The Distribution, Composition and Management of Derelict Drifting Fish Aggregating Devices (dFADs) in the North Atlantic Ocean

La Distribución, Composición y Manejo de Dispositivos de Agregación de Peces a la Deriva (dFADs) Abandonados en el Océano Atlántico Norte

La Distribution, Composition et la Gestion des Dispositifs de Concentration du Poisson Dérivants (dFADs) abandonnés dans l'océan Atlantique Nord

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EXTENDED ABSTRACT

The use of floating objects to enhance fishing success has been documented for thousands of years, as numerous species of fishes are attracted to regions of high rugosity and the shelter that can be found in such areas. The term Fish Aggregating Devices (FADs) commonly refers to any man-made object intentionally deployed to increase the catch size and the efficiency of harvesting target species; drifting FADs (dFADs) move with local currents rather than being anchored in one location. An estimated 81,000-121,000 dFADs are deployed annually around the world (Gershman et al. 2015). Atlantic dFADs are commonly composed of a floating raft, a satellite-linked GPS beacon buoy, and a subsurface component known as an aggregator or a curtain that serves to attract fish. The raft provides buoyancy, while the buoy allows the deploying vessel to remotely monitor the location of the dFAD and any aggregations of fish underneath with the use of sonar. Atlantic dFADs are often deployed in the Gulf of Guinea to target tunas, and as a result of their remote monitoring and passive nature, can be lost or abandoned for numerous reasons, including inclement weather. Many dFADs are also abandoned as they drift too far for economically feasible recovery. Their westward drift with prevailing currents brings many derelict dFADs into the greater Caribbean region. Such dFADs are considered abandoned, lost, or otherwise discarded fishing gear (ALDFG), and pose a significant risk to pelagic, coastal, and benthic ecosystems. Imzilen et al. (2021) reported that 19-22% of all dFAD deployments in the Atlantic Ocean end in a beaching event, and that this rate was consistent year-round despite fluctuations in prevailing circulation patterns resulting from the Atlantic hurricane season.

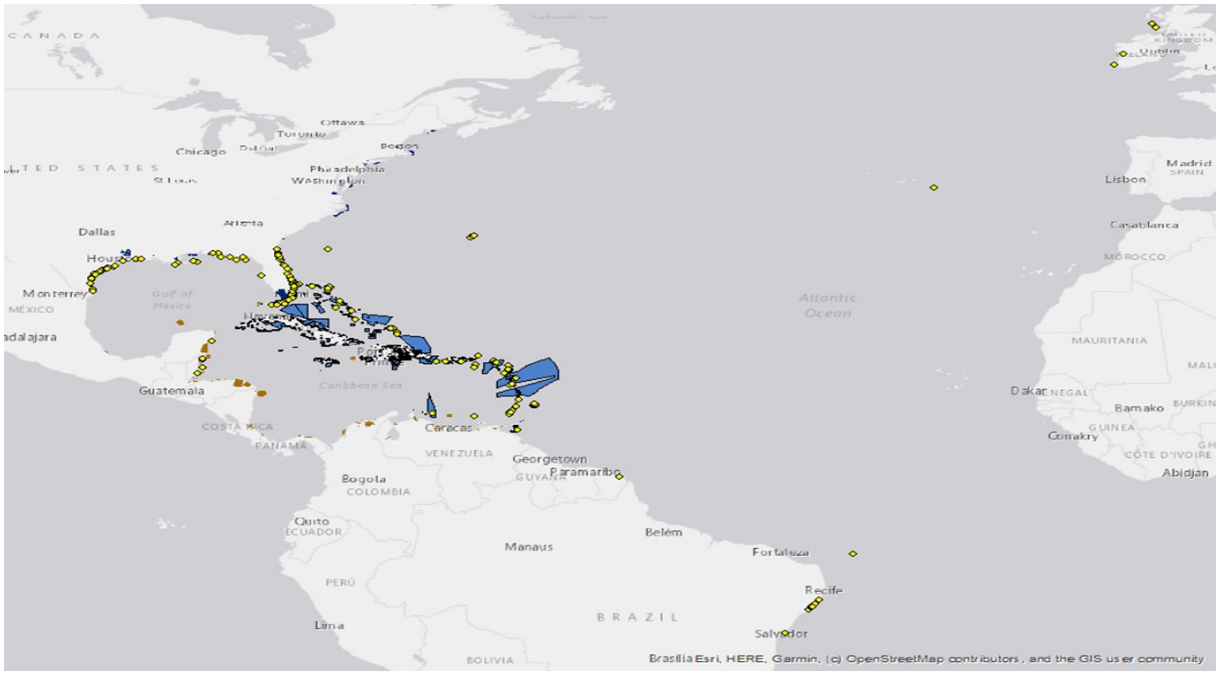

Figure 1. . A visual comparison of all beaching locations of FADs reported to the Caribbean FAD Tracking Project from May 1999 – November 2021 and United States State Parks and National Parks, Marine Protected Areas, and other designated conservation areas. Yellow dots represent beached FADs, dark blue polygons represent United States parks, and orange and blue polygons represent Caribbean Marine Protected Areas and other conservation regions. Map made with ArcGIS ArcMap 10.8.

The governing body that oversees the Atlantic purse seine fishery is the International Commission for the Conservation of Atlantic Tuna (ICCAT). Over the course of the past three decades, ICCAT has imposed mandatory Recommendations (Rec.) regarding FAD use, deployment, construction, identification and more. To reduce the risk of megafauna entanglement, all FADs deployed by ICCAT Contracting Parties and Cooperating Non-contracting Parties (CPCs) may not have a net cover or net aggregator (ICCAT 2020). Additionally, marking on FAD buoys must be legible or the FAD may not be deployed. To date, there is no additional guidance regarding the specifications of FAD buoy marking, however. Due to this lack of identification markings, attributing ownership of derelict FADs is a challenge, and cleanup and removal costs are often left to the local jurisdiction in which the FAD beached. Although it is widely accepted that dFAD use is prolific in the Atlantic Ocean, and is growing globally on an annual basis, there is little understanding regarding the number of derelict dFADs in the basin, nor where they are beaching, what they are composed of, and if they are compliant with ICCAT Rec. 19-02. To address this gap in knowledge, the Caribbean FAD Tracking Project (CFTP) was established in 2019 to document derelict dFADs in the North Atlantic Ocean and greater Caribbean region.

Due to the widespread use and nature of derelict dFADs, this study collected reports from the North Atlantic Ocean, Caribbean Sea, and the Gulf of Mexico. Reports of derelict FADs were found online through keyword searches using terms such as “bamboo raft” and “buoy on beach” on social media, search engines, and independent blogs. The CFTP also solicited reports of derelict, beached FADs from citizen scientists, conservation organizations, beachcomber groups, and local and federal government organizations around the Caribbean. All reports were asked to include information such as the find date and location, and photos that included all aspects of the FAD. These photos were used to determine raft and buoy make and model, as well as identify the presence of a raft cover or aggregator, document post-manufacture markings, entanglements, and any other notable occurrences. Compliance of reported FADs with ICCAT Rec. 19-02 was designated through examination of the FAD components documented in these images. Statistical analyses including Chi-square tests and Multivariate Analyses of Variance (MANOVA) were run in RStudio 4.0.3. Chi-square tests determined if there was a significant difference in the number of several categorical variables; FAD rafts composed of different materials such as bamboo, PVC, or 5L polyethylene containers, the number of derelict FADs found during the Atlantic hurricane season (June 1st – November 30th) and during the dry season, as well as the number of compliant and non-compliant FADs, and FADs of uncertain compliance. MANOVAs were run to determine if there were significant differences in the number of FAD rafts of different materials and FADs of

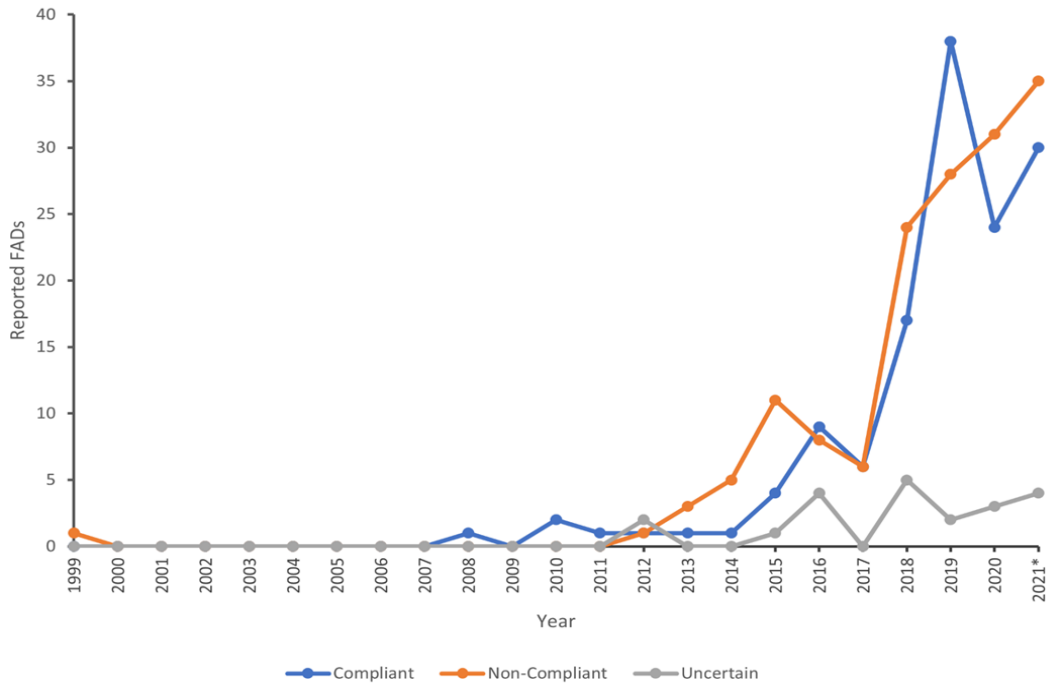

Figure 2. The number of reports received per year by the Caribbean FAD Tracking Project by all methods of communication (Email, Facebook, personal communication), categorized by compliance with mandatory ICCAT Rec. 19-02. Compliance was determined by reference to reports and associated photographs. Asterix (*) indicates an incomplete year of data collection

various levels of compliance with ICCAT Rec. 19-02 over time.

A total of 317 derelict FADs were reported to the CFTP dating from May 1999 to November 2021. These FADs were found in 27 countries bordering the Atlantic Ocean and nearly one quarter (n = 68, 22.7%) of all reported FADs were found in United States State or National Parks, in Marine Protected Areas, or other conservation regions where commercial fishing is restricted, if not prohibited (Fig. 1). There was no significant difference in the number of derelict FADs reported during the Atlantic hurricane and dry seasons ($\chi^2 = 1.8947$, df = 1, p = 0.1687), consistent with the findings of Imzilen et al. (2021). The construction of dFAD rafts differs significantly ($\chi^2 = 389.68$, df = 8, p < 2.2e-16), with synthetic materials utilized with increasing frequency. Of the 184 dFAD rafts reported to the CFTP, the majority were photographed and analyzed to determine compliance (n = 179, 96.8%). Seventy-three FADs had a net cover, while 37 had a net aggregator, totaling 96 (51.9%) non-compliant FADs, although some FADs may have been deployed prior to changes in recommendations and may have aged out of compliance. Reports of 217 dFAD buoys were documented, with photographs supplementing the majority of reports (n = 212, 97.7%). Of the photographed reports, 178 (84%) bore a post-manufacture mark, of which over half (n = 122, 68.5%) were legible and compliant with ICCAT Rec. 19-02 specifications, and one third of all reported buoys (n = 64, 32%) were non-compliant at the time of reporting. Of all reported FADs, only 39 (12.3%) could be tentatively attributed to a vessel or flag state based on post-manufacture markings. A total of 155 (50.3%) photographed dFADs were non-compliant with some aspect of ICCAT Rec. 19-02 (Fig. 2). Three deceased sea turtles were reported entangled in FADs: two green sea turtles (*Chelonia mydas*) and one unidentified species.

The FADs reported to the CFTP represent a fraction of the total number of FADs in the Atlantic Ocean, derelict or active. Based on the most recent estimates of the number of FADs deployed in the Atlantic annually, and the average number of deployments that end in a beaching event, it is likely that the 317 reported FADs make up anywhere from 1.19-6.83% of the number of derelict dFADs in the Atlantic Ocean that were deployed that year. This estimate does not include FADs that remain adrift from previous years. Although these FADs represent a fraction of those in the Atlantic Ocean and Caribbean Sea, they offer insight to the shortcomings of current management efforts and compliance. The lack of specificity regarding a post-manufacture marking scheme to indicate ownership results in a challenge to attribute accountability for derelict FADs, as only 12.2% of all reported FADs could be tentatively attributed to a deploying vessel. Additionally, without open access to ICCAT records of FAD deployments or ownership, it is nearly impossible to determine when a FAD was deployed, as FADs may age out of compliance or be deployed without regard to ICCAT specifications. Systematic observational studies are recommended to gain additional insight into FAD construction to recommend best practices to reduce entanglements, as well as to establish an effective post-manufacture marking scheme to indicate ownership. Surveys of fishers that use dFADs could offer insight into the rationale for FAD abandonment which could be used to limit such actions in the future. The FADs reported to the CFTP represent a small portion of the total number of FADs in the Atlantic Ocean, yet their distribution and the understanding that FAD use is becoming more prolific suggests that derelict FADs will continue to appear along Atlantic coastlines, bringing with them the threats that so often accompany ALDFG. The greater Caribbean region will face continued adverse effects if sufficient mitigation efforts and enforcement are not put in place to curb the impact of derelict FADs in the Atlantic and greater Caribbean region.

KEYWORDS: Derelict gear, ICCAT recommendations, t-RFMO, Marine debris, ALDFG

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