ISC/15/BILLWG-1/10

CPUE of the North Pacific striped marlin caught by Japanese coastal drift netters

Kotaro Yokawa and Ko Shiozaki

National Research Institute of Far Seas Fisheries
5-7-1 Orido Shimizu-ku Shizuoka 424-8633 JAPAN

Summary

Standardized CPUE of striped marlin caught by Japanese coastal drift net fishery is updated to 2013. Data in 2011 was not used in the analysis because almost data was lost by the Great Eastern Japan Earthquake. GLM model with log-normal assumption with the effect of year, month, latitude and longitude being incorporated. Three approach was conducted, e.g., all data standardized by model of main effects, data of core fishing season of striped marlin standardized by model of main effects, and data of core fishing season and fishing area standardized by model of main effects and two way interactions of year*month and latitude*longitude. Though the trends of standardized CPUE standardized by three approach were similar, the model with two way interactions attained better residual pattern than others.

Introduction

Japanese coastal drift netters is one of the main fisheries actively caught striped marlin in the North Pacific since the 2000 when National Research Institute of Far Seas Fisheries started to compile the log-book of this fishery. In March 2011, this fishery discontinued their operation due to the suffering from the Great Eastern Japan Earthquake. Fortunately many of drift netters survived from the Tsunami attach, and remained drift net boats partially restart their operation in the end of 2011 but log-book in 2011 and part of 2010 were lost. The operation of Japanese coastal drift netters seems to return to normal condition in 2012. In this study, we standardized CPUE of striped marlin caught by Japanese coastal drift netters in the period since 2000.

Materials and Methods

The log-book of Japanese coastal drift net fishery collected by Fishery Agency of Japan and compiled in National Research Institute of Far Seas Fisheries. The coverage of log-book was around 60 – 70 % in the beginning of history but more than 95 % in recent years. In each set, the log-book recorded date and position of gear setting, length of net deployed, number of catch by species.

The standardization of CPUE was conducted using the GLM (log normal assumption) method and the effect of year, month, latitude and longitude. Their two way interactions were also introduced in some case.

Results and Discussions

Operational area of Japanese coastal drift-netters is limited within EEZ zone of Japan in off the northeast Japan area (Fig. 1). The activities in 2012 was not high due to the influences of Tsunami disasters, which destroyed all of landing and processing fasciitis of fishes (Fig. 2). Striped marlin caught all year around and its main fishing season was 3rd quarters of the year (Fig. 3), and actually, more than 80 % of total catch in the period of 2012 – 2014 was obtained in this 3rd quarter (Fig. 5). In the recent years (2012 – 2014), there seems general tendency that striped marlin catch obtained in the northern part of the fishing area in summer seasons and in the southern part in winter seasons. The detailed position of high CPUEs seems to be rater variable by year and season and no clear trend can be observed (Fig. 4). This could be due to the complicated sea condition of the fishing ground where Kuroshio derived warm current, Oyashio derived cold current as well as lower salinity coastal waters meet.

With the information about fishing activities of Japanese drift-netters in recent years described above, simple GLM model with the effect of month, latitude and longitude was developed to standardized the CPUE of striped marlin. Because the data after the early August was not available in year of 2014, CPUE was also standardized only using data up to 2013. The result of CPUE standardization shows that it was quite stabilized up to 2010, and after the Great Eastern Earthquake, it shows recovery trend (Fig. 6). The results of CPUE standardizations using only data of high fishing season (June – October) shows roughly trends (Fig. 7). Because the results of the analysis of operational patterns indicate that the position of high CPUE of striped marlin changed frequently and no clear tendency was observed, CPUE standardization was also conducted using model with two way interaction terms of year*month and latitude*longitude. For this purpose, data of only core fishing season (July – October) and core area (37N – 41N and 142E – 145E), and also data of years of 2003 and 2014 was deleted. The result of this analysis improved residual pattern and produced somewhat optimistic trend. Though there are missing years,

In 2014, the operational strategy of larger sized coastal drift-netters (40 tons >)

had changed by the guidance of Fishery Agency. In late summer and autumn, they switched their operation from large mesh drift net to stick-held blanket net targeting saury. Though the number of larger size drift-netters is only 6, more than 50 % of total striped marlin had been indicated to be caught by these 6 boats up to 2013. This is expected to decrease total catch of striped marlin as Japanese coastal drift-netters had been one of largest contributors for the catch of the North Pacific striped marlin, it should also give influences on the CPUE of striped marlin. In this study, however, calculated standardized CPUE up to 2014 using data up to early August 2014, these results would better be considered as reference.

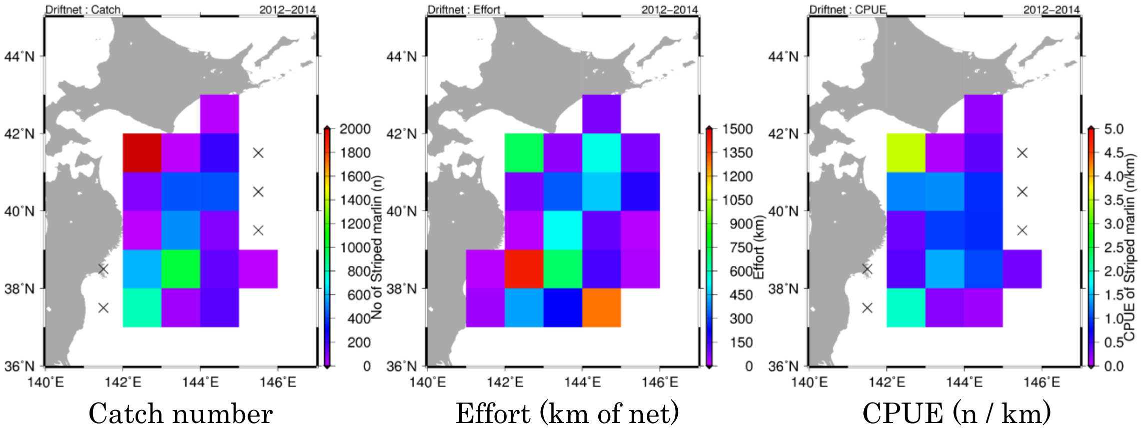

Fig. 1. Average catch number, effort (km of net) and CPUE (number / km) of striped marlin in 2012 – 2014 caught by Japanese coastal drift netters.

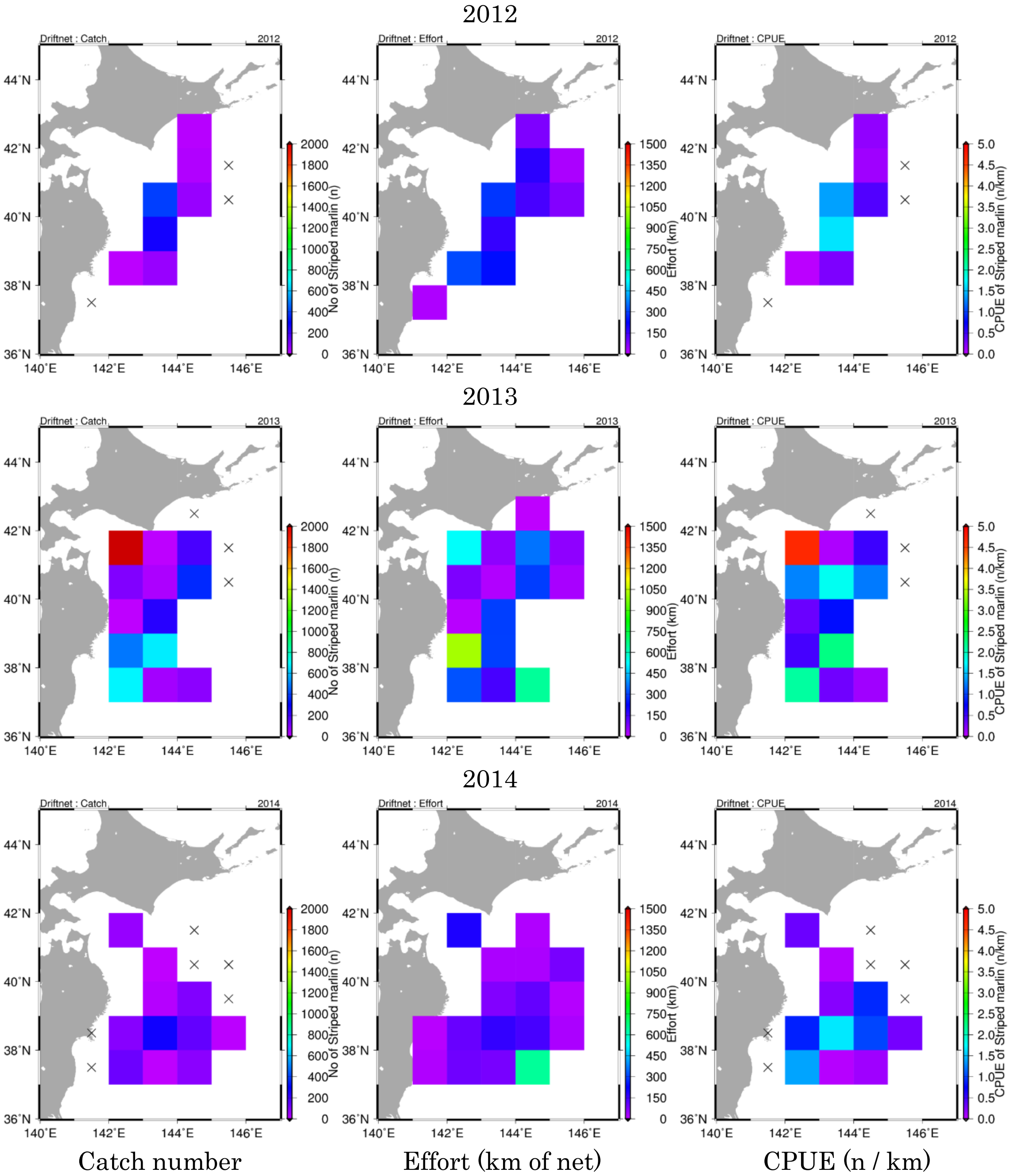

Fig. 2. Annual average catch number, effort (km of net) and CPUE (number / km) of striped marlin in 2012 – 2014 caught by Japanese coastal drift netters.

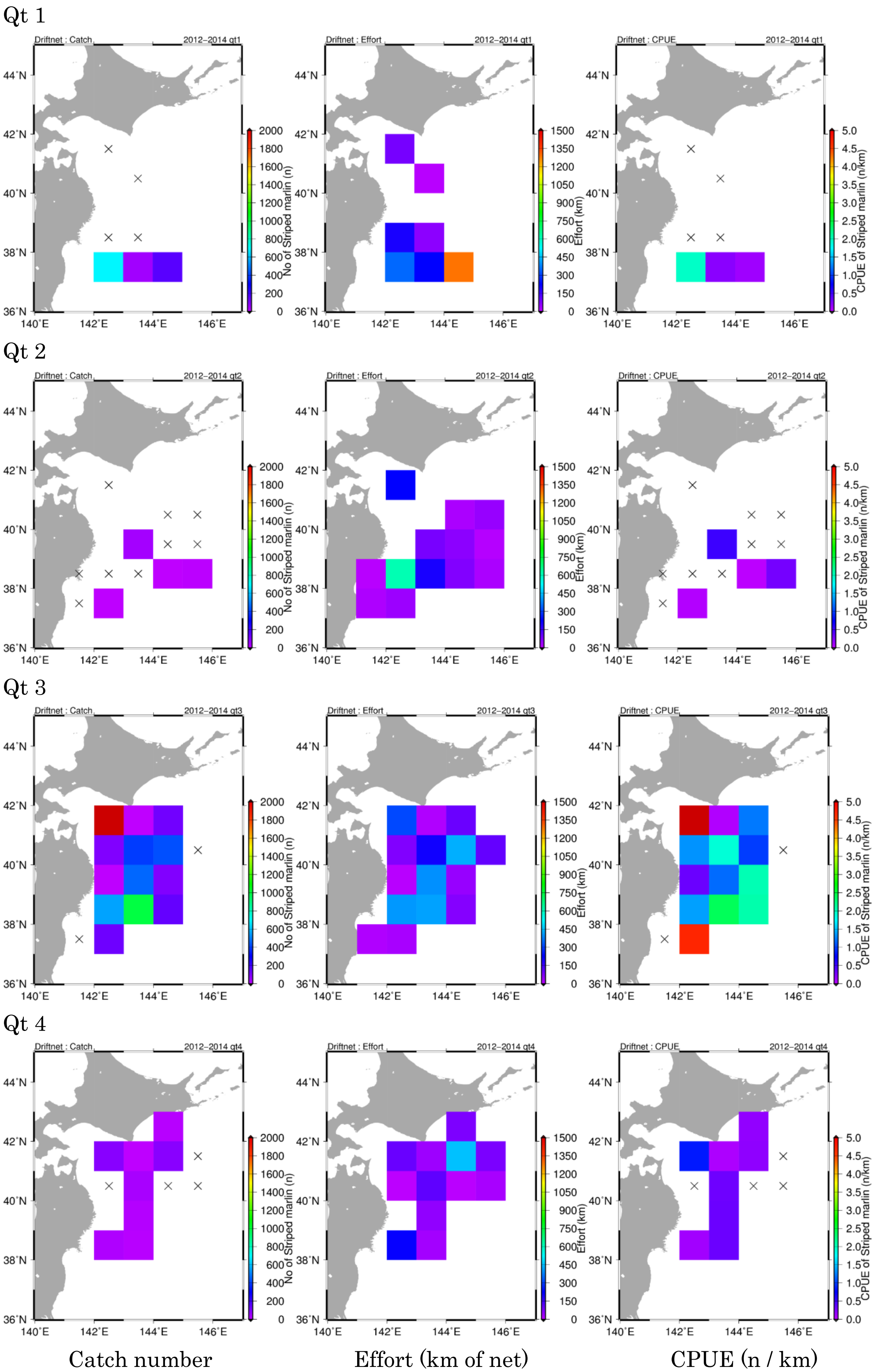

Fig. 3. Quarterly average catch number, effort (km of net) and CPUE (number / km) of striped marlin in 2012 – 2014 caught by Japanese coastal drift netters.

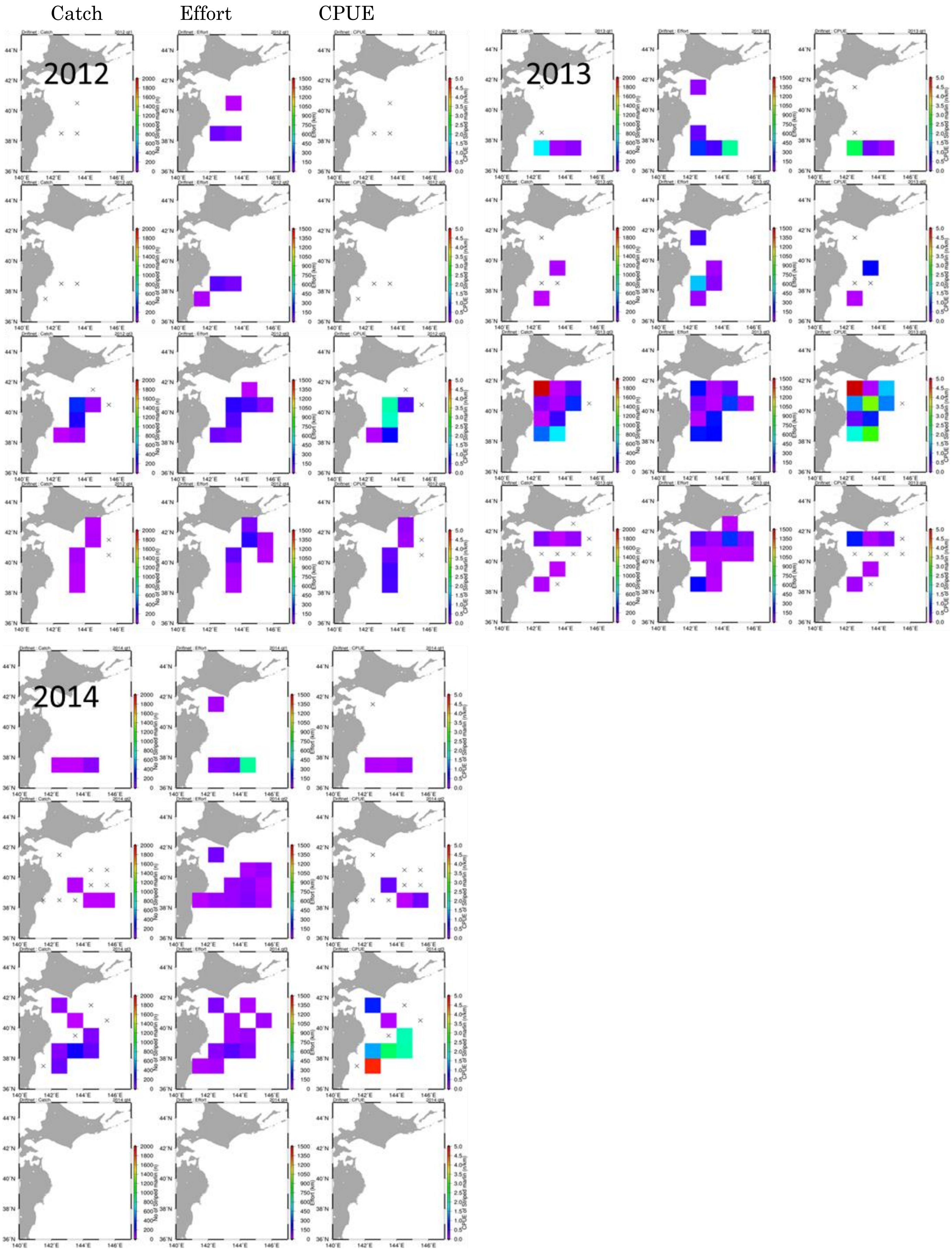

Fig. 4. Annual quarterly average catch number, effort (km of net) and CPUE (number / km) of striped marlin in 2012 – 2014 caught by Japanese coastal drift netters.

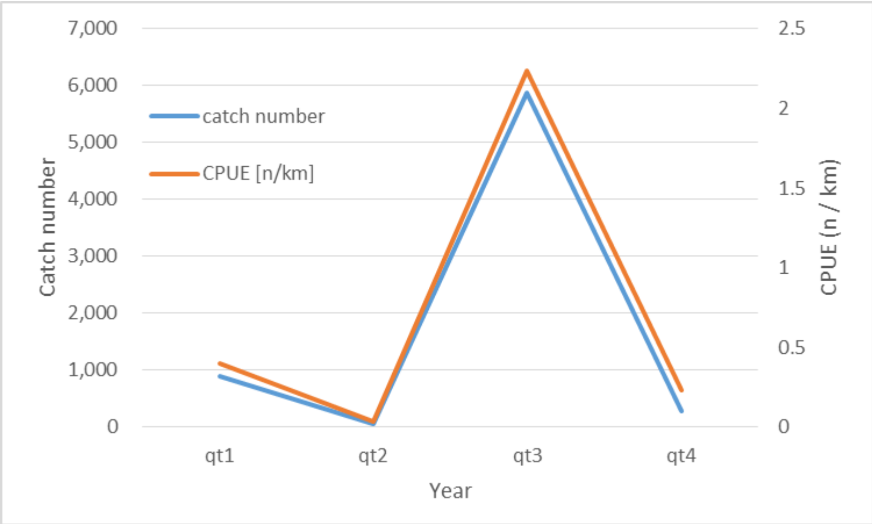

Fig. 5. Average quareterly nominal catch number and CPUE (n / km) in 2012 – 2014 of striepd marlin caguht by Japanese coastal drift-netters.

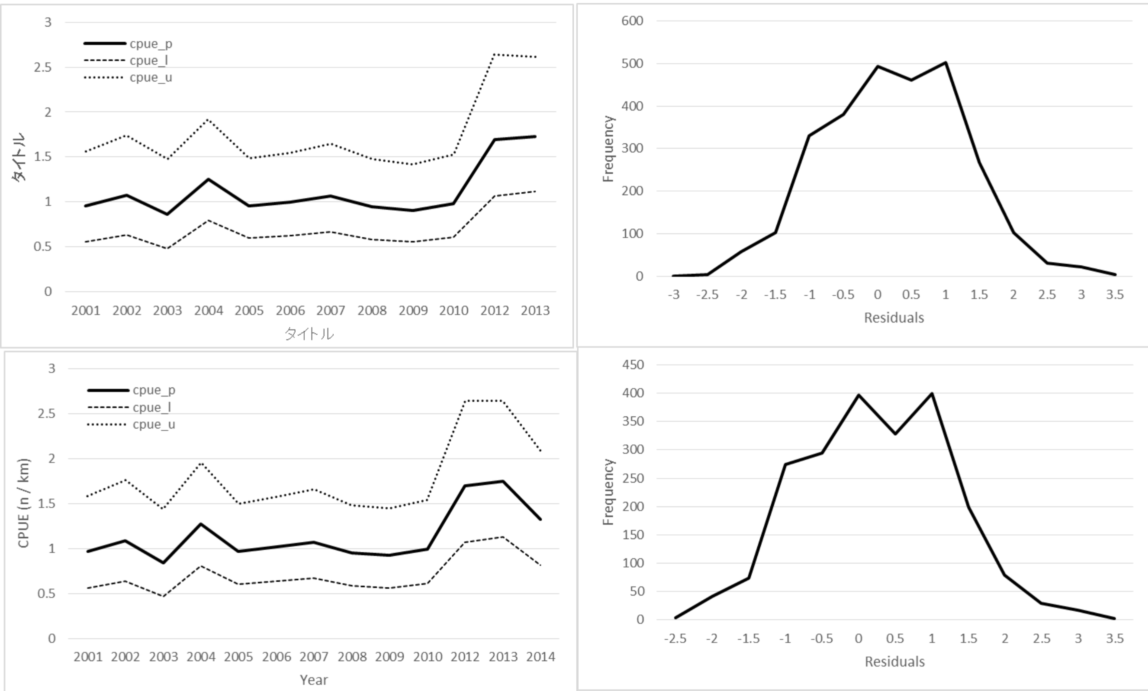

Fig. 6. CPUEs of striped marlin standardized with the model without interaction terms (left panels) and their residuals (right panels). Data in 2011 is not available. CPUEs standardized with data of 2001 – 2013 (upper panels) and with data up to 2014 (lower panels). Data in 2011 is not available.

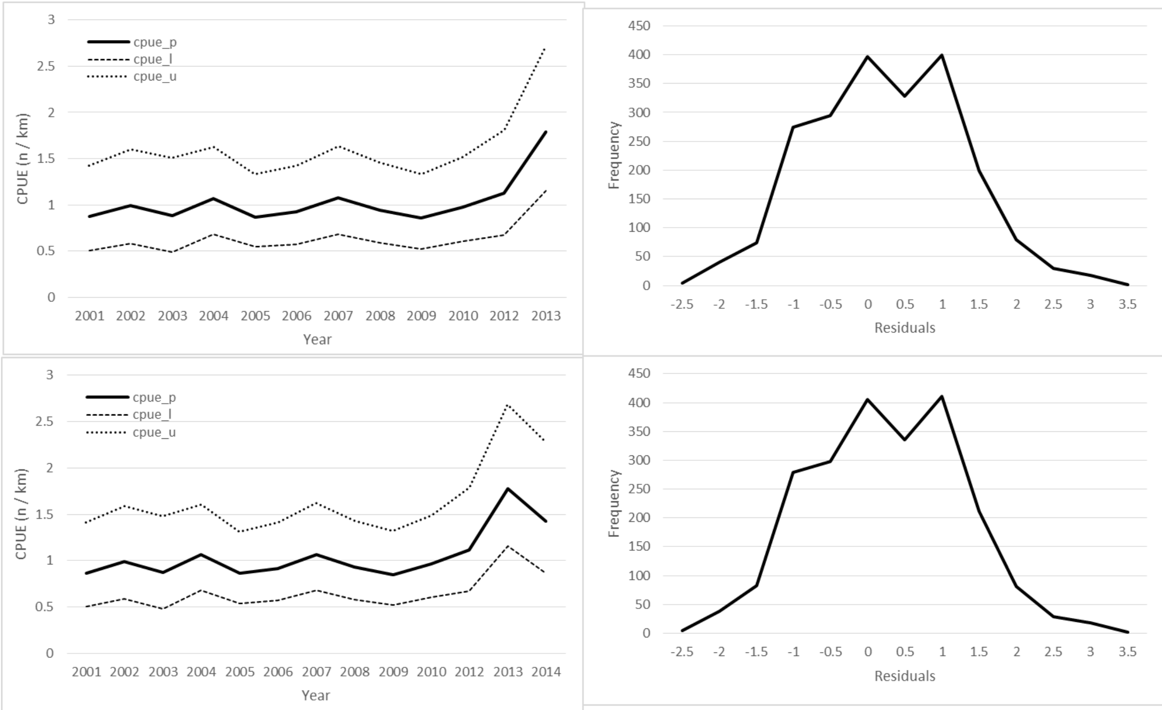

Fig. 7. CPUEs of striped marlin standardized with the model as ones in Figure 5 but only data of core season (June – October) used. Data in 2011 is not available.

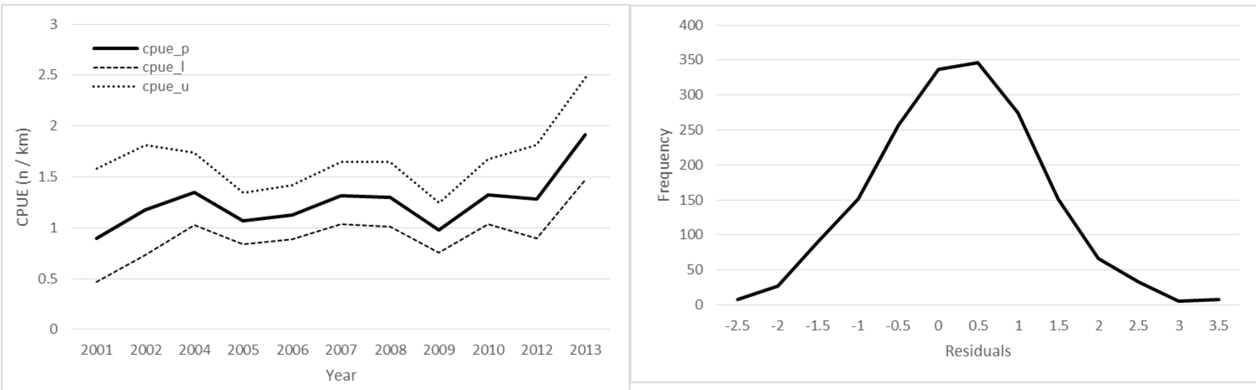

Fig. 8 CPUEs of striped marlin standardized with the model of two way interaction terms of year*month and latitude*longitude. Two obtain these interaction terms, only data of core season (July – October) and core area (37N – 41N and 142E – 145E), and also data of years of 2003 and 2014 was deleted. Data in 2011 is not available.

Appendix　SAS CPUE analysis

1) Log(CPUE)= year + month + latitude + longitude

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	38	689.302799	18.139547	24.24	<.0001
Error	2724	2038.738197	0.748435		
Corrected Total	2762	2728.040996			

R-Square	Coeff Var	Root MSE	lcpue Mean
0.252673	320.2748	0.865122	0.270119

Source	DF	Type III SS	Mean Square	F Value	Pr > F
yr	11	71.0951653	6.4631968	8.64	<.0001
lat	8	38.4345067	4.8043133	6.42	<.0001
lon	8	15.1590663	1.8948833	2.53	0.0096
mon	11	419.7570262	38.1597297	50.99	<.0001

Obs	yr	cpue_p	cpue_l	cpue_u
1	13	0.95702	0.55818	1.5656
2	14	1.07115	0.63171	1.7427
3	15	0.86667	0.47809	1.4778
4	16	1.25068	0.79211	1.9211
5	17	0.95861	0.59730	1.4836
6	18	0.99663	0.62158	1.5428
7	19	1.06582	0.66827	1.6453
8	20	0.94623	0.58217	1.4797
9	21	0.90686	0.55528	1.4220
10	22	0.98190	0.60847	1.5277
11	24	1.69665	1.06739	2.6382
12	25	1.72581	1.11679	2.6164

2) Log(CPUE)= year + month + latitude + longitude (data of core season (June – October) only)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	38	689.302799	18.139547	24.24	<.0001
Error	2724	2038.738197	0.748435		
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lon	8	15.1590663	1.8948833	2.53	0.0096
mon	11	419.7570262	38.1597297	50.99	<.0001

OBS	yr	cpue_p	cpue_l	cpue_u
1	13	0.95702	0.55818	1.5656
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10	22	0.98190	0.60847	1.5277
11	24	1.69665	1.06739	2.6382
12	25	1.72581	1.11679	2.6164

3) Log(CPUE)= year + month + latitude + longitude (data of core season and core area only)

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	62	459.543819	7.411997	10.37	<.0001
Error	1694	1211.351352	0.715083		
Corrected Total	1756	1670.895171			

R-Square	Coeff Var	Root MSE	lcpue Mean
0.275029	179.7776	0.845626	0.470373

Source	DF	Type III SS	Mean Square	F Value	Pr > F
yr	10	25.4165579	2.5416558	3.55	0.0001
lat	4	15.1407209	3.7851802	5.29	0.0003
lon	3	0.2131604	0.0710535	0.10	0.9604
mon	3	155.9079327	51.9693109	72.68	<.0001
yr*mon	30	76.9602017	2.5653401	3.59	<.0001
lat*lon	12	36.4667787	3.0388982	4.25	<.0001

Obs	yr	lat	lon	mon	cpue_p	cpue_l	cpue_u
1	13	.	.	.	0.89479	0.46563	1.5841
2	14	.	.	.	1.17409	0.73383	1.8129
3	16	.	.	.	1.34409	1.02786	1.7391
4	17	.	.	.	1.06801	0.84165	1.3416
5	18	.	.	.	1.12352	0.88282	1.4157
6	19	.	.	.	1.31378	1.03767	1.6495
7	20	.	.	.	1.29547	1.00974	1.6464
8	21	.	.	.	0.97516	0.75503	1.2439
9	22	.	.	.	1.32158	1.03354	1.6747
10	24	.	.	.	1.28585	0.89578	1.8096
11	25	.	.	.	1.91758	1.47157	2.4797