

## REVIEW OF SEA TURTLE BY-CATCH DATA IN THE ICCAT CONVENTION AREA OBTAINED THROUGH JAPANESE SCIENTIFIC OBSERVER PROGRAM

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### SUMMARY

*The document reviewed the historical information on the incidental catch of sea turtle by the Japanese pelagic longline fisheries within the ICCAT convention area collected by the Japanese scientific observers. A total of 681 sea turtles were caught with the 28 million hooks of eleven thousand fishing operations observed from 1997 to 2015. The most common species occurred was leatherback (N=312, 45.8%), followed by loggerhead (N=144, 21.1%), and olive ridley (N=76, 11.2%). Species of 149 individuals were unidentified, accounting for 21.9% of total sea turtle bycatch observed. Most of the turtles were caught in the tropical to temperate Atlantic (10° S to 25° N, area 2) and northern Atlantic (North of 25° N, area 1). In the areas 1 and 2, leatherback was the most common species, while olive ridley was the most common in the Southern area (10° S to 35° S, area 3). No turtle was recorded from far southern area (South of 35° S, area 4).*

### RÉSUMÉ

*Le document a examiné les informations historiques sur les prises accidentelles de tortues marines réalisées par les pêcheries de palangriers pélagiques japonais à l'intérieur de la zone de la Convention de l'ICCAT qui ont été recueillies par les observateurs scientifiques japonais. Au total, 681 tortues marines ont été capturées avec 28 millions d'hameçons dans le cadre de onze mille opérations de pêche observées de 1997 à 2015. Les espèces les plus communément rencontrées étaient la tortue luth (N = 312, 45,8 %), suivie de la tortue caouanne (N = 144, 21,1 %) et de la tortue olivâtre (N = 76, 11,2 %). Des espèces de 149 spécimens étaient non identifiées, soit 21,9 % du total des prises accessoires de tortues marines observées. La plupart des tortues ont été capturées dans l'Atlantique tropical à tempéré (10°S à 25°N, zone 2) et dans l'Atlantique Nord (Nord de 25°N, zone 1). Dans les zones 1 et 2, la tortue luth était l'espèce la plus commune, tandis que la tortue olivâtre était la plus fréquente dans la zone sud (10°S à 35° S, zone 3). Aucune tortue n'a été enregistrée de la zone extrême sud (Sud de 35°S, zone 4).*

### RESUMEN

*En este documento se revisa la información histórica sobre la captura incidental de tortugas marinas por las pesquerías de palangre pelágico de Japón dentro de la zona del Convenio de ICCAT recabada por los observadores científicos japoneses. Un total de 681 tortugas marinas fueron capturadas en 28 millones de anzuelos durante once mil operaciones de pesca observadas desde 1997 hasta el 2015. La especie más común fue la tortuga laúd (N = 312; 45,8%), seguida por la tortuga boba (N = 144; 21,1%) y la tortuga golfina (N = 76; 11,2%). No se identificaron las especies de 149 ejemplares, lo que supone el 21,9% de la captura fortuita total de tortugas marinas observada. La mayoría de las tortugas fueron capturadas en el Atlántico tropical templado (10° S a 25° N, área 2) y en el Atlántico norte (al norte de 25° N, área 1). En las áreas 1 y 2, la tortuga laúd fue la especie más común, mientras que la tortuga golfina fue la especie más común en el área sur (10° S a 35° S, área 3). No se registró ninguna tortuga en el área más meridional (al sur de 35° S, área 4).*

### KEYWORDS

*Sea turtle, leatherback, by-catch rate, longlining, by-catch*

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## 1. Introduction

Six sea turtle species, leatherback (*Dermochelys coriacea*), loggerhead (*Caretta caretta*), olive ridley (*Lepidochelys olivacea*), green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*), and Kemp's ridley (*L. kempii*) are known to distribute in the International Commission for the Conservation of Atlantic Tunas (ICCAT) convention area. All of them are listed as the IUCN Red list as endangered species (IUCN 2017) and many threats recognized include overexploitation for the meats, leather, and tortoiseshell, destruction of nesting beaches, climate changes, and incidental catches by the various commercial fisheries. Five species excluding Kemp's ridley are known to be caught incidentally by the pelagic longline fisheries, which is considered as one of major threats. Minami *et al.* (2013) reported about the incidental catch of sea turtles from 1997 to 2010 by the Japanese longline fishing operations in the ICCAT convention area.

In 2016, the Sub-committee on Ecosystem recommended the SCRS to request the CPCs harvesting ICCAT species, for providing annual sea turtle and seabird bycatch information in terms of bycatch rates and total number of bycatch for each fleet. It was further recommended to break down the information of catch rate and total number caught to a lowest taxonomic level as possible. In addition, the Sub-committee requested for the CPCs to describe the mitigation measures adopted by each fleet. This paper reports the detailed bycatch records on sea turtles by the Japanese longline fisheries in the ICCAT area to address the issues requested from the Sub-Committee.

## 2. Materials and methods

The Japanese scientific observer program has collected the information about operations and sea turtle bycatch in the longline fisheries in the ICCAT convention area since 1997, of which this document covers the data obtained from January 1997 to December 2015. The scientific observer data at set-by set level used in this study include fishing date, latitude and longitude of started fishing position, number of observed hooks, number of hooks per basket, number of bycaught sea turtles by species.

The bycatch rate of sea turtles was calculated as number of turtles per 1000 hooks. The following two categories for longline gear configurations was defined based on the number of hooks per basket: i) shallow-set for 7 to 13 hooks per basket; and ii) deep-set for 14 and more hooks per basket. Geographical distributions of observed hooks and the bycatch number of sea turtle were aggregated by  $5^\circ \times 5^\circ$  squares, and then were classified into the following four areas: area 1 for north of  $25^\circ$  N; area 2 for  $10^\circ$  S to  $25^\circ$  N; area 3 for  $10^\circ$  S to  $35^\circ$  S; and area 4 for south of  $35^\circ$  S. Quarter is used as the finest temporal scale, defined as Q1-4, corresponding to January to March, April to June, July to September, and October to December, respectively.

Bycatch number of leatherback was modeled using Generalized Additive Mixed Model (GAMM). The bycatch number of leatherback by set was used as response variables, and year, quarter, sea surface temperature (SST), and latitude (Lat) and longitude (Lon) at a level of 5 degrees were used as explanatory variables. An explanatory variable of Trip ID was used as a random effect. Number of hooks observed, in addition, was applied as offset variable. We estimated the number of bycatch with assuming the distribution of response variables follow zero-inflated Poisson regression, which are described as follows:

$$C \sim p + (1 - p)\text{Poisson}(0|\lambda); \quad \text{if } C = 0$$

$$C \sim (1 - p)\text{Poisson}(C|\lambda) \quad \text{if } C > 0$$

$$\log(\lambda) = \text{Year} + \text{Quarter} + s(\text{SST}) + s(\text{Lat}) + s(\text{Lon}) + r(\text{Trip ID}) + \log\left(\frac{\text{Hooks}}{1000}\right)$$

where  $C$  is observed bycatch number of leatherback in each operation,  $\lambda$  is expected number of bycatch per operation,  $p$  is occurrence rate of zero-catch event without connection to  $\lambda$ ,  $s()$  indicates penalized thin plate splines, and  $r(\text{Trip ID})$  is random trip effects. All analyses were performed with software R.3.4.0 (R Core Team 2017)", and the "mgcv" package was used for GAMM.

### 3. Results

#### 3.1 Fishing efforts observed

A total of 28,146,851 hooks observations were obtained with 11,812 fishing operations of the Japanese longline vessels from January 1997 to December 2015. The observed hooks were mainly distributed in the northern area of off Florida to Ireland, equatorial waters, and off southwest Africa (**Figure 1**). The majority of fishing operations observed in area 1 were shallow-sets, while those in area 2 were mostly deep-sets (**Figure 2**). In areas 3 and 4, both shallow-sets and deep-sets operations were observed. The number of observed hooks showed a substantial increase in the last several years, particularly in the areas 2, 3, and 4 (**Figure 3**). Dominant quarters on the observed hooks changed among years, quarters and areas. The observed hooks in all areas resulted to be dominant in particular quarter.

#### 3.2 Bycatch observed

##### 3.2.1 Overview

A total of 681 sea turtles, composed of leatherback, loggerhead, olive ridley, and unidentified species, were recorded as bycatch. Green and hawksbill turtles were not observed. The most common species was leatherback (N=312, 45.8%), followed by loggerhead (N=144, 21.1%), and olive ridley (N=76, 11.2%). The unidentified species (N=149) accounted for 21.9% of total sea turtles recorded.

The total number of bycatch observed showed distinct difference among areas, with observed catches in the areas 1, 2, 3, and 4 as 141, 490, 50, and 0 individuals, respectively. In areas 1 and 2, leatherback were the most dominant species, followed by loggerhead (**Figure 4**). No olive ridley was observed in the area 1, although the dominant species in the area 3 was olive ridley, followed by leatherback.

##### 3.2.2 Loggerhead

In the ICCAT convention area, nominal bycatch rate of loggerhead throughout the entire period was 0.005 per 1,000 hooks on an average. Annual bycatch rate fluctuated year by year, recording the highest value in 2015 (**Figure 5**).

##### 3.2.3 Olive ridley

Nominal bycatch rate of olive ridley during the survey period was 0.003 per 1000 hooks. It showed a large annual fluctuation and a gradual increase, particularly after 2011 (**Figure 6**). The olive ridley was only caught in the areas 2 and 3, with bycatch rates of 0.007 and 0.012, respectively. The incidental captures of this species in the area 3 were only observed in 2002 and 2015.

##### 3.2.4 Leatherback

Nominal bycatch rate of leatherback throughout the entire period was 0.011 per 1000 hooks. Bycatch rate fluctuated largely according to the years without showing marked trend (**Figure 7-a**). The highest bycatch rate was recorded in the area 2 (0.028), followed by the area 3 (0.007) (**Figure 7-b**). Although occasional high bycatch rate were recorded in individual areas, no remarkable trends were observed. Quarterly bycatch rates ranged 0.003 to 0.025 (**Figure 7-c**). The highest value was recorded in Q1 (0.025), and followed by Q4 (0.012).

Bycatch rates per operation ranged from 0 to 1.856, and a total of 11,543 operations (97.7%) observed were not bycaught leatherback. Family of bycatch rates showed zero-inflated distribution (**Figure 8**).

The result of the smoothing spline by the GAMM indicated a presumably high bycatch rate in the two latitude zones of between 0° and 5° N and between 40° N and 45° N, and a presumably lower by catch rate as going south from the equator as well as the zone of north of 45° N (**Figure 9**). Regarding the effect of longitude, the model estimated the high bycatch rate in two longitude zones of between 0° and 10° E and between 40° W and 45° W, and relatively lower bycatch rate in the west from 50° W and the zone between 10° W and 30° W (**Figure 10**). For the effect of sea surface temperature, the model expected relatively high bycatch rate when it ranged from 23 to 25°C (**Figure 11**).

## **4. Discussion**

### ***4.1 Problems on species-unidentified individuals***

The observer records included over 20% of turtles of which species were unidentified. Some sea turtle species except for leatherback, especially loggerhead and olive ridley which are common bycatch species in longline fisheries, are difficult to identify. Thus, the regular process of confirming the species identification through photo identification by the expert has been established. Still, an individual will be listed as unidentified turtle when the observer identified the species of a turtle as hard-shelled one (e.g. loggerhead or olive ridley) without the photographic record. Although the “unidentified sea turtles” have potential to include leatherback, loggerhead, olive ridley, green, and hawksbill, it is expected that the unidentified group include only few leatherback due to its easy identification by their characteristic form. The number of unidentified sea turtles has increased after 2011 corresponding to the increase of the number of observed hooks.

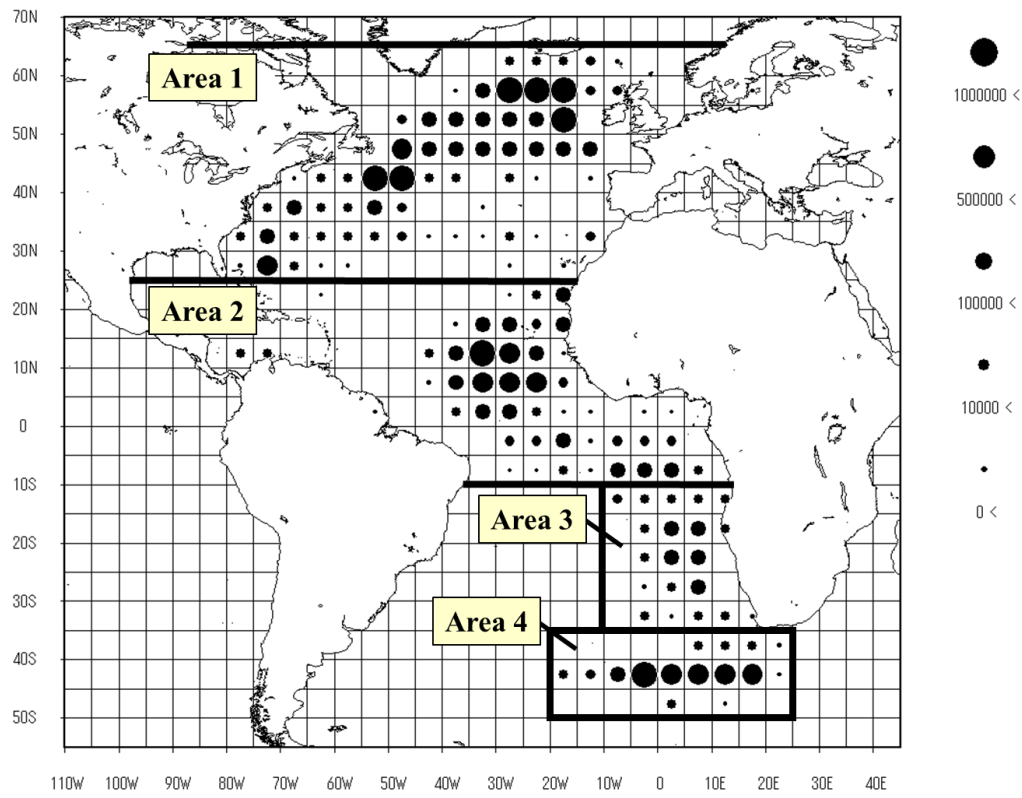
The data of bycatch was too poor to discuss about the annual or quarterly trends of bycatch rates for loggerhead and olive ridley. The majority of species-unidentified individuals seemed to be composed of these two species. Problems on those individuals prevent us from estimating accurate and reliable bycatch rates for these species. In future, procedures to assign the species-unidentified individuals into loggerhead and olive ridley are needed to discuss bycatch impacts at a species level.

### ***4.2 Factors affecting on bycatch rate***

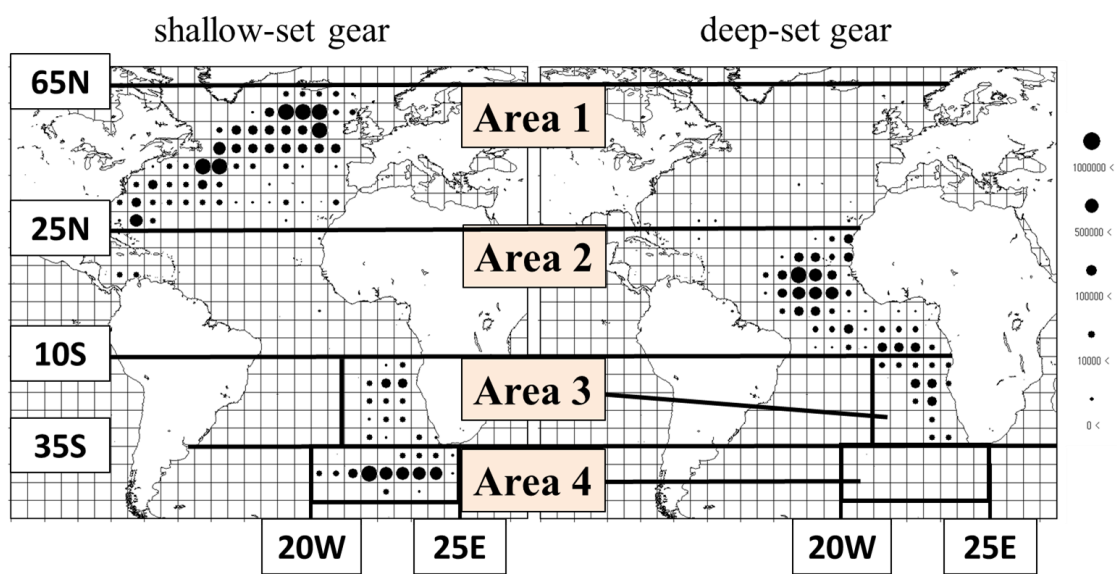
The bycatch rates of leatherback varied greatly over quarters and/or areas. Our results of the GAMM analyses in the leatherback bycatch rate clearly showed that there were less homogeneities in bycatch rate even within an area. The results, in addition, indicated importance of oceanic condition (e.g. SST) as factors affecting bycatch rates. It is strongly recommended that various factors possible to affect bycatch rates of sea turtles should be considered to obtain accurate bycatch rates by species used for calculation of total bycatch number and to evaluate the impacts of longline fisheries on sea turtle populations.

## References

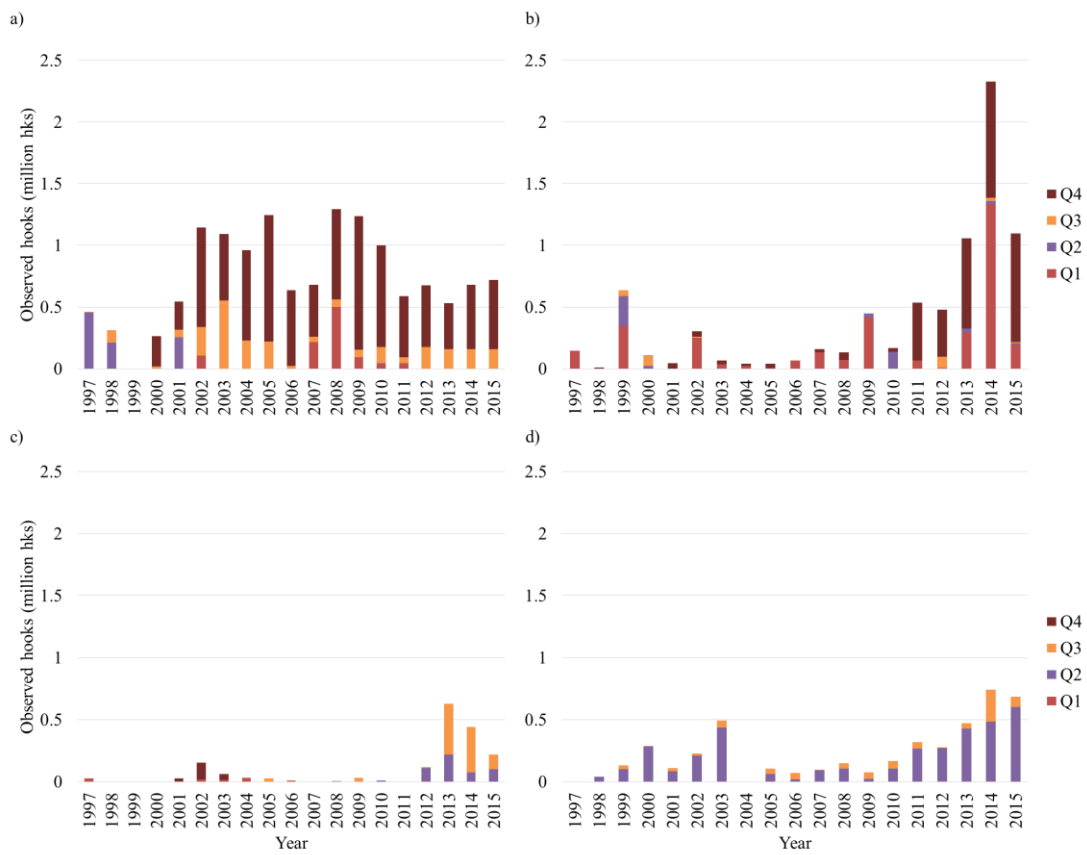
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**Figure 1.** Distribution map of a total number of observed hooks from 1997 to 2015 with area classification.

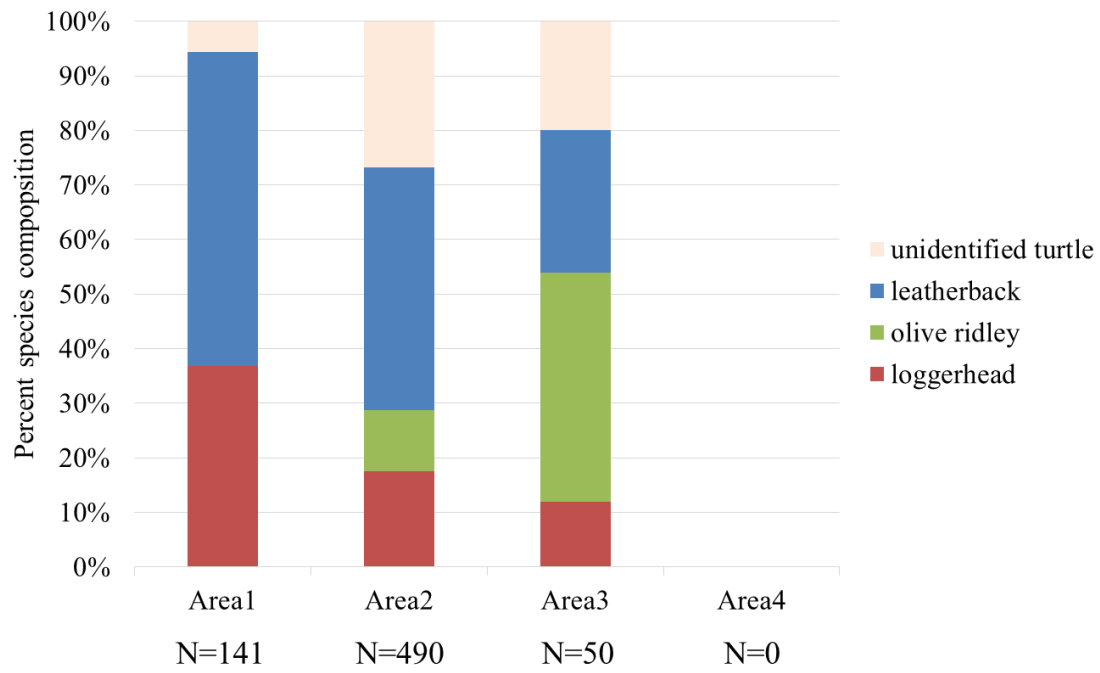


**Figure 2.** Distribution maps of a total number of observed hooks in shallow-set and deep-set gears in the ICCAT area.

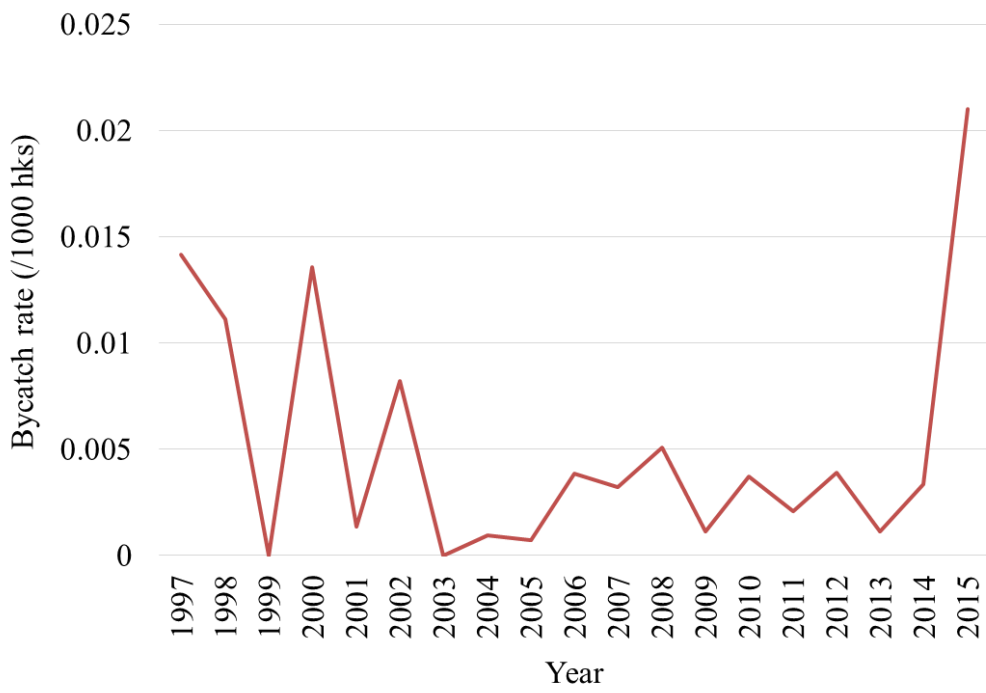


**Figure 3.** Annual number of observed hooks indicated by quarter. Panels of a-d show those in areas 1-4, respectively.

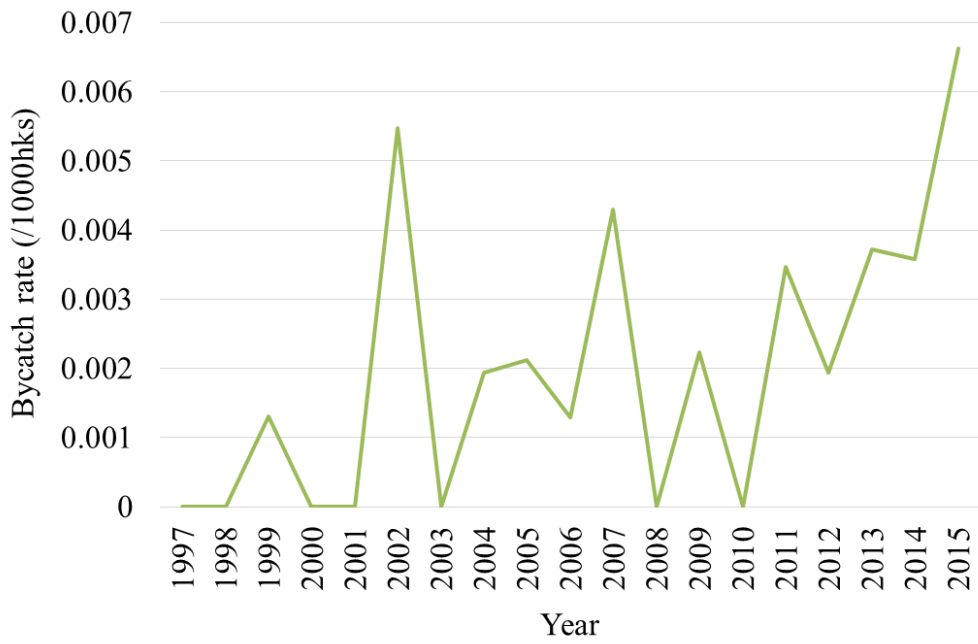




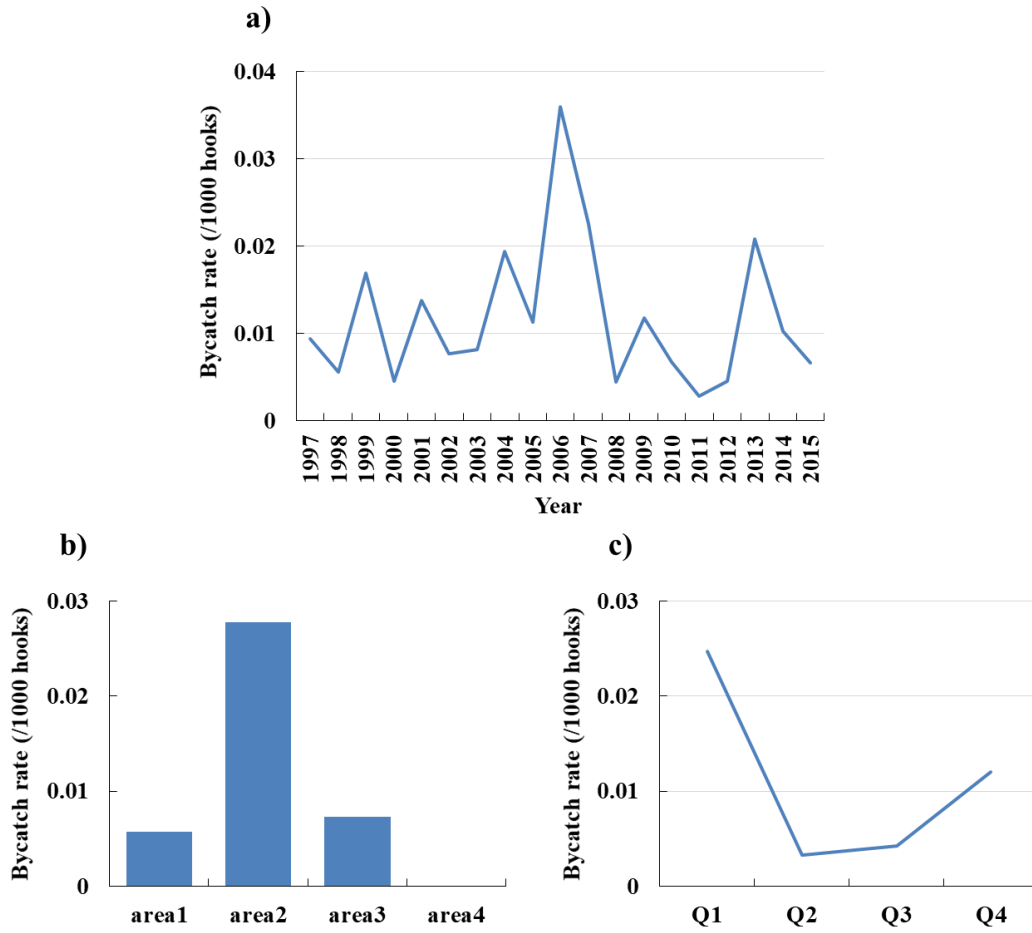
**Figure 4.** The number of bycaught turtles and species compositions shown by area.



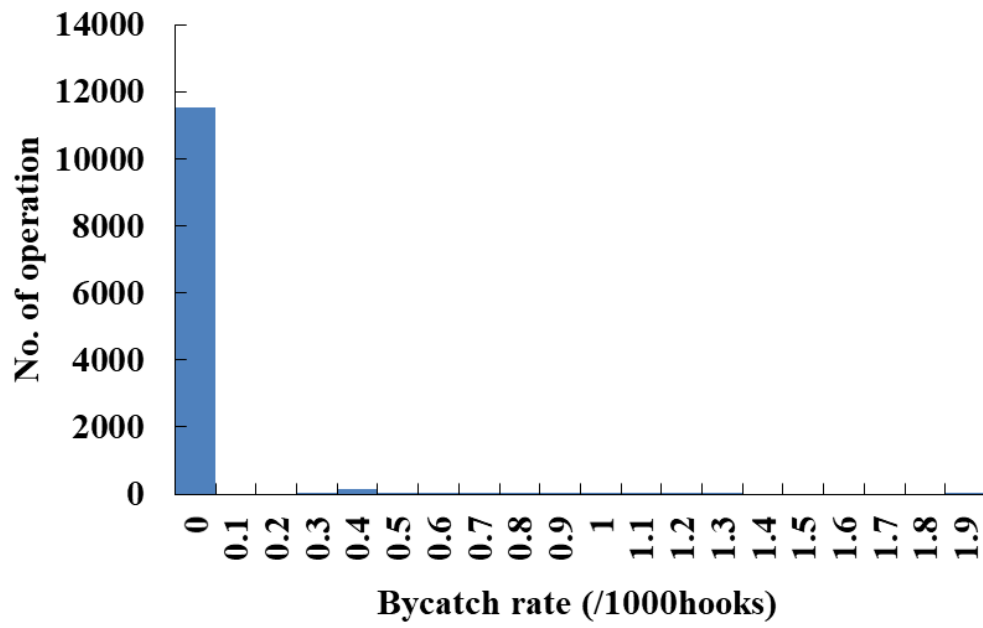
**Figure 5.** Annual trend of bycatch rate (number per 1000 hooks) for loggerhead.



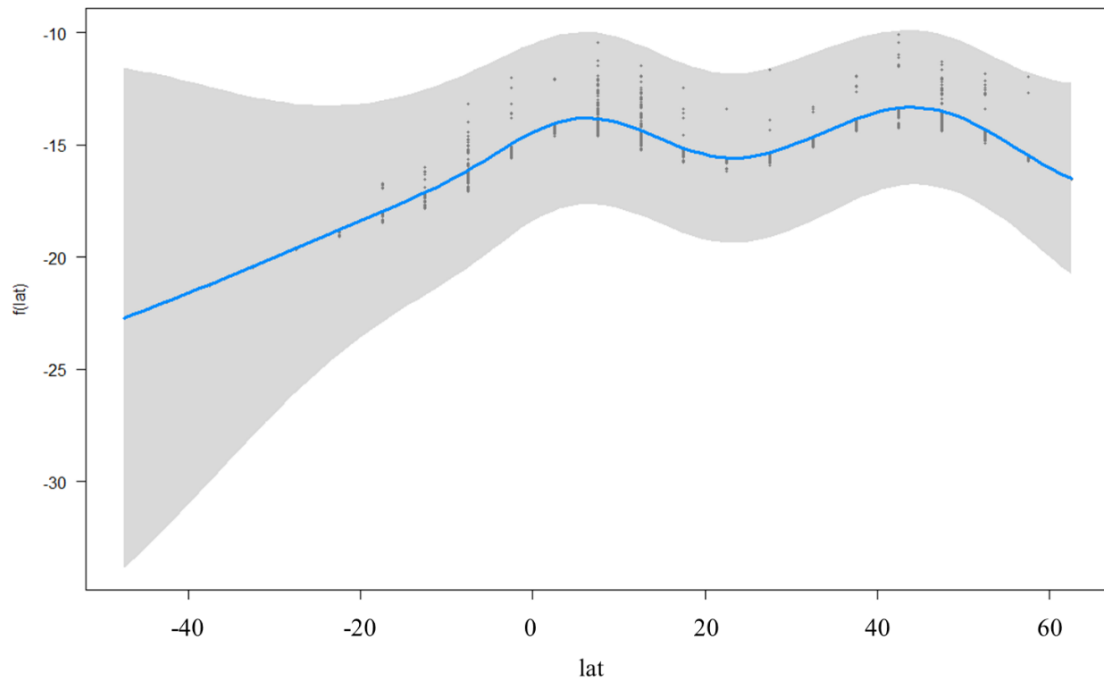
**Figure 6.** Annual trend of bycatch rate (number per 1000 hooks) for olive ridley.



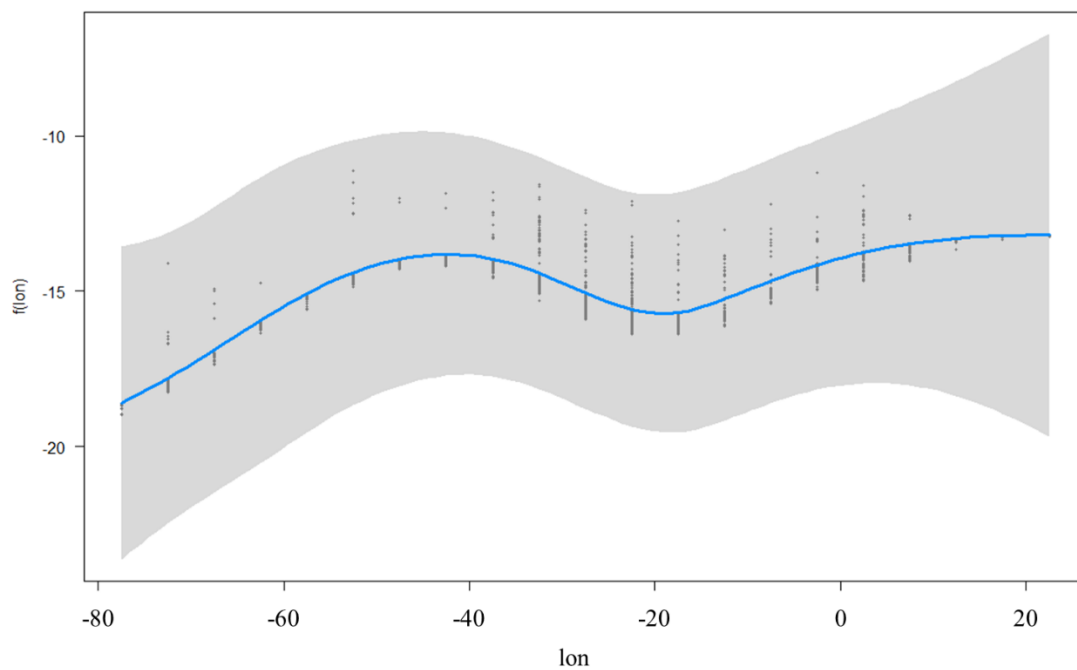
**Figure 7.** Bycatch rates (number per 1000 hooks) of leatherback. Panels of a-c show them annually, by area and by quarter, respectively.



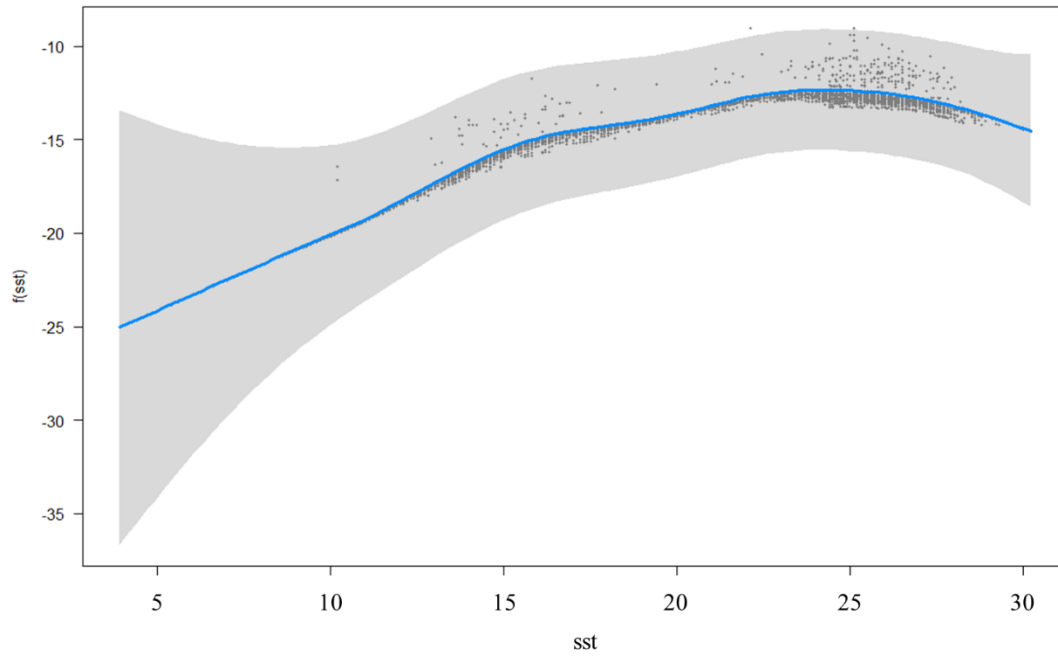
**Figure 8.** Frequency distribution of bycatch rates of leatherback per operation.



**Figure 9.** Smoothing spline for relative leatherback number of bycatch and latitude by GAMM.



**Figure 10.** Smoothing spline for relative leatherback number of bycatch and longitude by GAMM.



**Figure 11.** Smoothing spline for relative leatherback number of bycatch and sea surface temperature by GAMM.