A radar image seabird identification method for analyzing the effects of FADs on seabirds

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1、INTRODUCTION

In tuna purse seining, dense seabird concentrations and slow flight speeds often indicate floating objects or surface concentrations of tuna (Itano 2003). There are at least six hypotheses to explain why pelagic fish associate with floating objects (Fréon and Laurent 2000) and why tuna distribution is affected by floating objects (Conand 1995; Marsac et al. 1998). However, few studies have focused on the potential impact of FADs on other marine organisms. The influence of anchored FADs, whether located offshore or near-shore, on seabirds has been tested but there is no precise idea of the real relationship between seabirds and floating objects (Jaquemet et al. 2004). A fishing vessel's radar is an effective instrument for observing the distribution, migration, and behavior characteristics of seabirds (Alerstam 1993; Bertram 1999; Mateos 2011). The purpose of our study was to use seabird radar images to determine the distribution characteristics of seabirds near FADs and in areas without FADs. We also tried to develop a more scientific and effective method for interpreting radar images. For this purpose, we examined geographical factors such as latitude and longitude with the presence of FADs.

2、Materials

An experienced skipper of tuna purse seiner is adept at using radar that has been tuned to detect the presence of tuna schools or FADs. From February 14, 2021, to May 7, 2021, a researcher from Shanghai Ocean University worked aboard the tuna purse seine fishing vessel, "Zhongtai 7," operating in the central and western Pacific Ocean (latitude [0.05° S–5.90° S], longitude [161.38° E–179.79° E], Fig. 1). The researcher used a 12-megapixel wide-angle camera to capture images of the seabird-dedicated radar screen. This radar (marine surveillance radar FAR-2157(-BB), S-Band (60 kw), X-Band (50 kw), and Furuno) scanned a circular area of 16-NM radius around the boat. The images were saved as. jpg files and analyzed after the survey was completed. A total of 174 images collected over 82 days were selected for further analysis. At the same time, the researcher recorded statistical information of "Zhongtai 7" that found FADs dropped by other tuna purse seiners, which included information on when or where the FADs were found. The time and location of the FADs matched the radar images.

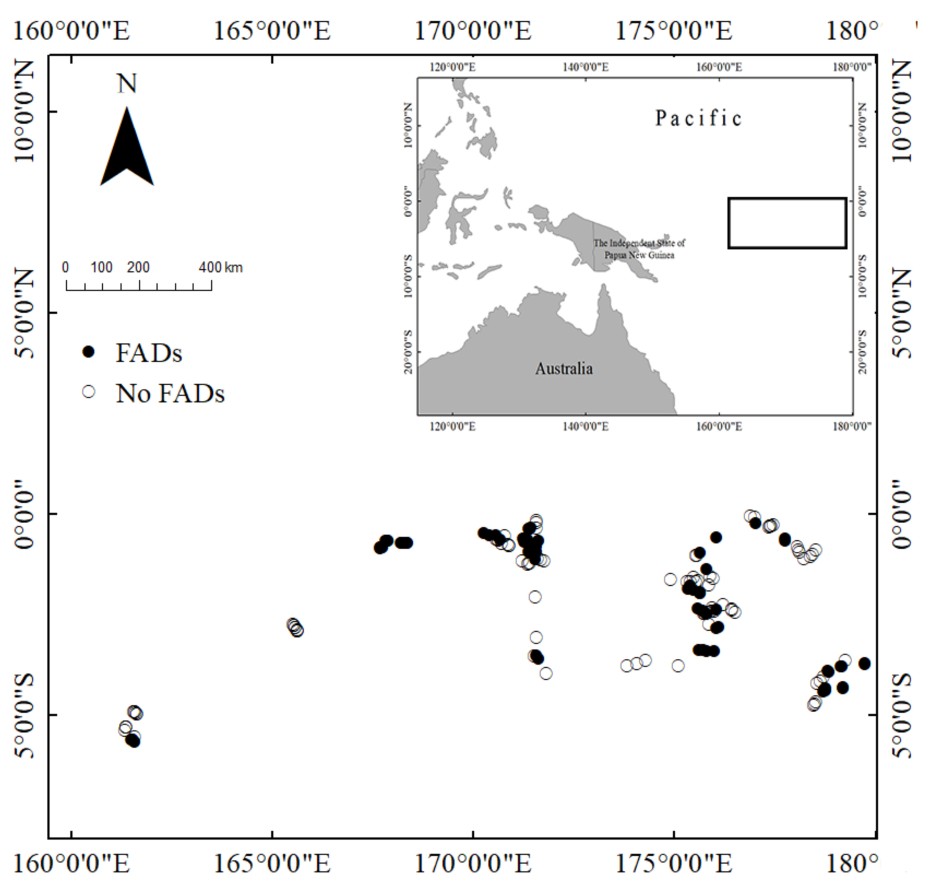

Fig. The survey area and radar sampling sites in the Kiribati (FADs: seabirds around FADs, no FADs: seabirds without FADs)

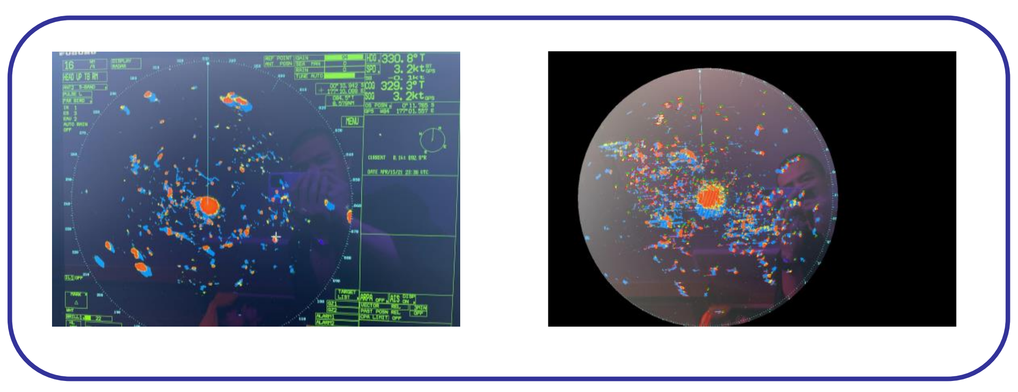

Fig. radar image processing diagram

3、METHODS

(1)For each validated cluster (seabird-echoes) showing the position and movement path of seabirds, we used findContours, a fundamental function in OpenCV, to detect the points alongside the boundary for the image provided by the coder with the same intensity in terms of pixels. Knowing the radar disk range of 2758.49 km2 and the pixel number n, we could calculate the area of each pixel (2758.49/n km2) and then convert the area occupied by each cluster from pixels to km2.

(2) The time and place where the FADs and driftwood were detected by the "Zhongtai 7" was recorded by the radio officer. In theory, when the unique limitation is the line-of-sight range to the ocean horizon, a seabird's ability to detect any visual cue is estimated to reach no more than 20–50 km. Therefore, seabird echoes within 50 km of FADs or driftwood were noted.

(3)A Generalized Additive Mixed Model (GAMM)

$$g(y) = \beta_0 + s(lat) + s(long) + \tilde{R} + \varepsilon$$

4、RESULTS

FADs effect on cluster number and seabird area

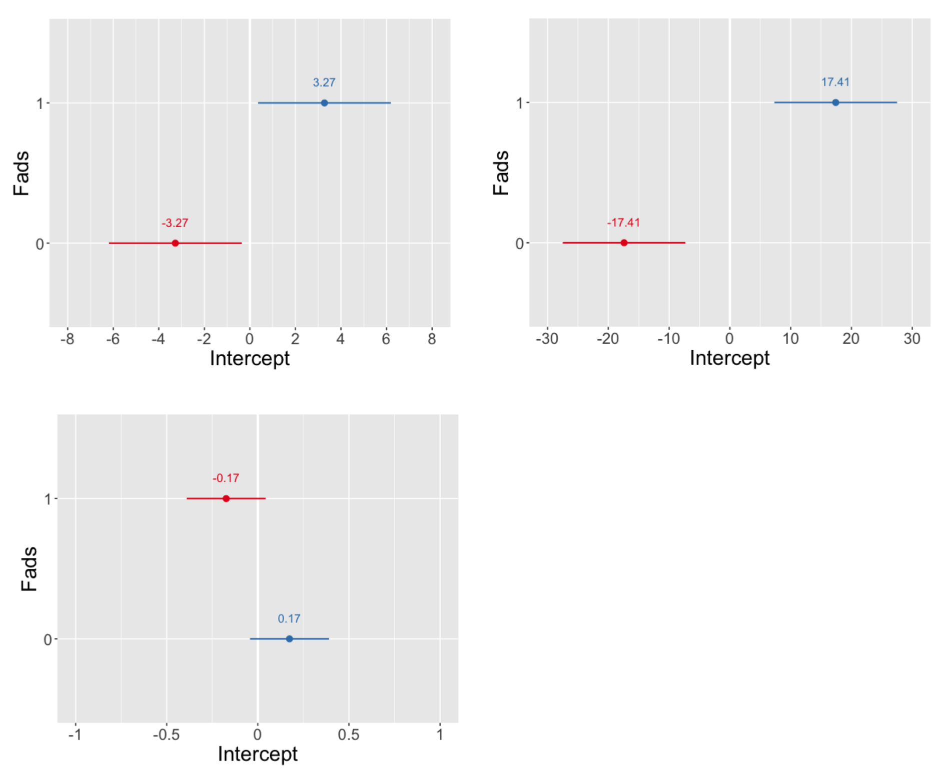

Fig. (a) random effect of seabird number, (b) random effect of seabird area, and (c) random effect of seabird activity level.

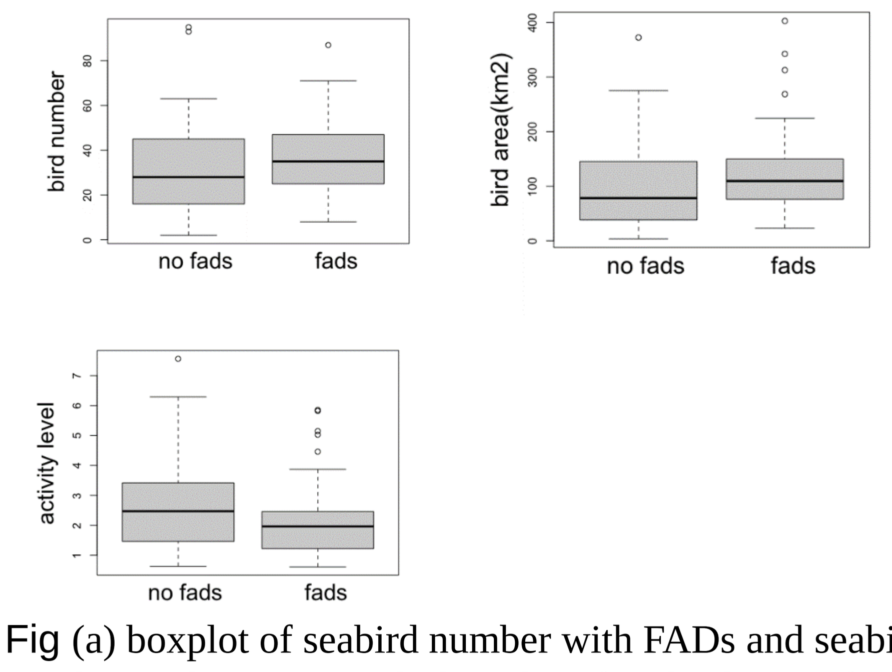

Fig (a) boxplot of seabird number with FADs and seabird number without FADs, (b) boxplot of seabird area of FADs and seabird area without FADs, and (c) boxplot of seabird activity level with FADs and seabird activity level without FADs.

5、RESULTS

Non-linear relationships with location variables

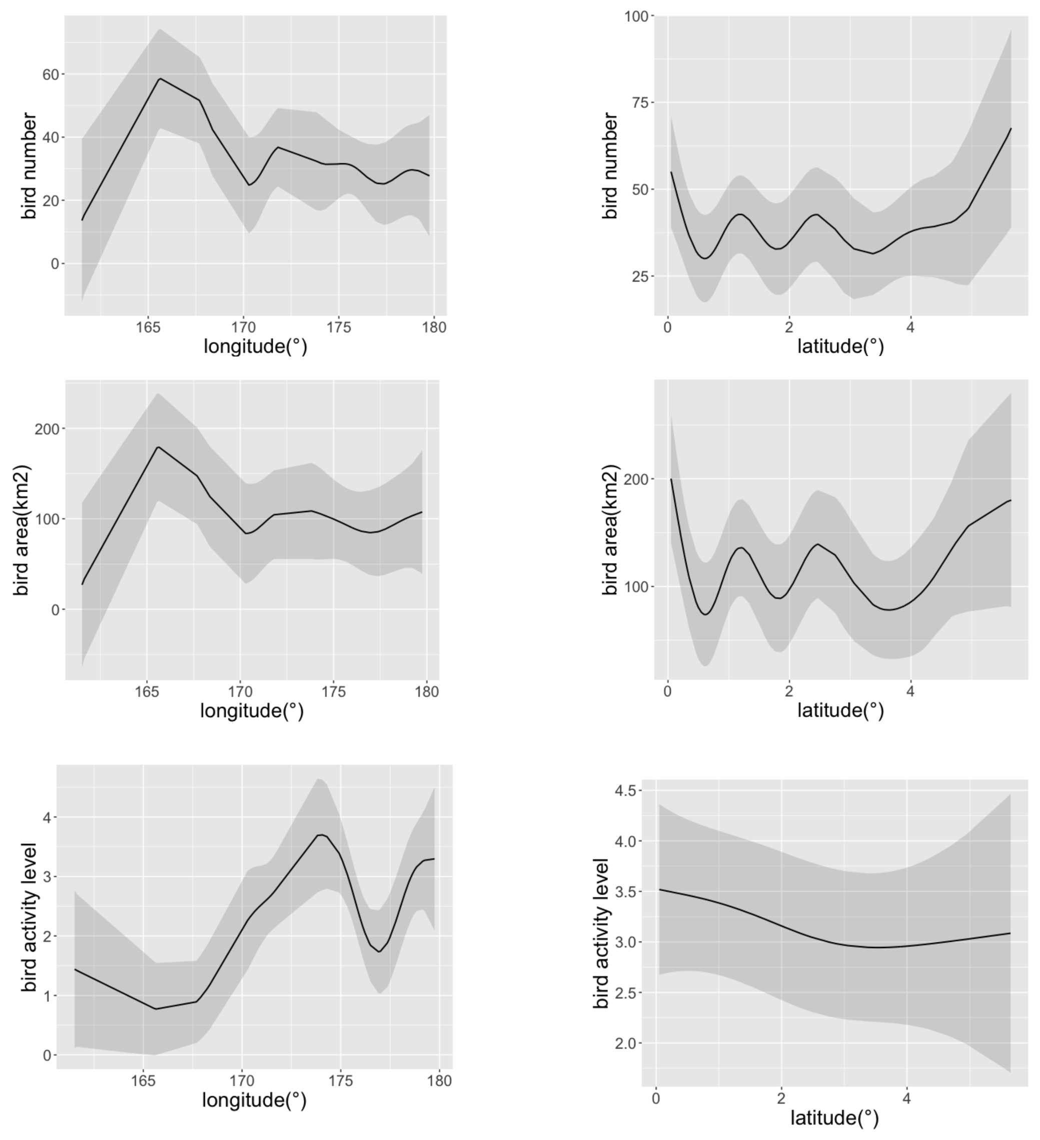

Fig. The relationships between location variables and response variables. Note: The numbers shown on the vertical axis in each plot indicate the response variable. Solid lines represent the estimated effects of location variables. Shaded regions denote 95% confidence intervals.

6、CONCLUSIONS

To the best of our knowledge, this is the first study on the potential influence of drifting FADs on seabirds at sea using tuna purse seiner radar. In the open ocean, where the occurrence of prey and drifting FADs are patchy, the impact of FADs is more pronounced than it is closer to shore. The impact of FADs on seabirds has been studied. Sébastien Jaquemet et al. (2004) determined that seabirds would take advantage of the attractive power of FADs during feeding or foraging. Across et al. (2000) observed some seabirds associated with drifting FADs during their feeding season. It is well known that tuna and other fish are attracted by floating objects, which makes them easier to catch. The FAD fishing method is used by thousands of fleets all over the world (Scott et al. 2014). FADs also mean more opportunities for seabirds to feed. Seabirds have been observed sitting on FADs, suggesting that FADs may provide temporary resting places for seabirds at sea. Our study confirmed that FADs have an attractive effect on seabirds. FADs have more clusters of seabirds and a larger area of seabirds around them than areas without FADs. There is also lower seabird activity level around FADs due to foraging or resting behavior.

Our study also described the spatial distribution characteristics of seabirds. Bird number and bird area are similar and have similar trends with respect to latitude and longitude. However, bird activity level has the opposite trend, in that birds move faster in areas where seabirds are fewer. Camille Assali et al. (2016) suggested that seabird clusters represent a foraging network. Seabirds tend to concentrate in places where prey are abundant rather than where productivity is low (such as in tropical areas) (Ribic et al. 1997; Mills 1998). Therefore, high density or slow movement of seabirds can indicate a potential fishing ground. In order to provide a more precise prediction of FADs or fish locations, studies must collect more seabird radar images that describe seabirds around FADs or fish shoals.

Founding:

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