Towards the use of non-entangling and biodegradable dFADs: actions to mitigate their negative effects in the ecosystem

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Abstract

In the last decades, science-industry active collaboration has resulted in actions aiming at mitigating the potential negative effects of drifting fish aggregating devices (dFADs) on marine species and ecosystems. The increasing use of dFADs in tropical tuna fisheries has moved scientists and the EU fleet to search for solutions in oceans where they operate. These actions mainly seek to avoid entanglement and promote release of vulnerable species through voluntary adoption of a Code of Good Practices. Besides the efforts to promote the use of non-entangling dFADs (NEFADs), the actions are recently being focused on the use of natural origin materials for dFAD construction to reduce marine litter and impacts when dFAD beaching occurs in sensitive areas like coral reefs. This document summarizes the main actions put in place at global scale by the EU tropical tuna purse seine (PS) fishery: i) ISSF Skippers Workshops, ii) Code of Good Practices, and iii) small and large-scale trials for biodegradable dFADs.

Introduction

Nowadays, about half of the tropical tuna caught worldwide is fished by PS with dFADs and the EU and associated tropical tuna PS fleet is responsible of around 10%. dFAD have developed together with available technology improving fishing efficiency in terms of search time and successful catch rates (Dagorn et al., 2012; Lopez et al., 2014). Similarly, dFADs construction materials have also evolved, looking for higher resistance to increase dFAD durability, using synthetic materials, mainly petroleum derived products, which are extremely durable (Moreno et al 2017a). Moreover, to attain slower drifting and higher aggregation potential of the dFAD the tail configuration has been adapted and depth increased (Table 1 and Figure 1). All these synthetic materials can contribute to the increasing problematic of marine litter (Dagorn et al., 2012) and potential disruption to ecosystems like coral reefs, mangroves or beaches (Maufroy et al., 2015). The use of potential entangling materials like nets with large mesh size (e.g. >7cm) and inadequate configuration of raft and underwater part of the dFADs (e.g. open net panels) are responsible for most entanglement events of sensitive species like turtles and sharks (Filmalter et al., 2013; Lopez et al., 2017). t-RFMOs have adopted bycatch mitigation measures through recommendations and resolutions for the use of non-entangling dFADs and use of more sustainable materials (i.e., biodegradable materials) in their construction (conservation and management measures in place: IATTC C-18-05; ICCAT, Rec. 16-01; IOTC: Res. 18/08; WCPFO CMM 18-01). These measures have also been implemented as sustainable fishing standards by tuna processors and retailers as well. In this scenario, the EU fleet, in collaboration with research institutes, is making significant efforts to improve dFAD designs, reduce the impact of these floating objects in the ecosystem, and to commit with RFMOs requirements and the most demanding international sustainability standards; as follows:

1. ISSF (International Seafood Sustainability Foundation) Skippers workshops with EU fleet

Since 2009, ISSF has been organizing bycatch mitigation workshops with tropical tuna fishers around the globe with over 90 workshops and 25 fleets participating (Murua et al., 2019). Fishers from OPAGAC/ANABAC/ORTHONGEL companies operating in the Indian, Atlantic and Pacific Oceans have regularly attended ISSF Skippers Workshops organized in Spain, France, Seychelles and Mauritius. An important element of the workshops in recent years has been finding ways to minimize the impact of dFAD structures on the ecosystem, such as ghost fishing and marine pollution. In addition, an anonymous questionnaire is filled in by participants providing useful information on current fishing practices. Based on results from the questionnaires in 2017 for the Spanish and French fleets, participants informed that high entanglement risk dFADs with open wide mesh purse seiner nets are no longer used by any EU vessels operating in the Indian, Atlantic and Pacific.

Most dFADs' tails are constructed with small mesh (< 7 cm) and/or mesh tied in bundles (i.e, Low Entanglement Risk FAD; LERFAD). Only in the Indian Ocean there is a significant proportion of NEFADs (35%) constructed with no netting according to consulted fishers. dFAD depth in recent years has been increasing in most oceans and fleets. The dominant depth classes for the different oceans were between 40 and 80 m for the EU fleet. In regard to materials to construct the dFAD's raft frame, bamboo continues to be an important element, especially the Eastern Pacific Ocean for the Spanish and in the Atlantic and Indian Ocean for the French. In recent years, galvanized metallic tube frames has gained importance due to their durability and lighter weight. The materials to provide flotation support vary between oceans and fleets: net corks are the main component for French fleet while for Spanish PVC pipes is the main component in Pacific, old PS net corks or plastic corks in the Indian Ocean and cork and plastic containers in the Atlantic Ocean. The desirable lifetime of biodegradable dFAD is also ocean dependent being between 8-11 months. Gaining insight on a yearly basis into what kinds of dFADs, including designs and materials, are being used by different fleets in all oceans is very useful to evaluate possible impacts in the ecosystem and find mitigation solutions.

2. Code of Good Practices and specific programs onboard EU purse seiners: use of non-entangling dFADs and a verification system

The use of non-entangling dFAD is promoted by EU fleet during last years. French fleet through the specific programs like "CAT DCP éco", "Requins" and "CAT Sélectivité" has modified dFAD construction to eradicate the entanglement of sensitive species and further improve the selectivity strengthening the ecological character of dFADs and working on tools allowing the release alive of sharks at sea (Goujon et al., 2012). The Spanish fleet (ANABAC and OPAGAC), established in 2012 a voluntary agreement known as the "Code of Good Practices" (CGP) for responsible tuna fishing activities. The aim of this agreement is to use best fishing practices by reducing incidental mortality of sensitive species and the obligatory use of non-entangling FADs (i.e., the CGP includes LERFAD and NEFAD of ISSF categories as non-entangling FADs). Nowadays, all ANABAC and OPAGAC vessels (69 purse seiners and 23 supply vessels), operating in 4 tRFMOs areas are being monitored and evaluated for these practices. Besides the information regarding bycatch species, specific data-collection forms recording details of design and construction materials for the raft and the underwater part of dFAD have been applied since 2015. Since the implementation of the Code significant improvements have been observed in the compliance of best available bycatch mitigation practices and the majority of dFADs used by the fleet are totally non-entangling, reaching the 80-90% (Lopez et al., 2017; Grande et al., 2019).

3. Small and large-scale trials for biodegradable dFADs in collaboration with EU fleet

In the last decade, public and private sector funded initiatives to test suitable natural materials and designs for biodegradable dFADs. These studies conducted by EU scientists and EU tropical tuna PS dates to the early 2000s and tests were mainly looking for natural suitable materials like jute, sisal, coconut fiber, high-resistance cotton and palm leaves in the Indian and Atlantic Oceans (Delgado de Molina *et al.*, 2004, 2007; Franco et al., 2009, 2012;Lopez et al., 2016; Moreno et al. 2017a). Despite their limitations derived from small-scale trials (Moreno et al., 2017b), these previous studies have provided a foundation to develop recently launched larger-scale experiments in the Indian (Zudaire et al., 2017), Atlantic (Moreno et al., 2017b) and Pacific Oceans (TUNACONS, 2017). The Indian Ocean trial, coordinated by an EU research centres (AZTI, IRD and IEO) and funded by EU and with collaboration of ISSF, ABNJ, and EU PS fleet (ANABAC, OPAGAC and ORTHONGEL), plans to deploy 1000 "BIOFADs" (i.e., non-entangling and biodegradable dFADs) built using resistant cotton for ropes and canvas and bamboo canes. Atlantic Ocean trial, funded by ISSF and ABNJ, will deploy 600 experimental dFAD to test similar type of materials but adapted to the dFAD characteristic requirements at the region and to collaborating Ghanaian fleet. Similarly, in the Eastern Pacific Ocean the project on degradable FAD (i.e., NEDs), EU funded and coordinated by IATTC, will deploy 800 NEDs and test materials like sisal, abaca, cotton, balsa wood and bamboo canes with the collaboration of Ecuadorian and EU fleet (TUNACONS and OPAGAC FIPs). The results from these large scale-trials will help both scientists and industry focus the discussion on suitable biodegradable materials and designs for dFADs addressing the problematic of marine litter, ghost fishing and dFAD beaching.

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Annex 1 – Tables and Figures

TABLE 1. Description of general dFAD structure and components including the materials found in their construction.

SURFACE STRUCTURE	Type of floats	a.1 - Floats	Round shape high impact polystyrene float used to provide floatability (e.g., floatability of 5.8 kg/float) to the FAD (use of 4-8 floats by FAD). *Spanish named use by the Fleet: Bolos*
		a.2 - Corks	Net corks from ethylene vinyl acetate (EVA) usually recovered from old purse seine nets and used to provide floatability (e.g., mean floatability of ~10.6 kg by cork) to the FAD (use of 4-8 floats by FAD). *Spanish named use by the Fleet: Corchos o flotadores.*
		a.3 - Plastic containers	Plastic containers or bottles (e.g., volume of 5 L) of hexene copolymer used to provide floatability to the FAD (e.g., use of ~42 containers by FAD). *Spanish named use by the Fleet: Bidones o garrafas.*
		a.4 - PVC Pipes	Pipes (e.g., dimension of 1 m and ~100-150 mm Ø) from polyvinyl chloride (PVC) used to provide floatability to the FAD (use of 2-4 pipes by FAD). *Spanish named use by the Fleet: Tubos de PVC.*
		a.5 - Balsa tree	Wooden strips of different configuration made with a tree species (*Ochroma pyramidale*) found in south and central America and in several islands of WCPO. It is used to provide floatability to the FAD. *Spanish named use by the Fleet: Madera de balsa.*
	Type of cover	b.1 - Canvas	Non-meshed canvas, generally dark-coloured synthetic raffia (UV-resistant high-density polyethylene (HDPE)), used to cover the raft and to provide shade and prevent FAD detection by others. The material for the construction of the canvas can be also from vegetal origin (e.g., cotton, natural raffia, abaca, etc). *Spanish named use by the Fleet: Lona or raffia.*
		b.2 - Small mesh size net	Polyamide small mesh size (<7 cm or 2.5 inch stretched mesh) net, reused net from coastal purse seine fisheries or new. This net is used to strengthen the structure of the raft. The use of this mesh size net in the raft is classified as non-entangling in ICCAT, IATTC and WCPFC and as entangling in IOTC; and is classified as Low Entanglement Risk FADs by ISSF. *Spanish named use by the Fleet: Red sardinera, red Alicante or paño de Medina*
		b.3 - Large mesh size net	Polyamide large mesh size (>7 cm or 2.5 inch stretched mesh) net, from old PS tuna nets and used to strengthen the structure of the raft. The use of this mesh size net in the raft is classified as entangling in ICCAT, IATTC, WCPFC and IOTC; and is classified as High Entanglement Risk FADs by ISSF. *Spanish named use by the Fleet: Red atunera.*
	Type of raft	c.1 - Metallic frame (square)	Square shape metallic frame raft (dimension ~1.5-2x2 m) made with galvanized iron tubes. It is used as the main structure of the raft, providing strength and weight to try to submerge a bit the raft and prevent FAD detection. Also, it is durable and easy to store onboard due to its small diameter (~30 mm Ø). *Spanish named use by the Fleet: Parrilla con cuadro metálico*
		c.2 - Metallic frame (octagonal)	Octagonal shape metallic frame raft (dimension ~1.8x2 m) made with galvanized iron tubes. It is used as the main structure of the raft providing strength and enough weight to try to slightly submerge the raft below the sea surface and prevent FAD detection. Also, it is durable and easy to store onboard due to its small diameter (~30 mm Ø). *Spanish named use by the Fleet: Parrilla octogonal*
		c.3 - Bamboo raft	Bamboo raft made with ~10 bamboo canes (1.5-2 m and ~70 mm Ø). It is used as the main structure of the raft providing strength and floatation to keep the raft near the sea surface. *Spanish named use by the Fleet: Parrilla de bambú*
		c.4 - Mixed raft (Bamboo and metallic frame)	Square shape raft built by putting together a metallic galvanized tube frame with bamboo canes across (details in previous types). It used as the main structure of the raft providing strength and a balance between the weight of the metal and the floatation of the canes. *Spanish named use by the Fleet: Parrilla mixta*

UNDERWATER STRUCTURE	Type of tail appendage	d.1 - Rope	Tail made by polyethylene or natural origin (e.g., cotton) rope (~20 mm Ø). The use of ropes is classified as Non-Entanglement Risk FADs by ISSF. *Spanish named use by the Fleet: Cabo*
		d.2 - Tail tied in sausages	Tail with netting tied in coils or "sausages", made by polyamide large (>7 cm or 2.5 inch) or small mesh (<7 cm or 2.5 inch) netting. Both mesh size nets used in "sausages" are classified as non-entangling in ICCAT, IATTC and WCPFC and as entangling in IOTC. ISSF classifies small mesh size nets in "sausages" as Low Entanglement Risk FADs and large mesh size nets in "sausages" as High Entanglement Risk FADs. *Spanish named use by the Fleet: Rabo en chorizo*
		d.3 - Open net tail	Tail with net in an open or stretched configuration, made with polyamide small mesh (<7 cm or 2.5 inch) netting. Often with bamboo canes across at several meter intervals to provide weight and keep the net panels open. The use of small mesh size net is classified as non-entangling in ICCAT, IATTC and WCPFC and as entangling in IOTC; and is classified as Low Entanglement Risk FADs by ISSF. The open net with a mesh size of 7 cm or 2.5 inch or more are considered High Entanglement Risk FAD by ISSF and classified as entangling in ICCAT, IATTC, WCPFC and IOTC. *Spanish named use by the Fleet: Rabo de red abierta*
		d.4 - Tail with sails	Tail with netting tied in "sausages" or rope on the sides to which several polyamide small mesh (<7 cm) netting or raffia open panel sections or "sails" (e.g. 2-4 sections) are attached. This configuration is used mainly to control FAD drift (e.g. slow down drift speed). The use of small mesh size net as sail is classified as non-entangling in ICCAT, IATTC and WCPFC and as entangling in IOTC; and is classified as Low Entanglement Risk FADs by ISSF. Sails made with larger size mesh (> 7 cm or 2.5 inch) are classified as High Entanglement Risk by ISSF and as entangling in all RFMOs. *Spanish named use by the Fleet: Rabo con velas*
	Type of attractors	e.1 - Synthetic raffia or salt bags	Attractors done with synthetic raffia or reused salt bags tied to the tail to attract fish. *Spanish named use by the Fleet: Adornos de saco de sal*
		e.2 - Frayed ropes	Synthetic (polyethylene) or natural origin (cotton, abaca, etc.) frayed coloured ropes, tied to the tail to attract fish. *Spanish named use by the Fleet: Adornos de cabo coral.*
		e.3 - Plant origin adornments	Plant origin attractors like palm leafs, tied to the tail to attract fish. *Spanish named use by the Fleet: Adornos con hojas de palma.*
	Weight	f.1 - Cable from PS	Weights made from surplus purse seine net cable. *Spanish named use by the Fleet: Lastre con jareta*
		f.2 - Chain	Weights made by surplus chain from the purse-seine *Spanish named use by the Fleet: Lastre con cáncamos*

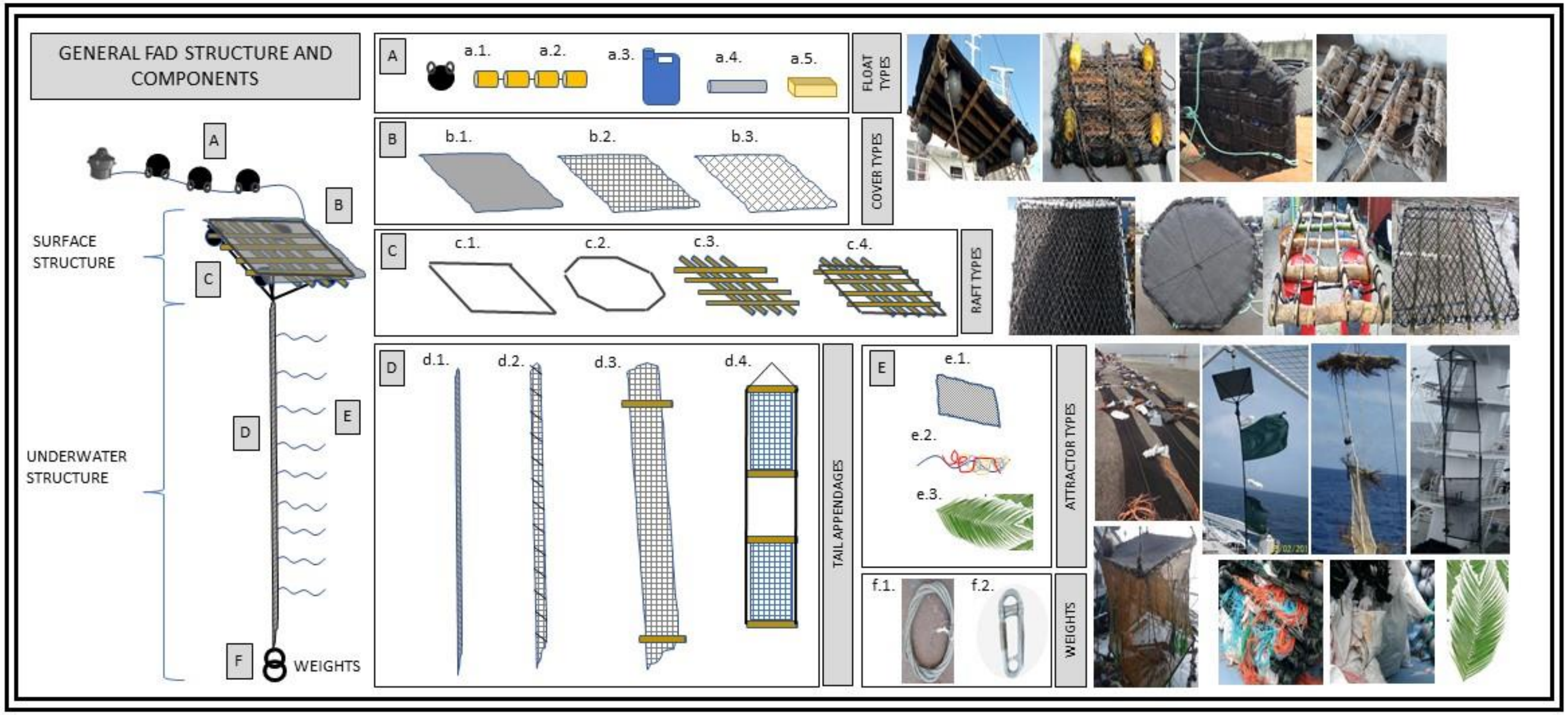

FIGURE 1. Designs of general dFAD structure and components including the materials found in their construction.