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Report of the 2nd Meeting of the Joint Tuna RFMOs Working Group on FADs

WCPFC-SC15-2019/EB-WP-13

Joint t-RFMO FAD Working Group

JOINT T-RFMO FAD WORKING GROUP

SECOND MEETING

**8-10 May 2019
San Diego, USA**

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1. OPENING OF THE MEETING

The meeting was opened by the Chair, Dr. Josu Santiago, at 9:15 am on Wednesday 8 May 2019. The Chair gave the floor to Dr. Guillermo Compeán, Director of the IATTC, who welcomed the participants from the four tuna RFMOs with tropical tuna fisheries. He thanked the European Union for the financial support, as well as FAO for its contribution. He recognized the presence of numerous representatives of NGOs and the fishing sector. After stressing his confidence that the Chair, thanks to his profound knowledge of the matter and experience, would successfully steer the meeting towards a positive result, he concluded by highlighting the importance of this opportunity to share experiences from different oceans and fisheries.

Dr. Santiago then welcomed the Contracting Parties from the four tuna RFMOs present at the meeting. In total, 144 participants from 27 Contracting Parties, namely Belize, Colombia, Korea, Ecuador, El Salvador, European Union, Gabon, Ghana, Guatemala, Honduras, Japan, Ivory Coast, Liberia, Mauritania, Mexico, Nicaragua, Nigeria, Pakistan, Peru, Republic of Maldives, Sao Tomé y Príncipe, Senegal, Seychelles, Sri Lanka, Thailand, United States and Venezuela. Also in attendance were the Secretariats of the four t-RFMOs managing tropical tuna fisheries, IATTC, ICCAT, IOTC and WCPFC, as well as six non-governmental organisations and entities, namely IPNLF (The International Pole & Line Foundation), ISSF (International Seafood Sustainability Foundation), MSC (Marine Stewardship Council), PEW Charitable Trusts, SFP (Sustainable Fisheries Partnership), and WWF (World Wildlife Fund). The list of participants is provided as

[Appendix 1.](#)

In his introductory remarks, Dr. Santiago first referred to the background of the meeting, next he reviewed the process to date, stressing the common interest that all tuna RFMOs share regarding the need to manage efficiently the issue of FADs. He recalled the first meeting of this Joint t-RFMO FAD Working Group (JWG), which was hosted by ICCAT, which was successful with the only shortcoming being the absence of WCPFC. The first meeting, in Madrid in 2017, led to the adoption of a series of tasks to be carried out by countries and by RFMOs individually as well as jointly. Another result was the establishment of the joint technical working group on FADs (Tech-JWG) at the end of 2018, composed of four representatives nominated by each of the four t-RFMOs, to progress on the matters identified by the 1st JWG meeting towards this meeting. The Tech-JWG's efforts provided the basis for the organization of the present meeting, with the objective of continuing the process of cooperation between the tuna RFMOs in FAD-related technical matters, pursuant to the mandate of the JWG as reflected in the letter circulated by the chair of the Kobe process. The Chair expressed his thanks for the support and contribution of the IATTC staff and in particular Dr. Jon Lopez, as well as the financial support provided by the European Union and FAO, through its GEF-funded Common Oceans tuna program.

The Chair then referred to the planned organization of work during the meeting. He concluded by pointing out that the agenda was very busy, the time very short and the participants numerous, which showed the need for a well-structured and orderly meeting.

2. ADOPTION OF THE AGENDA

The provisional agenda was adopted as presented ([Appendix 2](#)).

The Chair took this opportunity to present the schedule of the meeting. He stressed the informal and open nature of the meeting and that contributions from all participants were welcome. However, a more formal session setup was proposed for the afternoon of the last day of the meeting, with a view at discussing and adopting a set of recommendations.

3. REVIEW OF THE PROGRESS OF THE KEY AREAS FOR ACTION FOR THE JWG

Each RFMO Secretariat presented its progress in the different key areas for action by the JWG, identified during its first meeting in Madrid in 2017. [Appendix 3](#) shows the progress made at t-RFMO level with regards the commitments agreed at that meeting.

Dr. Compeán, for the IATTC, followed by Dr. Miguel Neves dos Santos (ICCAT), Dr. Paul de Bruyn (IOTC) and Dr. Anthony Beeching (WCPFC), detailed the actions and progress made by their respective organizations.

There were extensive questions and comments on the presentations. In response to a question on science-industry collaboration, Dr. Compeán referred to a series of documents posted in the webpage of this meeting as well as of the meeting of the IATTC Scientific Advisory Committee the following week which describe the collaborative arrangements and activities between scientists and industry, including the implementation of concrete projects such as those focused on biodegradable and non-entangling FADs .

On a question of observer coverage, Dr. Beeching highlighted the importance of 100% coverage for purse-seine fleets in both the WCPFC and IATTC areas. Such coverage ensures the collection of good data in a timely manner to support the management of these fisheries. Conversely, there is less knowledge about other fleets with less observer coverage (*e.g.* longline fleet).

In response to a question on the reporting mechanisms and the possible reluctance to report on FAD activities, Dr. Compeán reiterated that the information collected by observers on FAD activities is helpful

and that there are more difficulties with access to higher-resolution information on FADs, which can be obtained directly from the satellite service companies or through the vessels' owners. Dr. de Bruyn noted that in the IOTC there is not 100% observer coverage, and that an additional stumbling block for FAD data was how to define and inform which data must be collected and reported. However, he also mentioned the existing collaboration between scientists and industry to obtain fine-scale FAD data. Dr. Compeán added that there was often a considerable delay in the provision of the required information.

To a question about why the FAD limits adopted by each t-RFMO are different and on what basis IATTC set limits based on vessel size, Dr. Compeán responded that these were the results of negotiations and were fundamentally arbitrary. The Chair agreed, but added that, thanks to the gathering of new information, it would be possible in the near future to take more informed decisions in that respect.

Regarding concerns about the lack of data collection and reporting on FADs by some RFMO CPCs and how such lack of data may compromise future attempts to manage the FAD fishery in an informed manner, various t-RFMO representatives noted that, while some data lags remain, there are many ongoing initiatives on FAD data collection and research and the information gathered should lead to better-informed FAD management in the near future.

4. REVIEW OF THE CURRENT MANAGEMENT MEASURES ON FADS

Ms. Rachael Wadsworth (USA) presented an overview of [current global management measures for FADs](#) in the four t-RFMOs. The intent of the presentation was to inform discussions on consistency between the t-RFMOs and options for future FAD management. The t-RFMOs all utilize fisheries management measures, such as catch and/or effort controls, with the objective of maintaining fishing at sustainable levels. These measures also regulate fishing on FADs by limiting fishing. The measures vary between the t-RFMOs and can include purse-seine capacity limits, closures of Convention areas, or more specific time/area closures for FAD fishing. More recently, the t-RFMOs have begun adopting specific FAD measures, including data collection requirements, marking requirements, active FAD limits, and FAD designs to reduce entanglements. Although all of the t-RFMOs have adopted limits on active FADs or buoys, those limits differ among regions. There are also variations in the adoption of other measures such as designs to reduce entanglements. Discussions on future FAD management may include measures such as retrieval options, biodegradable materials, deployment limits, and reducing strandings.

Dr. Emmanuel Chassot presented the document [JWGFAD-02-01a](#), "*Outburst of FAD fishing following quota implementation: The case of Indian Ocean yellowfin*", which describes the evolving role of FADs in the Indian Ocean yellowfin fisheries. To comply with the yellowfin catch limit, purse-seine fleets have sharply reduced the seasonal targeting of free-swimming schools of large yellowfin: they contributed around 5% of the yellowfin purse-seine catch in 2018 compared to about 38% during 2012-2016. The authors assessed the recent changes in spatial-temporal distribution of the fleet and changes in catch and bycatch composition. They also analyzed the fishers' strategies and tactics to optimize their now limited number of monitored FADs, discussed the adverse impacts of the Indian Ocean yellowfin quota, and recommended an impact assessment prior to the implementation of any major conservation and management measure, such as setting a total allowable catch for a stock.

During the discussion, a question was raised as to why the seasonal pattern in catch locations, evident in earlier years, has disappeared. According to Dr. Chassot, one possible explanation is that the location of free school sets is dictated by the movements of the schools, which are related to spawning patterns, whereas for fishing on FADs, vessels follow the FADs and harvest the aggregations (generally smaller fish not yet influenced by spawning migrations). However, the catch patterns are also influenced by access agreements, which have changed over time, making interpretation of causes difficult.

Dr. Dave Gershman (Pew Charitable Trusts) presented Document [JWGFAD-02-02a](#), "*Toward true FAD*

deployment limits in the t-RFMOs”, noting that the growing numbers of FADs in use continues to be a challenge for the t-RFMOs, as a review of the provisions shows they are not restrictive enough at the fleet level and actually would allow a considerable number of purse-seine operators to increase FAD deployments. To achieve true limitations, t-RFMOs should improve data collection on FADs, including through the collection of buoy transmission information, and develop management objectives that clearly identify their purposes. Candidate objectives offered include avoiding adverse impacts on tropical tuna populations (via a proxy measurement of catch-per-unit-of-effort of purse-seine operations) and limiting impacts on habitats from FADs that become marine debris.

Following the presentation, it was clarified that the data/estimates shown in the presentation were generally obtained from existing scientific studies in the literature, although some estimates were based on consultations with buoy manufacturers and the fishing industry.

It was noted that the existing limits are restrictive in some oceans, with an overall decrease of FAD numbers, but in other areas more restrictive limits may be required.

The JWG was asked to respond to an informal poll with multiple-choice questions on management measures on FADs. The results are presented in **FIGURE 1** of [Appendix 4](#). The majority (80%) thought that the current management measures are insufficient. The most urgent priorities for future FAD management were considered to be the reduction of juvenile tuna catch and non-tuna bycatch (55%), followed by the reduction of other impacts on the ecosystem (23%) and the reduction of purse-seine FAD effort (22%). Measures should be adopted jointly (49%), including limits on FADs, biodegradable FADs, time-area closures and measures to avoid strandings. More than 90% of the participants thought that consistency in FAD management in all t-RFMOs is needed, and that management varies by type of FAD.

During the general discussion, a question was raised as to whether it made more sense to assign a fixed FAD limit per vessel or to set it proportional to vessel capacity, as done at IATTC. IATTC established differential limits on FADs by vessel size because historical information on fleet/vessel FAD use was available, which together with capacity limits avoids a possible overall increase in FADs, unlike when such capacity limits are not established. Fleet capacity limits are therefore an important component of any measure to limit FAD effort, and such limits need to be considered when setting limits on FAD numbers per vessel. However, it was also noted that caution should be considered on how “usage” is defined when allocating per-vessel limits, as not all usage metrics are equivalent (*e.g.* fleets/vessels deploying the most FADs may not be those making the most FAD sets). There is much more information available now than previously, and analyses are being undertaken that can provide some insight on that question. It was also noted that the number of FAD sets (which has been shown to increase at a higher rate than FAD deployments) might be another metric that could be easier to control. However, one participant commented that a possible effect of limiting sets would be increased FAD deployments, to give vessels more options to choose from. Thus, a limit on FAD sets should be accompanied by a limit on deployments.

It was acknowledged that the implications of activation and deactivation of buoys on these limits would have to be factored in when determining such limits. The signal status of FADs is an issue with artisanal fisheries as well: even if the buoy is turned off, the FAD may still be used for fishing. This effort must also be accounted for.

Some general questions related to management objectives arose. One concerned the motivation for an industry to seek certification, considering the costs involved. It was noted that certification may lead to higher prices for the catch, and retailer demand for certification was increasingly regarded as a basic requirement for sale.

It was asked whether t-RFMOs should focus on assessment and management of target species, given that they are not set up to address the broader issues of bycatch, habitat impacts, and other ecosystem

considerations, and may lack the resources to address them. In response, it was pointed out that target species management cannot be addressed in isolation from those other issues. Fisheries management that focuses only on maximizing MSY may have adverse effects on populations of bycatch species, on the stocks of other target species (including their MSY), and even on the MSY of the target species if selectivity changes (e.g. reductions of MSY resulting from increased catches of smaller fish on FADs). Impacts on habitat and ecosystem can affect not only target stock productivity, but can have much broader consequences. Furthermore, it was noted that t-RFMOs generally include elements of ecosystem considerations in their mandates.

In conclusion of the discussion of this item on the agenda, the Chair stressed the need to define clear objectives, that any proposed measure or solution should be holistic. He noted the existence of a broad range of possible management measures on FADs that none had been identified as the single best solution. Hence it was pointed out the need of a combination of measures, which, furthermore, should be flexible and adapted to each concrete situation and ocean also considering the impact of other gear types in those areas.

5. DEFINITIONS OF TERMS RELATED TO FAD FISHING, NOTABLY THOSE RELATED TO SCIENCE AND MANAGEMENT OF FADS

Following the detailed presentation by the Chair on the definitions of terms related to FADs and buoys used in FAD fishing operations, prepared by the Tech-JWG, there was a long discussion on process and method, but without entering into the substantive consideration of specific definitions.

The JWG acknowledged the progress with the definitions from the Madrid meeting, but also considered that more work is needed within t-RFMOs to further revise those definitions. It was noted that the data requests and resolutions on FADs already include divergent and undefined terms related to FADs (e.g. undefined 'active' FADs, etc..) among t-RFMOs which have hampered the collection and submission of FAD data to t-RFMOs. Moreover, the lack of clear definitions and data-collection forms has led in some cases to misunderstandings about the data to be collected and submitted by CPCs. Thus, the JWG underlined that it is both necessary and urgent to agree on definitions of FADs, buoys, and other elements of FAD fishing operations, including clarification and concrete examples, to facilitate the collection and submission of FAD-related data.

The informal poll (**FIGURE 2** of [Appendix 4](#)) showed that harmonizing definitions among t-RFMOs is considered highly necessary (55%) or at least advisable (38%). A majority (71%) believed that common definitions can be drafted, but flexibility may be needed. Definitions used in current management measures are not clear enough (95%), and should be reviewed by individual RFMOs (52%) or jointly by all RFMOs (43%). Definitions should be the same for science and management (78%), and this work on definitions should continue being part of the JWG (97%).

The JWG discussed the process of agreeing and adopting harmonized definitions among t-RFMOs, including several possibilities, such as (i) agreeing some definitions during the current meeting, and discussing the difficult ones intersessionally; (ii) having the definitions reviewed by a broader group of experts before discussing them in t-RFMOs, (iii) presenting the definitions to meetings of Scientific Committees and Commissions for review and adoption. Some participants thought that the final review of definitions and classifications related to FAD fishing could be conducted within the FAO Coordinating Working Party (CWP) on Fishery Statistics, but that the CWP would need input from the Secretariats of the tuna RFMOs.

The JWG agreed that a possible way forward would be to present the definitions agreed by the Tech-JWG ([Appendix 5](#)) to the Scientific Committees for review; they could then be fine-tuned by the Tech-JWG before being submitted for consideration by each t-RFMO.

It was noted that definitions related to responsibility for FADs/buoys should also be incorporated, as the issue of ownership has legal implications. However, the Tech-JWG does not have the expertise or mandate to undertake this aspect of the work.

6. MINIMUM STANDARDS AND FORMATS TO OPTIMIZE AND HARMONIZE THE COLLECTION OF DATA ON FADS AND DEFINITION OF SYSTEMS TO ACCURATELY QUANTIFY NUMBERS OF FADS AND ACTIVE BUOYS

Dr. Paul de Bruyn (IOTC) gave a [presentation](#), reminding the participants that at the first meeting of the JWG in 2017, the Chair concluded that *“to date, although management plans have been adopted in several t-RFMOs allowing for a better monitoring and data collection on FAD-associated fisheries, there is still lack of sufficient information and data on FADs”*. However, some progress has been made since then, and several RFMOs are making efforts to improve their FAD data collection systems. This includes developing or modifying data-collection forms, or adopting new measures to improve the collection of FAD-related data. Dr. de Bruyn described the efforts made in the different t-RFMOs regarding collecting data on FAD operations, many of which are ongoing, as data-collection forms are still being developed, and several issues reduce the amount of FAD data being submitted to t-RFMOs. The JWG may be able to ease this situation, since these issues are common to all oceans, so the expertise available at the JWG level would facilitate the discussion and resolution of some of the obstacles and complications in individual t-RFMO data-collection mechanisms. A clear list of minimum standards would help t-RFMOs to strengthen their data-collection systems, and a standardized reporting format would greatly ease the workloads for the providers of FAD data, many of whom operate in several ocean areas. Data-collection forms such as the new IATTC ROF and FAD form 9/2018v2, ST08 at ICCAT and 3FA_01 at IOTC, could be compared to look for commonalities and used to supplement each other’s strengths and develop a consistent data collection system across all oceans.

Dr. Maitane Grande presented J-T-RFMO FAD WG 2019_Grande_S:06, a review of current requirements and procedures and proposed standards for data collection and reporting on FADs to t-RFMOs. The proposals in this document are the result of a collaborative work between scientists and the fishing industry.

Dr. Grande also presented J-T-RFMO FAD WG 2019_Grande_S:06 (2) on the collaborative work among the fishing industry, buoy suppliers and research institutions to gather information on buoy tracks and acoustic records for scientific purposes. This information is contributing to the knowledge about buoy use, FAD dynamics and the behaviour and ecology of tuna and non-tuna species associated with FADs. The document describes progress to date in the collection and processing of buoy-derived data in the framework of the EU RECOLAPE project, which has enabled going beyond the current t-RFMO FAD data requirements.

Dr. Lorelei Guéry presented J-T-RFMO FAD WG 2019_Guery_S:06 on a Spatial Capture-Recapture (SCR) model that can be applied to estimate the spatial and temporal distribution, density and, more widely, time-at-sea and detection probability of dFADs. dFADs without available trajectories were considered as animals. The data were contributed voluntarily by French tuna vessel owners and tuna-fishing associations in the Atlantic Ocean.

The JWG noted that the ‘missing trajectories’ correspond to buoys that are described by unique identifiers which have been observed in the fishery and that the approach does not account for buoys without information on the identifier. This method enables density estimates to be derived for the fraction of buoys for which trajectories are not available.

The JWG noted that it would be methodologically feasible to account for missing parts of trajectories in the method as well as to use statistics on nearest points for improving estimates, but this would require

further work and could be done at a later time.

Dr. Alexandra Maufroy presented J-T-RFMO FAD WG 2019_Maufroy_S:06 on options for better monitoring and control of operational buoys. A great deal of useful information comes from satellite buoys, but information on the raft remains key, since FADs may drift without a buoy attached. Buoy manufacturers present at the meeting indicated that deactivations do not happen regularly at sea, since fishers have no interest in deploying buoys without getting position and fish biomass information, and deactivation would result in losing the buoy's history, which is important for fishers. Fishers activate buoys on the vessel to check their functioning before deployment, and buoys may cease transmitting in some cases, for instance when the buoy moves under the raft or when it is deactivated by a third-party vessel and brought back to port.

Some participants thought that fishing companies should be able to show that activations/deactivations do not occur. There are many incomplete buoy trajectories in the FAD tracking data for the Western-Central Pacific Ocean, although this may be due to a filtering process applied before the data are provided. Information from the Eastern Pacific Ocean indicates that the number of buoys at sea decreased sharply at the start of the annual closures of the purse-seine fishery and increased at the end of the closure, but this pattern is hard to explain.

The informal poll (Figure 3 of [Appendix 4](#)) indicated that 99% of the participants thought that it is necessary to harmonize data collection standards on FADs in all oceans, and 60% considered it highly necessary. Regarding whether data requirement standards can be drafted that address the needs of all RFMOs, 69% thought it was possible, but some flexibility is needed; 85% thought it was possible to develop systems to quantify the overall number of FADs, and 66% considered this a priority. A large majority of the JWG (85%) considered that materials and designs of FADs should be considered when quantifying the number of FADs. The JWG also felt that harmonization of data collection should continue to be part of its work.

Generally, the JWG felt that there has been some good progress in the collection of data on both buoys and FADs in recent years, and that the information on FADs should be harmonized among the t-RFMOs.

Finally, it was noted that the data sets used for compliance and science are different. It was also suggested that, as an incentive, the number of buoys/FADs allowed for a vessel could be linked to the “eco-friendliness” of its FADs, *i.e.* more buoys could be available for vessels using only biodegradable FADs.

7. MARKING AND TRACKING OF FADS

Dr. Anthony Beeching (WCPFC) made a [presentation](#) on the current situation of FAD marking and tracking systems in the different t-RFMOs, and explained the main drivers for marking and monitoring: 1) compliance; 2) economic considerations; 3) scientific research; and 4) environmental impacts. The administration of tracking and monitoring was presented, as well as challenges related to data ownership and sharing. Finally, a table comparing progress among t-RFMOs was presented, showing that each RFMO is moving forward but has set priorities in different areas.

Dr. Lauriane Escalle presented “*Recently available dFAD tracking data in the WCPO: challenges, new research areas and potential useful tool to guide management*” a spatio-temporal description of the PNA FAD tracking dataset for 2016-2018, including deployments, FAD density and fate of FADs at the end of their trajectories, including loss and stranding events. Challenges associated with the dataset were also described, including the fact that it is still incomplete, and that trajectories are truncated by service providers before being submitted to the PNA and SPC.

Regarding the importance of fine-scale tracking data (finer than 1 position per day), Dr. Escalle explained that a higher buoy transmission rate than once per day would enable better correlation between buoy

data and fishing operations.

It was clarified that the identification of “lost” FADs is based on linking the position of the FAD’s last record to the fishing grounds of the owner of the FAD: if a FAD is not within the owner’s fishing ground at the end of its trajectory, it is assumed to be lost. However, another vessel may still fish on the FAD, so it would be more correct to say the FADs are lost to the owner vessel or company.

It was noted that FAD data is useful not only for fisheries, especially the historical data: for example, for improving detection of the effects of ENSO events.

It was also noted that many strandings would not be noticed because trajectories are incomplete, but also because buoys are commonly deactivated if they drift outside main fishing areas.

Mr. Taha Imzilen presented “[Global analysis of beaching events in French dFAD trajectory data for impacts on sensitive habitats and proximity to ports](#)”, a spatial investigation of strandings, the origin of stranded FADs, and an evaluation of the risk of stranding by time and area of origin.

An informal poll (**Figure 4** of [Appendix 4](#)) showed that FAD tracking data/information would be used for a variety of purposes, such as compliance (15%), science (12%), mitigation (18%) and all three combined (55%); a majority (60%) of the JWG favoured using FAD monitoring data/information for both compliance and science. A slight majority (52%) thought that the main impediment to developing a FAD tracking and monitoring program was political, while 24% cited economic reasons. Interestingly, 54% of the JWG considered FADs to be fishing simply by being in the water, while 29% considered that they fish only when a fishing set is made. Finally, almost all the JWG (94%) supported including marking and tracking in the JWG’s work, and 69% considered this a priority.

In the discussion, it was suggested that increased FAD strandings may be due, in part, to the increased number of FADs in the water that are not being fished. An alternative explanation was linked to the fact that FAD fishing and deployments now occur year-round and in areas/periods that were not historically exploited. This seasonal variation corresponds to stronger currents, which would be expected to carry FADs further faster. It was found that in recent years the number of strandings stabilised, which may be caused by a change in fishers’ behaviour but this is subject to further research. Improved monitoring and tracking would be expected to facilitate interception of buoys/FADs before strandings can occur.

It was explained that identifications of stranded FADs were based entirely on satellite data, filtered using a ‘spatial proximity method’, and that, with improvements in technology, recovery of FADs is more feasible now than historically. In addition, one element of the research focused on FADs/buoys located close to ports, with the expectation that they may be relatively easy to recover.

There is some uncertainty regarding the number of strandings of FADs/buoys because a stranded FAD may become afloat and beach a second or multiple times, depending upon the design of the FAD and the nature of the stranding substrate.

Mr. Adam Baske presented “[Options for improving dFAD recovery and accountability to minimize coastal habitat damage and marine litter](#)”, which complemented the previous presentations by showing results from a crowdfunded database of strandings in the Atlantic Ocean. Options for improving dFAD accountability and recovery were also presented, including: 1) definitions of ownership and associated responsibilities; 2) clear requirements regarding “deactivation” of dFADs that are still adrift; 3) strengthening of dFAD recovery requirements; 4) independent RFMO-wide tracking of dFADs; and 5) clear mechanisms for coastal states, in collaboration with RFMOs, to communicate with dFAD owners on stranding events and abandoned, lost, and discarded fishing gear.

It was noted that, even though a vessel may be associated with a specific buoy/FAD, it was not always

possible to link the vessel to a flag State, because not all vessels appear on public registers. Mechanisms for owners of abandoned or stranded FADs to compensate affected areas should be developed.

The spatial stranding information was obtained largely via a Caribbean regional network of concerned individuals. Similar networks exist in other regions: in particular, PNA is developing a FAD logsheet and SPC has requested a specific component requiring information on strandings, with shared fields that would be filled in at time of deployment/service and stranding. Such a form could be shared with a wider group of interested members of the public.

The concept of “polluter-payer” in relation to FAD strandings was discussed. No concrete mechanisms were discussed, but it was suggested that it would be reasonable to expect compensation if, for example, coral reef damage resulted from a FAD impact. The JWG also discussed at what level compensation might be paid, for instance at the regional level, or to specific areas with particular impacts.

The JWG discussed FAD identification, and the issue of whether the buoy, the FAD, or both should be identifiable. The discussion centered on whether the raft component of a FAD should have its own identifier, given that buoy replacements by other operators are a common occurrence, and that otherwise a FAD that is separated from its buoy cannot be identified. A complication is that the raft identifier would identify only the initial owner, whose buoy might have been replaced, thus the user of the FAD may not be its owner. Also, on-board observers may not be able to record the buoy identifier during a set, not only because of their other duties, but also because the identifier can only be seen from very close to the FAD. However, for purposes of both science and compliance, the identifier should be known, and buoy changes monitored through time, and it was therefore proposed that a system for marking both buoys and FADs should be explored, including its practicality.

In the case of EU at least, detailed buoy information is available, because buoys are registered and all buoy changes are recorded in a separate logbook for FADs, and this information can be cross-referenced with FAD positions. However, this type of information is not available at the RFMO level, and matching trajectories and observer records is very difficult, particularly with low resolution buoy data.

It was suggested that the JWG should define a transmission frequency for buoys appropriate for data collection in support of science. It was also proposed that fishers should be given incentives to cooperate in reducing pollution by FADs, including strandings.

The JWG discussed the utility of using the guidelines agreed at the FAO Committee on Fisheries (COFI), and whether agreeing definitions of FADs and FAD fishing should be a priority for the JWG during this meeting. Both IATTC and WCPFC consider FADs to be fishing gear, but the FAO definition does not.

In this context, the JWG took note of the upcoming FAO Workshop on Best Practices to Prevent and Reduce Abandoned, Lost or otherwise Discarded Fishing Gear, to be held in Vanuatu on 27-30 May 2019.

After a discussion of priorities, and the need for specific recommendations at the end of the meeting, it was generally agreed that this topic of monitoring and marking should be a high priority.

8. FAD FISHERY INDICATORS

Dr. Jon Lopez (IATTC) presented a first draft of a list of FAD indicators developed by the Tech-JWG, with about 40 potential metrics, ranging from catch and effort to ecosystem indicators, which would form the basis for the discussion and adoption of a set of minimum FAD indicators for global use. It will also help in defining data collection and reporting needs and prioritizing the estimation of indicators for a holistic assessment of the FAD fishery.

The JWG considered this prioritized list of indicators very useful, and should be shared with t-RFMO scientific bodies, including the working groups on ecosystems for use in the development of ecosystem

report cards.

The need for an indicator of the total biomass associated with FADs was at the core of two documents presented by Dr. Santiago during this session: *“Treatment of acoustic data obtained from echosounder buoys for tuna biomass estimates”* (J-T-RFMO FAD WG 2019_Uranga_S:08) and *“A novel approach to obtain indices of abundance of tropical tunas from echosounder buoys”*(J-T-RFMO FAD WG 2019_Santiago_S:08).

In the first document, data from various brands of echosounder buoy in the Indian and Atlantic Ocean during 2010-2018 were analyzed, to develop a method for harmonizing data from different buoy brands by setting common acoustic units and sampling volume for all data sources. Information on target strength, composition and fish length, by species and area, are integrated to convert the acoustic signal into estimates of biomass.

The second document presents a novel approach for deriving a Buoy-derived Abundance Index (BAI) that could be incorporated into assessments of tropical tuna stocks. In a preliminary application of the methodology to obtain direct indices of abundance of juvenile yellowfin tuna in the Atlantic Ocean, acoustic signals collected at specific depths, times of day, and period of FAD drift, were standardized using a Generalized Linear Mixed Modelling (GLMM) approach, which assumes that the acoustic signal from the echo-sounder is proportional to the abundance of tuna.

Dr. Gary Melvin, chair of the ICCAT SCRS, explained that a great deal of information can be extracted from echosounder buoy data, but there are limitations, and not all echosounders are the same. The key is to get as much information as possible with the tools available. One possibility would be to add sensors that would provide additional information, and this could be investigated with buoy manufacturers.

Dr. David Die, former chair of the ICCAT SCRS, indicated that these types of indices will be very useful, although this approach has started with the hardest task, developing a single-species indicator, rather than an overall biomass indicator. There is a great deal of literature on translating acoustic signals from vessels doing surveys, but this is very different, because what is sensed is associated with a moving object to which the sensor is attached. Dr. Santiago noted that this is no harder than deriving abundance indicators from CPUEs, and was confident the result would be useful for stock assessments.

Dr. Laurent Dagorn presented *“Machine learning for characterization of tuna aggregations under drifting FADs from commercial echo sounder buoys data”* (J-T-RFMO FAD WG 2019_Baidai_S:09), which proposes a new methodology, based on machine learning, for characterizing fish aggregations under dFADs from the acoustic data collected by echosounder buoys. A random forest algorithm is used to translate the raw buoy data into metrics of tuna presence and abundance. The results showed that detection of tuna aggregations with echosounder buoys was typically more effective during daytime periods and at specific depths. Pattern recognition of presence/absence of tunas under dFADs was fairly good in both the Atlantic and Indian Oceans (75 and 85% correct predictions, respectively), but estimates of the precise range of aggregation sizes were less accurate.

Regarding how the acoustic signal is converted to account for sizes, Dr. Dagorn explained that the actual acoustic value is not used, but rather the resulting image - the same technology used for facial recognition, for instance. In answer to a suggestion that combining data for several days might produce better estimates, because the tuna will remain aggregated for several days, he noted that the difficulty is that the length of time that tuna stay at a FAD seems to vary spatially.

The informal poll showed that, in the absence of a single indicator to assess the impact of FAD fisheries, 54% of the JWG opted for a combination of catch and effort, activity and ecosystem and ecological indicators (**Figure 5** of [Appendix 4](#)), and 69% thought that current data collection systems support the

development of the most important indicators, at least partially. A large majority (70%) thought that the best unit of effort for purse-seine fisheries is a combination of metrics such as search time, number of sets, catch per set, and buoy-related indicators. Opinions on the possibility of producing indicators robust to changes over time were less clear: 31% thought it possible, while 56% did not know, but considered it important. However, 98% were in favor of including new data sources (e.g. buoys, electronic monitoring) in the development of metrics, and of including the matter of indicators in the future work of the JWG.

9. PROGRESS REGARDING SCIENTIFIC INFORMATION ON FADS AND ONGOING RESEARCH IN THE DIFFERENT T-RFMOS

Following a presentation by Dr. David Die on progress regarding scientific information on FADs and ongoing research at the different t-RFMOS, an extensive discussion took place on several aspects of research, its results, and its use for management advice at the t-RFMOS.

The participation in FAD research of a wide variety of stakeholders, including scientists, industry, buoy manufacturers, NGOs, governments, and the t-RFMO scientific committees, has greatly facilitated collaboration and the transparency of the analyses and results presented. Also, it is important in reaching agreement on management recommendations at the RFMOS.

Much of the FAD research has been presented at the scientific committees of the t-RFMOS, and the communication of ongoing FAD research among t-RFMOS should be improved. Dr. Die presented a summary of research related to FADs and/or FAD fisheries in each t-RFMO, with a list of contacts and links to reports/results, which included more than 30 projects, and he noted that there may be more, on legal aspects, for example. The JWG noted the importance of this summary, and suggested adding an approximate cost for each project, to illustrate the growing trend of FAD research in recent years. The European Union has been a main financial contributor, but NGOs such as ISSF, as well as the industry, have also contributed substantially to FAD research in different t-RFMOS, and individual governments have contributed locally. The JWG highlighted the importance of coordination at a multi-regional level, such as the JWG and other inter-RFMO fora, for avoiding repetition of research and for prioritizing research needs to address the main gaps in order to provide robust management advice.

In this regard, the JWG noted that several t-RFMOS have developed, or are developing, Strategic Research Plans; FAD research should be part of such plans, and mechanisms such as the Kobe process are important for ensuring common and synergistic research objectives. All t-RFMOS should participate in meetings like this one, including CCSBT, which may not have FAD fisheries for tropical tunas but may be impacted by lost FADs. In summary, the JWG agreed on the following objectives: clearly-defined research recommendations, enhanced coordination among RFMOS, identification of issues and gaps in research, prioritization of future research to optimize the resources available, both scientific and financial, and mitigation of the impacts of FAD fisheries, all of which would also help to improve the overall image of these fisheries. With regard to financing, it was recommended that t-RFMOS include funds for FAD research in their regular budgets, to avoid relying exclusively on external funds. Dr. Gala Moreno (ISSF) presented Document J-T-RFMO_S:09, "*Towards acoustic discrimination of tuna species associated with FADs*", which summarizes ongoing research on the acoustic characterization of the main target species of FAD fisheries: skipjack, bigeye and yellowfin tunas. In at-sea experiments on single-species schools, the target strength of each species is being studied as a function of the size of the fish. Yellowfin and bigeye have swim bladders, and thus can be easily distinguished from skipjack, which have no swim bladder, using double-frequency sonar. However, swim bladders only become fully developed when the fish are about 45 cm long, so this may not work for smaller fish, and differentiating yellowfin from bigeye has been less successful. This should be taken into account when evaluating the feasibility of management measures based on minimum sizes, in particular for yellowfin and bigeye in purse-seine fisheries. Dr. Moreno highlighted the importance of working with buoy manufacturers to ensure that acoustic signals

are correctly converted to estimates of biomass for each species (or yellowfin+bigeye), and that the protocols and formats used by all manufacturers and types of buoy are compatible. Also, the acoustic signal from buoys should include a GPS signal, to identify the exact location of the target school.

The JWG noted the importance of the t-RFMOs being prepared to store and process the very large data sets associated with this research, which would require Bigdata and Artificial Intelligence protocols to optimize analysis and interpretation. Vessel owners should share the echosounder data with research institutes, national scientists and governments and/or RFMOs, and the t-RFMOs should consider creating scientific groups to work directly with these data.

Regarding the cost-effectiveness of buoys able to discriminate species, Dr. Moreno explained that the higher cost is more than offset by the advantages for fishers in terms of optimizing effort and catches, avoiding catching undersized fish, and complying with management measures.

The informal poll revealed that 45% of the JWG felt that this research has helped only in a few instances, and 19% that it had not helped at all, in the development of FAD management measures by the t-RFMOs (**Figure 6 of Appendix 4**). Also, 86% thought that there is some (but not enough) collaboration among t-RFMOs in matters of research, and that this should be improved. The main reasons for not addressing some fundamental research questions were considered to be a lack of time and resources (52%) and operational issues (*e.g.* allocation of fishing opportunities) (31%). Bottlenecks for resourcing/funding research are due to the fact that it is not funded from Commission budgets (45%) or because it is tied to a particular operator or fleet (31%). Finally, the JWG considered that the most critical research gaps that should be funded were: evaluation of FAD management strategies (32%); mitigation of ecological effects (25%); fishing mortality of target species (22%); ecology of FAD-associated communities (9%); materials, design and construction techniques (6%); and sensor technology and its use in assessments (6%).

10. IMPACTS OF FADS IN TUNA FISHERIES AND RECENT DEVELOPMENTS IN THEIR MITIGATION

Dr. Moreno presented a review of the key environmental impacts of FADs: undesired fishing mortality of small yellowfin and bigeye tunas, bycatch of sharks, impacts of FAD structures on coastal habitats, pollution, and the possible effects of FADs on the ecology of fish (J-T-RFMO FAD WG 2019_Moreno_S:10). She highlighted several research activities, mostly through collaboration between scientists and fishers, that investigated options for mitigating these impacts. To reduce the fishing mortality of small yellowfin and bigeye, without reducing the catch of skipjack too much, the most promising technique is acoustic discrimination, using the different acoustic responses of each species to select the target.

The three major options to reduce pollution due to FADs are to reduce the number of FADs, modify the structure of FADs (biodegradable FADs), and reduce lost or abandoned FADs.

Concerning sharks, Dr. Moreno summarized the mitigation measures, which would be addressed in detail by Dr. Laurent Dagorn (see below).

Several future mitigation options were discussed, including FAD retrieval programs and innovative approaches such as FAD sharing, anchored FADs, and FADs with navigation capabilities. Dr. Moreno made the following recommendations: biodegradable FADs without netting, vessel designs that facilitate the safe and live release of bycatch, involving fishers in research, and regulatory and/or market incentives to achieve implementation of technological solutions.

Dr. Dagorn [presented](#) the various solutions that have been found in recent years to mitigate the impacts of FADs and FAD fishing on pelagic sharks, mainly silky and oceanic whitetip sharks. Silky sharks frequently associate with floating objects (77% of floating objects in the Indian Ocean, 40% in the Atlantic), and are thus vulnerable to FAD fishing and to FADs: a major discovery has been the extent of “ghost” mortality of sharks caused by FADs. Designs for non-entangling FADs, which eliminate this risk, have been defined and

disseminated to fishing fleets worldwide. The adoption of good mitigation practices for sharks caught in purse-seine nets could significantly reduce the overall mortality of sharks caused by the fishery.

Dr. Dagorn also made a [presentation](#) on a study which aims at modelling the movements of tunas in arrays of FADs, with the goal of assessing the effects of changing densities of FADs on tuna movements and the consequences for FAD-associated and unassociated schools ([J-T-RFMO FAD WG 2019 Perez S:10](#)). Using data on distances between natural floating objects and distances between FADs, a first simulation of the model suggests that the addition of FADs to the ocean could lead to tunas spending significantly less (6-10 times) time in unassociated schools.

Dr. Hilario Murua [presented](#) efforts to improve FAD designs in order to reduce their impacts on the ecosystem ([J-T-RFMO FAD WG 2019 Zudaire S:10](#)). The ISSF workshops for fishing captains, conducted since 2009 all around the world, have played a very important role in disseminating good mitigation practices and in getting fishers' feedback on mitigation options. He reviewed the current FAD designs in the EU fleet, which no longer uses FADs that pose a high risk of entangling marine fauna. In the Indian Ocean, 35% of the FADs are now non-entangling, with no netting.

Dr. Murua also made a [presentation](#) on the EU BIOFAD biodegradable FAD project ([J-T-RFMO FAD WG 2019_Zudaire_S:10 \(2\)](#)), which aims to test biodegradable materials for constructing FADs, and also investigate the socio-economic aspects of bioFADs. So far, 554 "bioFADs" have been deployed by the EU fleet in the Indian Ocean. Preliminary results show that the cotton canvas used to cover the raft degrades significantly during the first month, and that the biomasses associated with non-entangling FADs are greater than for bioFADs. BioFADs are slightly more expensive to build than traditional FADs, but this is trivial compared to the cost of the electronic buoys attached to FADs.

In answer to a question about whether incomplete buoy data prevent tracking FADs and assessing their impacts on coastal environments, Dr. Murua noted that the dynamics of the FAD 'populations' are not well understood, and there are no data to assess whether more FADs strand if deactivated; modelling FAD drifts would help in developing potential scenarios. Deactivation of FADs is not a new phenomenon: fishers have regularly deactivated them to avoid paying transmission costs for lost FADs.

The increased depths of the underwater structures of FADs have increased the amount of litter caused by FADs, although the number of FAD deployments has decreased in some regions and the use of biodegradable materials should reduce the impacts in the future. It should also help to reduce plastic pollution in coastal countries, and modelling FAD drifts will also be a useful tool for preventing FAD strandings.

To a question about information on FADs drifting to coastal waters, and their potential effects on local artisanal fisheries, Dr. Moreno answered that there is no research being done on this. She also noted that more research was needed on the effects of the depth, behavior and selectivity of purse-seine nets on catches of bigeye, with a view to reducing catches of small bigeye.

Dr. Moreno explained that, because fishers want a slow drift of FADs, they increase the depth of the underwater structure. FAD designs with short underwater appendages that would generate slow drifts are being researched, in particular through collaboration with oceanographers who develop oceanographic buoys to study currents.

Regarding the urgency of advancing on measures for the conservation of sharks, and the slow pace of research to develop techniques to mitigate shark bycatch, Dr. Dagorn explained that several options have been tested in recent years. Some proved effective for reducing the fishery-induced mortality of sharks, but many showed no potential and were abandoned, and were not shown in the presentations. Several other options are identified for the future, which deserve funding and time for research.

Regarding how long it might take to achieve 100% biodegradable FADs, the progress achieved in the past five years in moving to non-entangling FADs is encouraging, and a similar timeline might be possible. Reducing the environmental impacts of FADs is urgent, more so because of growing public awareness of the high number of FADs deployed and their potential consequences.

The informal poll showed that a majority (57%) thought that large numbers of FADs could negatively impact tuna populations, even without fishing. A larger majority (65%) also thought that there has been progress in the last 10 years to reduce bycatches, including of juvenile tunas. A plurality (40%) considered that juvenile tunas, ETP¹ species, and finfish species are most impacted, and 49% thought that FAD pollution and strandings are a major concern for the ecosystem. Finally, regarding short/medium-term priorities for mitigating of impact of FAD fisheries, 40% thought that the focus should be on juvenile tunas, 31% on the ETP species, and 24% on pollution and stranding of FADs (Figure 7 of [Appendix 4](#)).

11. CURRENT AND FUTURE INITIATIVES FOR FAD FISHERY SUSTAINABILITY

Mr. Guillermo Morán ([Tunacons](#)) presented "different initiatives led by the industry towards the sustainability in the FAD fishery", which introduced two main actions for dealing with FAD issues: 1) biodegradable FADs; 2) retrieving FADs and buoys before any strandings or entanglements happen.

Mr. Miguel Herrera, of [OPAGAC](#), which represents nine companies involved in purse-seine fisheries for tropical tunas in the Atlantic, Indian, and Pacific Oceans, presented Document J-T-RFMO FAD WG_Herrera_S:11 (2): *Implementing management plans and voluntary initiatives regarding FADs: the OPAGAC experience – an update*. He described OPAGAC's actions, carried out in the context of its Fishery Improvement Project (FIP), to assess its impacts on target species, bycatch, and the habitat, with a focus on FADs. Two actions were particularly important: (i) the release of all available data on FADs used by their vessels, including data to ensure compliance with RFMO requirements, and voluntary exchange of all available buoy track and echosounder data for 2009-2018 with the [AZTI](#) research institute; and (ii) participation in capacity-building, research and pilot initiatives to mitigate ecosystem impacts.

Mr. Herrera also presented Document J-T-RFMO FAD WG_Herrera_S:11, about the [FAD-Watch project](#), a pioneer cooperative initiative involving fishing companies, the Seychelles Fisheries Authority (SFA), local and international NGOs and industry, AZTI, and buoy service providers.

Regarding arrangements in Ecuador to ensure regular reporting of data on FADs, per IATTC requirements, and provision of buoy data for scientific research, Mr. Morán indicated that Tunacons has been working with industry and the government to ensure that all required FAD data are reported to the IATTC, and is working on protocols for the exchange of other information, through the adoption of a National FAD Management Plan. The companies involved in Tunacons are willing to share the information for scientific progress, but more communication among governments, scientists, vessel owners and fishers is needed. Mr. Herrera reiterated that OPAGAC has established protocols for the release of all available FAD data, for compliance and research, the latter on a voluntary basis and under a very strict confidentiality policy.

Regarding efforts to reduce catches of juvenile tunas, Mr. Herrera indicated that OPAGAC companies are involved in many research projects, including buoy discrimination, electronic monitoring systems, and other initiatives, as well as in management strategy evaluation (MSE) processes and the implementation of management plans in the four t-RFMOs.

Regarding the feasibility of FAD-Watch initiatives in the WCPFC area, Mr. Herrera indicated that this is difficult because implementation can be uneconomical in small island states and territories, in particular those with very large EEZs or comprised of many islands, since the cost of recovering a FAD can be more

¹ Endangered, threatened, and protected

than the average cost of a FAD (over 1,200 USD). The main reason OPAGAC participates in programs such as FAD-Watch and BIOFAD is because they are seen as the best tools for minimizing the impacts of FADs; however, BioFADs may not fully resolve the problem of FAD strandings in the short term, and other solutions should be explored to prevent FADs reaching sensitive coastal areas. The areas covered by FAD-Watch in Seychelles were determined by Island Conservation Society, a local NGO which has field staff in each location. However, they may need to be revised as more information is collected, if FAD strandings are recorded in areas outside those covered by the program.

Mr. Herrera noted that it was feasible to recover FADs and keep them on the vessel, as required by IATTC before each closure, but FADs that have been at sea for long periods usually accumulate barnacles and other sessile organisms which, if left on deck to die and rot, may become a biohazard to the vessel crew.

Concerning the future extension of the FAD-Watch pilot to other areas, Mr. Herrera noted that these initiatives require the participation of as many of the fleets that contribute to the stranding of FADs as possible, and therefore require multilateral arrangements. In some countries, FADs are appropriated by the coastal fisheries, which use them to fish or dismantle them and sell the components. OPAGAC is also releasing information on buoys to many offshore drilling companies, which then take care of intercepting and disposing of the FADs, to reduce as much as possible the potential impact of FADs on those companies' activities. This type of approach could be used in countries where impacts are very low and the implementation of a full-scale FAD-Watch initiative is uneconomical.

The informal poll (Figure 8 of [Appendix 4](#)) showed that 59% of the JWG thought that current sustainability initiatives were driven by the market/consumers, whereas they will/should be driven by management. In recent years, initiatives like FIP, Eco-labels and certifications, *etc.*, have affected sustainability moderately (45%) or significantly (33%). A substantial majority (66%) thought that industry and RFMO sustainability plans should be similar (63%) or even the same (24%), and that they should be harmonized across RFMOs (88%).

12. AREAS OF FUTURE CROSS-RFMO COLLABORATION ON FADS

The JWG recognized that the agenda for the current meeting was very ambitious, resulting in several issues being covered less comprehensively than expected, and discussed possible avenues for collaboration in the future and for improving the future working of the group. A recommendation was made that, at future meetings, fewer topics should be covered, and scientific presentations should focus on potential management implications.

The JWG concluded that the Tech-JWG should continue, as it provides a forum for the specific issues to be addressed. Ideally it should remain small, and include only experts who could significantly advance the issues being discussed; the JWG, however, should remain inclusive, and ideally include participants from the FAD working group of each t-RFMO.

The JWG recommended that, in future, its agenda should be reduced to allow sufficient time to discuss priority issues and advance progress on these issues. The Tech-JWG would provide input to the JWG based on progress made on specific issues. The individual RFMOs could provide guidance on the priorities to be discussed, in addition to defining the mandate of the JWG. It was generally agreed that this avenue of collaboration should continue, as it provides a good forum for t-RFMOs to discuss issues of common concern.

13. OTHER MATTERS

No other matters were discussed.

14. RECOMMENDATIONS

The JWG adopted the recommendations in Appendix 6.

15. ADOPTION OF THE REPORT AND CLOSURE

The Chair thanked the participants for their participation and contributions, the IATTC staff for organizing the meeting, and the interpreters for their work. In turn, the JWG thanked the Chair for his able leadership.

The meeting was adjourned.

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Appendix 2. Agenda

1. Opening of the meeting
2. Adoption of the agenda
3. Review of the progress of the key areas for action for the joint t-RFMO FAD WG identified during the 1st Meeting of the Group
4. Review of the current management measures on FADs
5. Definitions of terms related to FAD fishing, notably those related to science and management of FADs
6. Minimum standards and formats to optimize and harmonize the collection of data on FADs and definition of systems to accurately quantify numbers of FADs and active buoys.
7. Marking and tracking of FADs
8. FAD fishery indicators
9. Progress regarding scientific information on FADs and ongoing research in the different tRFMOs
10. Impacts of FADs in tuna fisheries and recent developments in their mitigation.
11. Current and Future initiatives for FAD fishery sustainability.
12. Areas of future cross RFMO collaboration on FADs
13. Other matters
14. Recommendations
15. Adoption of the report and closure

Appendix 3. Reports by t-RFMOs

GENERAL ISSUES	IOTC	ICCAT	WCPFC	IATTC
LEGAL ASPECTS				
Definition of a FAD	Adopted in Resolution 18/08, definition in paras. 1 & 2 “This Resolution defines an instrumented buoy as a buoy with a clearly marked reference number allowing its identification and equipped with a satellite tracking system to monitor its position”. This does not explicitly define a FAD though.	Under discussion within the scope of the joint t-RFMOs FAD WG	Defined CMM 2008-01, CMM 2009-02 CMM 2018-01 Para 18 [for 2019 only]	IATTC Resolution C 18-05
Definition of ownership and responsibilities	Under discussion FAD ownership often changes at sea through buoy transfers, which are monitored in logbooks and by onboard observers through a dedicated sampling form. However, buoy ownership seldom changes as this has to be done through the satellite provider company.	Under discussion within the scope of the joint t-RFMOs FAD WG	PNA is discussing the implementation of a registry for FADs	Under discussion
DEFINITIONS AND COMMON INDICATORS				
Identify available sources for common definitions	Under discussion within the scope of the joint t-RFMOs FAD WG	Under discussion within the scope of the joint t-RFMOs FAD WG	Work in progress	FAO Fish Tech RPT 568, IATTC FAD WG, Joint Tuna-RFMO Tech WG
Harmonize definitions related to science and management of FADs: FAD set (associated vs non-associated), non-entangling, biodegradable, active buoy, type of operation at FADs etc. Prioritization should be	Under discussion in the WPDCS where there has been a detailed comparison of IOTC and CECOFAFAD definitions, but with no final agreement between data end users yet, as the purpose of the data collection is unclear, as is the	Discussions started in the ICCAT FAD WG, but pending the work being conducted within the scope of the joint t-RFMOs FAD WG.		Under discussion in the FAD WG. Some interim definitions have been adopted by the Commission (year 2018; ref)

GENERAL ISSUES	IOTC	ICCAT	WCPFC	IATTC
given to those definitions with direct management implications and the science needed to guide that management	type of definitions that are required.			
Need to develop harmonized FAD fishery indicators (e.g. number of FADs, FAD sets, ratio of FAD-associated sets to unassociated sets, numbers of vessels deploying FADs and supply vessels etc.) to estimate the contribution of FADs to the overall effective fishing effort and capacity in tropical tuna fisheries across ocean regions	The WPDCS has requested that harmonization of terminology and data collection / reporting requirements for FOB and instrumented buoys is considered for inclusion as one of the topics to be addressed during the agenda of the joint tRFMO FAD working group. A consultant is now working on this dataset.	Discussions started in the ICCAT FAD WG, but pending the work being conducted within the scope of the joint t-RFMOs FAD WG.		Under discussion in the Joint tuna RFMO Tech WG – Task led by IATTC
ENHANCED COOPERATION				
Collaboration between industry and scientists for the improvement of the collection of data, scientific research and to develop effective mitigation techniques	Scientific collaboration with the industry in several initiatives: -collate historical and current data on FADs in a consistent format, - BIOFAD project to test biodegradable FADs in real conditions, - implement best practice for handling and safe release on PS (IOTC–2018–WPTT20–26), - investigate the feasibility to implement a FAD recovery program (IOTC-2018-WPEB14-12)	Several ongoing initiatives	ISSF and others work with WCPFC members to promote non-entangling biodegradable FADs (lower-entanglement risk designs now required from 1st Jan 2020 under para 19, CMM 2018-01)	Collaboration well established through several channels (Virtual meetings, BASECAMP, training workshops, research projects) Collection of data improved at the staff level. The staff is also requesting that industry provide higher resolution data on buoys

GENERAL ISSUES	IOTC	ICCAT	WCPFC	IATTC
Coordination and collaboration on research plans on FADs across t-RFMOs		None		Two levels: at the scientists' level is well developed, but at the formal level there is room for improvement
Creation of a small technical working group of experts under the KOBE umbrella, with a focus on research and other technical aspects	IOTC has joined the TWG	Partially, tWG conducting work within the scope of the joint t-RFMOs FAD WG	WCPFC has joined the TWG	The IATTC is part of this technical group since late 2018
ELABORATION AND IMPLEMENTATION OF APPROPRIATE MANAGEMENT FRAMEWORKS				
Define clear management objectives	Management objectives are not entirely clear (Res. 18/08): - minimize the capture of small BET and YFT - prevent, to the extent possible, the loss or abandonment of FADs. - reduce entanglement of sharks, marine turtles or any other non-target species - reduce impact on the marine environment by using biodegradable materials	Intersessional work on going within Panel 1 aiming to revise rec. 16-01	PNA is discussing the implementation of a registry for FADs	Accomplished. General objectives defined, but specifics need to be discussed
Review existing FADs management plans and explore potential for harmonization across t-RFMOs		Intersessional work on going within Panel 1 aiming to revise rec. 16-01		Partially accomplished; internal frequent reviews but bot across t-RFMOs
Assess the effectiveness of various management options for FADs within the framework of general tropical tuna fisheries management (e.g. overall fishing capacity)	Resolution 15/09 defines objectives for an ad hoc FAD working group: "to assess the consequences of the increasing number and technological developments of FADs in tuna fisheries and their ecosystems, in order to inform	None	CMM 2018-01 Para 23 FAD fishing Closures and FAD limit 350 max per vessel all deployed with Instrumented buoy. Annual review of the measure	Work in progress (e.g. project J.2.a)

GENERAL ISSUES	IOTC	ICCAT	WCPFC	IATTC
	and advise on future FAD-related management options". The first ad hoc working group was held in 2017 but was unable to answer this.			
Address monitoring (e.g. 100% observer and VMS coverage) and compliance issues	Res. 15/03 VMS mandatory for all active registered vessels. 100 % observer coverage is implemented by the EU PS fleet under the Best Practice of Handling and Release practices	Intersessional work on going within Panel 1 aiming to revise rec. 16-01	All deployed FADs have instrumented buoys all RFVs have VMS 100% observer coverage on P/S. CMM 2018-01 para 36 ROP reports for trips during FAD closure are prioritized [data and analysis]	Undertaken – 100% observer coverage in large seiners, EM in development, and annual Compliance Committee.
Consider adaptive, precautionary, management with respect to emerging issues with FADs, taking into account the best available science	Precautionary action has been taken through the adoption of a FAD limit in Res 18/01, though not based on any science advice.	Intersessional work on going within Panel 1 aiming to revise rec. 16-01		Some research undertaken, but not precautionary

Appendix 4. Definitions by Tech-JWG

Definitions of terms related to buoys used in FAD fishing operations

Document prepared by the joint tRFMO Technical Working Group on FADs

Abandonment (deliberate loss): The situation in which the buoy cannot be located by the owner on the monitoring device, following request to buoy supplier company. The buoy satellite transmission has been remotely deactivated.

Acquired buoy: Buoy purchased and assigned to an identifiable entity (purse seiner vessel or group of purse seine vessels or registered owner of a purse seine vessel) to whom is issued the purchase invoice.

Activation: The act of enabling satellite communication services by the buoy supplier company at the request of the buoy owner. The owner then starts paying fees for communication services. The buoy can be transmitting or not, depending if it has been manually switched on.

Active buoy: A buoy with enabled satellite transmissions. It can be transmitting or not, depending if it has been manually switched on.

Buoy on stock: Any buoy that is in the inventory of a vessel or a fishing company and not deployed at sea.

Buoy owner: Any legal or natural person, entity or branch, who is paying for the communication service for the buoy associated with a FAD, and/or who is authorized to receive information from the satellite buoy, as well as to request its activation and/or deactivation. The buoy owner may have acquired the buoy or may have bought it from a previous buoy owner.

Buoy: Any floating device that can send visual, radio or satellite signals to facilitate determination of its location, and that can have additional equipment to increase fishing efficiency (e.g., echosounder)

Deactivation: The act of stopping or terminating satellite communications services by the buoy supplier company at the request of the buoy owner. The owner stops paying fees for communication services.

Echosounder buoy: Satellite buoy that includes an echo sounder that provides rough estimates of the FAD-associated fish biomass that is transmitted to the fishermen remotely.

Loss (accidental loss): The situation in which, without any intervention of the owner, the buoy cannot be located by the owner on monitoring device. The main causes of signal loss are buoy retrieved by another vessel or person (At-sea or on-shore), FAD sinking and buoy failure.

Monitored [tracked] buoys: Buoys owned by a purse seiner vessel that are in operational condition.

Operational buoy: Any instrumented buoy, previously activated, switched on and deployed at sea, which transmit position and any other available information such as eco-sounder estimates.

Reactivation: The act of re-enabling satellite communications services by the buoy supplier company at the request of the buoy owner. The owner starts paying fees for communication services again. The buoy can be transmitting or not, depending if it has been manually switched off before reactivation.

Satellite buoy: An instrumented buoy with a satellite tracking system (e.g., GPS) to monitor its position with a clearly marked reference number allowing its identification, and that can have additional equipment to increase fishing efficiency (e.g., echosounder)

Shared buoys: Buoys whose information is shared by several purse seiner vessels or/and other members of the fishing company.

Switching off: Action of applying or inserting a magnet on a pre-operational buoy to stop satellite transmissions of position and any other available information such as eco-sounder estimates.

Switching on: Action of applying or removing a magnet on a pre-operational buoy to allow satellite transmissions of position and any other available information such as eco-sounder estimates.

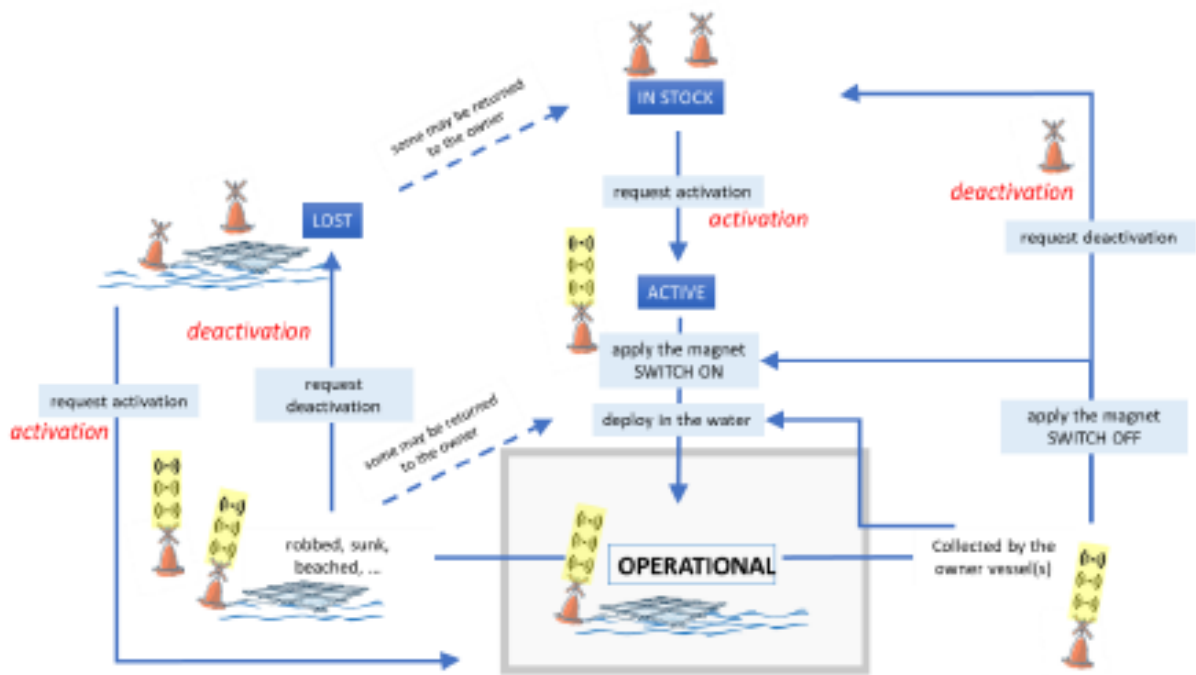


Figure 1. Life cycle of an instrumented buoy (adapted from Grande et al., 2019)

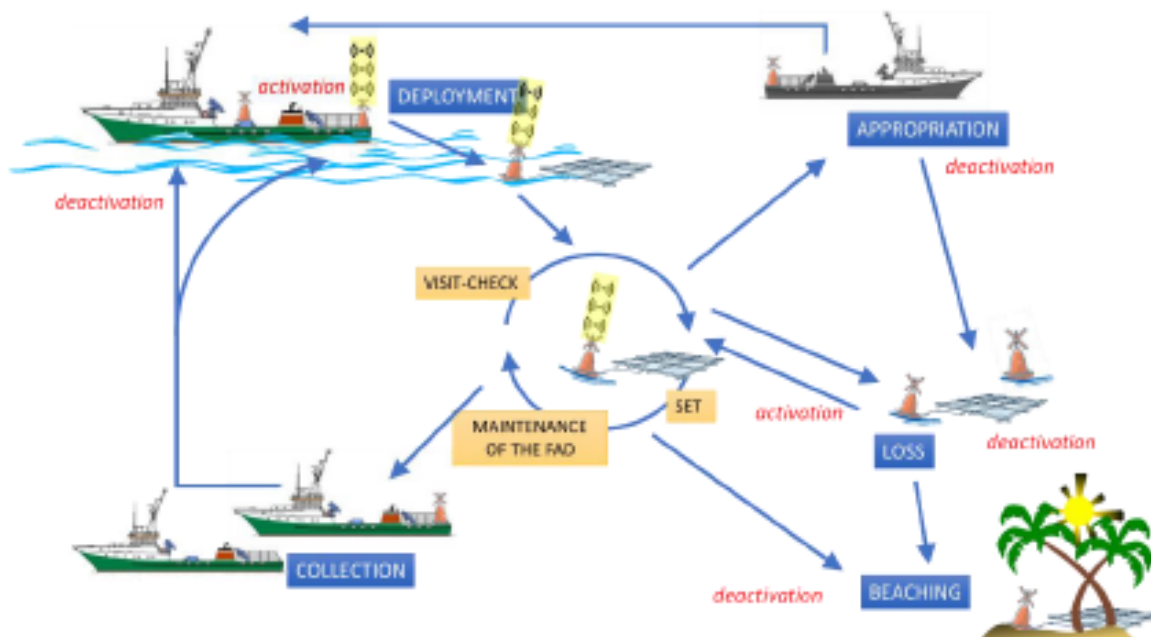


Figure 2. Life cycle of a buoy in connection with FAD activities (adapted from Grande et al., 2019)

Definitions of terms related to FAD fishing operations

Draft document prepared by the joint tRFMO Technical Working Group on FADs

Abandoned FAD: FAD from which the communication has been intentionally stopped by remotely deactivating the buoy attached or has been left at sea without a buoy.

Active FAD: The term "active" is confusing when referring to a FAD. It is more appropriate in the context of a buoy.

Anchored FAD (AFAD): It usually consists of a FAD (see FAD definition), tethered to the bottom of the ocean with a mooring. AFADs are called 'payaos' in some regions

Associated set: see Floating object set

Beaching: Event consisting of a FAD that was previously drifting at sea washing ashore and becoming grounded, beached or entangled on a reef, potentially causing damage to coastal ecosystems.

Biodegradable FAD: FAD composed of renewable lignocellulosic materials (i.e. plant dry matter) and/or bio-based biodegradable plastic compounds, prioritizing those materials that comply with international relevant standards or certification labels for plastic compostability in marine, soil or industrial compost environments. In addition, the substances resulting from the degradation of these materials should not be toxic for the marine and coastal ecosystems or include heavy metals in their composition.

Deployed FAD: FAD that is physically placed or deposited in the water by a vessel engaged in or supporting the activities of fishing.

Dolphin set: Deployment of a fishing gear around a tuna-dolphin association

Drifting FAD: FAD not tethered to the bottom of the ocean. A DFAD has a floating structure (such as a bamboo or metal raft with buoyancy provided by buoys, corks, etc.) and a submerged structure (made of old netting, canvass, ropes, etc.).

Ecological FAD: see Biodegradable FAD

Encountered FAD: Any FAD (anchored, drifting, man-made or natural) which a vessel comes across and/or interacts with in the course of fishing.

FAD: see Fish-Aggregating Device

FAD owner vessel: The vessel that last deployed and/or monitored a satellite buoy on a FAD. This may change during the life-time of a FAD with FAD appropriation, and buoy leasing and selling processes

FAD set: Setting a fishing gear around a tuna school associated with a FAD

Fish-Aggregating Device [FAD]: Permanent, semi-permanent or temporary object, structure or device of any material, man-made or natural, which is deployed, and/or tracked, and used to aggregate fish for subsequent capture. FADs can be either anchored (aFADs) or drifting (dFADs).

Floating object [FOB]: Any natural or artificial floating (i.e. surface or subsurface) object with no capability of moving on its own. FADs are those FOBs that are man-made and intentionally deployed, and/or tracked. Logs are those FOBs that are accidentally lost from anthropic or natural sources.

Floating object interaction: Any physical activity involving a floating object. A physical activity includes, but is not limited to deployment, maintenance, modification, monitoring, visiting, retrieving or setting.

Floating object set: Setting a fishing gear around a tuna school associated with a floating object.

Free school set: The net is set around a free-swimming school of tuna, i.e. a school that is not associated with any floating object or cetaceans.

Log: Artificial (ALOG) or natural (NLOG) floating objects resulting from contingency (from anthropic or natural sources). They can be classified as FALOG (artificial log resulting from accidental loss from human fishing activity), HALOG (artificial log resulting from human non-fishing activity), ANLOG (natural log of animal origin) and VNLOG (natural log of vegetal origin).

Lost FAD: FAD that can no longer be tracked by any vessel because the information of the buoy attached is no longer received due to several deliberate or involuntary reasons (buoy satellite transmission terminated or lost, FAD and/or buoy sinking, ...)

Monitored FAD: A FAD with a satellite buoy transmitting position at least every day.

Non-entangling FAD: FAD designed to minimize ghost fishing (entanglement of fauna, primarily sharks and turtles).

Object set: see Floating object set

Payao: see anchored FAD

Stranding: see beaching

Supply vessel: see support vessel

Support vessel: A vessel that operates in support of purse seine vessels fishing on FADs, and whose role is to deploy, repair, retrieve or maintain FADs at sea.

Tender vessel: see support vessel

Unassociated set: see free school set

Visited FAD: see encountered FAD

Whale set: Deploy a purse-seine net to catch tuna associated with one or more live whales.

Whale shark set: Deploy a purse-seine net to catch tuna associated with live whale sharks.

Appendix 5. Poll results

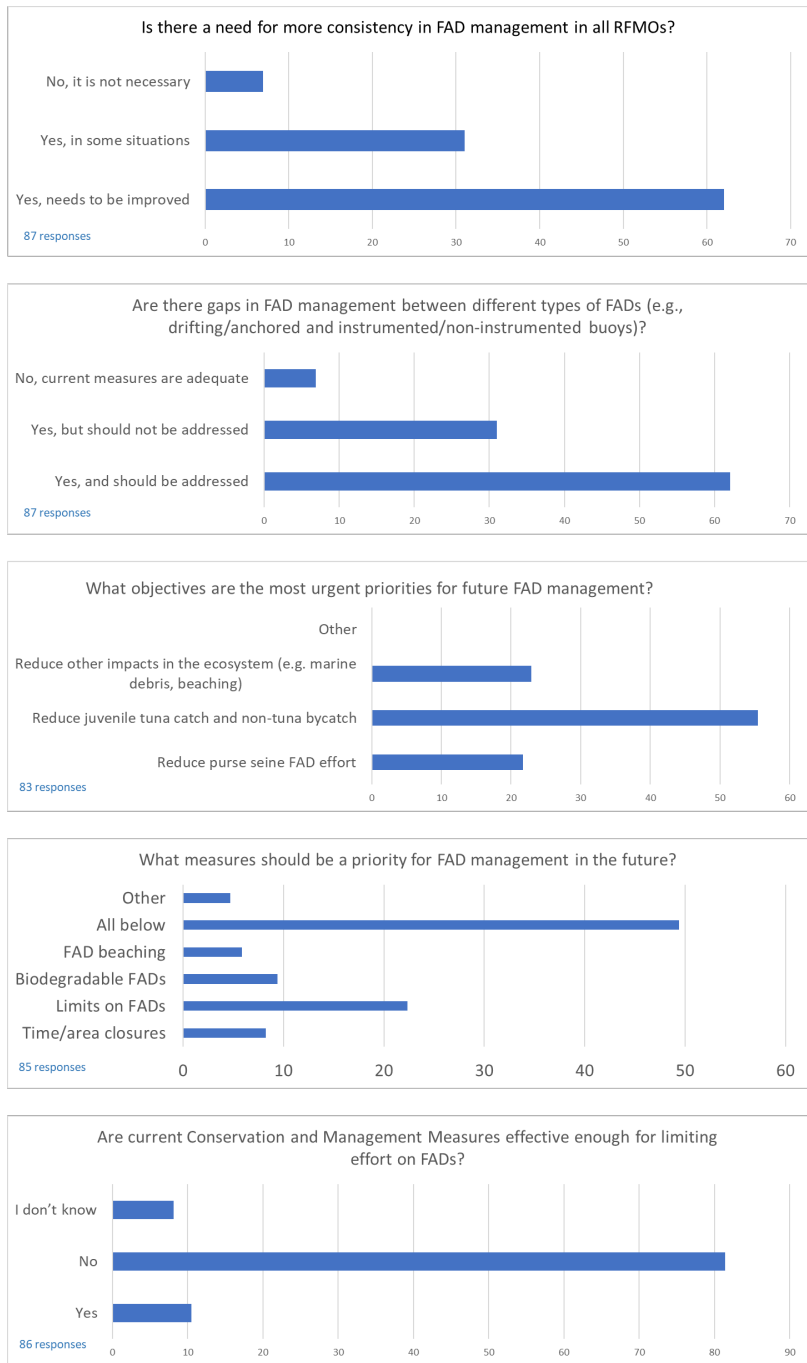


FIGURE 1. Results of the informal poll on management measures on FADs

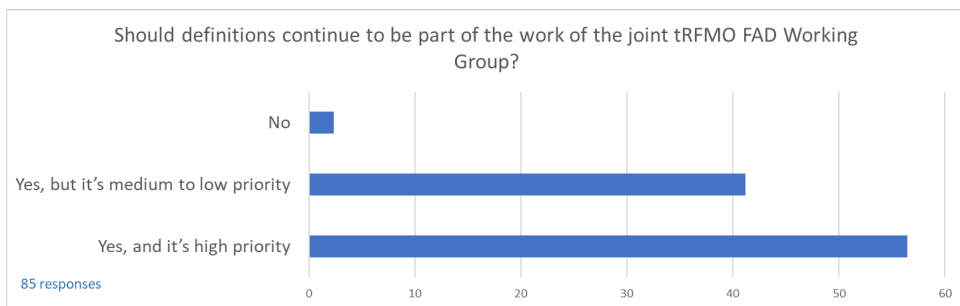
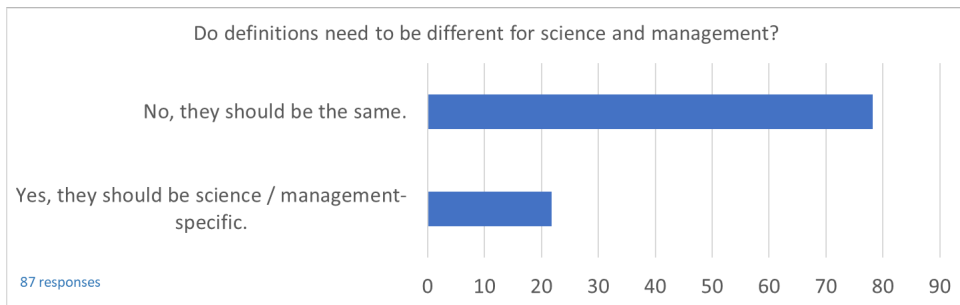
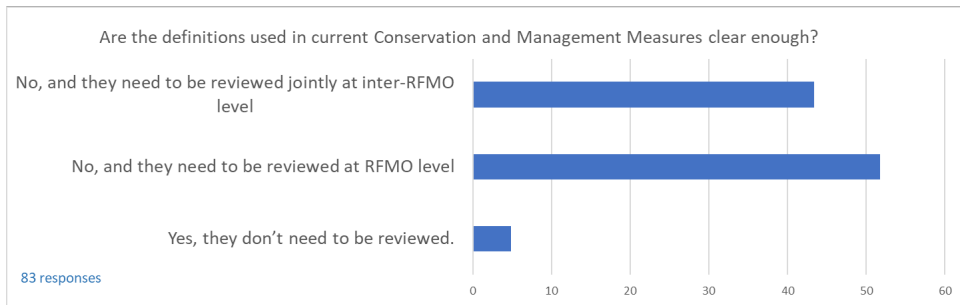
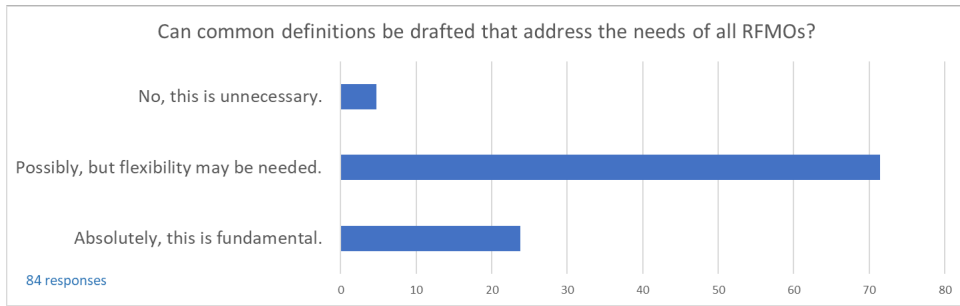
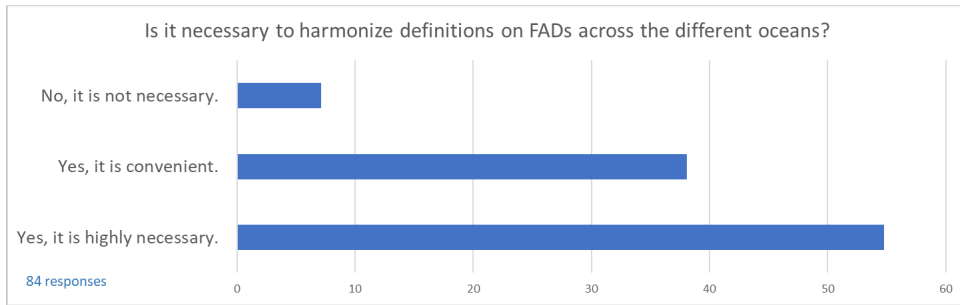


FIGURE 2. Results of the informal poll on definitions of terms related to FAD fishing

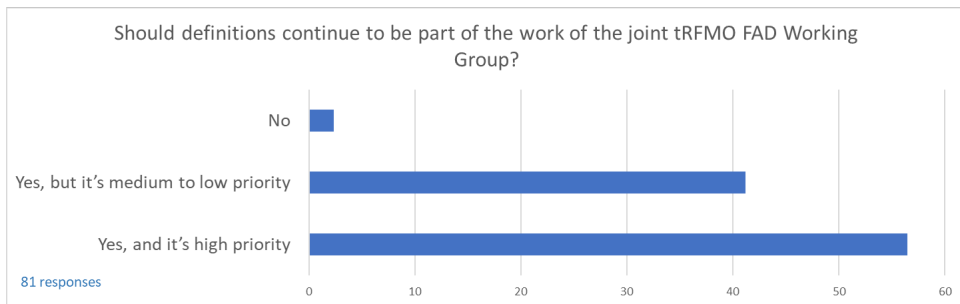
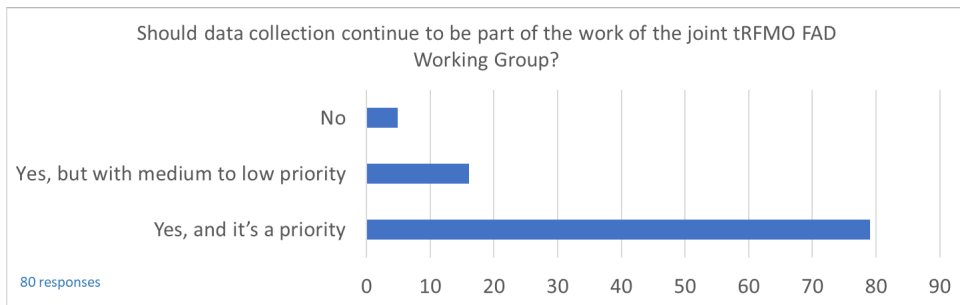
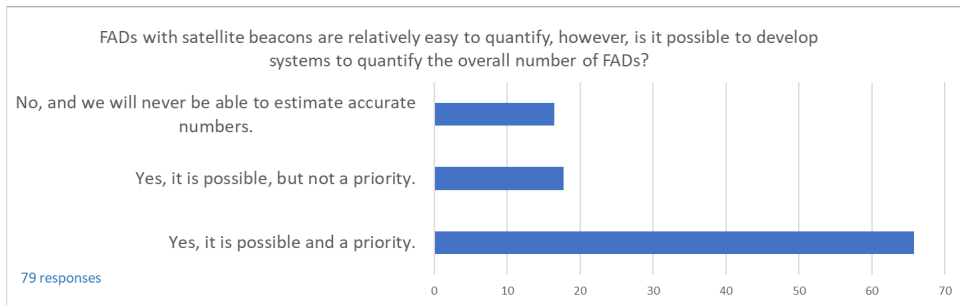
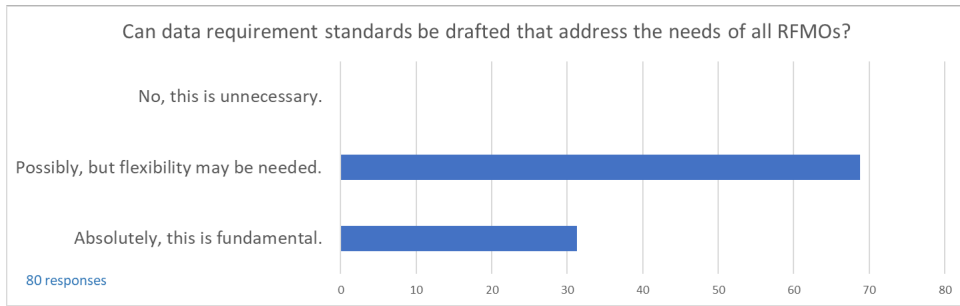
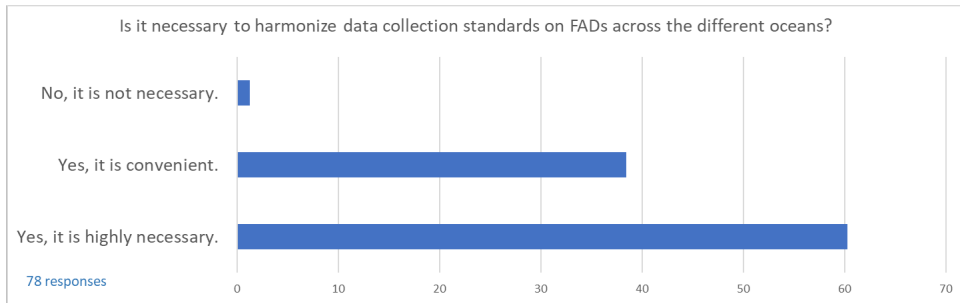


FIGURE 3. Results of the informal poll on data collection on FADs

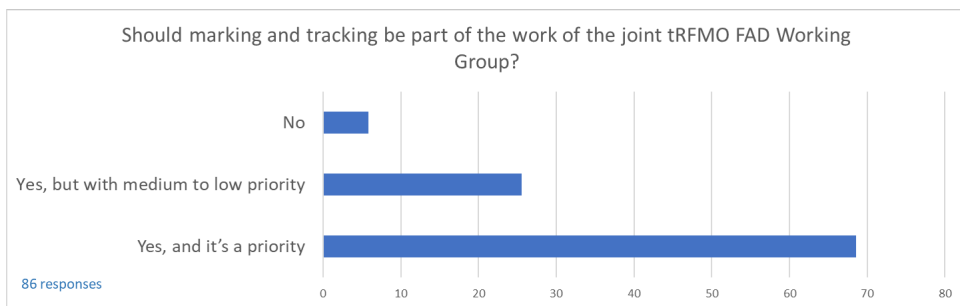
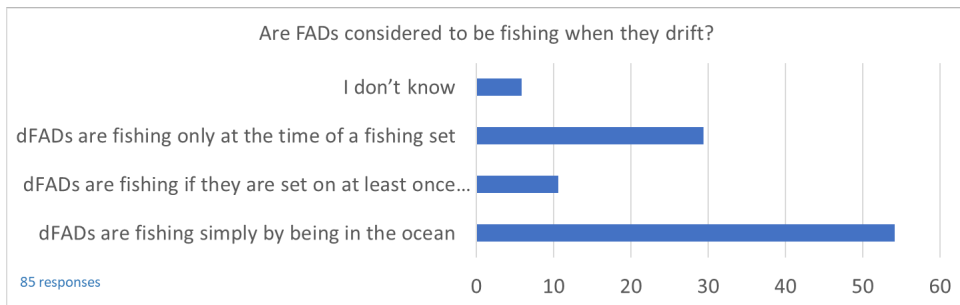
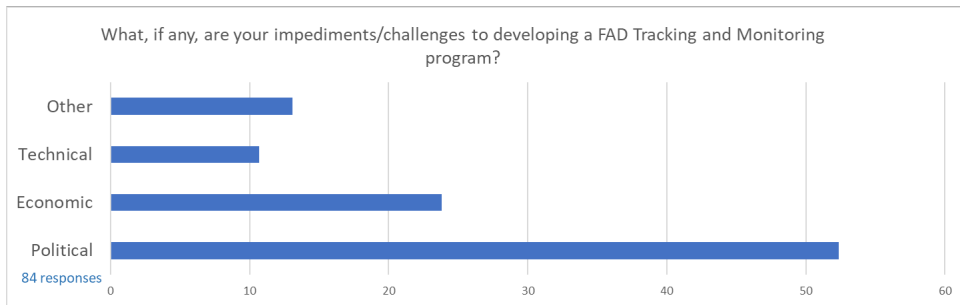
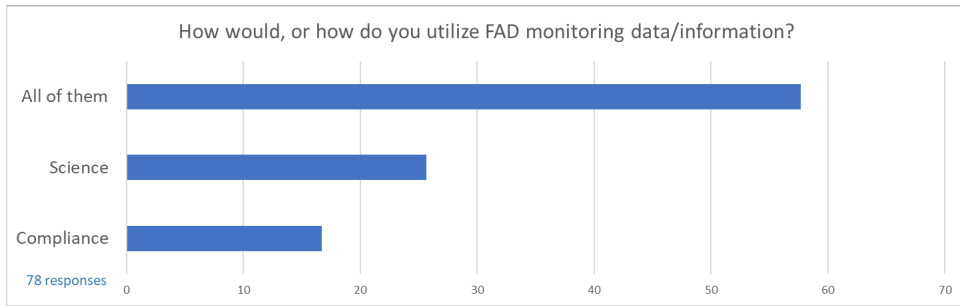
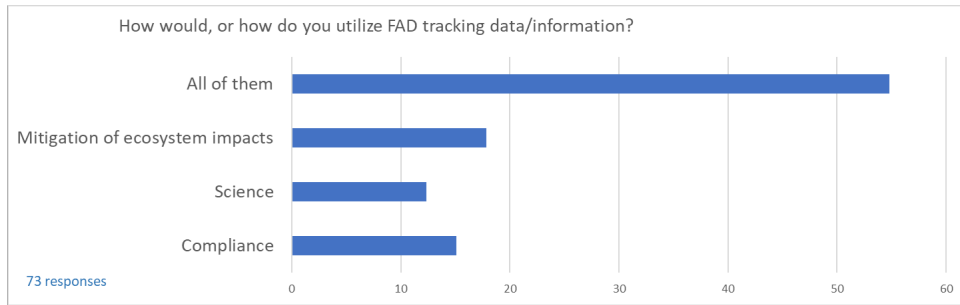


FIGURE 4. Results of the informal poll on marking and tracking of FADs

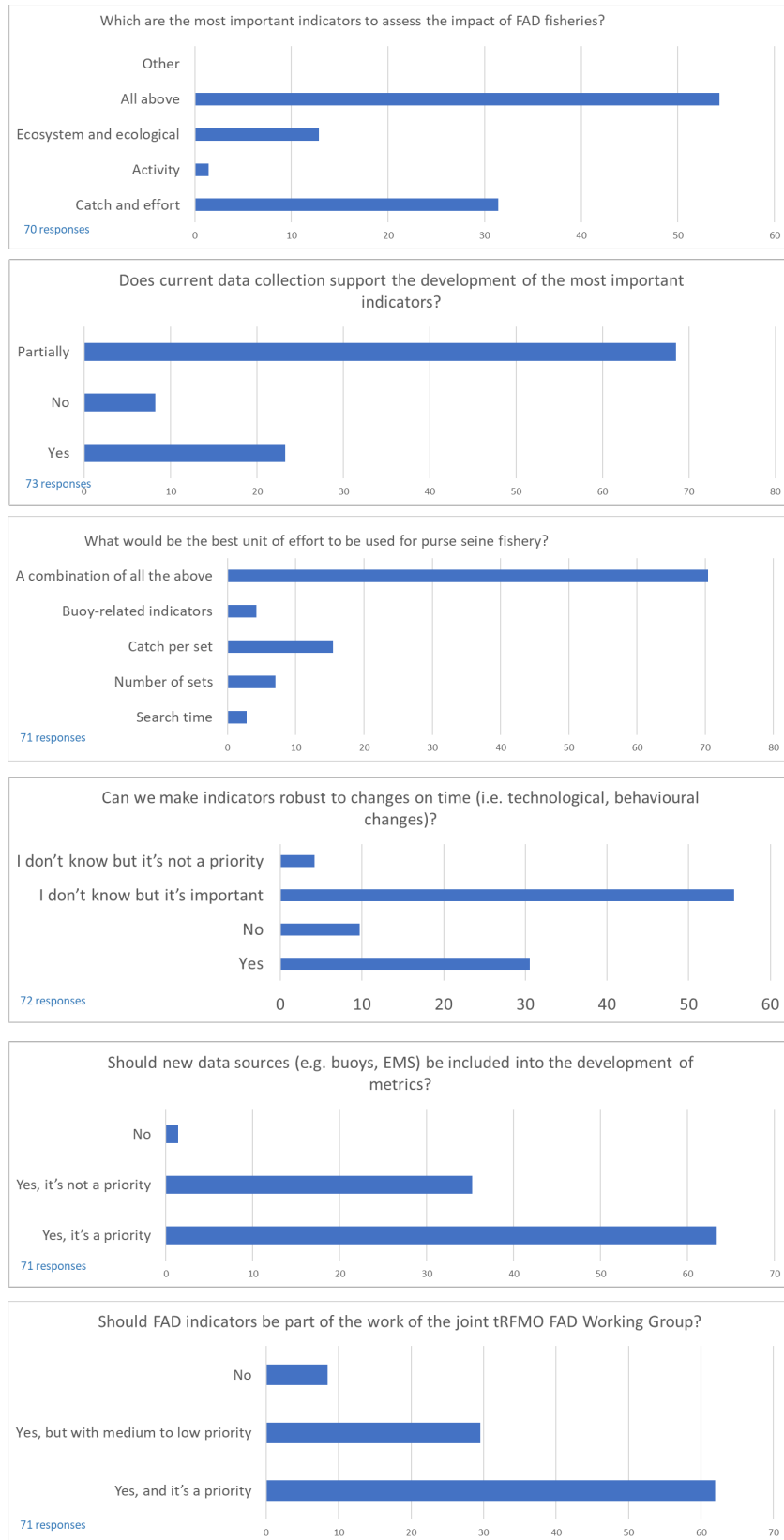
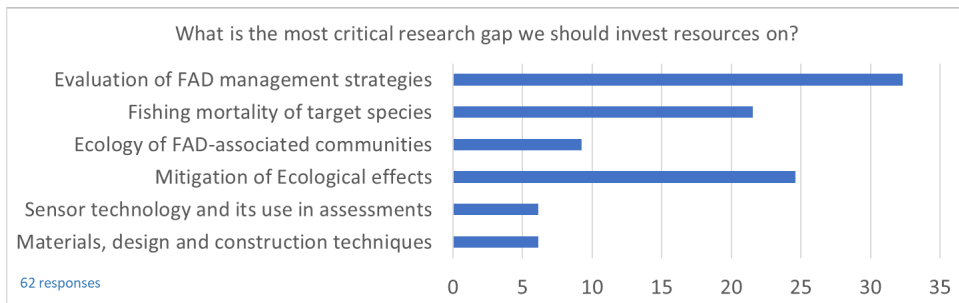
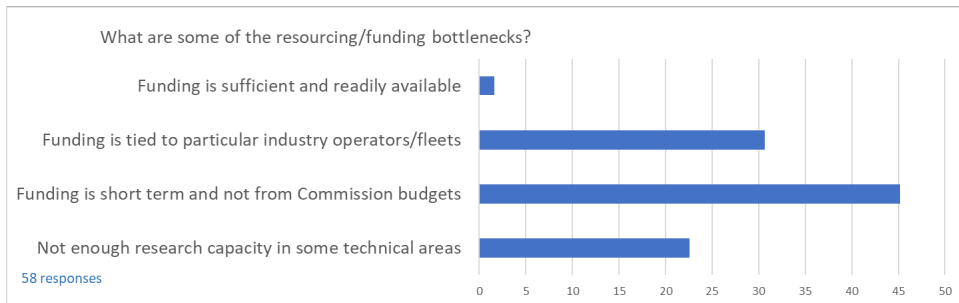
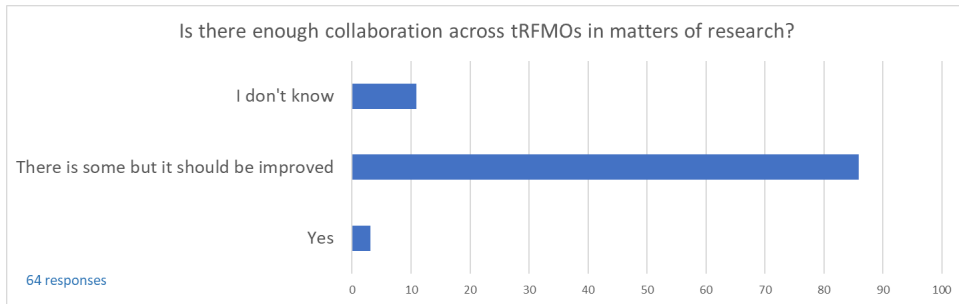
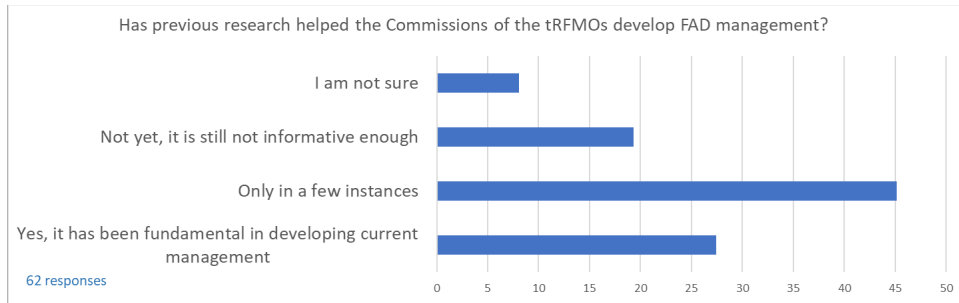


FIGURE 5. Results of the informal poll on FAD fishery indicators



Appendix 6. Recommendations

GENERAL:

The Working Group recommends that:

1. The mandate and responsibilities of the Joint t-RFMO Working Group on FADs (JWG) be discussed within each t-RFMO, and that guidance on these matters be provided by the RFMOs (perhaps through the Kobe process steering committee) in order to clarify and define the respective roles of the JWG and the Joint Technical Working Group (JTWG).
2. The agendas of future meetings of the JWG should focus on a limited number of key issues, thus allowing more progress to be made on identified priority issues. The JTWG should identify the key issues to be discussed.

SESSION 4: MANAGEMENT

3. t-RFMOs should prioritize scientific studies which provide advice on potential limits on FAD deployments /sets and/or the current active FAD/buoy limits, in relation to management objectives.
4. The t-RFMOs should explore opportunities for consistency and harmonization, if possible, across t-RFMOs in FAD management measures .
5. Each t-RMFO should develop, as a matter of priority, systematic monitoring and reporting procedures on the number of active FADs/buoys in its Convention Area.
6. FAD management objectives should be defined, both within each t-RFMO and jointly, to guide research, data collection, and the development of effective conservation measures.

SESSION 5: DEFINITIONS

7. Each t-RFMO should adopt definitions of priority terms related to the FAD fishery.
8. The JTWG should identify definitions whose harmonization is a priority.
9. Any definitions proposed by the JTWG should be reviewed by the Scientific Committee of each t-RFMO.

SESSION 6: DATA COLLECTION

10. The minimum standards for data collection should be reviewed by the relevant technical or scientific working groups within each t-RFMO, and revised or adopted as appropriate.
11. Discussions on minimum data collection standards should be prioritized in the future work of the JTWG.

SESSION 7: MARKING AND TRACKING

12. Given the possibility of buoys becoming separated from a FAD or being replaced, a system for marking both buoys and FADs should be explored.
13. High-resolution buoy position data should be made available for research purposes.

SESSION 8: INDICATORS

14. The suite of indicators prepared by the JTWG and presented during the meeting should be reviewed, and used as appropriate, by each t-RFMO.
15. Those indicators should be extended to include research on overall biomass indicators, such as buoy-derived indices and the status of stocks/species.
16. Time series should be developed by each t-RFMO for all the indicators, including buoy-related indicators, using historical data to capture fishery evolution and seasonality and ENSO-cycle

variability.

17. The development of indicators should be consistent with data collection criteria and definitions.

SESSION 9: RESEARCH

18. The JTWG should develop a five-year joint research plan on FADs, with input from the Scientific Committees of the t-RFMOs.
19. The joint FAD research plan should define priorities for each of the research actions, with higher priority for items that benefit all t-RFMOs or more than one t-RFMO, and organize *ad hoc* scientific meetings, as appropriate.
20. t-RFMOs should set aside and invest resources in medium- and long-term research on FADs, preferably research that is conducted jointly or transferable across t-RFMOs.
21. The Scientific Committees of the t-RFMOs should consider the positive experience of the workshops for vessel captains, owners and crew, and develop a mechanism for regular exchange of scientific information and stakeholder knowledge across t-RFMOs.
22. The results of research conducted by different groups and/or with the support of different fleets should be promptly and widely shared with all fleets and researchers involved and other interested parties.
23. t-RFMOs should facilitate cooperation/collaboration with t-RFMOs actively involved with acoustics, promote professional development in acoustics and, where necessary, hire scientists with expertise in acoustic data analysis, to work with the data related to acoustic buoys.

SESSION 10: MITIGATION

24. t-RFMOs should accelerate progress to reduce contributions of FADs to marine litter and mitigate negative impacts on coastal habitats and marine ecosystems and endangered, threatened and protected species, such as use of FADs without netting and those made with biodegradable materials, as well as mechanisms and incentives for recovering FADs.
25. At its next meeting, the JWG should consider the impact of FADs on juvenile tunas and review mitigation measures to reduce those impacts.
26. Continue to involve fishers in the process of finding solutions.
27. Conduct region-specific research to test mitigation strategies, as solutions adapted to each ocean and region.
28. Consider incentives to promote implementation of technological solutions.

SESSION 11: INITIATIVES FOR SUSTAINABILITY

29. Collaboration, mutual trust, and sharing of knowledge and data among t-RFMOs, scientists, industry and NGOs should be strengthened in order to tackle unresolved issues related to the sustainability of the FAD fishery.

SESSION 12: COLLABORATION ACROSS RFMOS

30. Hold a meeting to evaluate the information available to assess the effect of each t-RFMO's measures on FADs, with special focus on sharing information on challenges and successes.