BYCATCH DISTRIBUTION AND STANDARDIZED CPUE OF SEA TURTLE USING DATA FROM JAPANESE SCIENTIFIC OBSERVER PROGRAM OF LONGLINE FISHERY IN THE ATLANTIC

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SUMMARY

Bycatch distribution and standardized CPUE of sea turtles using data from Japanese scientific observer program of longline fishery in the Atlantic from 1997 to 2010 were examined. Leatherback and the other turtles were mainly caught in the northern area and in the eastern tropical area, though bycatch distribution changed by species and/or season. No turtle was caught in the area off South Africa during all season. Standardized CPUE for leatherback turtle and the other turtles (combined loggerhead and olive ridley turtles) caught by longline fishery in the Atlantic was preliminarily examined using Japanese observer data from 1997 to 2010 with Delta-lognormal model. Trends of increase or decrease of standardized CPUE were not observed from 1997 to 2010, though some fluctuations with ranges from 0.00017 to 0.00207 for leatherback and from 0 to 0.00030 for other turtles existed.

RÉSUMÉ

Ce document a examiné la distribution des prises accessoires et les CPUE standardisées des tortues marines à l'aide des données du programme d'observateurs scientifiques japonais de la pêcherie palangrière opérant dans l'Atlantique de 1997 à 2010. La tortue luth et d'autres tortues ont été principalement capturées dans la zone septentrionale et dans la zone tropicale orientale, même si la distribution des espèces accessoires a changé par espèce et/ou saison. Aucune tortue marine n'a été capturée dans la zone au large de l'Afrique du Sud au cours de toute la saison. La CPUE standardisée de la tortue luth et des autres tortues (caouannes et tortues olivâtres combinées) capturées par la pêcherie palangrière dans l'Atlantique a été examinée de façon préliminaire à l'aide des données des observateurs japonais de 1997 à 2010 avec une approche delta-lognormale. Aucune tendance à la hausse ou à la baisse dans la CPUE standardisée n'a été observée de 1997 à 2010, même si quelques fluctuations ont eu lieu de 0,00017 à 0,00207 pour la tortue luth et de 0 à 0,00030 pour les autres tortues

RESUMEN

Se examinaron la distribución de la captura fortuita y la CPUE estandarizada de las tortugas marinas utilizando datos del programa japonés de observadores científicos de la pesquería de palangre en el Atlántico desde 1997 a 2010. Las tortugas laúd y otras tortugas se capturaban principalmente en la zona septentrional y en la zona tropical oriental, aunque la distribución de la captura fortuita cambiaba por especies y/o temporada. No se capturaron tortugas marinas en aguas frente a Sudáfrica durante toda la temporada. Se examinó de forma preliminar la CPUE estandarizada de la tortuga laúd y otras tortugas (tortuga boba y tortuga delfina combinadas) capturadas por la pesquería de palangre en el Atlántico utilizando datos de observadores japoneses desde 1997 hasta 2010 con un modelo Delta-lognormal. No se observaron tendencias de aumento o descenso en la CPUE estandarizada desde 1997 hasta 2010, aunque había algunas fluctuaciones con rangos desde 0,00017 hasta 0,00207 para la tortuga laúd y desde 0 a 0,00030 para otras tortugas.

KEYWORDS

By-catch, CPUE, sea turtles

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1. Introduction

Sea turtle populations have been affected by a large variety of factors, human activities (beach development, disturbance of nesting beaches, etc.) and non-human factors (predation, disease, etc.), on land and at sea. Sea turtles interact with many kinds of fisheries, trawl, gillnet, set-net, trap, purse-seine, and longline, in the coastal and oceanic regions. Holistic approach to manage various factors affecting sea turtle populations is necessary for conservation of sea turtles. Incidental catch of sea turtles in longline fisheries is occurred mainly in the tropical and subtropical regions in the world oceans and is one of the sources of their mortality. Japan has been conducting to develop and test mitigation measures to reduce incidental mortality of sea turtles in longline fishery. Also we have been conducting by-catch distribution of sea turtles by pelagic longline.

In this paper, by-catch distribution and standardized CPUE of sea turtles using data from Japanese scientific observer program of longline fishery in the Atlantic were examined.

2. Materials and Methods

By-catch data collected in Japanese observer program in the Atlantic from 1997 to 2010 were used for the analysis. Species identification was conducted using photos taken by observers. The number of sea turtle bycatch and number of hooks were collected into a grid of 5°x5° respectively. The catch numbers of sea turtles were divided by number of hooks and made 1000 times to obtain average CPUE values of sea turtles at each 5°x5° grid. The quarterly CPUE distributions (January-March, April-June, July-September and October-December) were presented.

In order to standardize CPUE of turtles, generalized linear model (Delta-lognormal model) was used in this analysis in order to overcome the problem of zero catch. The following form was assumed as full models respectively.

$$E(\text{Log}(R/(1-R))) = INC + YR + QT + AR + GE + INA + (\text{Log}(\text{Effort})) \quad R \sim \text{Bin}(p)$$
$$E(\text{Log}(\text{CPUE})) = INC + YR + QT + AR + GE + INA$$

R: zero-catch ratio in the total operations, CPUE: nominal CPUE except zero-catch

where log: natural logarithm, CPUE: nominal CPUE (catch of turtles in number per 1000 hooks), INC: intercept, YR: effect of year (1997-2010), QT: effect of season (1-4), AR: effect of area (1-5**, Figure 1**), GE: effect of gear type (number of hooks between floats; 7-10, 11-15, 16-19), INA: two way interactions.

We made the model selection using the stepwise F-test and Chi-square-test. Significant level was set to be 5 percent.

3 Results and Discussion

The data of total 6,845 operations and 14,563,789 hooks were obtained in the Atlantic from 1997 to 2010. Total of 183 leatherback, 56 loggerhead and 20 olive ridley turtles by the longline operations were observed during 1997-2010 (**Table 1**). Mortality rates in hauling were 8.5% for leatherback, 15.0% for loggerhead and 45.0% for olive ridley turtles (**Table 1**). Branchline No. of sea turtle hooked for each hooks per basket are shown in **Table 2**. Sea turtles were hooked more on the sallower branchlines. In general, sea turtles spend most of their time within the shallow surface layer of the water column. Although shallow longline has higher risk of catching sea turtles, many of the hooked sea turtles are retrieved alive. Therefore, mortality rates of sea turtles in this study may be low (**Table 1**). These results indicate that safe handling and live release is effective in reducing incidental mortality.

In January to March, data were obtained from the temperate area in the northwestern and central Atlantic as well as from the tropical area in the eastern Atlantic, in April to September they were collected from the temperature area in the northern Atlantic and off south African waters, and in October to December they were done in northern Atlantic and coastal area off Namibia (**Figure 2**).

Leatherback turtles were caught in the eastern tropical area and in the area off Namibia from October to March, in the northeastern area from July to December, in the northwestern area during all season **(Figure 3**).

Leatherback turtles were not caught in the central North Atlantic from January to March and from July to September, in the area off South Africa during all season (**Figure 3**). Other turtles were caught in the eastern tropical area from January to March and from July to September, in the area off Namibia from October to December, in the central North Atlantic from October to March, in the northwestern area during all season (Figure 4). Other turtles were not caught in the northeastern area from October to March and from July to September, in the area off South Africa during all season (**Figure 4**). Change in bycath distribution by species and/or season may depend on seasonal migration and breeding season of sea turtles.

In the standardized CPUE of sea turtles, the following models with many explanatory variables were finally selected respectively.

Leatherback turtle:

Log (R/(1-R)) = INC + YR + AR + GE + ERROR + (Log (Effort))

Log (CPUE) = INC + YR + AR + GE + ERROR

Other turtles:

Log (R/(1-R)) = INC + YR + QT + AR + ERROR + (Log (Effort))

Log (CPUE) = INC + YR + QT + AR + ERROR

The results of ANOVA are shown in **Tables 3** and **4** and the standardized CPUE for leatherback and the other turtles are shown in **Figures 5** and **6**. The trend of standardized CPUE for leatherback turtle was stable in the period of 1997-2010, though some fluctuations with ranges from 0.00017 to 0.00207 were observed (**Figure 5**). The trend of increase or decrease of standardized CPUE for other turtles was not observed, though some fluctuations with ranges from 0 to 0.00030 existed (**Figure 6**).

Table 1. The number of sea turtles and their mortality rates by Japanese observer data in 1997-2010.

Species	*Alive*	*Dead*	*Unidentified*	*Total*	*Mortality Rate (%)*
Leatherback turtle	162	15	6	183	8.47
Loggerhead turtle	45	8	3	56	15.09
Olive Ridley turtle	11	9	0	20	45.00
Unidentified turtles	13	3	1	17	

Table 2. Branchline Nº of sea turtles hooked for each hooks per basket.

Hook per basket	Branchline No.																			Operations
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
7	0	0	0	0	0	0	0													243
8	9	2	3	2	1	1	0	3												2526
9	0	2	1	1	0	0	0	0	0											1255
10	1	0	0	1	0	1	0	1	0	0										734
11	0	0	0	0	1	0	0	0	0	0	0									88
12	0	0	0	1	0	1	0	0	1	0	0	0								42
13	0	0	0	0	0	0	0	0	0	0	0	0	0							2
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0						6
15	1	0	0	0	0	0	0	0	0	0	1	0	0	0	1					96
16	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0				81
17	5	1	2	0	2	0	0	1	1	2	0	0	0	1	0	1	6			332
18	0	1	4	0	0	1	0	1	1	0	0	0	1	1	0	0	1	4		390
19	0	1	1	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	145

Table 3. Results of ANOVA for the finally selected model in the analysis of leatherback turtle.

Source	*DF*	*Chi-Square*	*Pr > ChiSq*
YR	13	73.84	<.0001
AR	4	25.89	<.0001
GE	2	15.45	0.0004

Source	*DF*	*Type III SS*	*Mean Square*	*F Value*	*Pr > F*
YR	14	2.2	0.2	2.0	0.0256
AR	3	0.3	0.1	1.3	0.2651
GE	2	0.2	0.1	1.3	0.2764

Table 4. Results of ANOVA for the finally selected model in the analysis of other turtles.

Source	*DF*	*Chi-Square*	*Pr > ChiSq*
YR	13	26.15	0.0163
AR	4	74.9	<.0001
QT	3	8.36	0.0391

Source	*DF*	*Type III SS*	*Mean Square*	*F Value*	*Pr > F*
YR	13	4.2	0.3	1.8	0.0668
AR	3	0.3	0.1	0.5	0.6667
QT	3	0.2	0.1	0.3	0.8029

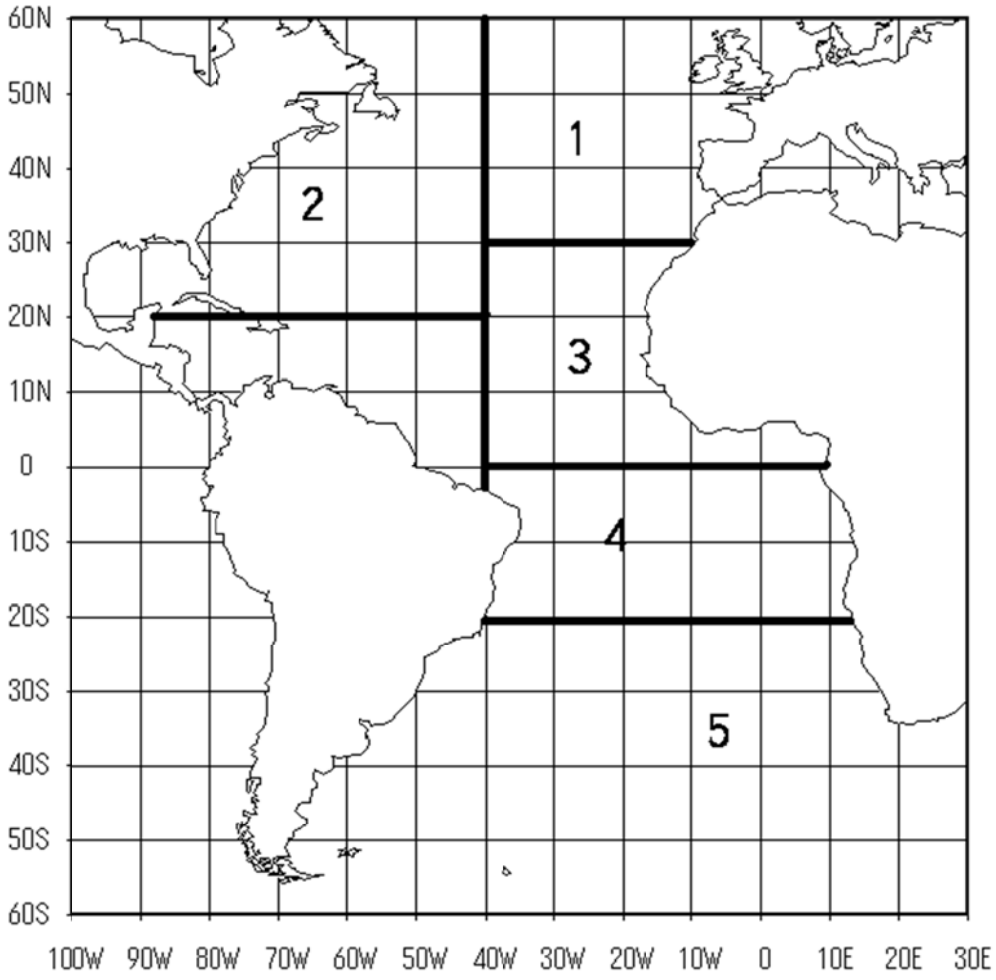

Figure 1. Area classification used for GLM.

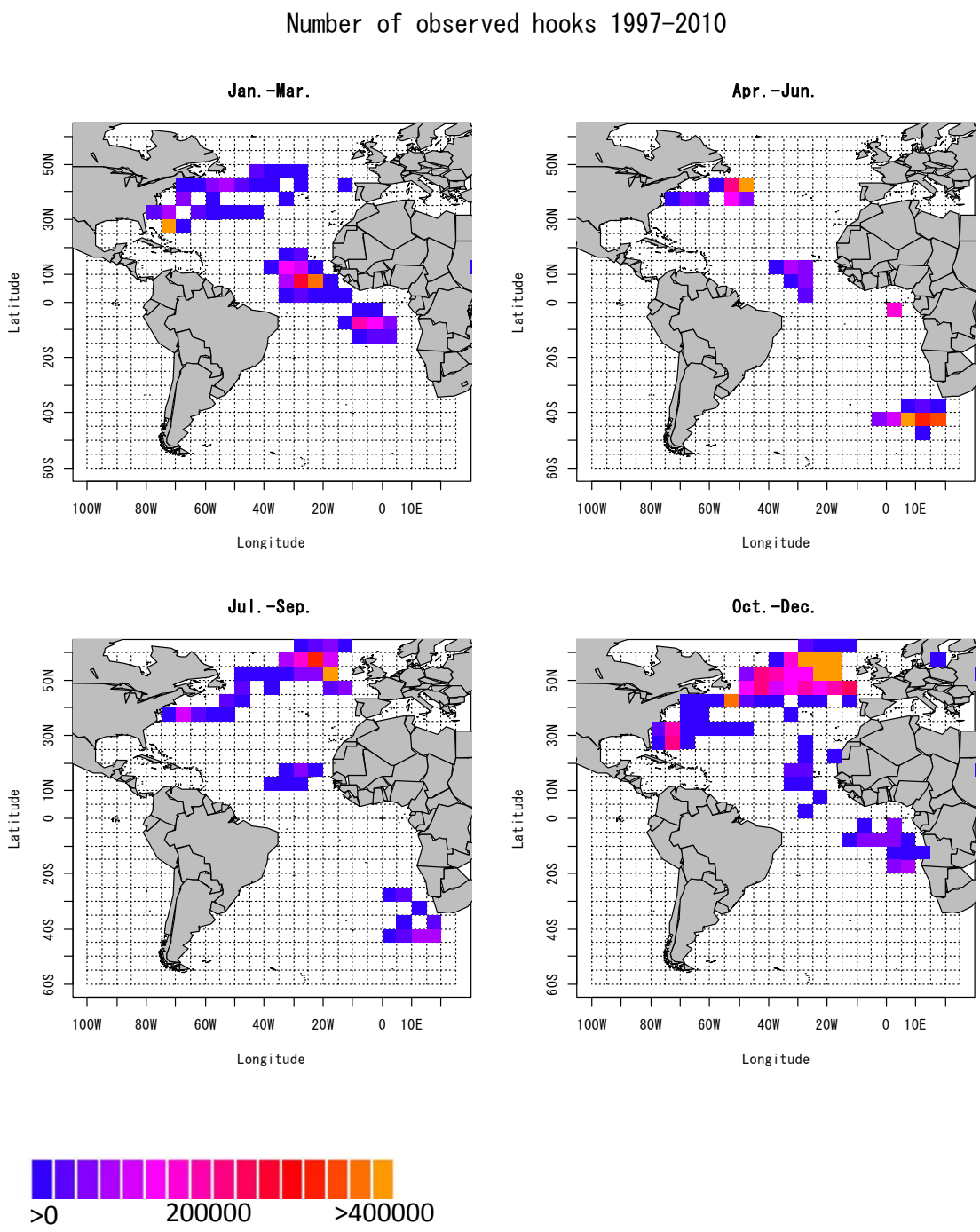

Figure 2. Effort (number of hooks) distribution from observer data during 1997-2010.

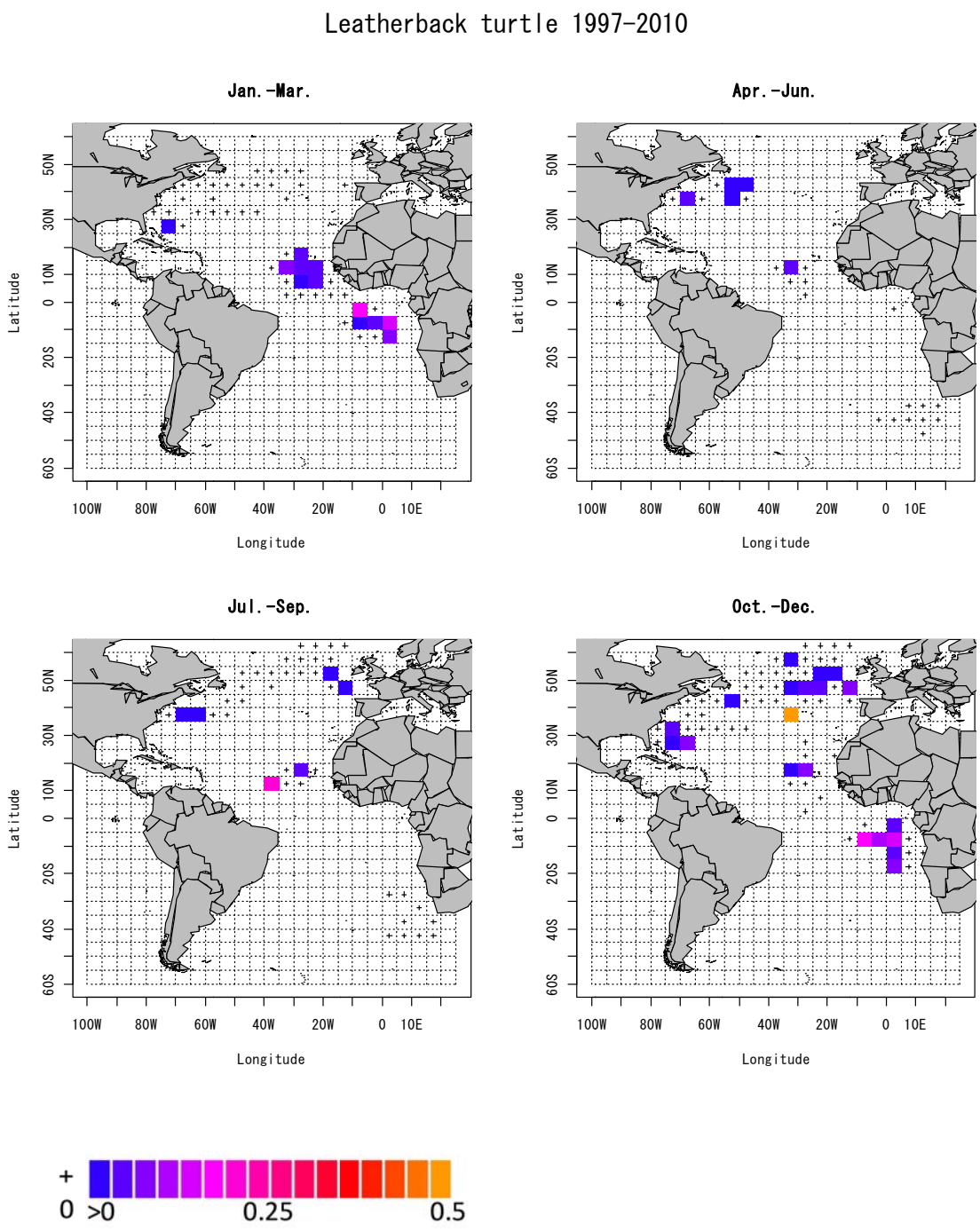

Figure 3. CPUE (number per 1000 hooks) of leatherback turtles at 5x5 grid square collected by Japanese observer program during 1997-2010.

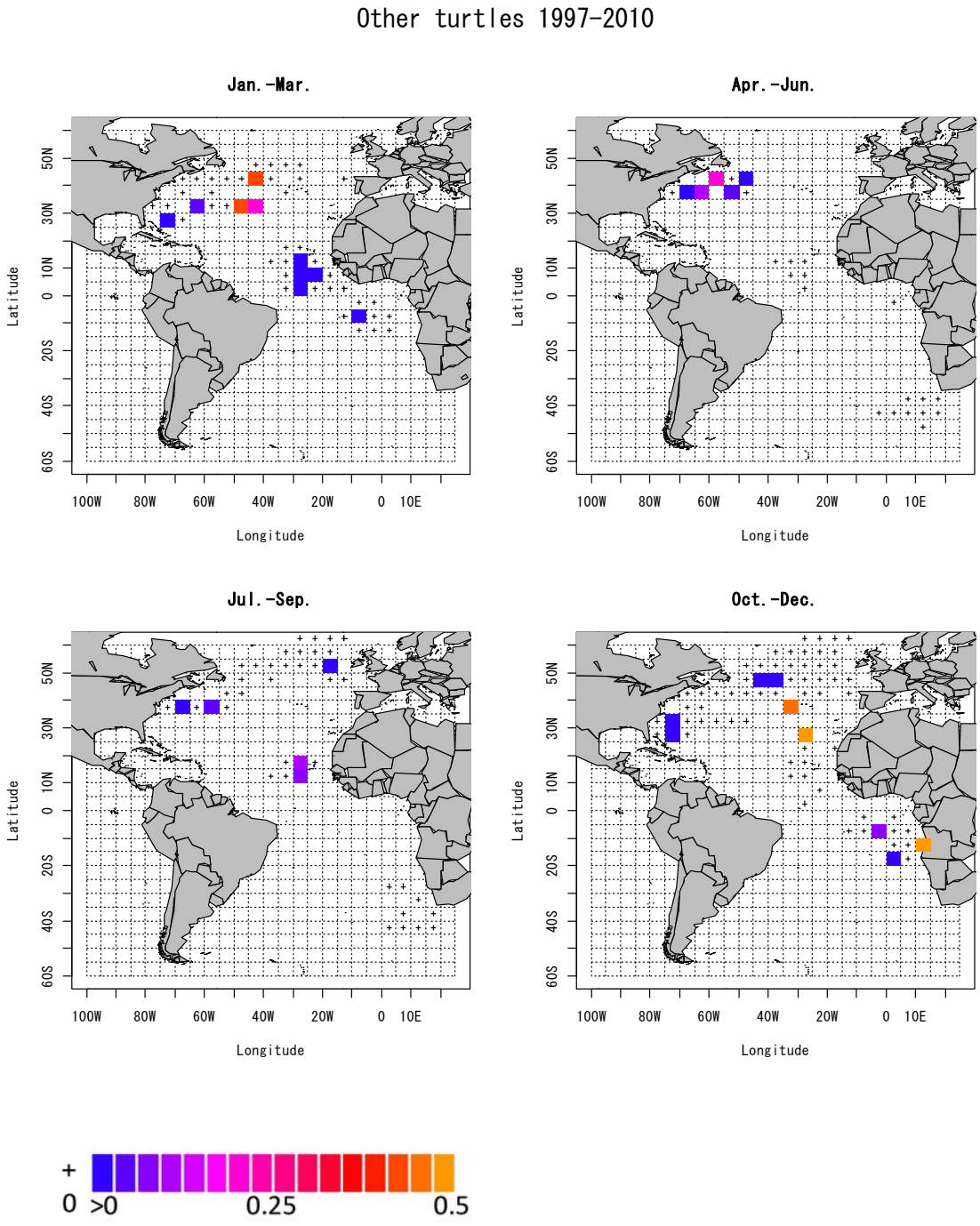

Figure 4. CPUE (number per 1000 hooks) of other turtles at 5x5 grid square collected by Japanese observer program during 1997-2010.

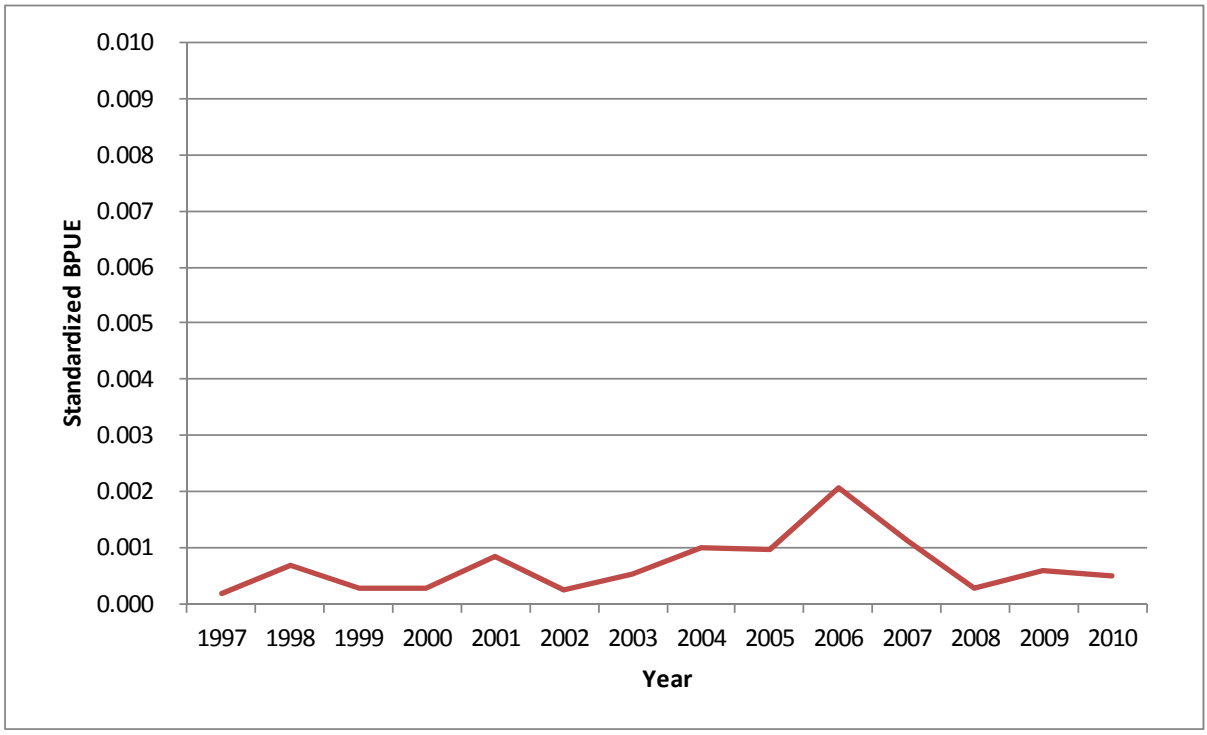

Figure 5. Standardized CPUE for leatherback turtle during 1997-2010.

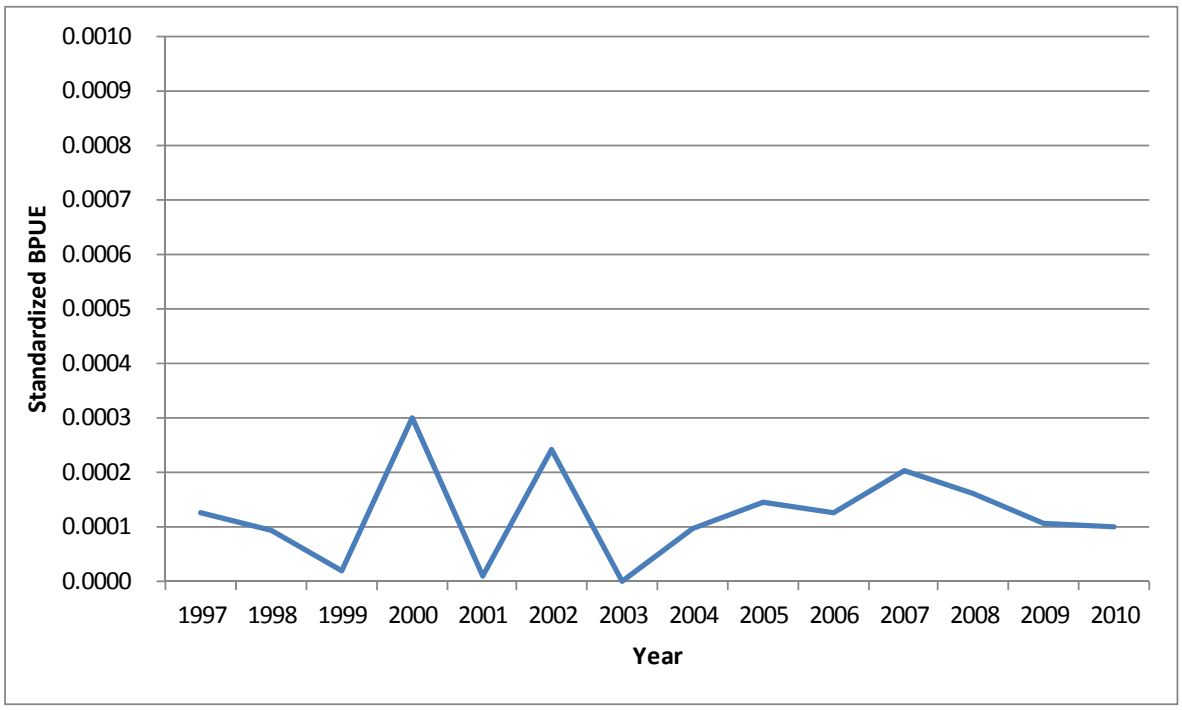

Figure 6. Standardized CPUE for other turtles during 1997-2010.