Incidental catch of seabirds by Taiwanese longline fleet in the Southern Oceans between 2010-2018

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Abstract

In this study, we update the distribution of seabird bycatch of Taiwanese tuna longline vessels from 2010-2018. Furthermore, we explore if seabird bycatch rate varies among fleets, including (1) Taiwanese fleets with different size and targets, and (2) Taiwanese fleet and Japanese fleet. We used observer data collected from 440 Taiwanese tuna longline vessels operating in the southern Ocean (south of 20° S) between 2010 and 2018. For the observed 103,511 thousand hooks, 1,523 seabirds were incidental caught. The mean annual bycatch rate ranges from 0.003-0.037 from 2010-2017. The bycatch rate of seabirds was not significantly different among vessels with different size and targets, when year and operation location were considered. In addition, the mean bycatch rate of seabirds was similar between Taiwanese and Japanese tuna longline vessels, when the operation time period and fishing ground are controlled.

Keywords: seabird bycatch, albatrosses, bycatch rates

Introduction

Longline fishery is one of the biggest threats to many seabird populations, especially for albatrosses (Anderson et al. 2011). For conservation purposes, several regional fisheries management organization, such as the IATTC, ICCAT, IOTC and WCPFC, have required members to collect data and implemented mitigation measures when their fishing vessels operating in the southern Oceans (IATTC 2011; ICCAT 2011; IOTC 2012; WCPFC 2015).

While Taiwan's tuna longline fleet has spread across the globe, its impacts on seabird bycatch requires continuously monitoring and minimization (Huang and Liu 2010; Huang 2011, 2015; Yeh et al. 2013). Taiwanese tuna longline vessels are categorized into two categories according to their size: the large-scale (>100 gross tonnage) and small-scale (<100 gross tonnage) vessels. The large-scale tuna longline fleets (LTLVs) mainly target on albacore (*Thunnus alalunga*), bigeye tuna (*T. obesus*), yellowfin tuna (*T. albacares*), and southern bluefin tuna (*T. maccoyii*). In the Southern Oceans, the major fishing ground is the Pacific Ocean, followed by the

Indian Ocean and the Atlantic. However, vessels targeting different species also operate in different areas. For example, vessels targeting albacores mainly distribute in the Atlantic Ocean and Pacific Ocean. In the Indian Ocean, southern bluefin tuna was dominant in the southeastern area, and escolar (*Ruvettus pretiosus*) was targeted in the southwestern Indian Ocean seasonally.

In this study, we update the distribution of seabird bycatch of Taiwanese tuna longline vessels. Furthermore, we explore if seabird bycatch rate varies among fleets, including (1) Taiwanese fleets with different size and targets, and (2) Taiwanese fleet and Japanese fleet. The study will provide insights in the potential factors of seabird bycatch rate, and have implications in the estimation of global seabird bycatch.

Materials and Methods

1. Data

We use the data collected by onboard observers from 2010-2018 for the large-scale vessels and 2012-2018 for the small-scale vessels. Note that the 2018 information is incomplete since the collection of 2018 data is still ongoing. Therefore, for the analysis on BPUE comparison among fleets, we excluded the 2018 data. The observer data include the species of capture seabirds, latitude and longitude of the seabird caught, the number of hooks deployed and observed, bait type, hook type, the size of the birds, the status of the bird when it was caught (dead/live), and mitigation measures used by each vessel.

2. Analysis

2.1 The distribution of seabird bycatch

To investigate the spatial pattern of seabird bycatch, we focused on the southern oceans (south of 20°S) where the albatross density is high. We calculated the bird captured per unit effort (BPUE) for each 5°x 5° stratum. The captured seabirds are classified into: (1) large albatrosses, (2) medium albatrosses, (3) small albatrosses, (4) other albatrosses (the albatrosses that are not identified to species level), and (5) other seabirds (Appendix 1). We compared the composition of bycatch seabird species among large and small-scale vessels.

2.2 Comparing the BPUE among fleets declared different targets

Considering that the distribution of seabird bycatch is skewed, we applied poisson regression to test if fleets with different targets have different seabird bycatch rate. Vessels are classified as: albacore targeting (ALB), bigeye tuna targeting

(BET), southern bluefin tuna targeting (SBT), mixed targets (MIX), and small-scale vessels (SML). The analysis was conducted at 5°x 5° stratum basis. We also considered time (year, 2010-2017) and location (latitude x longitude) as covariates.

2.3 Comparing the BPUE between Taiwanese and Japanese vessels

In this section, we aim to compare the BPUE of Taiwanese longline vessels to the BPUE of Japanese longline vessels. Considering the ongoing correction for the Japanese observer data of 2016-2017, we used the data between 2012-2015 for comparison. To control the variations in the fishing area between the two fleets, we focused on the area of 0°-50°E and the South of 20°S where both Taiwanese and Japanese vessels are operating. We calculated the BPUE (number of bycatch all seabirds per 1,000 observed hooks) for each 5°x 5° stratum, and compared the mean BPUE between the two fleets.

Results and Discussions

1. The distribution of seabird bycatch

There were 103,511 thousand hooks from vessels operating in the south of 20°S observed during 2010-2017. About 41.4% of the observed hooks were in the Pacific Ocean, 30.3% was from the Indian Ocean, and 28.3% was from the Atlantic Ocean.

In the same period, 1,523 seabirds were captured by Taiwanese longline fishing vessels. The mean annual BPUE ranges from 0.003-0.037 from 2010-2017. Among the seabirds bycaught by Taiwanese longline vessels, the large albatrosses were mostly caught in the area south of Africa (Indian Ocean side) and the east of Australia (Figure 1 & Figure 2). In the Atlantic Ocean, most of the seabird bycaught are small albatrosses (Figure 1 & Figure 2).

2. Comparing the BPUE among fleets declared different targets

While we found that BPUE varies across vessels that declared different targets, the results from our poisson regression suggest that the variation may because of the different spatiotemporal distribution of fleets. The large-scale, albacore-targeting vessels have the highest mean BPUE for all three oceans (Table 1). In contrast, the small-scale vessels and the large-scale, big eye tuna-targeting vessels have relative low BPUE (Table 1). However, such differences in BPUE among fleets were not significant when year and location are considered (Table 2).

3. Comparing the BPUE between Taiwanese and Japanese vessels

We focused on the area around South Africa (0°-50°E and the South of 20°S) to compare the BPUE between Taiwanese and Japanese tuna longline vessels. For 2012-2015, the mean BPUE of Taiwanese vessel is 0.198 seabirds per thousand hooks, while the mean of Japanese vessel is 0.20 (Figure 3). The spatial variations of BPUE in this area are also consistent between the Taiwanese and Japanese fleets. For both fleets, the seabird bycatch rates are the highest in the area near the southwestern Africa (10°-20°E and 30°-40°S).

This finding suggests that, with the consideration of spatial variations in fishing area, the BPUE between fleets could be similar. Other factors may also be potential factors for the observed catchability of seabirds of each fleet, such as the observation period, baits and hooks used. It requires further studies to explore the factors for catchability.

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Table 1. The number of bycatch seabirds and BPUE (number of birds per 1000 hooks) by fleet and ocean. Large-scale fleet including ALB (albacore-targeting), BET (bigeye tuna-targeting), SBT (southern bluefin tuna-targeting), and MIX (mixed-targets). SML represents small-scale vessels.

	Atlantic Ocean		Indian Ocean		Pacific Ocean		Overall	
	# of seabirds	BPUE	# of seabirds	BPUE	# of seabirds	BPUE	# of seabirds	BPUE
ALB	805	0.086	135	0.053	220	0.020	1160	0.050
BET	3	0.000	32	0.005	7	0.001	42	0.001
SBT			284	0.018			284	0.018
MIX			9	0.014			9	0.014
SML			22	0.003	6	0.000	28	0.001
Total	808		482		233		1523	

Table 2. Results of the poisson regression for BPUE per stratum. For the impacts of different fleet, the BPUE of ALB fleet was used as the baseline.

	Estimate	Std. Error	Pr(>|z|)
(Intercept)	-284.10	24490.00	0.991
LAT_grid	0.01	3.00	0.996
LON_grid	-0.00	0.25	0.992
Year	0.13	12.16	0.991
FleetBET	-2.55	130.10	0.984
FleetMIX	-14.29	117400.00	1
FleetSBT	-14.19	34980.00	1
FleetSML	-2.61	122.70	0.983

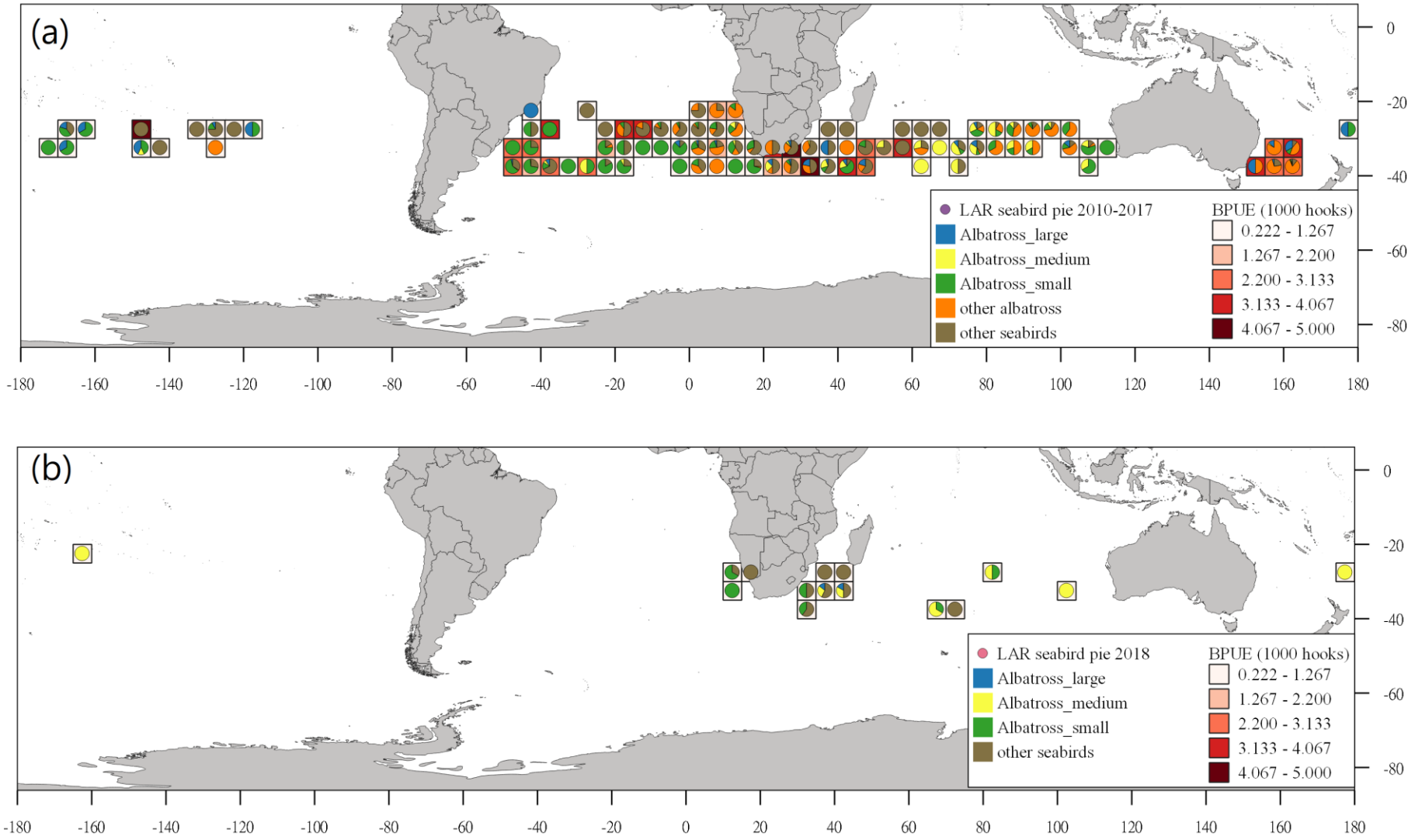
(a)
LAR seabird pie 2010-2017
Albatross_large
Albatross_medium
Albatross_small
other albatross
other seabirds
BPUE (1000 hooks)
0.222 - 1.267
1.267 - 2.200
2.200 - 3.133
3.133 - 4.067
4.067 - 5.000
0
-20
-40
-60
-80
-180 -160 -140 -120 -100 -80 -60 -40 -20 0 20 40 60 80 100 120 140 160 180
(b)
LAR seabird pie 2018
Albatross_large
Albatross_medium
Albatross_small
other seabirds
BPUE (1000 hooks)
0.222 - 1.267
1.267 - 2.200
2.200 - 3.133
3.133 - 4.067
4.067 - 5.000
0
-20
-40
-60
-80
-180 -160 -140 -120 -100 -80 -60 -40 -20 0 20 40 60 80 100 120 140 160 180

Figure 1. The distribution and composition of bycatch seabirds of Taiwanese large-scale longline vessels. Panel (a) shows data from 2010-2017 and (b) shows data from 2018.

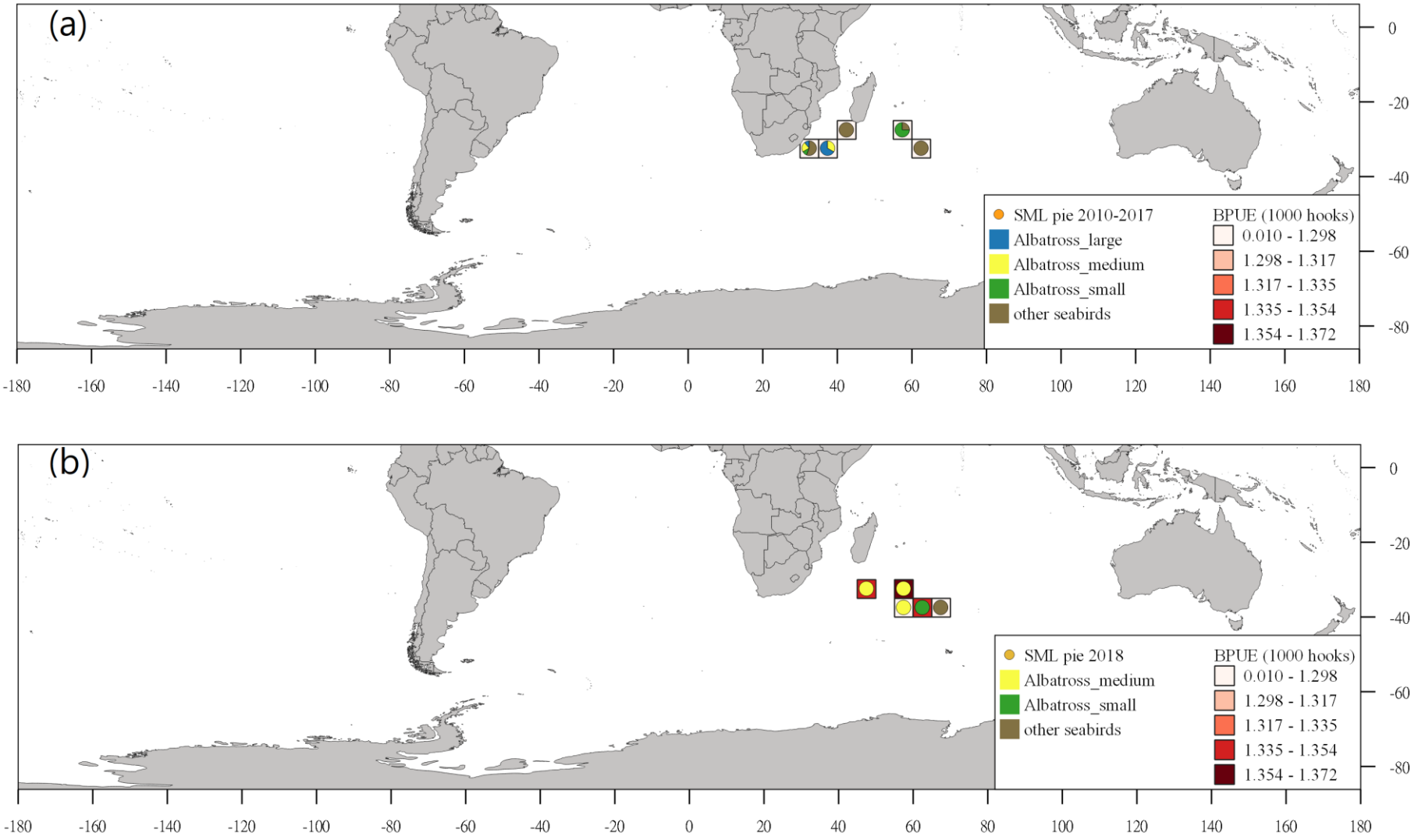
(a)
SML pie 2010-2017
Albatross_large
Albatross_medium
Albatross_small
other seabirds
BPUE (1000 hooks)
0.010 - 1.298
1.298 - 1.317
1.317 - 1.335
1.335 - 1.354
1.354 - 1.372
(b)
SML pie 2018
Albatross_medium
Albatross_small
other seabirds
BPUE (1000 hooks)
0.010 - 1.298
1.298 - 1.317
1.317 - 1.335
1.335 - 1.354
1.354 - 1.372
0
-20
-40
-60
-80
-180 -160 -140 -120 -100 -80 -60 -40 -20 0 20 40 60 80 100 120 140 160 180

Figure 2. The distribution and composition of bycatch seabirds of Taiwanese small-scale longline vessels. Panel (a) shows data from 2010-2017 and (b) shows data from 2018.

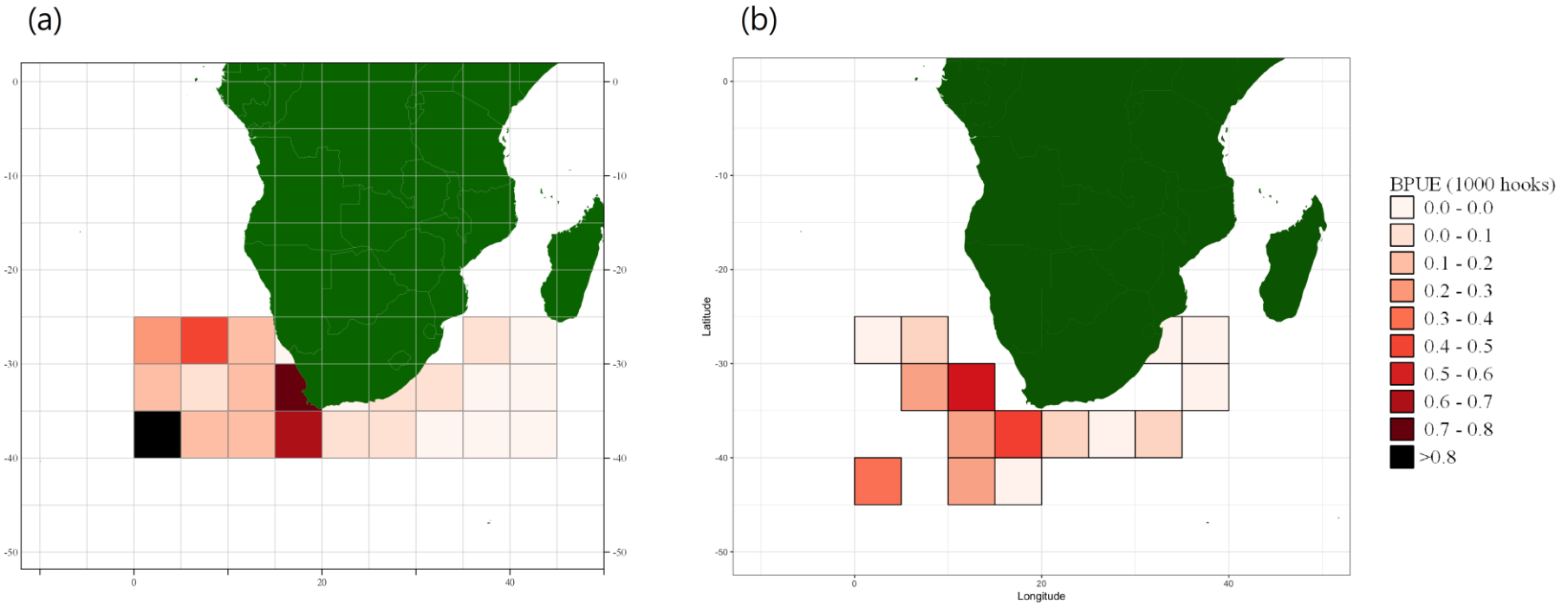

Figure 3. The comparison of BPUE (number of birds per 1000 hooks) for (a) Taiwanese large-scale longline vessels and (b) Japanese large-scale longline vessels from 2012-2015 in the area south of Africa.

Appendix I. The categories of albatrosses by size

Species code	Scientific name	Category
ALZ	Albatrosses nei	Albatross
DAM	Amsterdam Island Albatross	Albatross_large
DBN	Tristan Albatross	
DIP	Southern royal Albatross	
DIQ	Northern royal Albatross	
DIX	Wandering Albatross	
DQS	Antipodean Albatross	
DAQ	Short-tailed Albatross	Albatross_medium
DCU	Shy Albatross	
DER	Chatham Islands Albatross	
DKS	Salvin's Albatross	
DPK	Waved Albatross	
PHE	Light-Mantled Albatross	
PHU	Sooty Albatross	
TWD	White Capped Albatross	

DCR	Yellow-Nosed Albatross	Albatross_small
		Albatross_small
DIB	Buller' S Albatross	
DIC	Grey Headed Albatross	
DIM	Black-Browed Albatross	
DIZ	Laysan Albatross	
DKN	Black-footed Albatross	
TQH	Yellow-nosed Albatross	
TQW	Campbell Albatross	