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Preliminary results of the BIOFAD Project: Testing designs and identify options to mitigate impacts of drifting fish aggregation devices non the ecosystem

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Zudaire, I., Tolotti, M., Murua, J., Capello, M., Andrés, M., Cabezas, O., Krug, I., Grande, M., Arregui, I., Uranga, J. Goñi, N., Ferarios, J.M., Ruiz, J., Baidai, Y., Ramos, M.L., Báez, J.C., Abascal, F., Moreno, G., Santiago, J., Dagorn, L., Arrizabalaga, H. and Murua, H.

Preliminary results of BIOFAD project: testing designs and identify options to mitigate impacts of drifting Fish Aggregating Devices on the ecosystem

Iker Zudaire (1), Mariana Tolotti (2), Jefferson Murua (1), Manuela Capello (2), Margarita Andrés (1), Oihane Cabezas (1), Iñigo Krug (1), Maitane Grande (1), Igor Arregui (1), Jon Uranga (1), Nicolas Goñi (1), Jose Maria Ferarios (1), Jon Ruiz (1), Yannick Baidai (2), Maria Lourdes Ramos (3), Jose Carlos Báez (3), Francisco Abascal (3), Gala Moreno (4), Josu Santiago (1), Laurent Dagorn (2), Haritz Arrizabalaga (1), Hilario Murua (1).

(1) AZTI, Spain; (2) MARBEC (IRD, University Montpellier, Ifremer, CNRS), France; (3) Insituto Español de Oceanografía (IEO), Spain; (4) International Seafood Sustainability Foundation (ISSF), USA. Main author contact details: izudaire@azti.es, Phone: +34667174451

Abstract

The EU project BIOFAD was launched in August 2017. This 28-months EU project is coordinated by a Consortium comprising three European research centers: AZTI, IRD (Institut de recherche pour le développement) and IEO (Instituto Español de Oceanografía). The International Seafood Sustainability Foundation (ISSF) is also actively collaborating by providing the biodegradable materials needed to test biodegradable dFADs (drifting FADs). Following IOTC, along with other tuna RFMOs, recommendations and resolutions to promote the use of natural or biodegradable materials for dFADs, this project is seeking to develop and implement the use of dFADs with both characteristics, non-entangling and biodegradable, in the IOTC Convention Area. However, there are no technical guidelines on the type of materials and FAD designs to be used. The main objectives of the project are: (1) to test the use of specific biodegradable materials and designs for the construction of dFADs in real fishing conditions; (2) to identify options to mitigate dFADs impacts on the ecosystem; and (3) to assess the socio-economic viability of the use of biodegradable dFADs in the purse seine tropical tuna fishery. This document shows the preliminary results regarding the effectiveness of around 716 BIOFADs deployed, in terms of tuna aggregation, drift, materials' durability, etc. in comparison to currently deployed NEFADs (non-entangling dFADs). The project BIOFAD has counted since its inception with the support of the whole EU purse seine tuna fishery and, more recently, with the collaboration of the Korean purse seine fleet.

1. Introduction

In the last decade, efforts have been focused to eliminate the entangling characteristics of drifting Fish Aggregating Devices (FADs), as it is believed that this may affect negatively on sensitive species like turtles, sharks, and other associated non-target species. However, most of those non-entangling FADs (NEFADs) are made by synthetic and non-biodegradable materials (ex., nylon ropes and small mesh pelagic fishing nets) contributing significantly to the increase of marine litter (Dagorn et al., 2012) and other potential negative impacts for the ecosystem, such as FADs beaching (Maufroy et al., 2015). The EU Common Fishery Policy and the Marine Strategy Framework Directive have as objective to ensure environmentally friendly fishing methods, which include the minimisation of seafloor or other habitat destruction, avoid effects on other species, but also minimise the introduction of any litter into the marine environment. Along these lines, the Directorate General for Maritime Affairs and Fisheries (DG MARE) has proposed the gradual introduction of the use of biodegradable materials for FAD construction in different Tuna Regional Fisheries Management Organization (tRFMOs). The different tRFMOs have also addressed these issues through several recommendations and resolutions. For example, the Indian Ocean Tuna Commission (IOTC) and the International Commission for the Conservation of Atlantic Tunas (ICCAT) have adopted the obligation to replace existing FADs with NEFADs and to undertake research on biodegradable FADs. As such, the IOTC defined procedures on a FADs management plan through the resolution 19/02, where in Annex V it was also promoted the reduction of the amount of synthetic marine debris, by the use of natural or biodegradable materials for drifting FADs (IOTC, 2019). Similarly, the Inter-American Tropical Tuna Commission (IATTC) has recently stated the use of NEFADs by January 2019 and it promotes the gradual use of biodegradable materials (IATTC 2016).

However, an effective replacement of non-biodegradable FADs by those fully/partly biodegradable still requires investigation to solve important practical/technical aspects for the operationalization of this FAD type construction, including (1) the selection of appropriate biodegradable materials taking into account their durability, (2) information on biodegradable FADs behaviour regarding tuna aggregation, drifting performance, potential impacts, etc., and (3) a socio-economic study to assess cost and benefits of a phase in of biodegradable FADs by EU purse seine tropical tuna fishery. Besides, the implementation of biodegradable FADs will not be so straightforward, as these biodegradable materials following international standards are subjected to certain preconditions. Thus, more detailed definitions to be used by tRFMOs are required to provide accuracy when the term biodegradable is applied to define the materials used for FAD construction.

The Consortium, formed by the European research centres AZTI, IRD and IEO, launched the Specific Contract Nº 07 under the Framework Contract EASME/EMFF/2016/008 provisions of Scientific Advice for Fisheries Beyond EU Waters in August 2017. The project addresses the problems associated to the current used materials and designs for FADs construction. This 28-month project aims to provide solutions that shall support the implementation of BIOFADs (i.e. non-entangling and biodegradable) through the collaboration with the International Seafood Sustainability Foundation (ISSF), the EU purse seine tropical tuna fishery, Seychelles Fishing Authority (SFA) and through the consultation with IOTC. Thus, the main purpose of the project is to test the use of specific biodegradable materials and designs for the construction of BIOFADs in natural environmental conditions. The study will also provide criteria and guidelines to identify options to mitigate drifting FADs impacts on the ecosystem. It will also assess the socio-economic viability of the use of BIOFADs in the purse seine tropical tuna fishery in the Indian Ocean. Finally, it will suggest potential biodegradable materials and designs providing recommendations to foster the implementation of fully BIOFADs.

Specifically, this Specific Contract will carry out the following tasks (Figure 1):

- Task 1 – Revision of the state of the art regarding the use of "conventional FADs" (i.e. entangling and non-biodegradable), "NE FADs" (i.e. non-entangling and non-biodegradable) and "BIO FADs" (i.e. non-entangling and biodegradable) worldwide;
- Task 2 – Evaluating the performance (e.g. lifetime) of specific biodegradable materials and designs for the construction of FADs in natural environmental conditions;
- Task 3 – Testing, comparing and measuring the efficiency of new BIO FADs against current NE FADs to aggregate tuna and non-tuna species at sea in “real” conditions with the involvement of EU Purse Seine fishing fleet;
- Task 4 – Assessing the socio-economic impacts of BIO FADs use and phasing in the purse seiner fleet;

- Task 5 – Assessing the feasibility of using new biodegradable materials by the purse seiner fleet and recommendation of an optimum BIO FAD prototype.

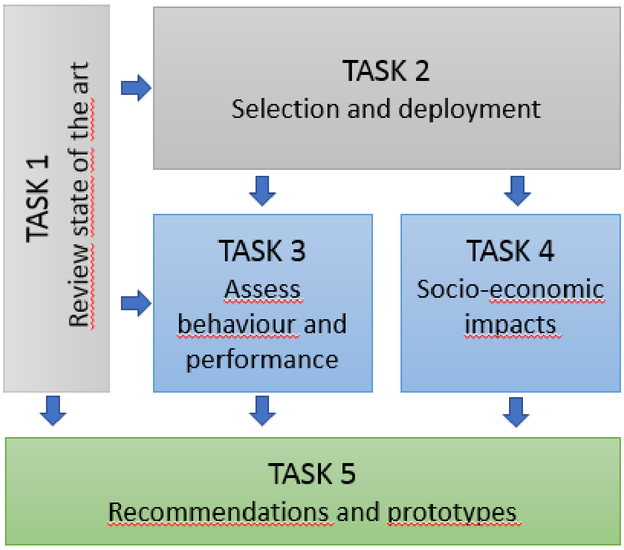

Figure 1. Flow chart of tasks of Specific Contract N0 7.

The aim of this document is to present the preliminary results obtained after 14 months of the at sea trials and describe the future works to be conducted.

2. Material and Methods

2.1. Partners, timeline and deployment strategy

The BIOFAD project is led by AZTI, IRD and IEO with the collaboration of the European purse seiner fleet (fleets associated to ANABAC, OPAGAC and ORTHONGEL), ISSF and SFA. Recently, the participation of the Korean purse seine vessels (DONGWON fishing company) operating in the Indian Ocean was also agreed.

The Specific Contract Nº7 started in August 2017 and will last 28 months. The Consortium has planned a large-scale experiment with the deployment of 1000 BIOFADs in order to obtain enough data to conduct reliable scientific research. The BIOFADs are deployed, in pairs, along with currently using 1000 NEFADs for comparison purposes. The deployment of BIOFADs has begun in April 2018, deployments were organized by trimesters, and this activity lasted 14 months (finishing in June 2019) to cover possible seasonality effects. For that, the project counts on the active collaboration of European purse seine industry with a participation of 42 purse seine vessels, supply vessels and recently two Korean purse seine vessels operating in the Indian Ocean agreed to join the project. In total, each PS vessel should deploy 24 BIOFADs (6 BIOFADs by trimester). This deployment strategy was planned by the Consortium to try to avoid the limitations previously identified in earlier small-scale trials (Moreno et al., 2017).

The methodology used for BIOFAD construction, selected biodegradable materials, prototypes design, BIOFAD deployment strategy, comparison with NEFADs, as well as BIOFAD monitoring, data collection and reporting were defined by the Consortium after being agreed with collaborators (Zudaire et al., 2017).

Three prototypes (Figure 2) were designed by the Consortium based on designs previously identified for Indian Ocean in the ISSF Workshop held in Donostia in 2016 (Moreno et al., 2016). Fishermen's requirements and needs for FADs construction were considered for those designs covering the different drifting performance that fisherman seek with their conventional NEFADs: superficial FADs (BIOFAD prototype C), superficial FAD with medium-deep tail (BIOFAD prototypes A1 and A2), and submerged FAD high-deep tail and cage type submerged FAD (BIOFAD prototypes B1 and B2, respectively). Details regarding materials, dimensions and construction of these 3 prototypes were provided in Zudaire et al. (2017). In a recent 2nd BIOFAD Workshop held in April 2019 in Spain, some modifications in the prototypes and the configuration of their components were agreed among the Consortium and participants. Among these changes, a multilayer cotton cover and the use of metallic frame for BIOFAD's raft construction were accepted.

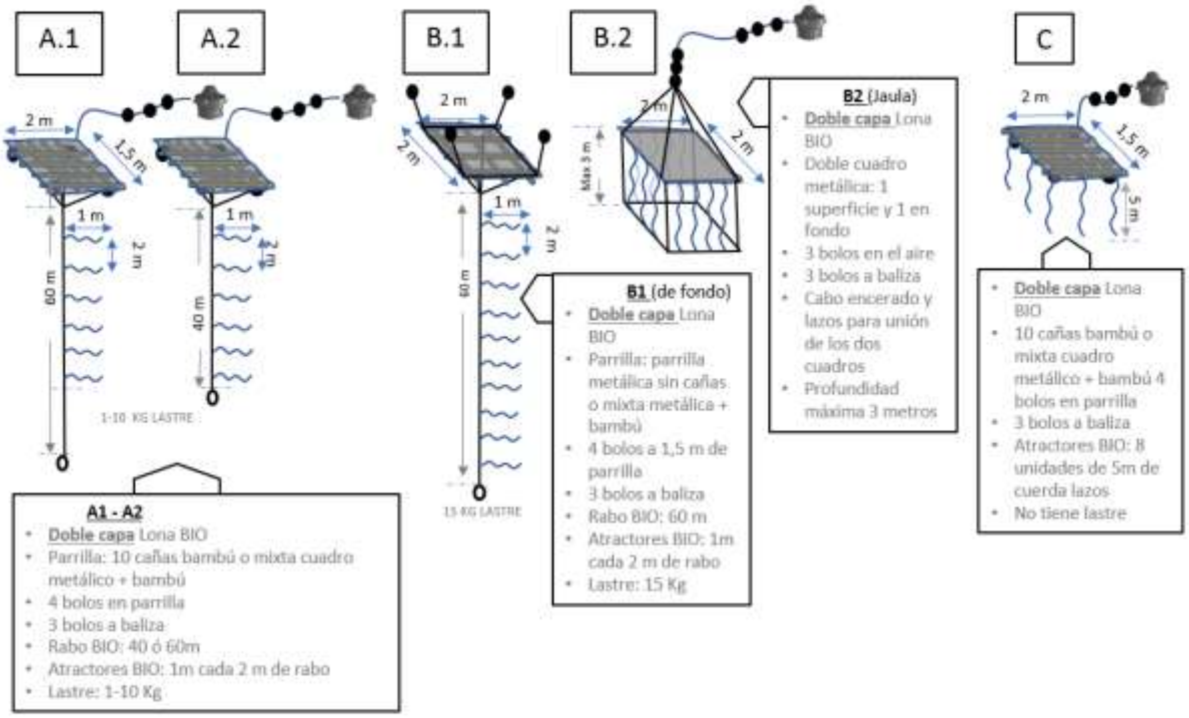

Figure 2. BIOFAD prototypes designs and the details of materials and dimensions for each of them.

Traceability of BIOFADs and their pairing NEFADs during their entire lifecycle is ensured throughout an identification system and deployment strategy agreed by the Consortium and participants (Zudaire et al., 2017). All the information related to the activities (i.e., new deployment, visit, buoy exchange, set, recovery, redeployment and elimination) with experimental FADs are reported by the fleet and collected by observers onboard. All this information is reported to the Consortium using an email template and a dedicatedly designed form for skipper and observers, and so making data available to scientist quickly. Besides the activity information, these forms are also used to gather the information regarding BIOFAD and NEFAD structure status control, using simple value scale to assign the stage of degradation to each of these components (Zudaire et al., 2017).

3. Main progress and preliminary results

3.1. BIOFAD deployments, spatial distribution and drifting performance.

To date, the Consortium has been informed about 716 BIOFAD been deployed together with their pairing conventional NEFADs by the EU fleet. This represents 72% of the initially planned goal for BIOFAD deployments. As it can be observed in the Table 1, the deployment effort has not been homogeneous and during the first months few BIOFAD were deployed for different reasons including reparation at dry dock, stop of fishing activity due to quota limitation, or delay in the coordination of fishing companies involved in the construction of the experimental FADs. Afterwards, during the second trimester, the deployment objective increased up to 87%. In the following trimesters the effort decreased again to 65%, 47% and 50% respectively.

Table 1. The number of BIOFAD deployed by trimester including the specific goal, reached % and aggregated data for deployments.

Timestres	Nº Deployments	Goal	% of the goal	Aggregated data
Trimester 1	93	250	37%	93
Trimester 2	218	250	87%	311
Trimester 3	163	250	65%	474
Trimester 4	119	250	48%	593
Trimester Extra	123	…..	49%	716
Total	716	1000	72%	

From the total of 716 BIOFAD deployed 81% corresponded to A1 prototype, 12% to A2, 5% to B1 and 3% to C1. The distribution of the experimental FADs deployed between April and December 2018 covered the western Indian Ocean as shown in the Figure 3. Differences in the drifting patterns shown by pairing experimental FADs (BIOFAD vs NEFAD) were also assessed without considering the effect of area and season at this stage of the analysis. Variability in the patterns was observed showing patterns with i) pairs following totally different drift, ii) pairs following partly similar drifts and iii) pairs following same patterns.

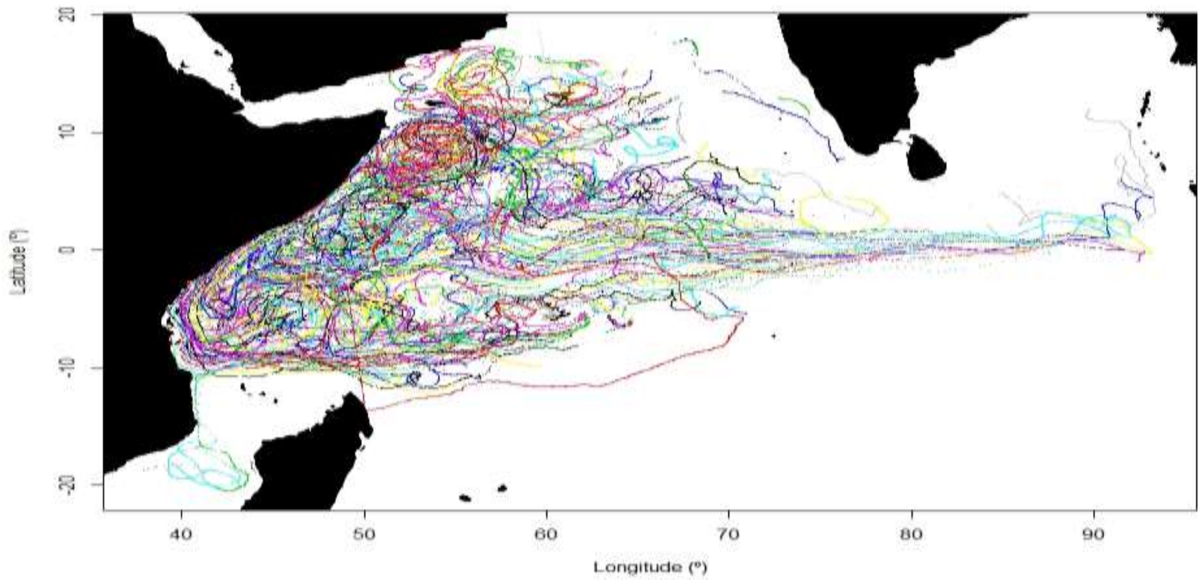

Figure 3. Representation of BIOFAD distribution through the echo-sounder buoy data provided by the EU PS fleet.

3.2. BIOFAD efficiency: material degradation, catch data and biomass indicator.

BIOFAD efficiency was assessed by analyzing different parameters: biodegradable material degradation process, catch data and biomass indicators. To identify the pros and cons of each biodegradable material (i.e., cotton canvas, and two type of cotton ropes), and justify the selection made, the quality status control of each component of the FAD which is collected by crew members onboard during their activities with experimental FADs has been used. This information is being requested to vessels to be sent when they carry out any activity with the experimental FAD. This source of information is also used to collect required information for the Life Cycle Analysis conducted in this project (analysis in progress and not shown in this document). As shown in the Figure 4 the degradation of the cotton canvas, used to cover the raft as replacement of netting or synthetic raffia materials, started to suffer significant degradation already during the first month at sea and this degradation increased in the second and third months, when more than 50% of the observations of this material were deemed to be in a "bad", "very bad" or "absent" states. The preliminary results showed that the degradation of the two cotton ropes, used in the submerged part of the FAD one as tail and the other as attractors, was less pronounced comparing with the cotton canvas (Figure 4). The status control for both ropes were deemed to be in “very good” or “good” quality until the fourth month at sea. However, in 10-25% of the observations the “absence” of these two materials was reported during the first and second month at sea, respectively. Contrarily to the cotton canvas, and according to the feedback received during the 2nd BIOFAD Workshop, the absence of the cotton ropes from the raft of the BIOFADs have been more related to failures at attachment between the tail and the raft rather than to a high degradation of the materials. If not correctly attached, this component could be lost resulting in the reported absences. Overall, the Industry had positively valued the performance of these two rope components. However, certain part of the fleet translated to the Consortium that longer lifetime is expected by them for those materials.

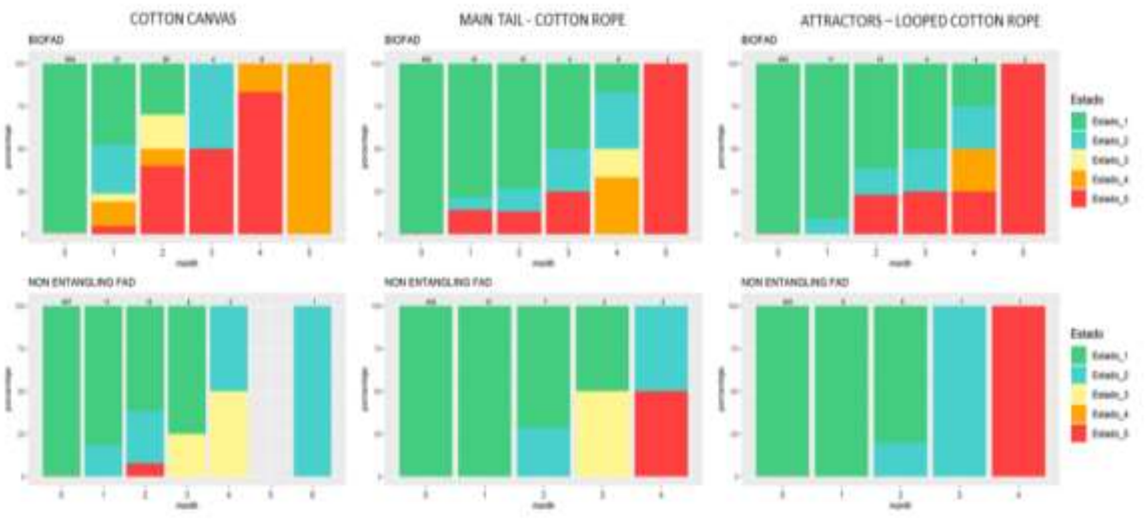

Figure 4. Status control assessment for the cotton canvas, main cotton rope and the cotton rope used as attractors for BIOFAD (upper figures) and synthetic material used as cover, tail and attractors for NEFAD (down figures). Estado_1 =Very good; Estado_2 = Good; Estado_3 = Bad; Estado_4 = Very bad; and Estado_5 = Absent.

The efficiency of the BIOFADs, in comparison with NEFADs, was further analysed through the catch data. In total, from April to December 2018, 40 sets were associated to these experimental FADs, 20 to BIOFADs and 20 to pairing NEFADs. There has not been found any significant differences at catches (tons of tuna) between FAD types (spatio-temporal effect was not considered at this stage of the analysis). Table 2 shows the overall comparisons between FAD type and prototype. Most of the sets in both FAD types were conducted in A1 prototype. However, considering the number of deployments by each of the prototypes, the percentage of use (i.e., ratio between number of sets and number of deployments by each prototype and FAD type) for A1 did not differ from the other prototypes at which sets were conducted. It is not the goal of this project to estimate the ratio of FAD used by the fleet; besides obtained values of the percentage of FAD use can not be extrapolated to a common FAD fishing operation since in this analysis only the experimental FADs were considered and not the total number of FADs available for the participating fleet. Besides, the low number of sets performed in the different prototypes difficult the comparative analysis between prototypes. Thus, for future analysis, if the low number of sets persist, the comparison between FAD type will be focused by prototypes, and mainly with prototype A1.

Table 2. Catch data (maximum and mean in tons), number of sets, number of deployments and % of use by FAD type and prototype.

	BIOFAD	CONFAD		
Max (tons)	150	225		
Mean (tons)	40,7	46,8		
Sets	20	20		
Deployments	554	466		
% use	4%	4%		
BIOFAD	A1	A2	B1	C1
Max (tons)	150	75	....	....
Mean (tons)	38	....	....	....
Sets	15	1	0	0
Deployments	401	60	24	13
% use	4%	2%	0%	0%
CONFAD	A1	A2	B1	C1
Max (tons)	98	225	....	70
Mean (tons)	33	115	....	68
Sets	13	2	0	2
Deployments	313	60	24	13
% use	4%	3%	0%	15%

As first approach of the estimation of the tuna biomass and Presence/Absence analysis through echo-sounder buoy data, only data corresponding to one buoy model was selected (i.e., M3i) to conduct the comparative analysis. Data filtering process followed the protocols defined in the RECOLAPE project (Grande et al., 2019) in order to keep a unique working procedure between the Consortium members and to take advantage of the work being done within the Framework Contract. Tuna Presence/Absence assessment to study the colonization time and lifetime of the aggregation was conducted by pairs (BIOFAD and its pair NEFAD). The pairs were compared regarding the distance between both in a given time. Estimated distance differences were then grouped in determined distance ranges, such us less than 50km, 100Km, 150Km etc. being the successive ranges accumulative, i.e., the next larger distance group includes the previous ones. Figure 5 shows a faster (in days) presence of tuna in NEFAD than in BIOFADs. This pattern was kept throughout the different range of distances between pairs.

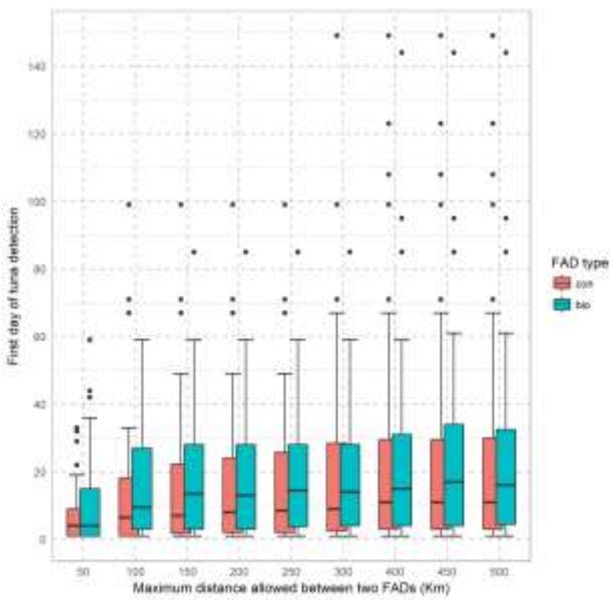

Figure 5. First day of tuna detection by type of FADs and by range of distance between pairs.

Similarly, Figure 6. shows the comparative assessment of the proportion of colonized FADs by pairs and distances. Results describe higher proportion of FAD colonization at NEFADs than in the BIOFAD throughout the different range of distances between pairs. This result is consistent with the pervious figure.

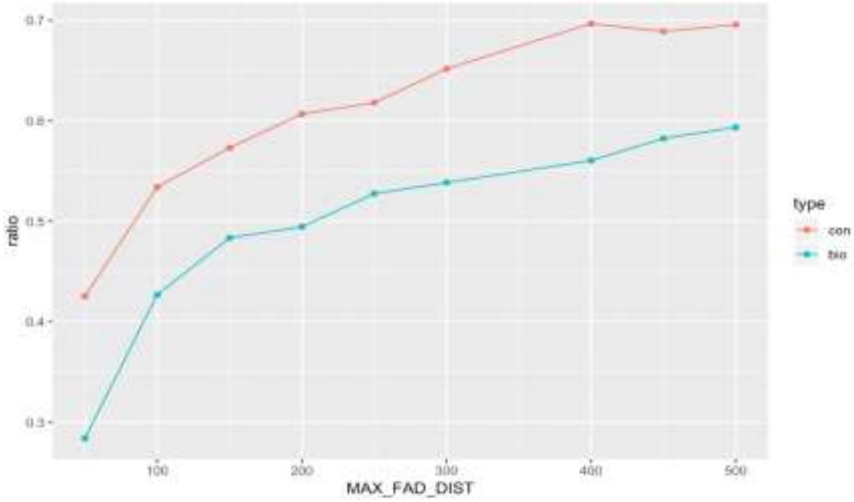

Figure 6. Proportion of colonized FADs (y-axis) by FAD type and by range of distance between pairs (x-axis).

Considering FADs with at least 30 days of after deployment and a maximum distance of 500Km between pairs: in 61% of the cases, both pairs showed presence of tuna; in 15% of the pairs both, BIOFAD and NEFAD, did not show any presence of tuna; in 20% of the cases NEFAD had presence of tuna while its BIOFAD pair did not and; in 3.3 the opposite pattern % was observed. Presence/Absence data was also analysed to estimate the proportion of FAD occupation by tuna aggregation, and as shown in Figure 7 higher proportions of FAD occupation by tuna were observed in NEFADs when the distance between pairs is lower. The proportion tended to stabilise when the distance between pairs is higher than 250Km among them.

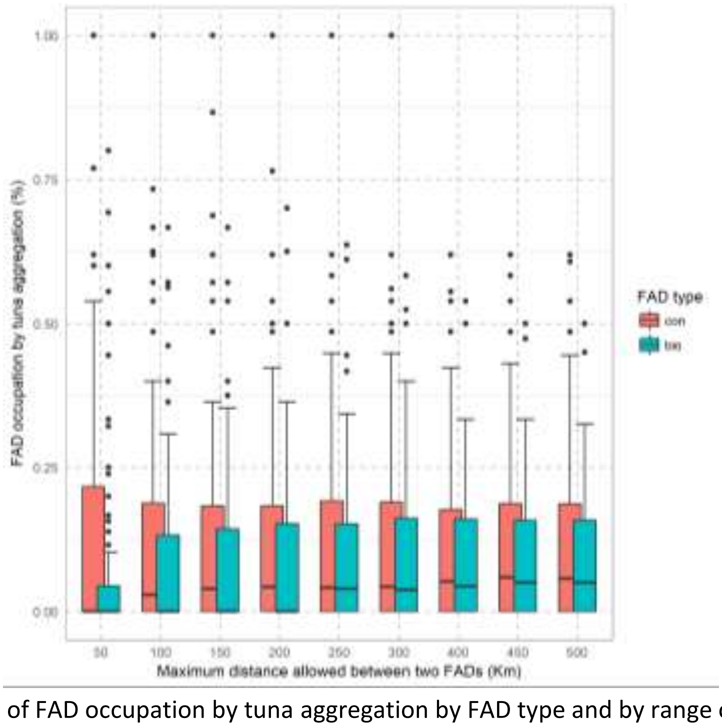

Figure 7. Proportion of FAD occupation by tuna aggregation by FAD type and by range of distance between pairs.

Echo-sounder buoy data was also used to estimate the tuna biomass from acoustic energy values (Uranga et al., 2019). In that case, data was also analysed by pairs, and grouped by weeks having as reference the deployment day. Biomass was estimated as the 99 percentile of daily estimation (when both pair acoustic data exist) and grouped by week. Figure 8 shows a very low tuna biomass estimation for both FAD types, being higher the values for NEFADs than for BIOFADs. A peak in the biomass estimation was observed around the week 22 where no clear pattern was observed among FAD types.

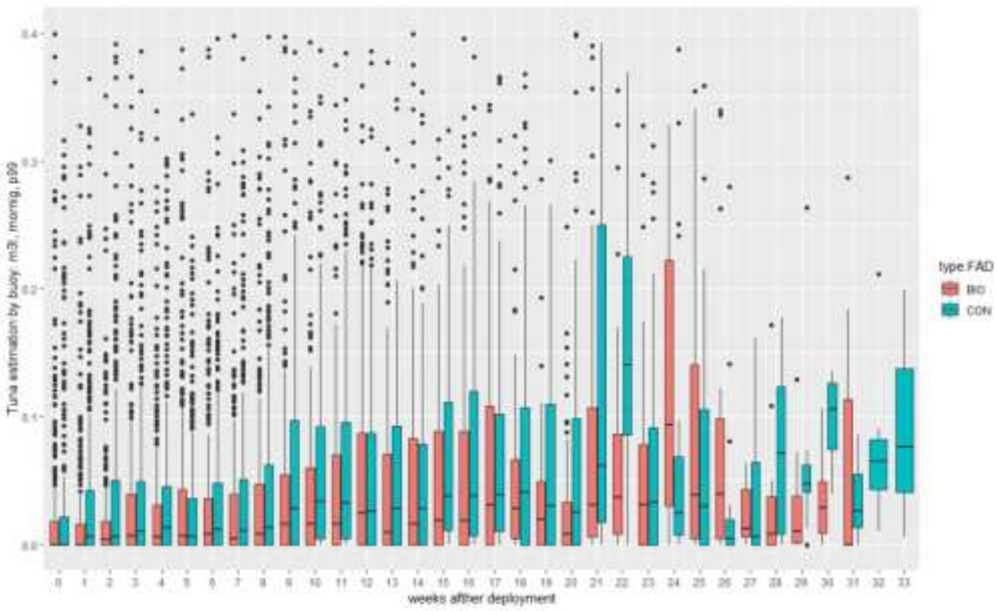

Figure 8. Tuna biomass estimation through echo-sounder data by FAD type and by group of weeks since first deployment.

4. Future and works in progress

In the following months data collected from April 2018 to June 2019 will be analyzed extending the analysis to different buoy models used by the fleet. The analysis shown in this document will be them updated and the spatial and temporal effect will also be included in the analysis to identify possible seasonal influence.

The development of life-cycle assessments for the different FAD prototypes and materials, including their expected biodegrading time and the subsequent potential negative and positive environmental effects (e.g., carbon print, impact of chemicals used to extend FADs durability, etc.) is in progress. Similarly, the assessment of the short and long-term socio-economic impacts (including the fisheries itself) of replacing NEFAD with BIOFAD will be conducted. The socio-economic analysis will also consider possible market incentives (e.g., eco-friendly labelling, etc.) to encourage the use of BIO FADs.

5. References

Dagorn L. Holland K. N. Restrepo V. Moreno G., 2013. Is it good or bad to fish with FADs? What are the real impacts of the use of drifting FADs on pelagic marine ecosystems? Fish and Fisheries, 14:391–415.

Grande M, Capello M, Uranga J, Baidai Y, Boyra G, Quincoces I, Orue B, Ruiz J, Zudaire I, Murua H, Depetris M, Floch L, Santiago J. 2019. From fishermen´ to scientific tools: Progress on the recovery and standardized processing of echosounder buoys data. J-T-RFMO FAD WG 2019_Grande_S:06.

Maufroy A, Chassot E, Joo R, Kaplan DM., 2015. Large-Scale Examination of Spatio-Temporal Patterns of Drifting Fish Aggregating Devices (dFADs) from Tropical Tuna Fisheries of the Indian and Atlantic Oceans. PLoS ONE 10(5): e0128023.

Moreno, G., Restrepo, V., Dagorn, L., Hall, M., Murua, J., Sancristobal, I., Grande, M., Le Couls, S. and Santiago, J. 2016. Workshop on the use of biodegradable fish aggregating devices (FADs). ISSF Technical Report 2016-18A, International Seafood Sustainability Foundation, Washington, D.C., USA.

Uranga J, Santiago J, Boyra G, Quincoces I, Grande M, Orue B, Zudaire I, Murua H. 2019. Treatment of acoustic data obtained from echosounder buoys for tuna biomass estimates. J-T-RFMO FAD WG 2019_Uranga_S:08

Zudaire, I., et al. 2017. Testing designs and identify options to mitigate impacts of drifting fads on the ecosystem. IOTC-2017-SC20-INF07