J-T-RFMO FAD WG 2019_ESCALLE_S:07

Recently available dFAD tracking data in the WCPO: challenges, new research areas and potential useful tool to guide management

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Summary

With the arrival of satellite and echo-sounder buoys, the use of drifting Fish Aggregating Devices (dFADs) by purse seiners has increased globally in the last few decades. The Parties to the Nauru Agreement (PNA) implemented a dFAD tracking programme in 2016, with a requirement to provide positions of satellite buoys attached to dFADs used by purse seiners within the PNA EEZs. These data, comprising more than 38,000 satellite buoy trajectories in the WCPO between 2016–2018, along with fishing data (logsheet, observer and VMS) provided detailed insights into fishery and dFAD behaviour. This investigation assessed the deployment and drifting behaviour of dFADs in the WCPO, as well as main areas of deployment, dFAD densities, dFAD connectivity between EEZs, and dFAD beaching events. The number of dFADs used by vessel was also estimated, with most vessels deploying less than 350 buoys per year. This corresponds to an estimated total of 30,000–65,000 buoys (re)deployed annually in the whole WCPO in 2016 and 2017. Preliminary analysis of the influence of dFAD densities on CPUE indicated a slight decrease of total tuna CPUE on dFAD sets with increasing dFAD density. While comprising limitations, such dataset could help guide management of purse seine fisheries.

Introduction

The use of drifting Fish Aggregating Devices (dFADs) by tropical tuna purse seiners has increased globally in the last few decades, particularly with the arrival of new technological developments to track dFAD locations such as satellite and echo-sounder buoys (Fonteneau et al., 2013; Lopez et al., 2014). In the Western and Central Pacific Ocean (WCPO) the number of sets on artificial dFADs has increased almost continuously since the 1990s and is currently more widely performed than sets on natural logs. In 2013, the number of dFADs deployed in the WCPO was estimated at more than 30,000 per year (Gershman et al., 2015) and considered likely to have increased every year since. While the number of active buoys at any time and the precise number of dFAD deployments per year is currently unknown, last year the Commission implemented a limit of 350 dFADs with activated instrumented buoys (activation on board only) per vessel at any given time (WCPFC CMM-2017-01). To reduce the impact of dFAD fishing on tuna stocks, specifically due to the high capture of juvenile bigeye tuna on dFAD associated sets (Harley et al., 2015), the Parties to the Nauru Agreement (PNA) and WCPFC implemented a three to four months dFAD closure where all dFAD-related activities (e.g. fishing, deployment, servicing) are prohibited (e.g. CMM-2017-01). Recently, the PNA implemented a upgraded dFAD tracking programme to improve understanding of dFAD dynamics and fleet behaviour and to inform management options.

Material and Methods

The dataset comprised location and time information from satellite buoys deployed on dFADs in 2016–2018. First cleaning processes included the removal of buoys with less than 10 transmissions, active for less than seven days or with only transmissions from the same position. Additional processing of the data consisted of classifying each transmission into "at-sea" or "on-board" positions using a Random Forest model and additional corrections to reduce segmentation rates following the method of Maufroy et al., (2015). The cleaned database consisted of 19.3 million transmissions from 36,041 satellite buoys reported by 74 fishing companies. Each buoy trajectory was divided into at-sea and on-board segments to focus on the actual drift part of a trajectory. Note that buoy transmissions were also modified prior to data submissions, with information outside PNA waters removed by the service provider. In addition, the transmissions of dFAD tracking data remains incomplete for some fishing companies, complicating the estimations of the number of dFAD used in the WCPO, as well as adding a bias to any analyses of the dataset.

Results and Discussion

For the three years studied, a large proportion of the deployments occurred in Kiribati south of the Gilbert Islands, north of the Tuvalu and Nauru EEZs, as well as in the Kiribati EEZ east of the Phoenix Islands in 2017 and 2018. The average drift time and straight-line drift distance are of 3 months and 1,080 km, whereas the average active time (including on-board sections) is 6 months with an average distance between first and last position of 1,685 km.

The distribution of drifting buoy density indicated areas with higher dFAD density in Kiribati south of the Gilbert Islands and around the Phoenix Islands; Tuvalu; Papua New Guinea; and the Solomon Islands (Figure 1). Models over all PNA waters were developed to study the influence of dFAD density and CPUE and showed increasing number of dFAD sets with increasing dFAD density, but also a decrease in skipjack CPUE in a 1° cell with monthly dFAD density of 100 dFADs /1° cell or more (GAM models explained 6.5–18.4% of variability). Finally, the number of active dFADs used per vessel was estimated and few/no vessels would have more than 350 active FADs in the water, at any given time. In addition, at the scale of the WCPO, it was estimated that 30,700–64,900 buoys were (re)deployed annually in 2016–2017; corresponding to 26,200–48,200 active dFADs per year in 2016–2017.

The position of buoys at the end of their trajectories was investigated to study the fate of dFADs, considering that a dFAD was lost when drifting outside the fishing ground of the company owning it (where the majority of that company's vessels were fishing). On that basis, 51.8% of dFADs were classed as lost, 10.1% were retrieved; 6.7% were beached, 15.4% were sunk, stolen or had a malfunctioning buoy; and 14.0% were deactivated by the fishing company and left drifting unmonitored at sea. In addition, the distance between last position of lost dFADs and core fishing ground of the company owning the dFAD was of 1,000–2,700 km, with an average of 2,000 km.

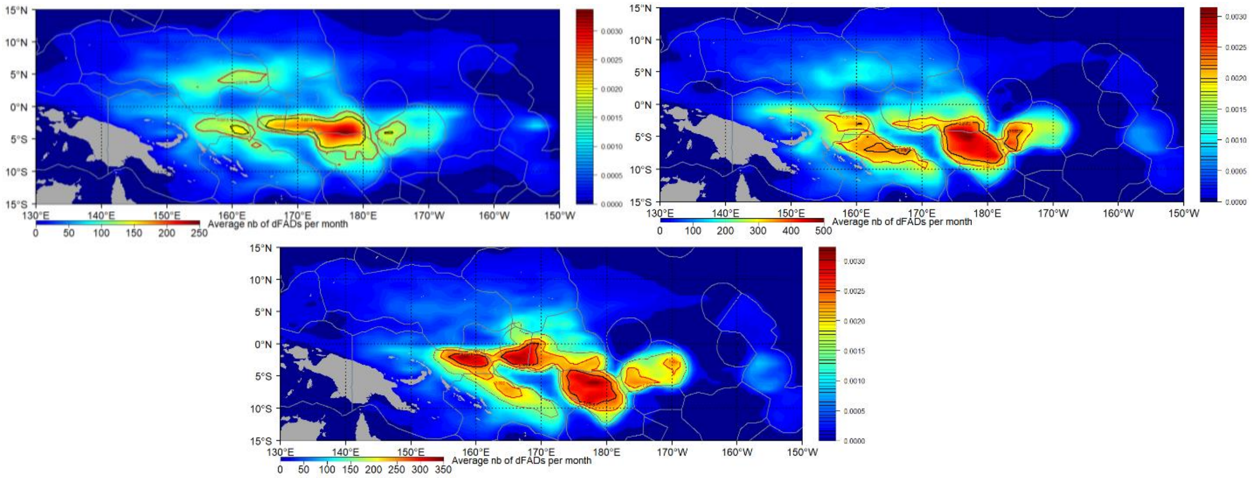

FIGURE 1. Smoothed kernel density of the average number of FAD satellite buoys transmitting at least once per month and per 1° grid cell during 2016 (top-left), 2017 (top-right) and 2018 (bottom). Red lines correspond to the 95th quantile.

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