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China's Annual report – Part I: The Jack Mackerel Fishery

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National Report of China to the 2015 SPRFMO Science Committee Part I: the Jack Mackerel Fishery

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1 *Description of Chinese Pelagic trawl Fishery*

The Chinese large pelagic trawlers have harvested the jack mackerel (*Trachurus murphyi*) in the SPRFMO AREA since 2000. The Chinese trawl vessels only operated in the high seas outside Chile EEZ. The number of Chinese vessels varied between 11 and 13 during 2004-2009, however the number of active vessels has decreased continuously since 2010 because of the decreased jack mackerel biomass and dropped to 2 vessels in 2013. In 2014, 3 vessels operated in the high seas of the South Pacific Ocean. The number of pelagic trawlers increased to 5 vessels in 2015 (Table 1).

Table 1 Number of vessels from 2010 to 2015

Year	Number of fishing vessels	Registered tonnage, GRT		Gear type
		<4,000	≥4,000	
2010	9	0	9	Pelagic trawl
2011	6	0	6	Pelagic trawl
2012	3	0	3	Pelagic trawl
2013	2	0	2	Pelagic trawl
2014	3	0	3	Pelagic trawl
2015	5	0	5	Pelagic trawl

Annual catch has fluctuated between 2318 and 160,000 tons from 2000 to 2014. During the period of 2001-2006, annual catch increased stably and peaked in 2006. Staring from 2007, jack mackerel catch declined continuously and

reached the lowest level in 2013. Table 2 presents the summary of annual catch, fishing days and catch per fishing day of the Chinese trawl fishery in recent years. Catch, fishing days, as well as catch per fishing day of the Chinese vessels decreased during 2010-2013, but showed obviously increases in 2014. Annual catch reached 21,264 tons in 2014, 2.55 times higher than it in 2013.

In 2015 two vessel, LONGTENG and LONGFA returned to the SPRFMO AREA started to fishing in 21 June and 6 June respectively. So the total number of Chinese vessels increases to 5 in 2015, and total catch of jack mackerel is 26260 tons up to July.

Table 2 Catch, fishing days and catch per day of jack mackerel by the Chinese fishing fleets over the period of 2010-2015

Year	Catch in tons	Fishing days	Catch per day in tons
2010	63,606	921	69
2011	32,862	591	56
2012	13,012	260	50
2013	8,329	177	47
2014	21,154	298	71
2015*	26,260	122	215

Note: The total catch of jack mackerel was 26260 tons through July 2015.

2 Catch, Effort and CPUE Summaries

The Chinese trawl fishery targets jack mackerel and the by catch species is mainly chub mackerel (*Scomber japonicus*). Catch of chub mackerel usually makes up a small fraction of the total catch and the percentage of by catch is less than 4%.

Annual total effort and CPUE presented the same trend with catch from 2010 to 2015 (Table 3). Effort in 2014 doubled when comparing to it in 2013, however CPUE only increased 31.8%.

Monthly catches of jack mackerel in the last five years is showed in Figure 1. Catch distribution on month changed from year to year. Catches in March, April and May declined sharply from 2010 to 2014, but catches in May to October was increased steadily during 2012-2014. The fishing season was shortening and there was no fishing activity in the first-three-month in 2013 and 2014.

Table 3 Catch, effort (trawling hours) and CPUE of jack mackerel by the Chinese fishing fleets over the period of 2010-2015.

Year	Catch in tons	Trawling time in hours	CPUE (ton/hour)
2010	63,606	8701.2	7.3
2011	32,862	7022.3	4.7
2012	13,012	3208.4	4.1
2013	8,329	1893.2	4.4
2014	21,154	3655.2	5.8
2015*	26,260	3630.5	7.2

Note: The total catch of jack mackerel was 26,260 tons through July 2015.

Monthly nominal CPUE is presented in Figure 2. Monthly CPUE fluctuated between to 1.6 (December 2013) to 13.1 ton per hour (May 2010). Monthly CPUEs in 2010 and 2011 showed opposite trends with catches at the last 2 or 3 month, except that the CPUE declined from 2010 to 2011 and began to rising form 2012.

Nominal CPUE were standardized by generalized additive model (GAM) and the estimated Year Effect (exponential transformed) by GAM was used as abundance index for jack mackerel (Li, 2012). Jack mackerel abundance declined steadily till 2011 and presented a slow growth trend from 2011 to 2014 (Figure 3).

Spatial distribution of catch in 2014 was similar to that in 2012 and 2013 (Figure 4 & 5). Contrary to earlier years, Chinese vessels are closer to the Chilean EEZ, and the fishing ground off North Chile has being become more and more important with the growing catch of jack mackerel. Just 5 or 6 year ago, Chinese

vessels once operated far from Chilean coast almost at 120°W, and jack mackerel caught form North Chile was negligible. Although jack mackerel biomass is showing sigh of recovery, there was no data to indicate that biomass or abundance in the eastern high seas is recovering.

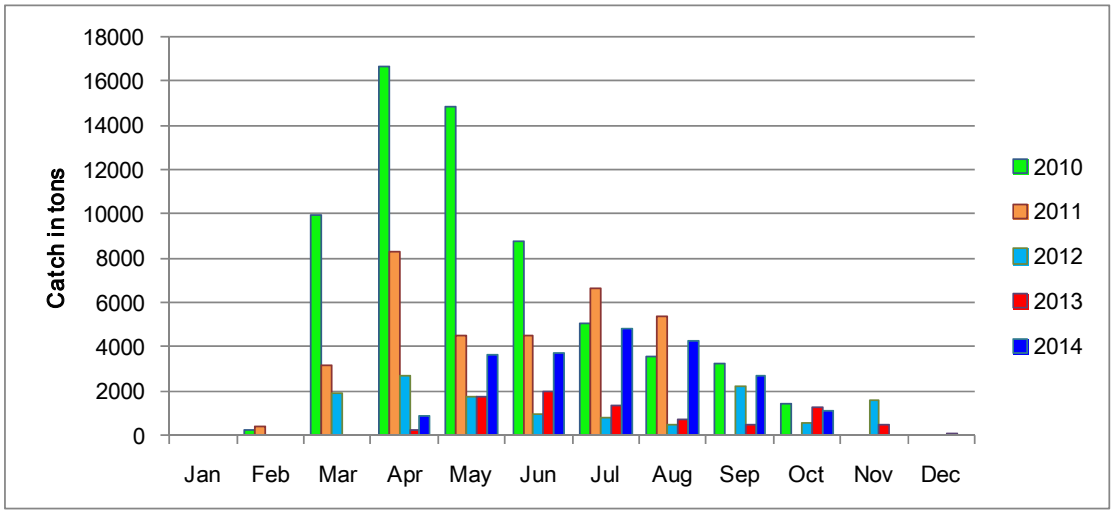

Figure 1. Monthly catch of jack mackerel by the Chinese trawling vessels during 2010-2014.

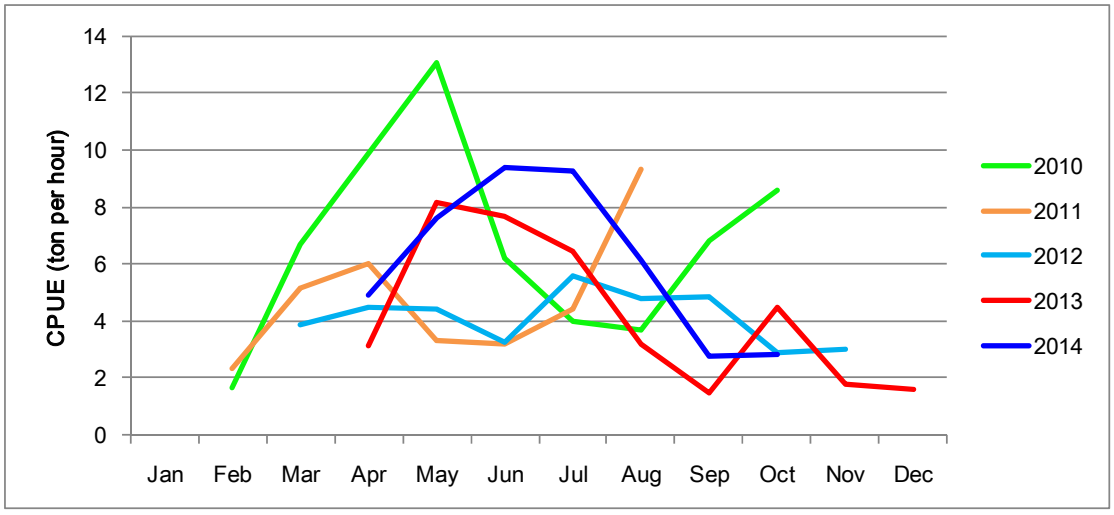

Figure 2. Monthly CPUE of the Chinese trawl fishery during 2010-2014.

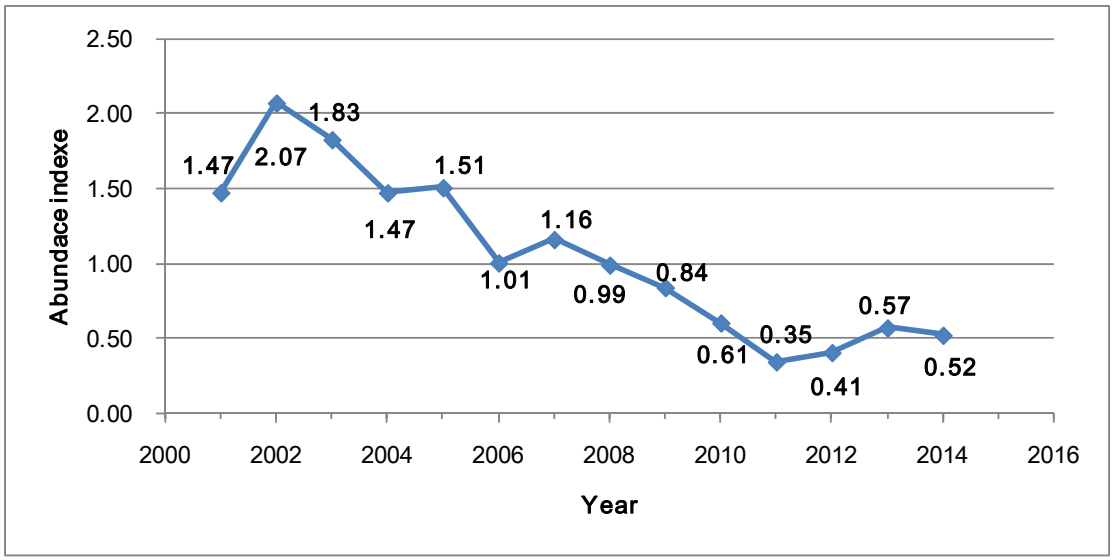

Figure 3. Estimated abundance index of jack mackerel during 2001-2014

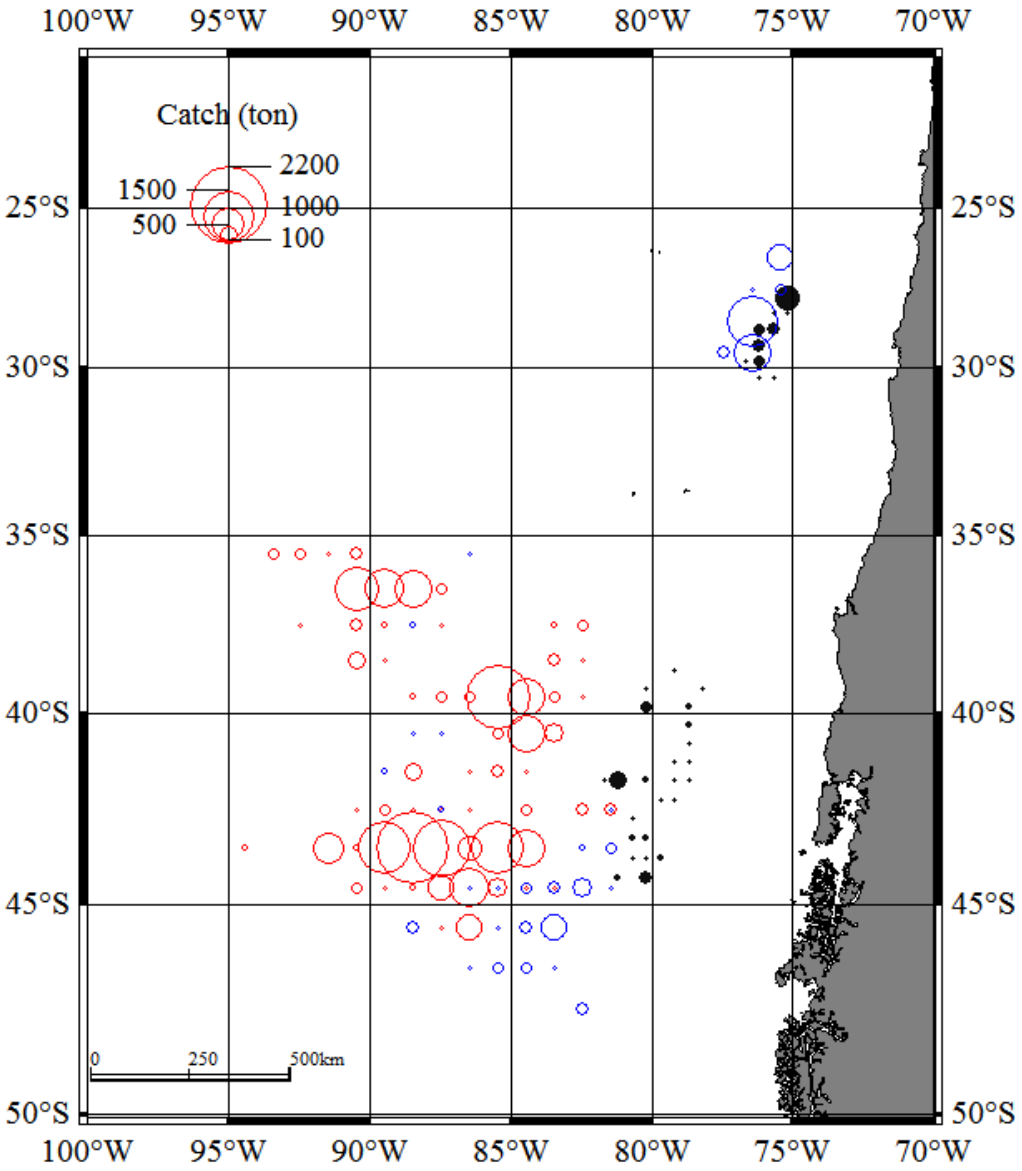

Figure 4. Catch distribution (1°×1°) by the Chinese fleets in SPRFMO area in 2011 (red circle), 2012 (blue circle) and 2013 (solid black circle)

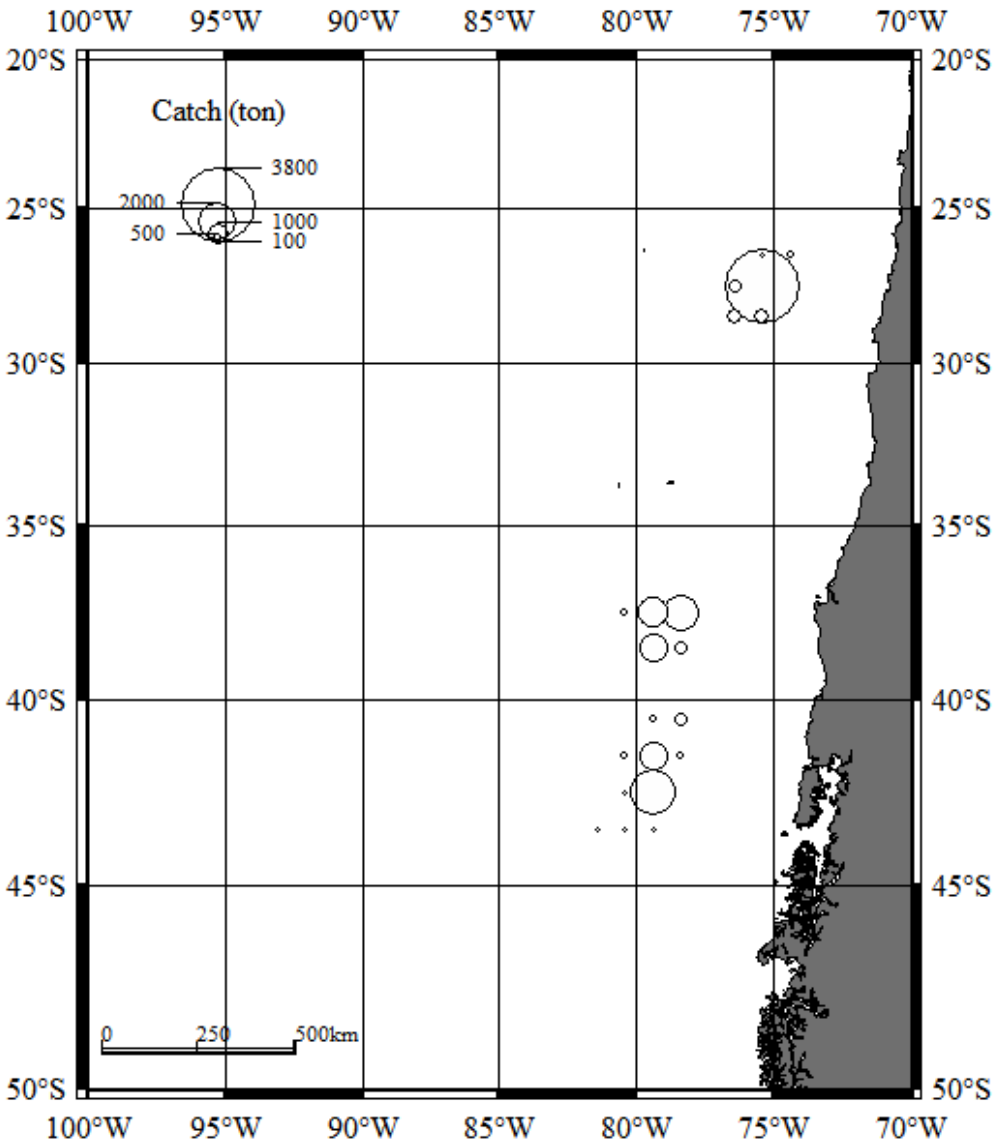

Figure 5. Catch distribution (1°×1°) by the Chinese fleets in SPRFMO area in 2014

3 Fisheries Data Collection and Research Activities

Fisheries data collection of jack mackerel consists of two parts, the catch data and observed data. Catch data collection were carried out in 2000, in which the Chinese trawlers began to fishing jack mackerel in the South East Pacific. The Chinese trawlers were requested to supply the fishing log books and report the monthly catching situation. Fisheries data from the log books include name of trawlers, start and end location and time (date and UTC time) of each tow, catch of jack mackerel and other bycatch species etc. In 2014, a total of 458 recorders of tow-by-tow data were collected.

Scientific data from the observer program was mainly the biological information such as fork length, weight, maturity stage, degree of stomach fullness. Otolith, gonads, muscle and other organs were also sampled on board. Furthermore, some jack mackerel were sampled randomly and frozen, and then transported to the laboratory for further testing and analysis. The scientific observers also measured environment data such as water temperature and salinity by using CTD.

Researches of jack mackerel stock in the Convention Area were related to reproductive biology, habitat and stock assessment in 2014. A total of 1055 jack mackerel were sampled in 2012 and 2014 to determine the reproductive condition of jack mackerel. Among them, 108 maturing females (fork length 297-466mm; weight 316-1259g; age 2-9) were measured to estimate the fecundity. The individual fecundity ranged 42,211-305,305 eggs with mean fecundity of 145,482 eggs, and the dominant group was 80,000-160,000 eggs (Table 4). The relative fecundity was 133-349 eggs/g with mean value of 211 eggs/g.

For the stock assessment research, biomass dynamics model was used to describe the population dynamics and assess the stock status for Chilean jack mackerel during 1997-2014. In order to evaluate the impacts of uncertainty on the population dynamics and management of Chilean jack mackerel stock, stock assessment model was developed by adding observed and processing errors in the population dynamics model and multiple constant fishing mortalities were used as the harvest controls to do the projections. Results of population dynamics model showed the estimated annual biomass was lower than 50% of B_{MSY} (12,622 thousand tons) over the past 18 years and fishing mortality rate was more than F_{MSY} (0.195) except for years of 2011 to 2014 (Figure 6). The result of stock assessment model indicated that B_{MSY} was underestimated but F_{MSY}, as well as biomass and total allowable catch (TAC) in the future ten years, were overestimated. Furthermore, the degree of overestimated for biomass and TAC in the future increased with the level of the fishing mortality. Projections and decision table showed that fishing mortality during 2015-2024 set to 0.75 time of the level of 2014 is the optimal

management measure (Figure 6, table 5).

Table 4 Estimated fecundity at different age for jack mackerel

Fecundity class	Age class								*N*
	2+	3+	4+	5+	6+	7+	8+	9+	
40,001-60,000	1								1
60,001-80,000		1	3	3					7
80,001-100,000		1	5	5	6	1			18
100,001-120,000		5	8	7					20
120,001-140,000		5	3	3	4	2			17
140,001-160,000			5	2	1	3			11
160,001-180,000			2	1	2	2			7
180,001-200,000			2	1	1	1	2		7
200,001-220,000					1	2	1		4
220,001-240,000							1		1
240,001-260,000					2	1	2		5
260,001-280,000							1	1	2
280,001-300,000				2	1		2	2	7
300,001-320,000								1	1
N	1	12	28	24	18	12	9	4	108

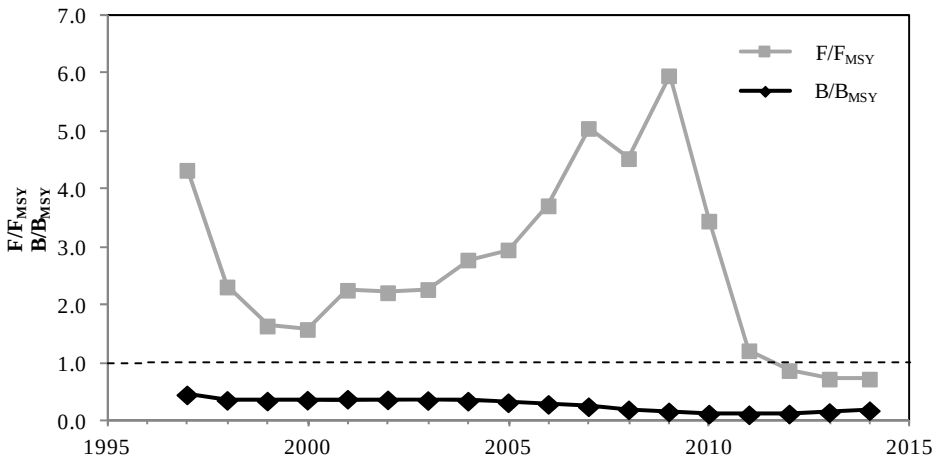

Figure 6. Population state of jack mackerel stock from 1997 to 2014

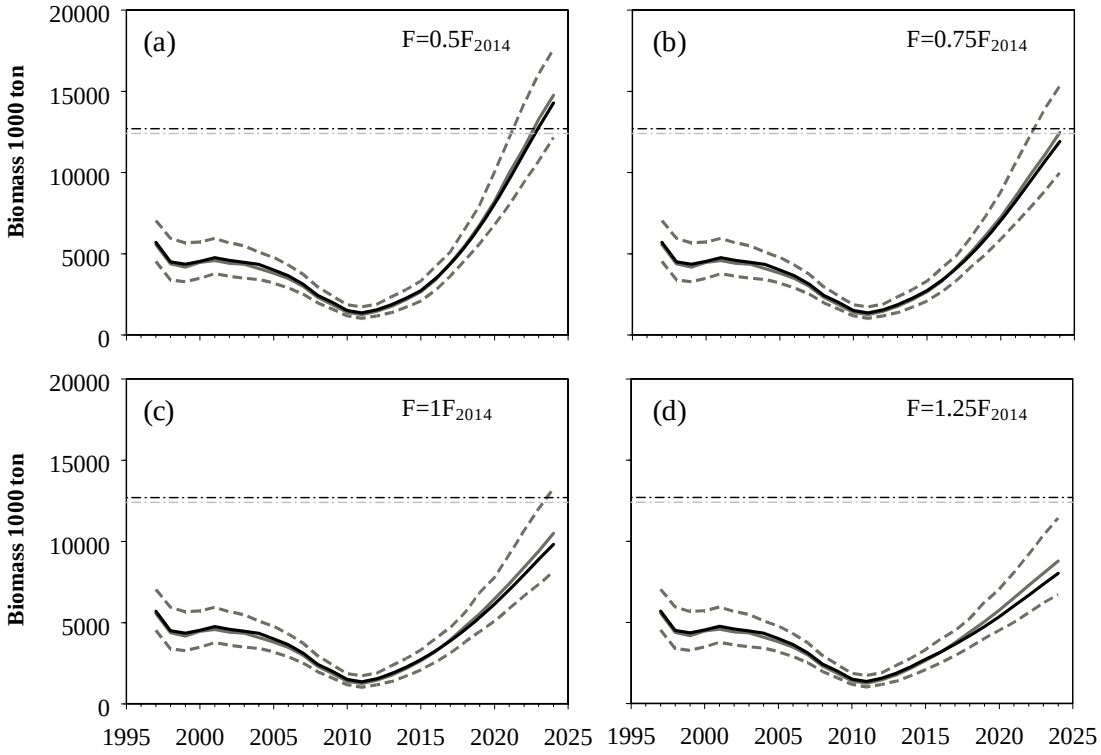

Figure 7. Projections of jack mackerel biomass trajectories for different multipliers of the estimated 2014 fishing mortality rate. The grey and black lines are medians of the "true" and simulated biomass respectively, the gray dashed lines are the 80% confidence intervals, the gray and black dashdotted lines are the "true" and simulated B_{MSY} respectively

Table 5 Summary results for the medium term predictions of jack mackerel stock based on true population dynamics model and simulated assessment model

Harvest control rules	$F=0.5F_{2014}$	$F=0.75F_{2014}$	$F=1F_{2014}$	$F=1.25F_{2014}$
$P(B_{2024}>B_{MSY\ true})$	83%	50%	14%	3%
$P(B_{2024}>B_{MSYsimu.})$	87%	51%	14%	2%
$TAC2015_{true}$ （1000 ton）	212	308	396	479
$TAC2015_{simu.}$（1000 ton）	215	311	401	485
TAC 2024_{ture}（1000 ton）	1023	1257	1356	1357
TAC $2024_{simu.}$（1000 ton）	1108	1370	1493	1512
Accumulative TAC_{ture}（1000 ton）	5811	7419	8400	8908
Accumulative $TAC_{simu.}$（1000t）	6203	7947	9024	9658

4 Biological Sampling and Length Composition of Catches

A total of 4967 jack mackerel were measured to get the length frequency from 25 April to 28 July 2014 by the scientific observer. Among of the 4967 samples, 900 jack mackerel were measured for fork length (FL), weight and determined the sex by examining the gonads. Otoliths and vertebras were also removed for age determination. Information about sampling location and time were also recorded.

In 2014, jack mackerel with fork length at 340-370mm was the principal mode; the second mode was fork length at 340mm and 380-400mm. The ratio of smaller fish (FL<330 mm) and larger fish (FL>400 mm) was very low, the percentages of each size class were less than 5%.

The length distribution of jack mackerel of the Chinese fleets was similar to the EU fleets in the last five years (Corten, 2014), but the percentage of immature fish was relatively lower in 2010.

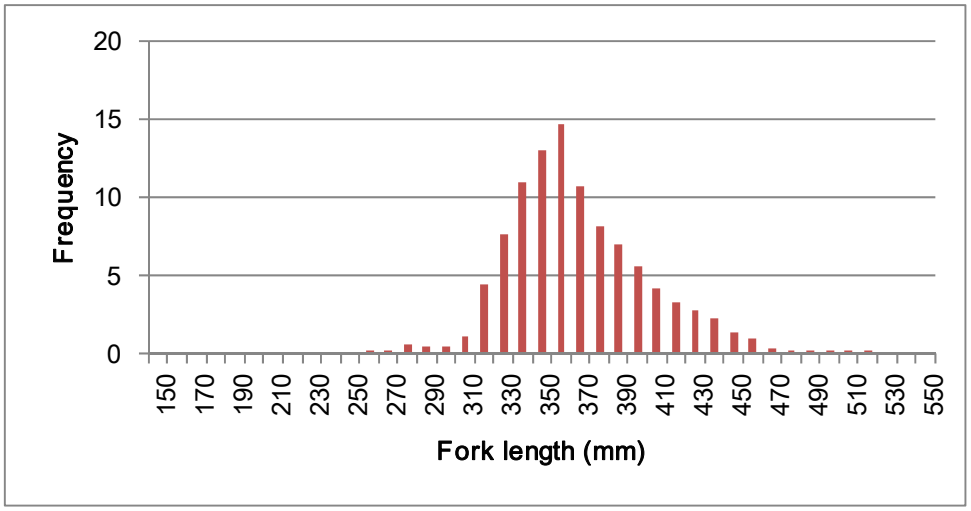

Figure 8. Fork length frequency of jack mackerel in 2014

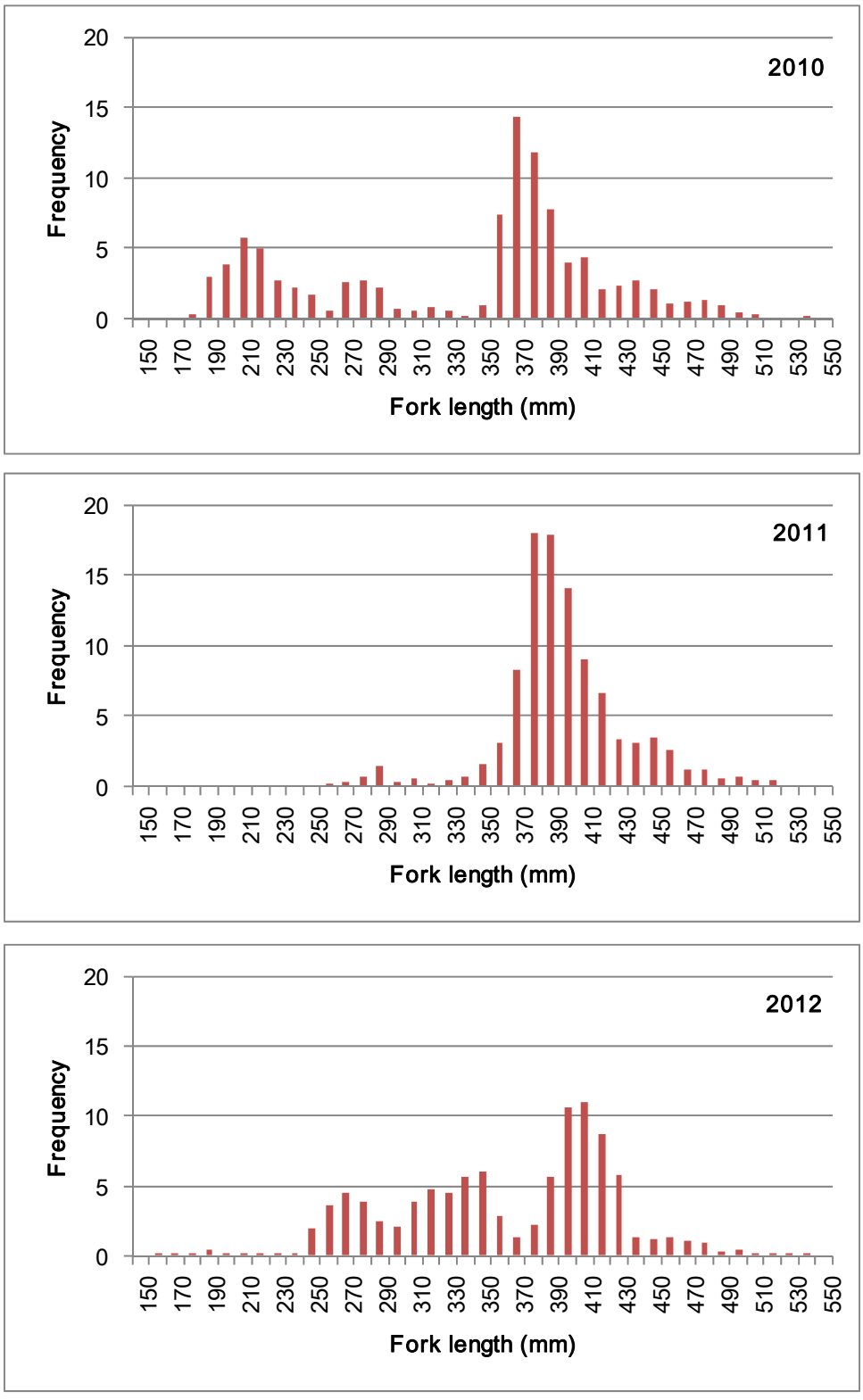

Figure 9. Fork length frequency of jack mackerel in 2010, 2011 and 2012

Table 6 Fork length frequency data of jack mackerel in 2014

Size calss	250	260	270	280	290	300	310	320	330	340	350	360	370	380	390	400	410	420	430	440	450	460	470	480	490	500	510	520	530	Total
	0	0	0	0	0	0	0	0	0	0	0	1	2	10	18	28	25	29	26	22	13	10	3	2	0	0	0	0	0	189
	0	0	0	0	0	0	0	0	0	4	8	20	35	32	29	19	17	10	8	6	3	2	0	0	0	0	0	0	0	193
	0	0	0	0	0	0	1	9	18	24	46	43	29	10	6	4	0	0	0	0	0	0	0	0	0	0	0	0	0	190
	0	0	0	0	0	0	2	4	14	31	33	51	26	20	13	11	5	3	1	4	1	0	0	0	0	0	0	0	0	219
	0	0	0	0	0	0	0	4	5	13	14	23	15	12	18	19	12	11	12	11	3	5	1	1	1	0	0	0	0	180
	0	0	4	0	0	0	4	11	16	30	25	35	19	17	9	6	4	4	4	5	3	0	0	0	1	0	0	0	0	197
	0	0	0	1	3	6	4	21	19	24	25	30	17	12	12	9	5	8	12	7	5	2	1	1	0	0	0	0	0	224
	0	0	0	1	0	2	1	3	3	10	11	28	26	29	21	21	16	14	9	3	4	3	1	0	0	0	0	0	0	206
	0	0	0	3	1	1	1	3	8	7	11	27	25	22	18	18	14	9	9	11	8	6	2	0	0	0	0	0	0	204
	0	0	0	1	0	2	10	18	27	20	16	16	18	14	11	11	11	10	6	3	0	2	1	0	0	0	0	0	0	197
	0	0	0	0	1	0	0	5	7	6	17	27	27	23	26	17	12	10	8	5	4	4	2	0	1	4	4	2	0	212
	0	0	2	0	1	0	2	11	16	24	26	24	21	12	11	12	11	4	5	7	1	0	1	0	0	0	0	0	0	191
	0	0	0	0	0	0	1	1	12	23	27	33	15	29	19	10	9	8	2	3	1	1	0	0	0	0	0	0	0	194
	0	0	0	0	1	0	1	7	15	20	26	31	21	14	21	10	10	5	7	6	4	0	0	0	1	0	0	0	0	200
	0	0	0	0	0	0	1	4	6	19	22	28	19	21	17	13	10	7	4	5	4	1	2	0	0	0	0	0	0	183
	0	0	0	3	0	0	3	13	17	14	26	34	34	22	12	12	7	2	3	2	0	1	1	0	0	0	0	0	0	206
	0	0	0	2	1	2	0	8	24	32	29	32	22	14	13	11	2	5	4	3	0	1	0	0	0	0	0	0	0	205
	0	0	0	1	1	0	0	7	13	30	46	30	25	10	9	9	3	5	1	2	0	1	0	0	2	0	0	0	0	195
	0	1	1	8	4	1	8	31	28	29	29	28	10	6	7	3	1	1	1	0	2	0	0	0	0	0	0	0	0	199
	0	0	0	3	3	3	6	22	28	43	29	27	7	6	4	2	4	2	1	1	1	1	0	0	1	0	0	0	0	194
	0	0	0	1	0	0	1	8	16	27	37	35	19	16	7	4	4	4	2	3	0	0	1	0	0	0	0	0	0	185
	0	0	0	2	1	1	1	7	23	31	37	22	26	12	12	6	7	4	1	1	1	0	0	1	0	0	0	0	0	196
	0	0	0	0	2	0	3	5	14	14	30	36	30	19	22	14	12	5	5	2	1	3	1	0	0	0	0	0	0	218
	0	0	0	0	3	0	3	13	29	34	41	28	23	6	7	3	1	0	2	0	2	1	0	0	0	0	0	0	0	196
	0	0	0	0	1	1	3	4	19	33	37	39	18	14	5	3	7	3	5	0	2	0	0	0	0	0	0	0	0	194
Total	**0**	**1**	**7**	**26**	**23**	**19**	**56**	**219**	**377**	**542**	**648**	**728**	**529**	**402**	**347**	**275**	**209**	**163**	**138**	**112**	**63**	**44**	**17**	**5**	**7**	**4**	**4**	**2**	**0**	**4967**

5 Summary of Observer Programme

China Distant Water Fisheries Association (CDWFA) and Shanghai Ocean University (SHOU) jointly take charge of the fisheries data collection for jack mackerel. In 2015, National Data Center for Distant-water Fisheries was held to take full charge of fisheries and related data collection.

In order to implement “Standards for the collection, reporting, verification and exchange of data” of SPRFMO, China fishery Authority accredit SHOU for the observers training, selection and dispatch. The observer programme has been continually under way since 2007 and SHOU sent in total of 8 scientific observers on board from 2007 to 2015.

6 Summaries

In 2014, 3 Chinese large pelagic trawlers operated in the South East Pacific and total catch of jack mackerel was 21,154 tons with 3655 trawling hours. The nominal CPUE was 5.8 tons per hour and showed an obviously increase when comparing nominal CPUE in 2013. However, the estimated standardized CPUE decreased from 0.57 in 2013 to 0.52 in 2014. The fishing season was shortening and there was no fishing activity in the first-three-month in 2013 and 2014. Spatial distribution of catch in 2014 was similar to that in 2012 and 2013. Fishing ground moved eastward and closed to the Chilean EEZ and jack mackerel catch form North Chile was increasing. The scientific observer sampled 4967 jack mackerel randomly on board, measured fork length and weight and collected other biological information.

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