Distribution of seabirds bycatch of Taiwanese longline fleets in Southern Ocean between 2010 and 2016

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Abstract

Observer data collected from 120 Taiwanese tuna longline vessel trips operating in the southern Ocean (south of 25° S) between 2010 and 2016, including 26 in the Atlantic Ocean, 24 in the Pacific Ocean, and 72 in the Indian Ocean, were analyzed in this study. For those 11874 sets, 1363 seabirds were incidental caught. The percentage of albatross bycatch was 62.4%. Thirteen species albatross were identified. The major species were black-browed albatross, wandering, yellow-nosed and sooty albatrosses. The percentage of albatross was highest in the Pacific Ocean and lowest in the Atlantic Ocean. As for the other seabirds, the white-chinned petrel, great shearwater and spectacled petrels were dominant. The highest bycatch rate was 0.318 bird per thousand hooks in the southwestern Pacific Ocean from January to March, followed by first season in the south western Atlantic Ocean (0.270 bird per thousand hooks). Although the bycatch number were higher in the area between 30°-40°S, the bycatch rates were higher in the south of 40° S.

Keywords: albatross, observer, seabirds, tuna longline fisheries

1. Introduction

Taiwan's tuna longline fleets have operating in the high-seas since early 1970s. There are two major fleets, the large-scale (>100 gross tonnage) and small-scale (< 100 GRT). 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 (*Thunnus maccoyii*). The Indian Ocean was the major fishing ground, followed by the Atlantic, and the Pacific Ocean. The major catch species was albacore in the Atlantic Ocean and Pacific Ocean. Sharks are major bycatch. In the Indian Ocean, southern bluefin tuna was dominant in the southeastern and escolar (*Ruvettus pretiosus*) was targeted in the southwestern Indian Ocean seasonally. In addition to albacore, bigeye tuna and yellowfin tuna, some of the small-scale vessels(STLVs) were targeted on swordfish, dolphin fish, and sharks in accordance to the fishing grounds.

There are many species of albatross distributed in the Southern Indian Ocean (Birdlife International 2004). Longline fisheries is considered as one of the impacts on albatross populations(Anderson, Small et al. 2011). For conservation of those incidental species, the IATTC, ICCAT, IOTC and WCPFC adopted recommendations and resolutions to request members to collect data and asked fishing vessels to take mitigation measures during operating in the southern Oceans (IATTC 2011; ICCAT 2011; IOTC 2012; WCPFC 2015). During the operation of Taiwanese longline fishing, some species of albatross were incidental catch (Huang and Liu 2010; Huang 2011; Yeh, Huang et al. 2013; Huang 2015). This study aims to analyze observer data from

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Taiwanese fishing vessels to update spatial-temporal characteristics of seabird incidental catch, and to further estimate bycatch rates for conservation suggestions.

2. Materials and methods

2.1 Observer Data Collection

Bycatch data were collected by onboard observers. Onboard observers recorded the fishing position (latitude and longitude for the start and end of setting and hauling), the number of hooks deployed and observed, the times of setting and hauling, bait type, catch information (species, number, status, length, weight, sex, if possible), and bycatch information (number, species, status (dead/alive), and sex, if possible) for seabirds, sea turtles, and cetaceans (Huang 2011). If the bycatch species was not able to be identified, photographs were taken for further identification. The seabirds mitigation measures, if used, are recorded, such as bird-scaring line (yes/no, number), branch-line weighted (yes/no), etc. The data analyzed for the LTLVs were from 2010 to 2015. For the STLVs, the observer program started in 2012; thus, only the data from 2012 to 2016 were used in this study.

2.2 Data Analysis

Considering the major albatross bycatch were distributed in high latitude of southern oceans. This research will focus on the area in the south of 25° S. For spatial stratification, it is separated to southeast (SE) and southwest (SW) for three oceans as showed in **Figure 2**. For temporal stratification, we separated the time into 4 quarters: 1st quarter (January~ March), 2nd quarter (April~ June), 3rd quarter (July~ September), and 4th quarter (October~ December). The rate of bycatch was computed as the number of seabirds caught per 1,000 hooks for each stratum (Ryan, Keith et al. 2002). Considering the seabird species is more diverse and some species could not be identified by observers. Thus, seabirds are separated into five groups, including large, medium, small albatrosses, other albatross and other seabirds.

3. Results

3.1 Observed fishing effort

There were 11874 sets from 120 trips observed in the south of 25° S during 2010-2016, including 1937 sets in the Pacific Ocean (24 trips), 7677 sets in the Indian Ocean (72 trips) and 2260 sets in the Atlantic Ocean (26 trips)(**Table 1)**. The annual observed sets were ranged from 761 to 2427. Twenty percent was from the Atlantic Ocean, 16.7% from the Pacific Ocean and 63.0% from the Indian Ocean. Most of them were southern bluefin tuna and albacore targeting vessels. The observed hooks per set was ranged from 2.0 to 3.4 thousand hook. The coverage rates by efforts was ranged from 3.0% to 10.4%. The observed efforts was distributed as **Figure 1**.

3.2 Seabirds bycatch distribution

In total, 1363 seabirds were caught in 722 sets by 61 trips, which was 6.1% sets and 40.7% vessels. Among those bycatch, more than 60% were albatross (Table 2). Thirteen species albatross were recorded. Black-browed (164), yellow-nosed (148), wandering (49), and sooty albatrosses (48) were the major species. Among other

seabirds, white-chinned petrels (255), great shearwater (104), and spectacled Petrel (66) have more individuals than the other species. The spatial species composition was distributed in **Figure 1**.

For all bycatch seabirds, fifty-six percentages was from the Atlantic Ocean, 11.7% from the Pacific Ocean, and 32.4% from the Indian Ocean. The percentage of albatross was 54.9%, 85.6% and 64.9% for the Atlantic, Pacific and Indian Ocean respectively (**Figure 2**). The seabirds bycatch distribution were showed from **Figure 3-7** for large, medium, small, other albatross and other seabirds.

There were three species of large albatross, including northern royal albatross, antipodean albatross and wandering albatross. Most of them were distributed in the southwest of Pacific and Indian Ocean (Figure 3). As for the medium size, the sooty albatross were major species in the Indian and Atlantic Ocean, followed by white capped albatross (Figure 4).

The number of small albatross was higher than large and medium size. Black-browed and yellow-nosed albatross were both more than 100 individuals. Most were distributed in the Atlantic Ocean and southeast Indian Ocean (Figure 5). Those not identified are categorized to other albatrosses which were distributed in the three oceans (Figure 6).

As for the other seabirds, more than 11 species were identified. The white-chinned petrels, great shearwater and spectacled petrels were major species and distributed in the ATLSE and INDSW (**Figure 7**).

3.3 Seabirds bycatch rates and spatial-temporal difference

The bycatch rates for each stratum were listed in Table 3. The number of observed hooks was zero in the first and second season for the INDSE and first season for PACSE. It showed the major fishing seasons in the southern oceans was second half of the year.

Among different strata, the highest bycatch rate was recorded in the first season of PACSW. The second and third was 0.270 and 0.235 per thousand hooks in the first season of ATLSW and second season of ATLSE.

The relationship between observed hooks and bycatch rates was showed in **Figure 8**. It's noted the bycatch rates were higher in the Atlantic Ocean, and the lowest in the Indian Ocean. However, the highest bycatch rates recorded in the Pacific Ocean with lower observed hooks.

4. Discussion

The previous study has identified the southern Atlantic and Indian Ocean was high bycatch for albatross (Huang and Liu 2010; Yeh, Huang et al. 2013). Due to more species-specific data collected thereafter, especially from albacore and small scale longline vessels, this research further identified more specific bycatch distribution for seabirds by groups.

For Taiwanese vessels, the seabird bycatch rate of the Atlantic Ocean was higher than the other two, especially in the southeast. It might be related to the overlapping of fishing efforts and seabirds abundance. With more updated research on the effectiveness of the mitigation measures (Melvin, Guy et al. 2014), the new standard mitigation measures were adopted by many organizations (IOTC 2012). The timely evaluation of the new mitigation measures based on observer data would be helpful to monitor the status of seabird bycatch. However, observers did not record details of

mitigation measures until 2013. More data collection would be necessary to further analysis. For the data collect recently, the major seabirds mitigation measures were tori-line, most of the vessels operating in the south of 25° S applied this measures. As for the night setting, due to the fishing setting were usually as long as 5~ 8 hours, most of the setting would be part of night setting, such as start in night and finish at early morning. The detail data might be useful to identify the seabird bycatch time.

Taiwanese observer program has been conducted for more 10 years, with increasing number of observers. Although the fishing efforts of large scale fishing vessels were decreasing, the fishing capacity of Taiwan small scale fishing vessels remains high. The observer coverage rates should be endeavoring to reach 5% for small scale fishing vessels. The seabird species identification rates were increased. However, considering the observer turnover rate was high, the education would be important for new recruit observers. In addition, photo identification by experts is necessary. In addition, the photo taken for mitigation measures, such as the format for line weighting, arrangement for tori lines (the length for pole, mainline, streamers) will also be necessary.

Acknowledgments

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Table 1 The observed trips, hooks of Taiwanese longline fleets by fleets in the three oceans from 2009 to 2015

Year	Atlantic		Pacific Ocean		Indian Ocean		Sum	
	Sets	thousand hooks	Sets	thousand hooks	Sets	thousand hooks	Sets	thousand hooks
2010	272	793	80	271	1171	3686	1523	4750
2011	423	1277	194	565	144	487	761	2329
2012	628	1743	322	999	718	2096	1668	4837
2013	379	712	488	1005	1560	3204	2427	4921
2014	462	1001	525	1130	1388	2818	2375	4949
2015	96	186	219	500	1069	2094	1384	2780
2016*	0	0	109	224	1627	3317	1736	3541
Sum	2260	5710	1937	4694	7677	17702	11874	28107

*: the efforts of total fleets of 2016 was not finalized yet, so the coverage rates was not estimated.

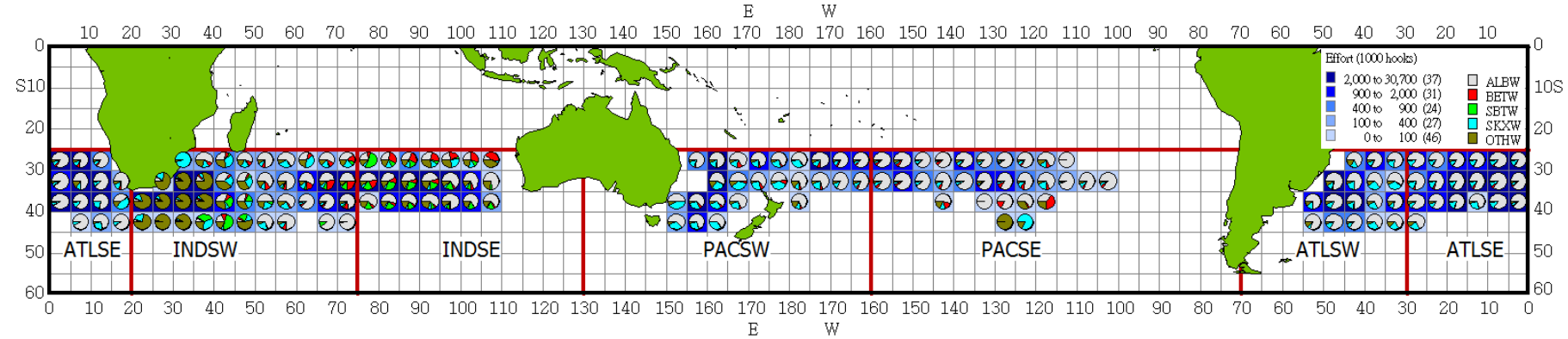
Table 2 Bycatch characteristics of seabird in the three Ocean

Types	Species	Atlantic	Pacific	Indian	Sum
Albatross_large	Wandering Albatross	9	14	26	49
	Antipodean Albatross		3		3
	Northern royal Albatross			2	2
Albatross_medium	Sooty Albatross	18		30	48
	White Capped Albatross	1	2	21	24
	Shy Albatross			6	6
	Light-Mantled Albatross			3	3
	Salvin'S Albatross			1	1
Albatross_small	Black-Browed Albatross	155	2	7	164
	Yellow-nosed Albatross	94		54	148
	Grey Headed Albatross	7	1	6	14
	Campbell Albatross		7		7
	Buller' S Albatross		2		2
Albatross		134	106	130	370
Seabird	White-chinned Petrel	134	9	112	255
	Great Shearwater	104			104
	Spectacled Petrel	66			66
	Flesh-footed Shearwater		6		6
	Grey Petrel	5	1		6
	Southern Giant Petrel	2	1	2	5
	Northern Giant Petrel	1		2	3
	Giant Petrels nei			2	2
	Wedge-Tailed Shearwater		2		2
	Maxn shearwater	1			1
	Westland Petrel		1		1
	Storm Petrel	2			2
	Other Shearwaters	20		9	29
	Other Petrel	7		19	26
	Other Seabird	2	3	9	14
Sum		762	160	441	1363

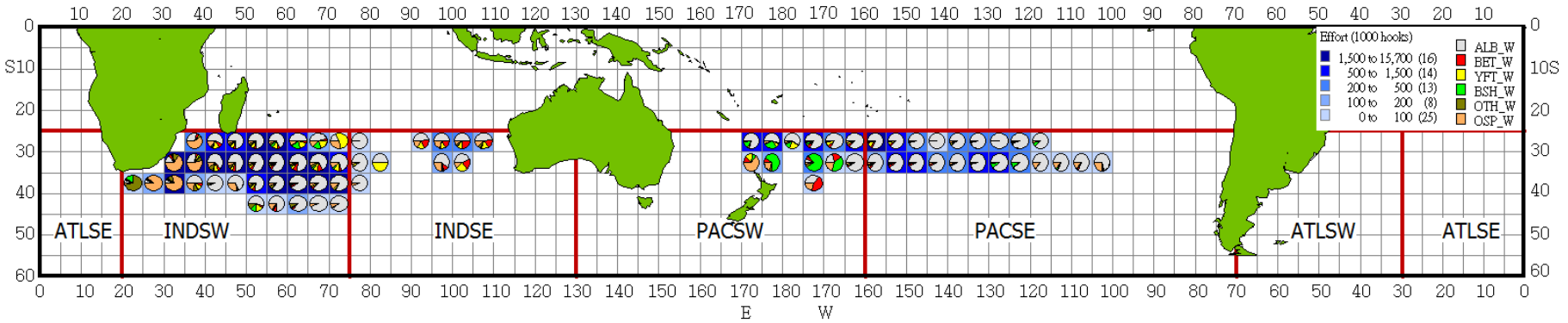
Table 3 Nominal seabirds bycatch rates by ocean by season

Unit: birds/1000 hooks

Ocean	Area	Season	Albatross large	Albatross medium	Albatross small	Albatross Other	Seabird	Sum
Atlantic	ATLSE	1	-	0.001	0.053	0.008	0.011	0.074
		2	0.003	0.008	0.074	0.047	**0.103**	**0.235**
		3	-	0.001	0.005	0.027	0.059	0.092
		4	-	-	-	-	-	-
	ATLSW	1	0.025	0.037	0.037	-	**0.172**	**0.270**
		2	0.003	0.001	0.095	0.001	0.045	0.146
		3	-	-	0.005	-	-	0.005
		4	-	-	-	-	-	-
Pacific	PACSE	2	-	-	-	-	0.006	0.006
		3	-	-	-	0.001	0.003	0.004
		4	0.004	-	0.004	0.004	-	0.012
	PACSW	1	0.036	-	0.004	**0.226**	0.052	**0.318**
		2	0.004	0.002	0.005	0.037	0.002	0.049
		3	0.001	-	0.002	-	0.001	0.005
		4	-	-	-	-	-	-
Indian	INDSE	2	0.001	0.006	0.005	0.006	0.001	0.018
		3	-	0.002	0.006	0.011	0.002	0.020
	INDSW	1	0.007	0.003	0.008	0.024	0.060	0.101
		2	0.003	0.006	0.000	0.004	0.012	0.026
		3	-	0.000	0.002	0.001	0.001	0.004
		4	0.003	-	-	0.003		0.006



(a)Large-scale tuna longline



(b)Small-scale tuna longline

Figure 1 Distribution of fishing efforts of Taiwanese tuna longline vessels in the southern Ocean between 2010-2015

Source: Overseas Fisheries Development Council.

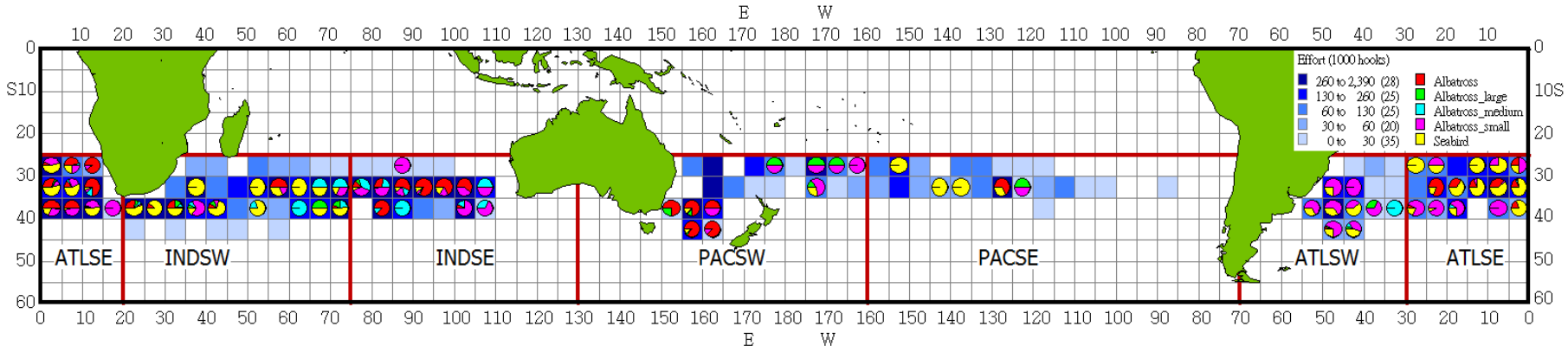


Figure 2 Distribution of observed efforts and composition of seabirds bycatch species of Taiwanese tuna longline vessels in the southern Ocean between 2010-2015

Source: Overseas Fisheries Development Council.

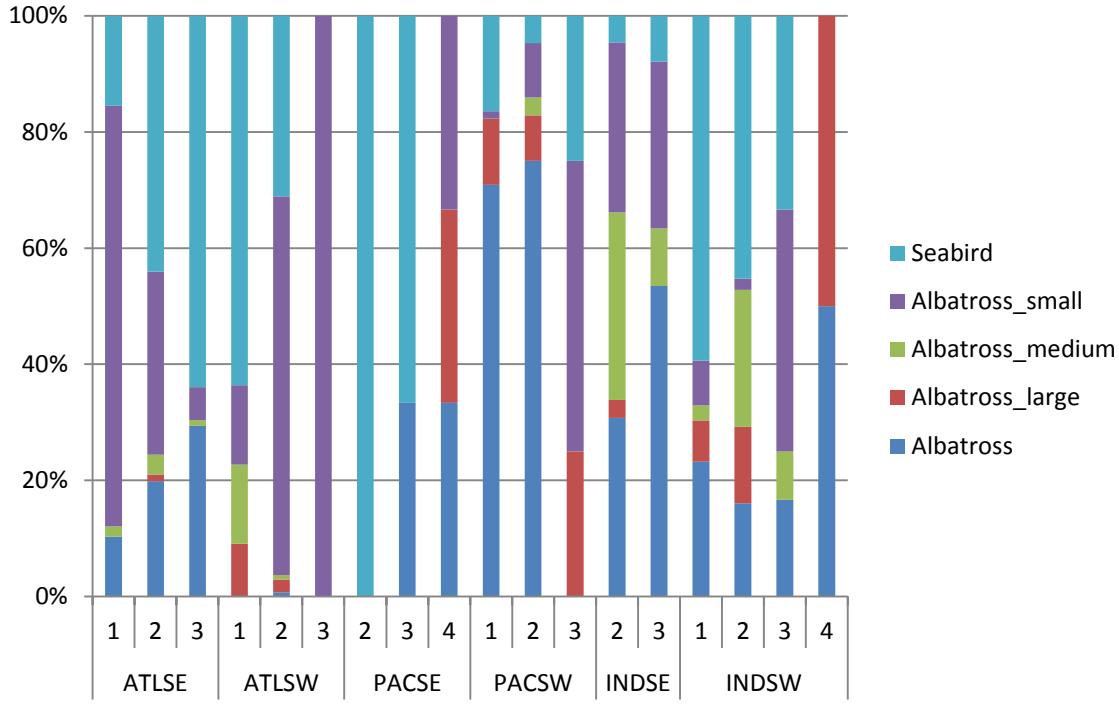


Figure 3 Seabirds bycatch species composition in the three oceans

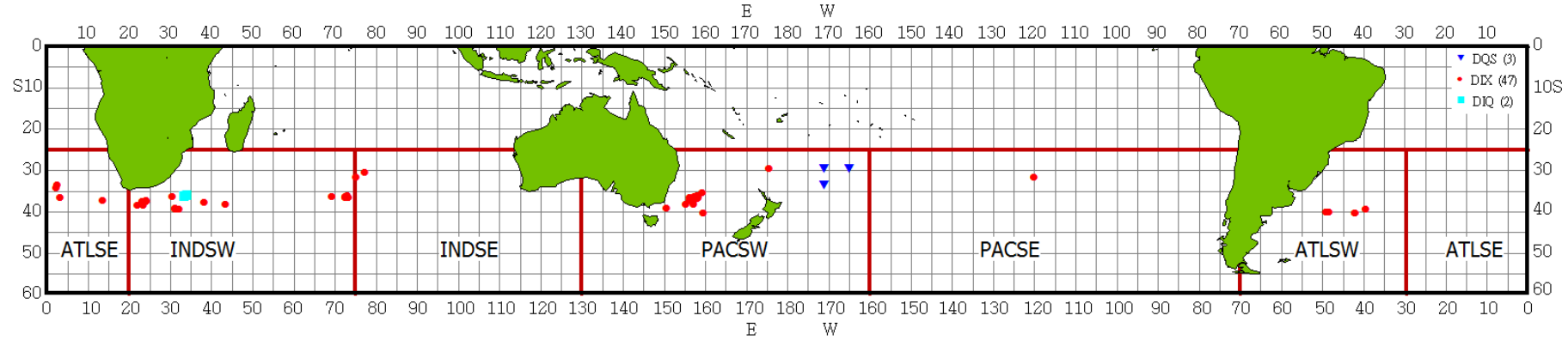


Figure 4 Distribution of bycatch large albatross (2010-2016)

Note: **DIQ:** Northern royal Albatross; **DIX:** Wandering Albatross; **DQS** Antipodean Albatross.

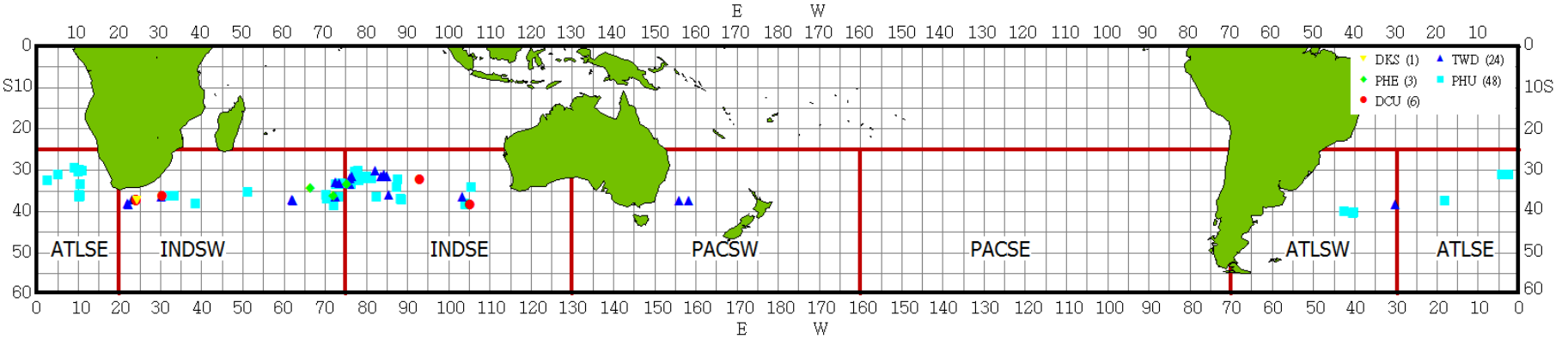


Figure 5 Distribution of bycatch medium albatross (2010-2016)

Note: DCU: Shy Albatross; DKS: Salvin'S Albatross; PHE: Light-Mantled Albatross; PHU: Sooty Albatross; TWD: White Capped Albatross.

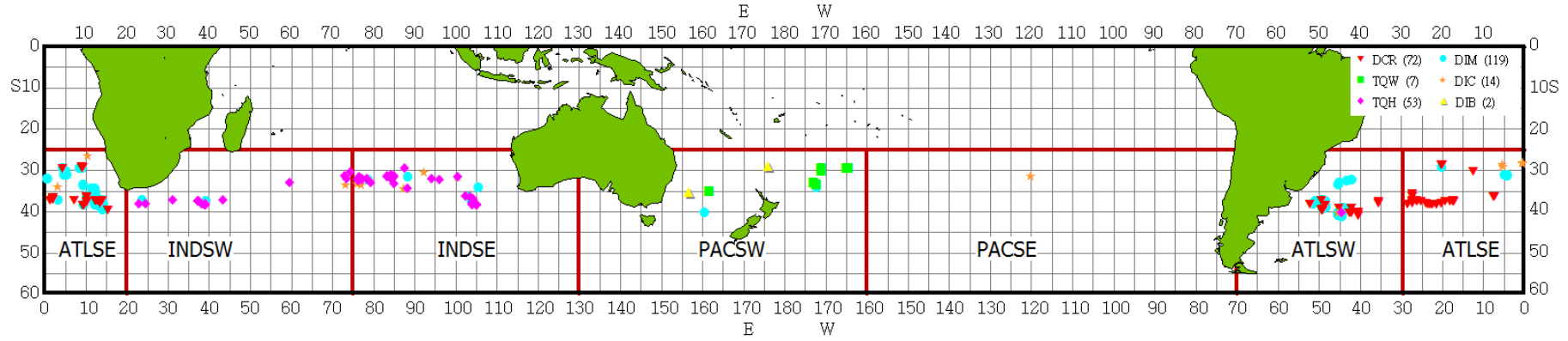


Figure 6 Distribution of bycatch small albatross (2010-2016)

Note: DCR:Yellow-nosed Albatross;DIB:Buller' S Albatross;DIC:Grey Headed Albatross;lDIM:Black-Browed Albatross;TQH:Yellow-nosed Albatross; TQW:Campbell Albatross.

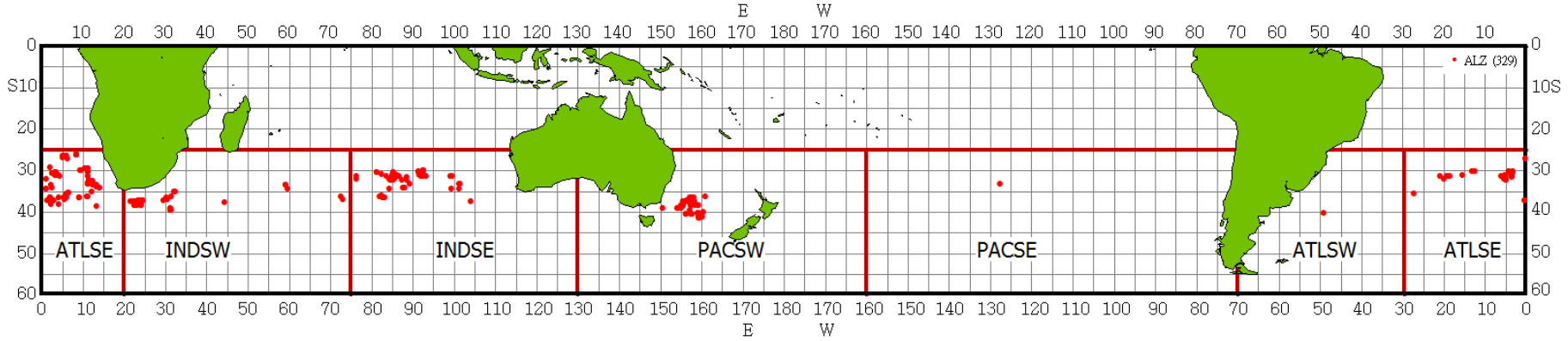


Figure 7 Distribution of other unknown albatross (2010-2016)

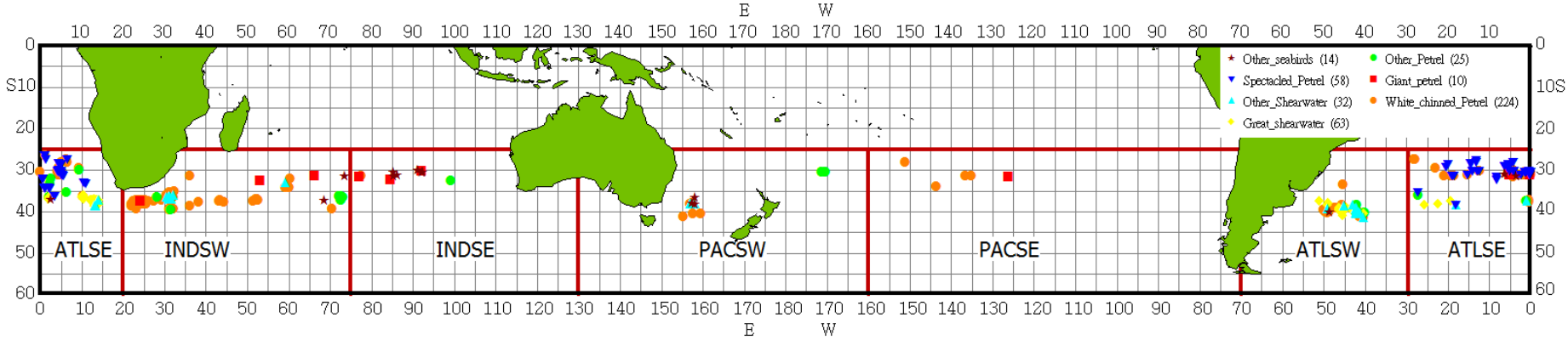


Figure 8 Distribution of other bycatch seabirds (2010-2016)

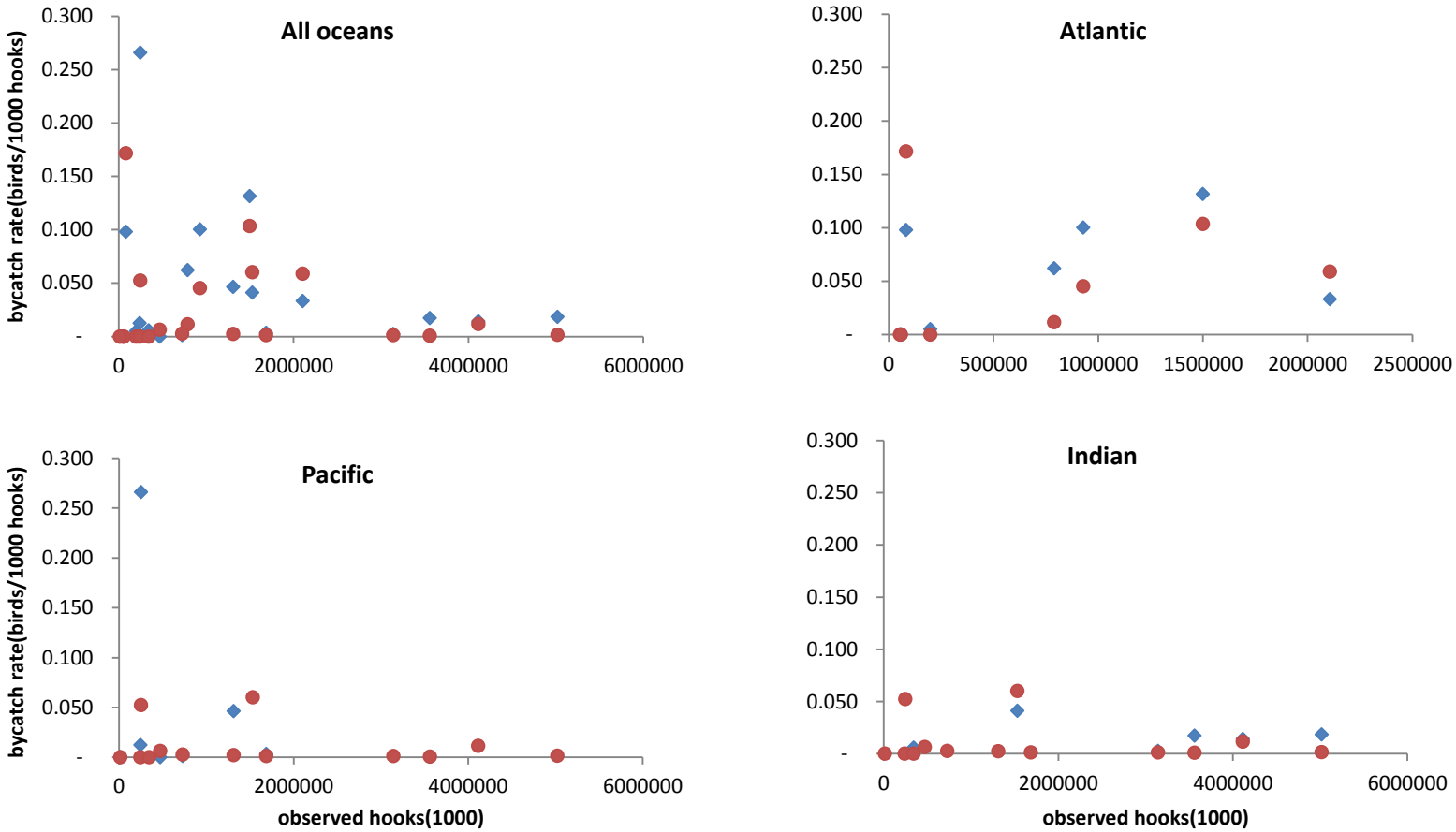


Figure 9 Relationships between bycatch rates and observed hooks

(The red circle was the bycatch rates for albatross and the blue square was other seabirds bycatch rates.