003	124.43	0.16	4108
2004	129.06	0.17	2491
2005	143.81	0.17	129
2006	171.39	0.17	475
2007	163.47	0.16	451
2008	164.16	0.16	363
2009	158.54	0.16	380
2010	156.97	0.16	714
2011	157.73	0.18	961
2012	165.20	0.12	989
2013	176.57	0.13	21

Striped marlin stock boundaries

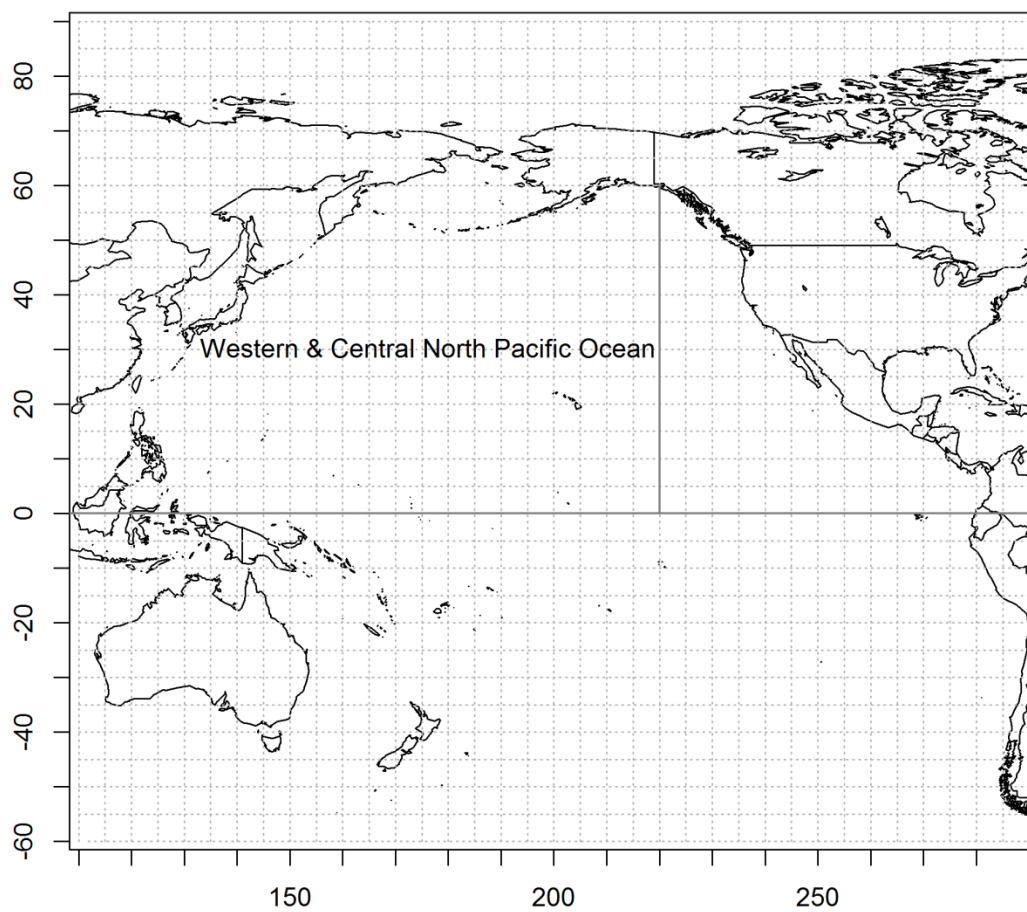


Figure 1. Spatial boundary for Western and Central North Pacific Ocean stock of striped marlin (*Kajikia audax*).

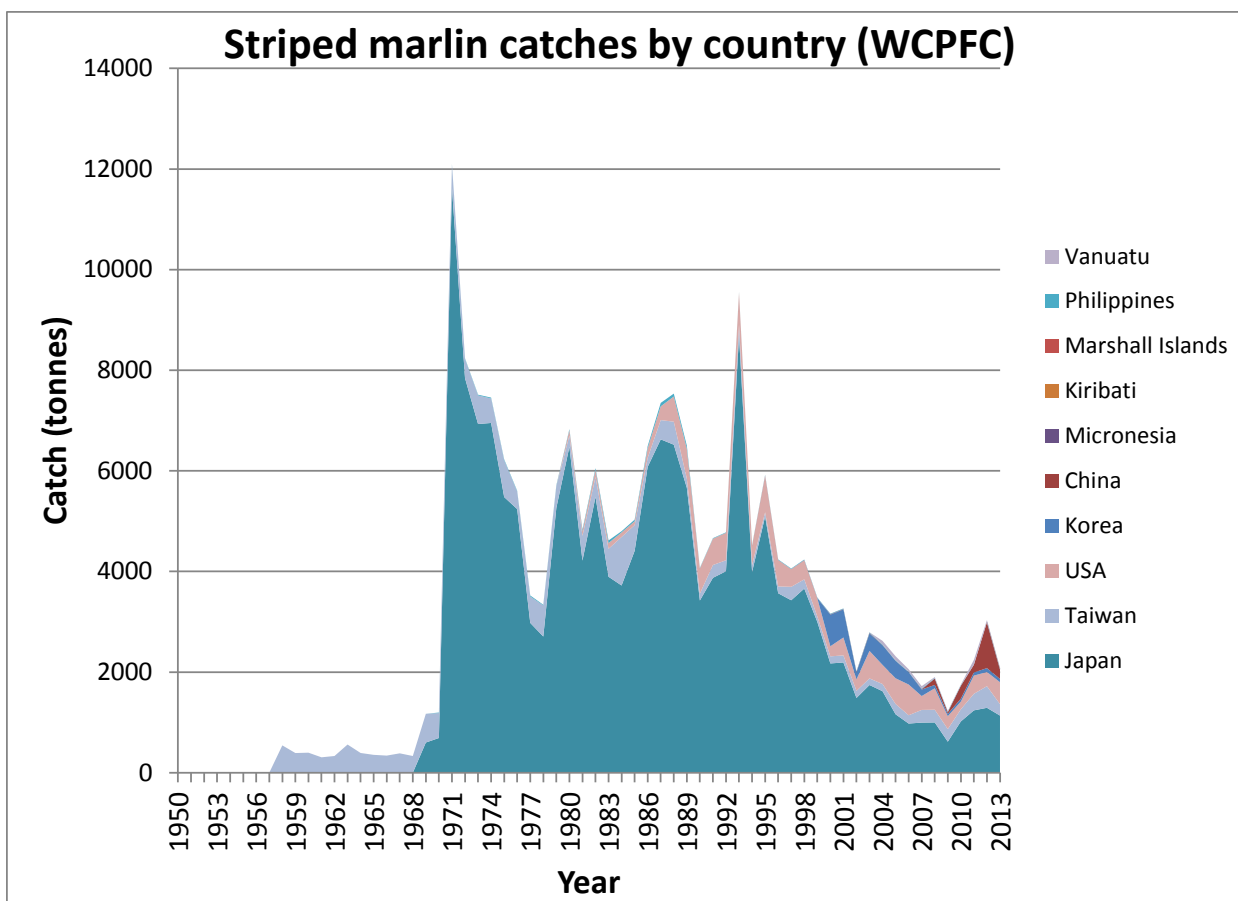


Figure 2. Striped marlin (*Kajikia audax*) catch in tonnes in the Western and Central North Pacific Ocean stock by country. Data provided by the WCPFC.

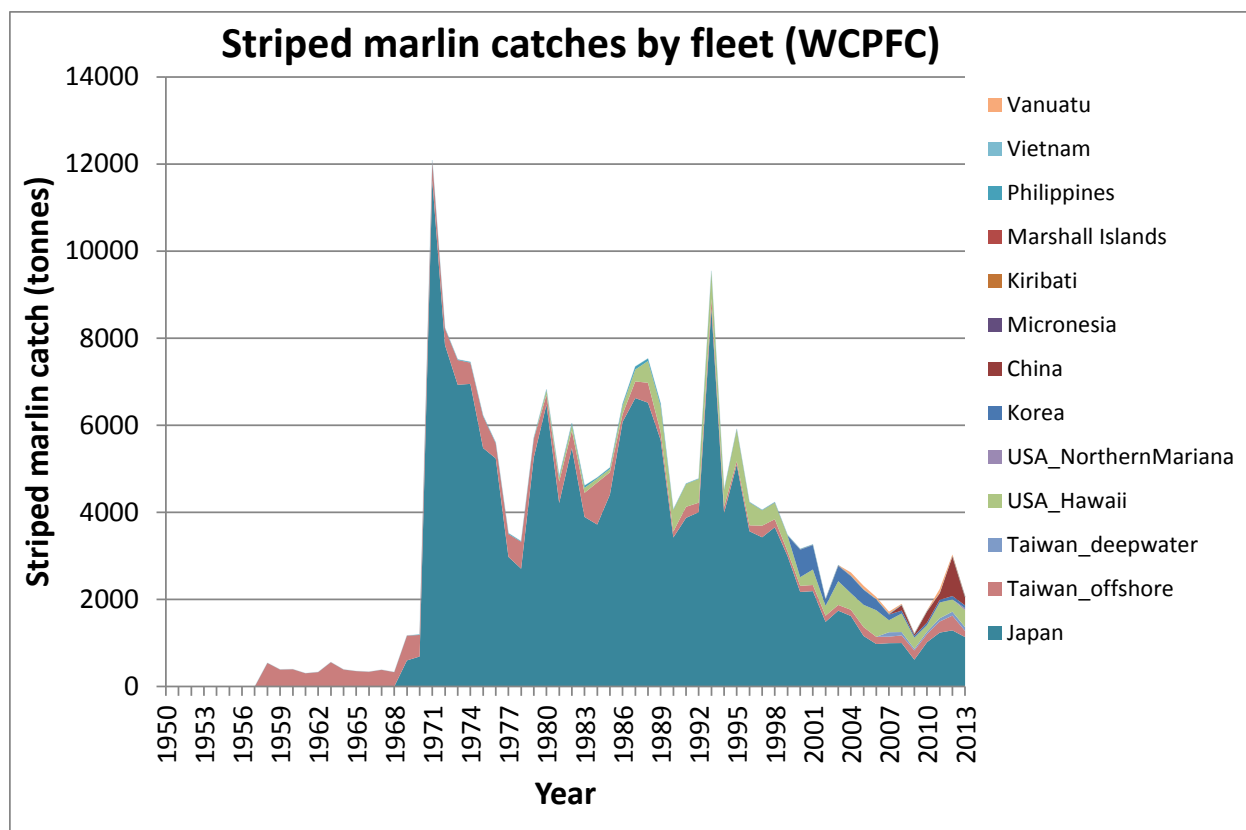


Figure 3. Striped marlin (*Kajikia audax*) catch in tonnes in the Western and Central North Pacific Ocean stock by fleet. Data provided by the WCPFC.

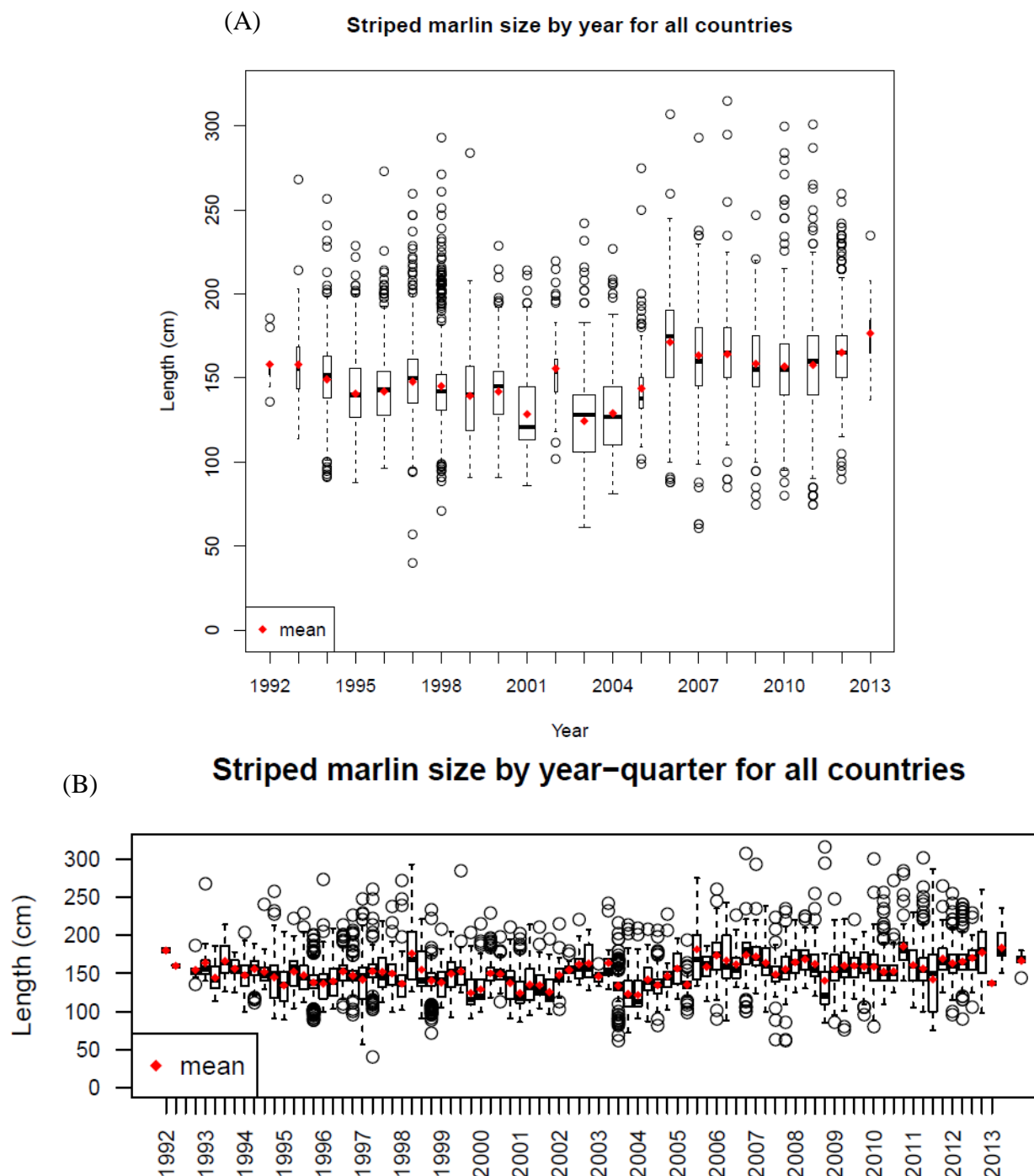


Figure 4. Box plots of striped marlin (*Kajikia audax*) length in cm, assumed to be eye to fork length, over time for all countries reporting in the Western and Central North Pacific Ocean stock to the WCPFC. Box plot thick black line within each box indicates median, box lower and upper edges indicate the first and third quartiles, box whiskers indicate 1.5 times the interquartile range above and below the first and third quartiles, and black circles indicate outliers. Red diamonds indicate average size for that year. Data provided by the WCPFC. (A) Size data tabulated annually for all countries. (B) Size data tabulated quarterly for all countries.

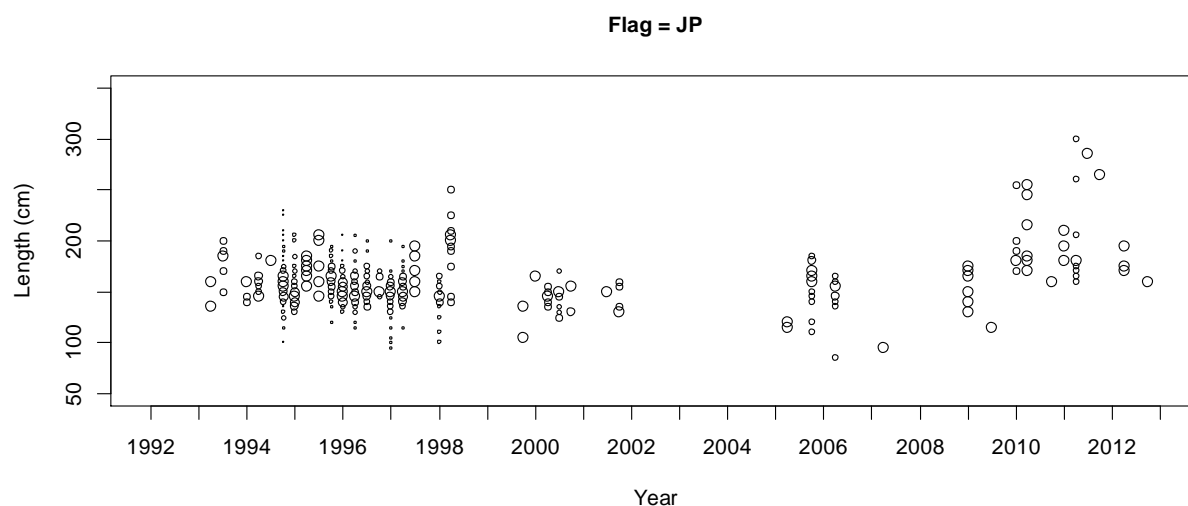


Figure 5. Bubble plot indicating size frequency (in cm, assumed to be eye to fork length) of striped marlin (*Kajikia audax*) over time for Japan in the Western and Central North Pacific Ocean stock. Bubble size corresponds to proportional frequency, and data is plotted by quarter. Data provided by the WCPFC.

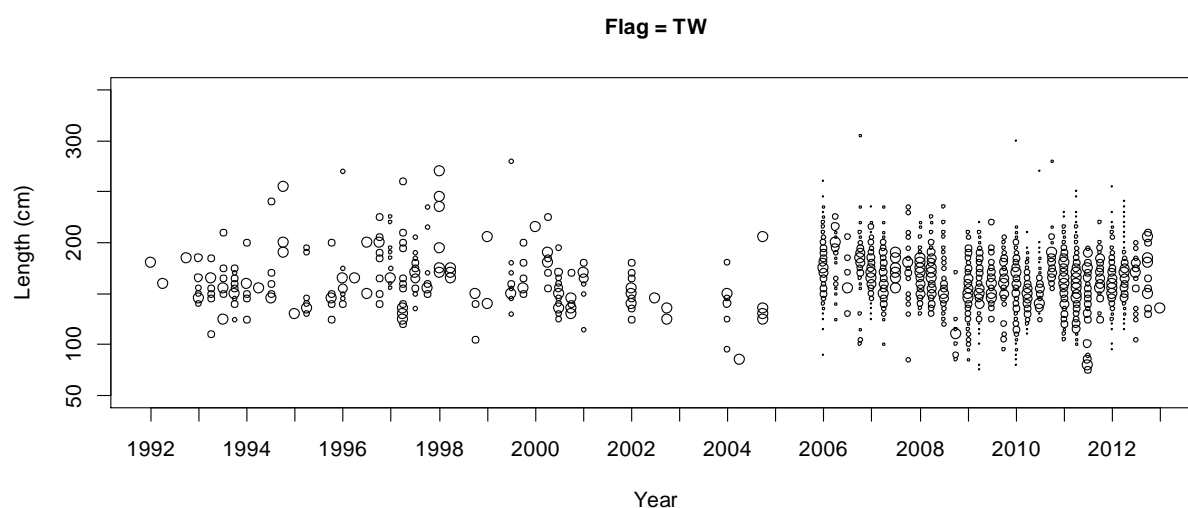


Figure 6. Bubble plot indicating size frequency (in cm, assumed to be eye to fork length) of striped marlin (*Kajikia audax*) over time for Taiwan in the Western and Central North Pacific Ocean stock. Bubble size corresponds to proportional frequency, and data is plotted by quarter. Data provided by the WCPFC.

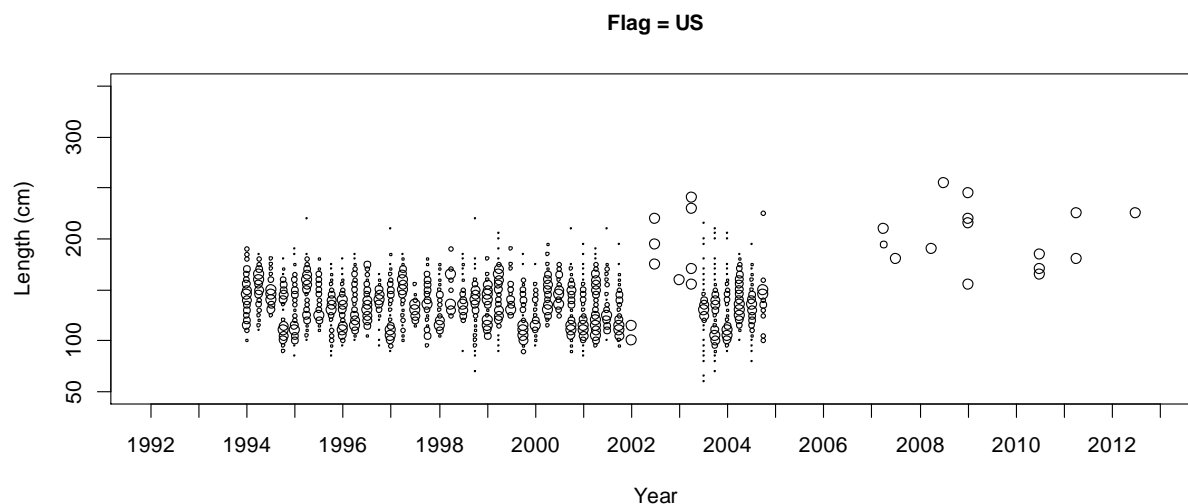


Figure 7. Bubble plot indicating size frequency (in cm, assumed to be eye to fork length) of striped marlin (*Kajikia audax*) over time for the United States in the Western and Central North Pacific Ocean stock. Bubble size corresponds to proportional frequency, and data is plotted by quarter. Data provided by the WCPFC.

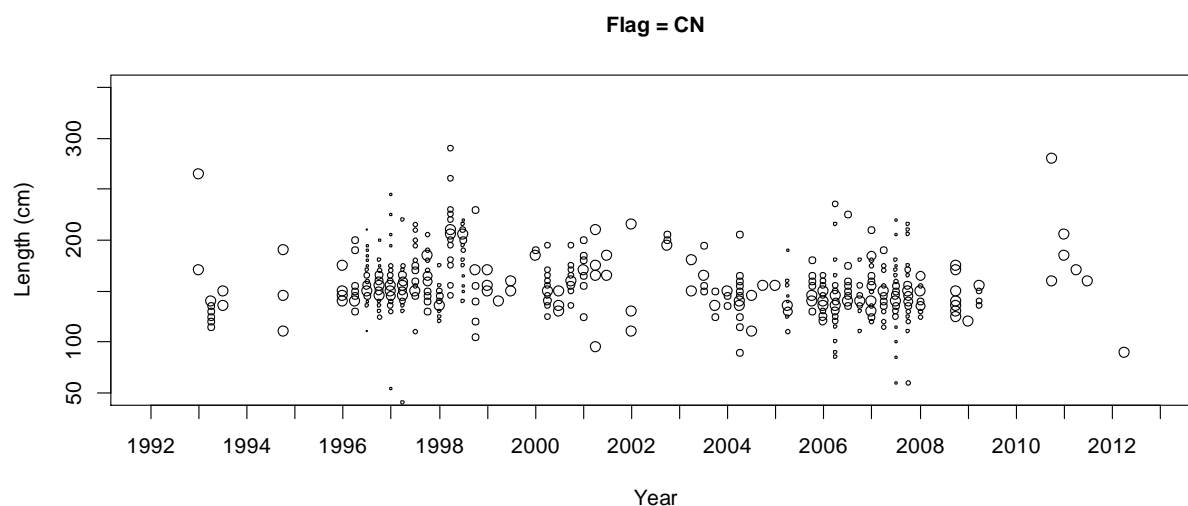


Figure 8. Bubble plot indicating size frequency (in cm, assumed to be eye to fork length) of striped marlin (*Kajikia audax*) over time for China in the Western and Central North Pacific Ocean stock. Bubble size corresponds to proportional frequency, and data is plotted by quarter. Data provided by the WCPFC.

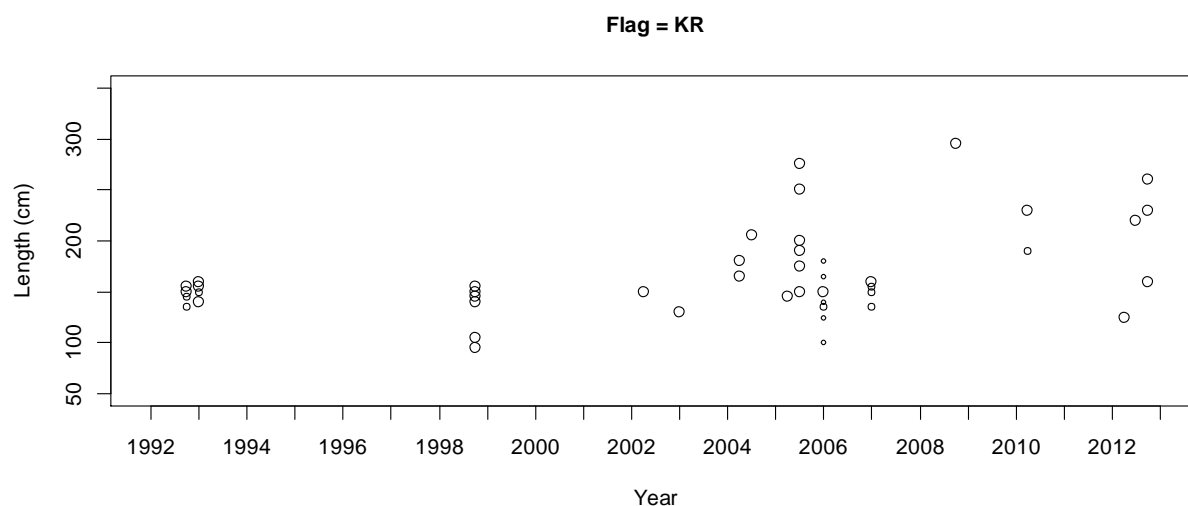


Figure 9. Bubble plot indicating size frequency (in cm, assumed to be eye to fork length) of striped marlin (*Kajikia audax*) over time for Korea in the Western and Central North Pacific Ocean stock. Bubble size corresponds to proportional frequency, and data is plotted by quarter. Data provided by the WCPFC.

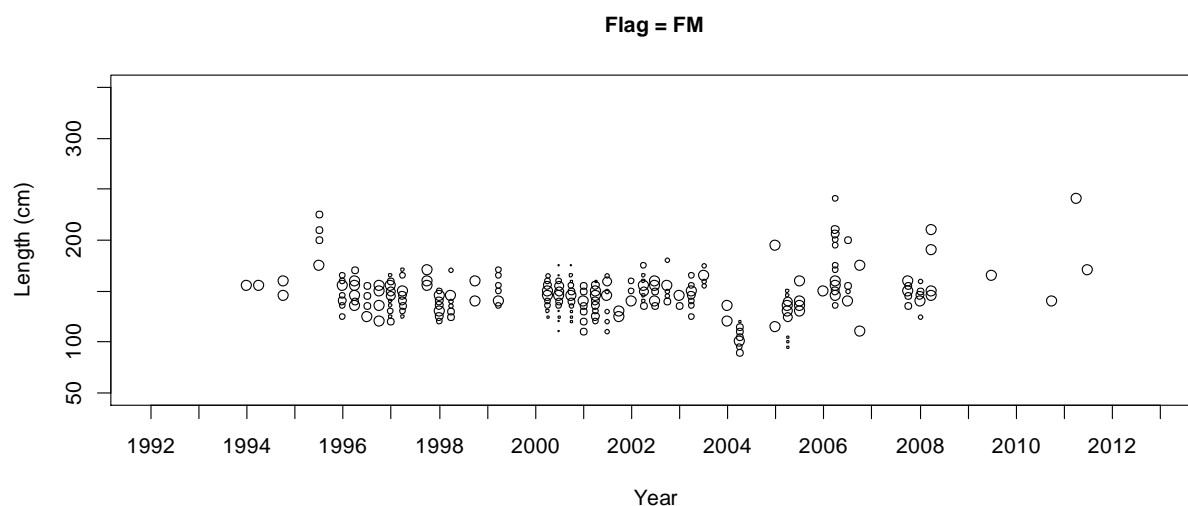


Figure 10. Bubble plot indicating size frequency (in cm, assumed to be eye to fork length) of striped marlin (*Kajikia audax*) over time for the Federated States of Micronesia in the Western and Central North Pacific Ocean stock. Bubble size corresponds to proportional frequency, and data is plotted by quarter. Data provided by the WCPFC.

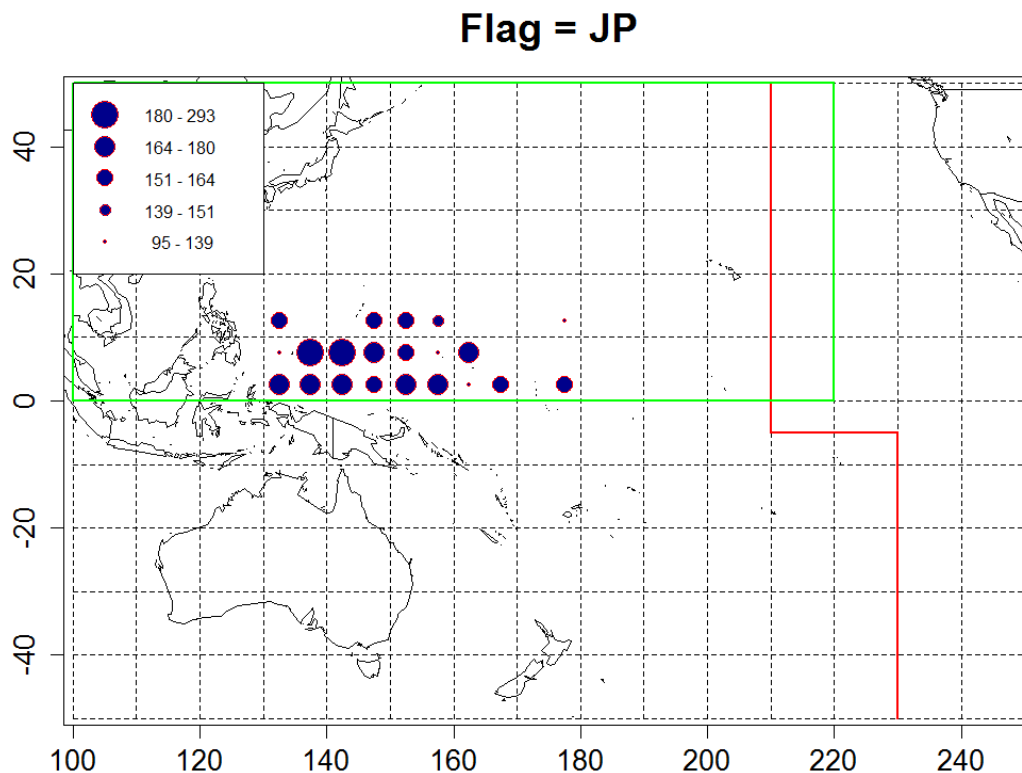


Figure 11. Spatial distribution of average size (in cm, assumed to be eye to fork length) of striped marlin (*Kajikia audax*) caught by Japan in the Western and Central North Pacific Ocean stock. Blue bubble size corresponds to average length in cm in a given 5° by 5° grid, and does not reflect sample size. Green boundary indicates the Western and Central North Pacific Ocean stock boundary for striped marlin, and red boundary indicates the WCPFC convention area. Data provided by the WCPFC.

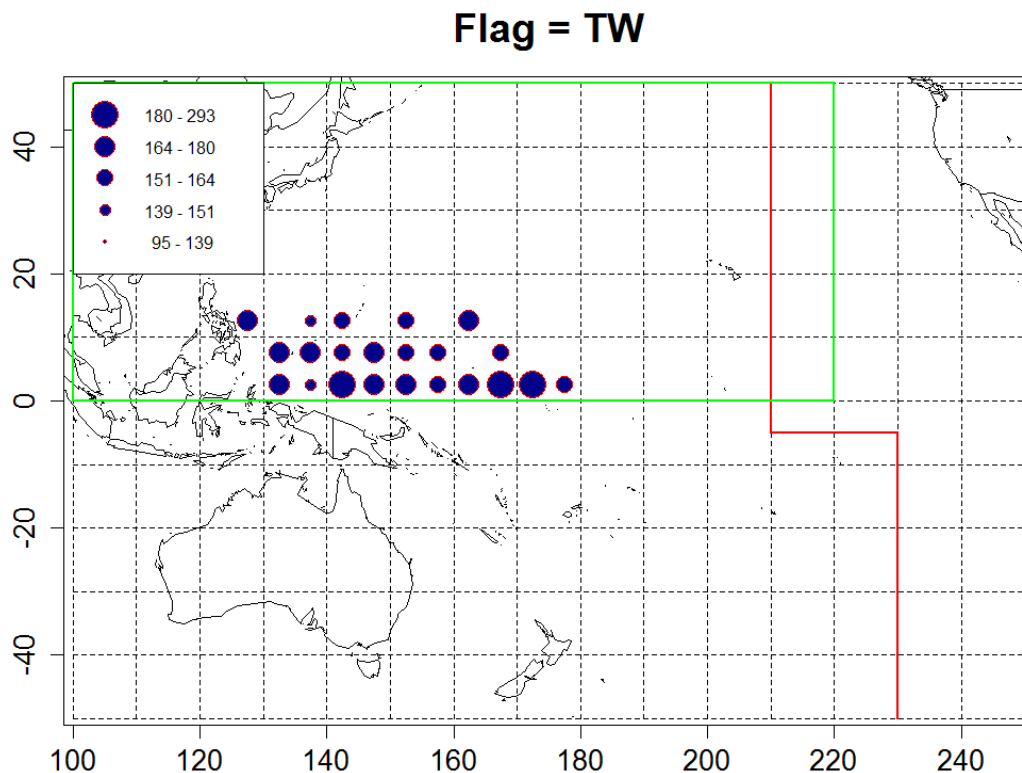


Figure 12. Spatial distribution of average size (in cm, assumed to be eye to fork length) of striped marlin (*Kajikia audax*) caught by Taiwan in the Western and Central North Pacific Ocean stock. Blue bubble size corresponds to average length in cm in a given 5° by 5° grid, and does not reflect sample size. Green boundary indicates the Western and Central North Pacific Ocean stock boundary for striped marlin, and red boundary indicates the WCPFC convention area. Data provided by the WCPFC.

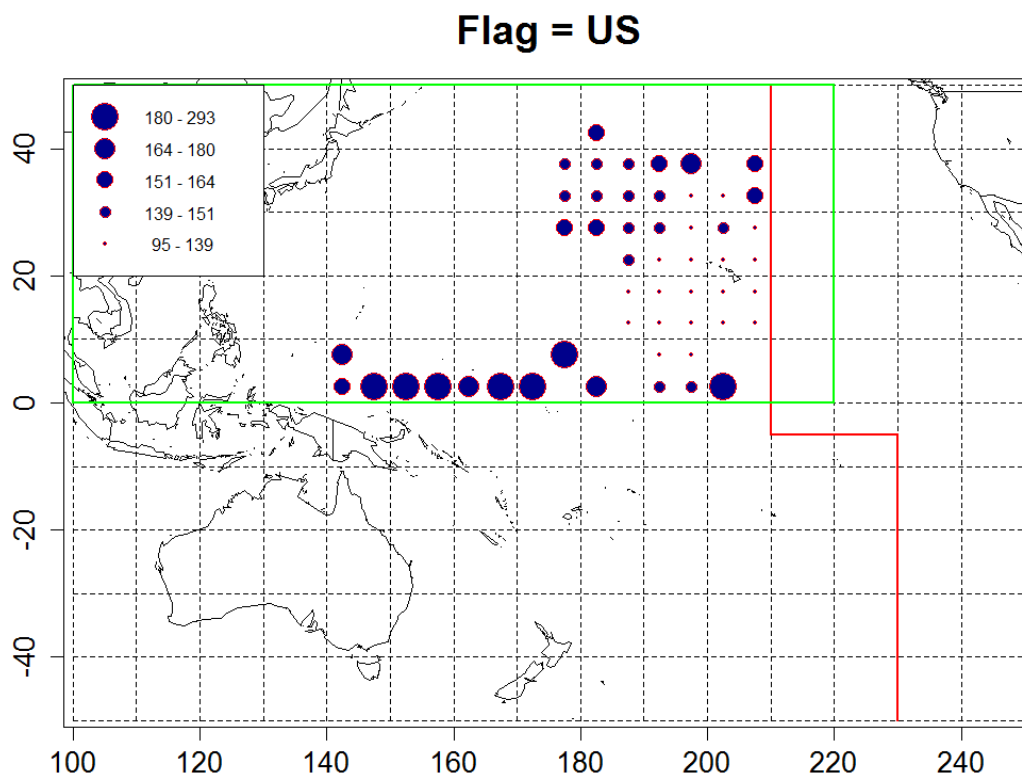


Figure 13. Spatial distribution of average size (in cm, assumed to be eye to fork length) of striped marlin (*Kajikia audax*) caught by the United States in the Western and Central North Pacific Ocean stock. Blue bubble size corresponds to average length in cm in a given 5° by 5° grid, and does not reflect sample size. Green boundary indicates the Western and Central North Pacific Ocean stock boundary for striped marlin, and red boundary indicates the WCPFC convention area. Data provided by the WCPFC.

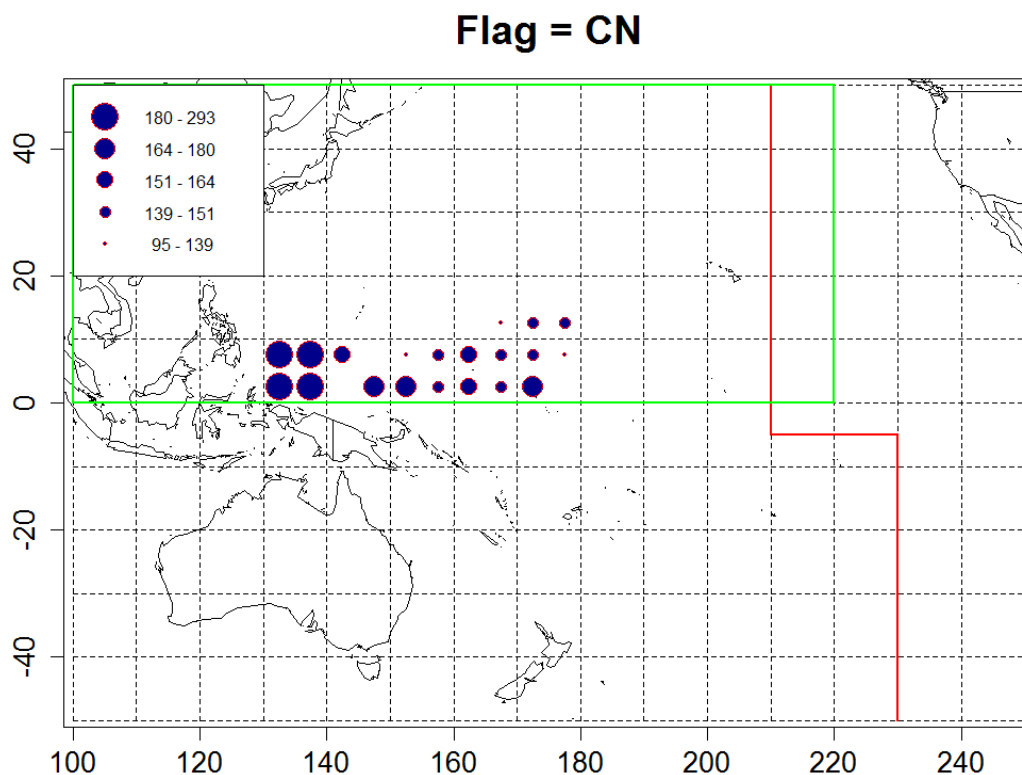


Figure 14. Spatial distribution of average size (in cm, assumed to be eye to fork length) of striped marlin (*Kajikia audax*) caught by China in the Western and Central North Pacific Ocean stock. Blue bubble size corresponds to average length in cm in a given 5° by 5° grid, and does not reflect sample size. Green boundary indicates the Western and Central North Pacific Ocean stock boundary for striped marlin, and red boundary indicates the WCPFC convention area. Data provided by the WCPFC.

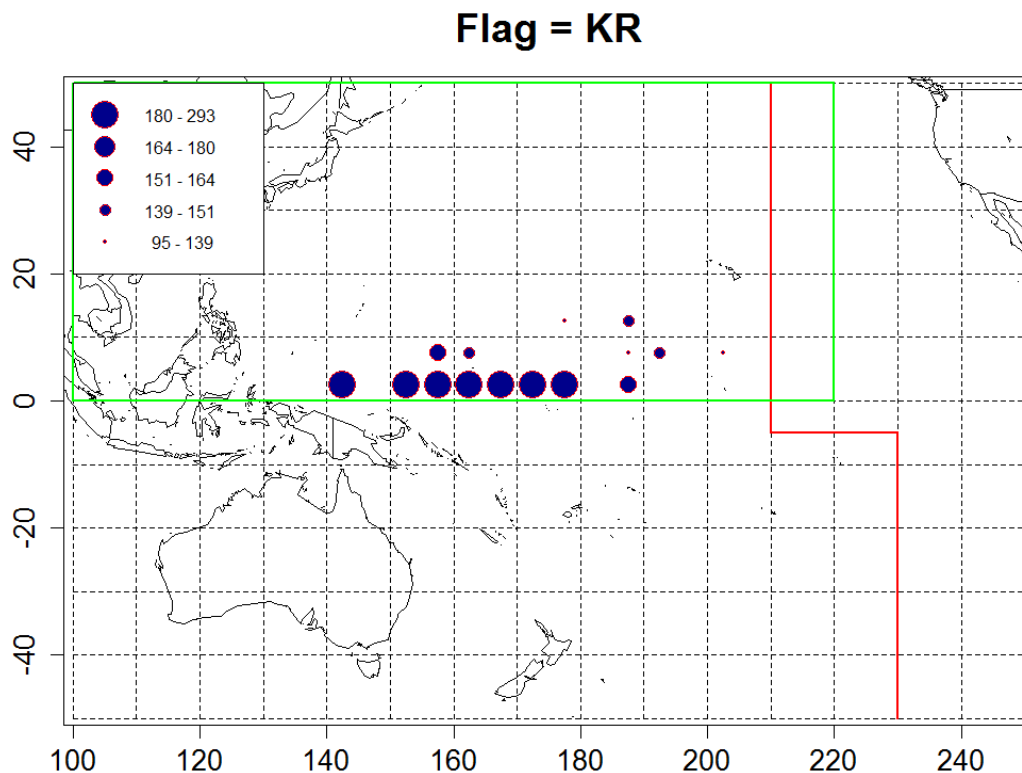


Figure 15. Spatial distribution of average size (in cm, assumed to be eye to fork length) of striped marlin (*Kajikia audax*) caught by Korea in the Western and Central North Pacific Ocean stock. Blue bubble size corresponds to average length in cm in a given 5° by 5° grid, and does not reflect sample size. Green boundary indicates the Western and Central North Pacific Ocean stock boundary for striped marlin, and red boundary indicates the WCPFC convention area. Data provided by the WCPFC.

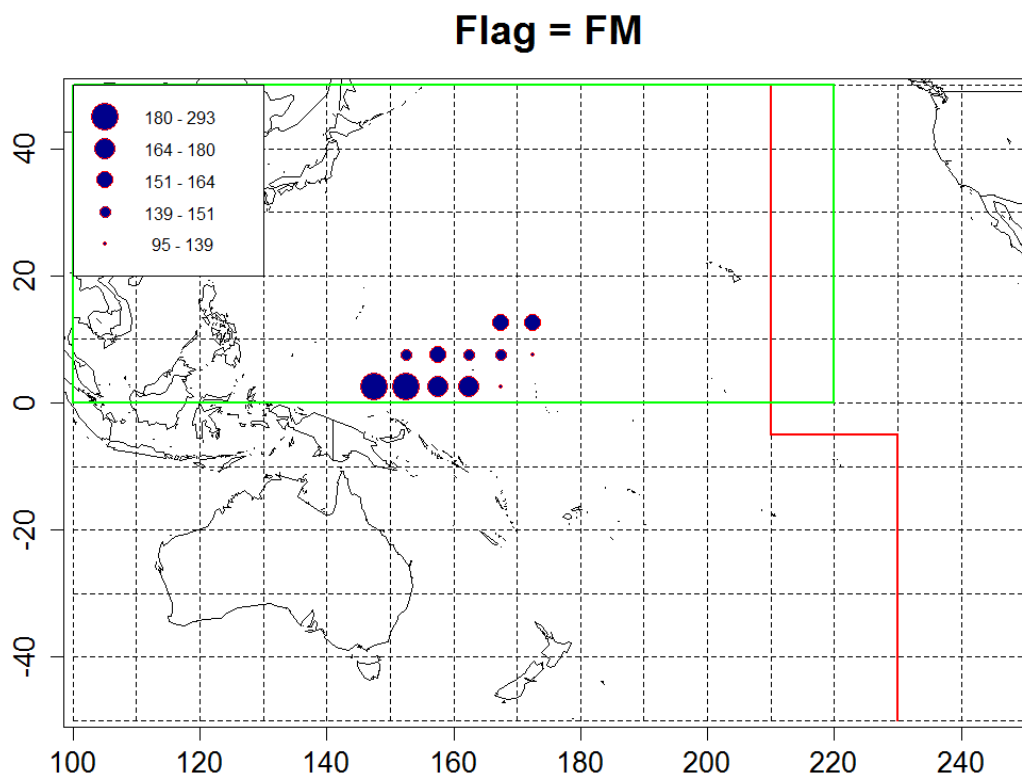


Figure 16. Spatial distribution of average size (in cm, assumed to be eye to fork length) of striped marlin (*Kajikia audax*) caught by the Federated States of Micronesia in the Western and Central North Pacific Ocean stock. Blue bubble size corresponds to average length in cm in a given 5° by 5° grid, and does not reflect sample size. Green boundary indicates the Western and Central North Pacific Ocean stock boundary for striped marlin, and red boundary indicates the WCPFC convention area. Data provided by the WCPFC.