METHODOLOGY FOR THE MONITORING OF FOB AND BUOY USE BY FRENCH AND ITALIAN TROPICAL TUNA PURSE SEINERS IN THE INDIAN OCEAN

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ABSTRACT

In this document, we present the methodology adopted by ORTHONGEL and its member fishing companies for the monitoring of FOB and operational buoy use in the Indian Ocean. In particular, we detail updates in purse seine fishing/FOB logbook that will allow a proper collection of information on FOB types and FOB activities and we detail the methodology recently adopted with buoy providers to ensure compliance with existing buoy limitations. We underline the need for a transparent and harmonized control of the number of operational buoys used by purse seiners that would address potential issues of under-reporting through cycles of activation/deactivation. We propose minimum standards of operational buoy monitoring that would ensure that a given vessel does not circumvent buoy limitations with "ghost buoys".

KEYWORDS

Floating Object | Fish Aggregating Device | Instrumented buoy | Purse seine fishery

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1. Introduction

In 2012, due to raising concerns regarding the increasing of Fish Aggregating Devices (FADs) and their negative consequences (Dagorn et al. 2012, Fonteneau et al. 2013), ORTHONGEL and its member fishing companies (Compagnie Française du Thon Océanique, SAPMER S.A., Saupiquet and Industria Armatoriale Tonniera) implemented for the first time a voluntary limitation of the number of tracking buoys used by French (22 vessels) and Italian (1 vessel) purse seiners (PS) on Floating OBjects (FOBs) in the Atlantic and Indian oceans (ORTHONGEL Decision No 11 of November 2011).

Convinced that limiting the number of buoys would reduce the number of dFADs at sea and their negative consequences, ORTHONGEL has advocated for the adoption of buoy limits in tuna RFMOs (Riva 2014, Goujon et al. 2017). In recent years, such limits have become mandatory for all tropical tuna purse seine fleets of the Atlantic, Indian and Pacific oceans (IOTC Res 15/08, ICCAT Rec 15-01, IATTC Res C-17-02, WCPFC CMM-2017-01) as a mean to reduce FOB fishing effort and dFAD impacts on ecosystems.

In parallel, considerable work has been done to clarify the notion of "FAD", their modalities of use and the options for FAD management (Goujon et al., 2014, Gaertner et al., 2016, Fonteneau et al. 2014 a-b, Grande et al. 2018). Among others, EU scientists and PS fleets have worked conjointly on definitions and data collection procedures that would allow evaluating separately the effects of FOB fishing in terms of fishing effort, habitat modification and pollution (Gaertner et al. 2016, Grande et al. 2019). Though less precise definitions have been adopted in IOTC Resolution 19/02, an update of the French fishing / FOB logbook is therefore necessary to take into account the results of this work.

On the other hand, clear definitions of the notion of "active buoy" and harmonized control rules have been lacking for several years in the Indian Ocean. This situation has left room for doubts regarding under-reporting of the number of buoys used on FOBs through cycles of buoy activation/deactivation. The implementation of IOTC Resolution 19/02 in 2020 should allow a better monitoring of the number of operational buoys, as FOB buoy activations will only be authorized onboard (as proposed in Maufroy et al. 2019) and FOB buoy reactivations will only be allowed after the buoy has been brought back to port (as proposed in Santiago et al. 2017). With the implementation of IOTC Res 19/02 in 2020, the methodology to monitor the number of operational buoys used by French and Italian PS is therefore necessary in the Indian Ocean.

The objectives of this document are therefore to : (i) describe the methodology that will be used in 2020 by the French PS fleet to report FOB and buoy activities, (ii) describe the methodology adopted by ORTHONGEL and its member fishing companies to monitor the number of buoys used on FOBs drifting at sea (iii) discuss potential limitations of this methodology in terms of monitoring of "ghost buoys" and (iv) proposes minimum standards for data collection, reporting and control of the number of operational buoys.

2. Methodology used by ORTHONGEL to monitor FOB and buoy activities

2.1. Meeting data collection and reporting requirement on FOBs

Following the implementation of the first FAD management plan in 2012, the structure of the French purse seine fishing logbook was updated in 2013 to allow collecting data on activities with FOBs and their instrumented buoys. At that stage, the decision was made to combine information on catches and FOBs in the same logbook so as to facilitate data reporting by captains. Various information such as the type of fishing set, the type of FOB or the type of instrumented buoy used on the FOB were added to the structure of the logbook (see **Table 1**). However, this version that is still currently in use in the Atlantic and Indian Oceans does not allow meeting all ICCAT and IOTC data collection and reporting requirements on FOBs (ICCAT Rec 16-01 and IOTC Resolution 19/02 among others). A solution is therefore necessary to meet these requirements and to better take into account scientific recommendations (Gaertner et al., 2016, Grande et al. 2019, **Table 2**).

Several options were examined by ORTHONGEL and its member fishing companies in 2018 and 2019. The first and originally preferred option was to take advantage of the implementation of the 3rd version of the Electronic Reporting System (ERS3) onboard French flagged fishing vessels in 2019, so as to avoid multiple declarations in multiple formats (ERS3, Excel ICCAT-like logbook, dedicated FOB logbook, etc). Yet, the current version of the ERS3 FOB plug-in requires corrections as it is not using the proper classification of FOBs, FOB activities, buoys and buoy activities. **Table 3** provides a description of the current FOB plug-in structure.

The second option would be to develop a FOB reporting software as proposed in the frame of the EU RECOLAPE project (Ruiz et al. 2019, Cauquil et al. 2019). This could be done for example by adapting the ObServe platform currently used for scientific observation onboard EU purse seiners and support vessels (Cauquil et al. 2015) to the needs of the industry. An extension of the ObServe platform is currently in development by the French Institute for Research and Development (IRD). Among others, pre-configured combinations of FOB operations, FOB types, buoy operations and buoy models will be available in the ObServe FOB extension allowing faster declarations by vessel captains.

In the meantime, while the ERS3 FOB plug-in still requires corrections and the ObServe FOB extension is still in development, the third option is to update the current version of the French fishing/FOB logbook. Though this solution should only be temporary, two main objectives were set for this update.

The first objective was to ensure that appropriate categories of FOBs, FOB activities and buoy activities were used in the logbook. The current version of the logbook contains unprecise categories FOBs such as for example “natural vs artificial FAD” (though this definition, currently in use in IOTC Res 19/02, does not allow evaluating the contribution of FOBs deployed by fishers to marine debris or habitat modification) or “ecoFAD” (referring to Low Entanglement Risk FADs, though the terminology “ecoFAD” could also be used for FADs built with biodegradable materials). Redundant categories or categories mixing FOB and buoy activities are also used (e.g. a vessel can choose between “buoy change” and “FOB visit” but cannot choose the combination of the two activities).

The second objective was to better describe the structure of DFADs deployed or encountered at sea by French purse seiners and their support vessels, so as to confirm that only Low Entanglement Risk (LER) FADs or Non-Entangling FADs (NEFADs) are used in the Atlantic Ocean (ICCAT Rec 16-01, ISSF 2019) and only NEFADS are used in the Indian Ocean (IOTC Res 19/02). As required in FAD management plans (ICCAT Rec 16-01 and IOTC Res 19/02), FAD design characteristics should also be described, so as to evaluate the potential impacts of FOBs on marine and coastal ecosystems.

2.2 The French fishing/FOB logbook and FOB management plan in 2020

Though updating the Excel fishing/FOB logbook should in theory only be a temporary solution for the French PS fleet of the Atlantic and Indian Oceans, an updated version is currently in preparation and will be used for all fishing trips in 2020 (including those beginning in 2019 and ending in 2020). **Table 4a** describes the general structure of the updated logbook and **Table 4b** details information related to FOB and buoy activities.

The fishing component of the logbook, that is meeting IOTC and ICCAT requirements on fishing logbooks, will remain very similar and only minor changes in the structure will be operated to facilitate data reporting by vessel captains and data use by scientists. The FOB component of the logbook has been fully redesigned. Particular emphasis was laid on improving the declarations of FOB types, FOB activities and buoy activities. Outdated and incorrect wording were removed and replaced by the CECOFAD recommended classification (Gaertner et al. 2016). While this classification has not been adopted in the Indian Ocean where DFADs are defined as any FOB deployed by fishers or equipped by an instrumented buoy, this will allow collecting good quality data for scientific purposes. This will also allow using the same terminology in the data collected by fishers and by observers. This classification, that is close to the wording used by fishers themselves (the terminology *épave* = wreck describes logs; the terminology *radeau* = raft describes dFADs) should in theory be easily understood and used onboard. Should this not be the case, an identification key will be displayed on board and assistance will be provided by fishing companies, ORTHONGEL or observers (**Figure 1**).

Also, in order to monitor the potential impacts of FADs in terms of pollution, stranding or ghost fishing (Maufroy et al. 2015, Filmalter et al. 2013), more detailed information on the structure of FOBs will be collected in the fishing/FOB logbook. To facilitate the reporting of such information, a list of predefined categories of FADs will be available in the logbook, as proposed for the ObServe FOB extension in the frame of the RECOLAPE project (Cauquil et al. 2019). These FADs will be described in more details in the French FAD management plan, allowing easier declarations by vessel captains. This will also allow describing the evolution of FAD designs year after year, which could be done in collaboration with other PS fleets. As the primary objective should be to evaluate to contribution of purse seiners to the modification of ecosystems, less detailed information will be collected on other FOBs whose structure could be easily deduced from FOB categories.

In addition, the ISSF classification of entangling FADs will be used to report the presence or the absence of meshing elements on FADs (ISSF 2019). PS and support vessel captains will therefore be required to report the absence of mesh (NEFADs), the presence of mesh < 7 cm (Lower E??R?? FADs) or the presence of mesh ≥ 7 cm (Highest Entanglement Risk or HERFADs) both on the surface of the FAD and in its subsurface structure, for any dFAD deployed or encountered at sea.

Finally, the list of buoy brands and models will be updated. The whole list of models used by the French fleet will be available in the logbook. For the models that are not used by the French fleet, minimal information will be required such as the brand of the buoy and the presence of an echosounder, as this information is necessary for assessing FOB fishing effort and efficiency.

3. Methodology used by ORTHONGEL to monitor buoys used at sea

3.1 Monthly Buoy Declarations (MBDs)

From 2012 to 2015, buoy manufacturers transmitted to ORTHONGEL "Quarterly Buoy Declarations" in compliance with IOTC Res 12/08 requesting among others *"FAD numbers and/or FAD beacons numbers to be deployed"* and ICCAT Rec 11-01. Active buoys were defined as buoys registered on the satellite system and switched on, regardless of their use on a FOB drifting at sea (**Figure 2**). For each purse seiner and each quarter, the number of buoys active at the beginning of the quarter was provided alongside with the number of buoy activations and deactivations during the quarter to detect potential "ghost buoys".

HF (radio) buoys were voluntarily prohibited since July 2012 (ORTHONGEL's decision N°10, 2011) to ensure the tracking of FOB buoys at any time during their use. Sharing dFADs among purse seiners was allowed to encourage a reduction of the number of dFADs at sea and to limit dFAD loss. The contribution of shared dFADs to the number of active buoys of a given purse seiner was calculated as 1/ number of sharing purse seiners. Finally, buoys deployed by support vessels were assigned to their assisted purse seiner or group of purse seiners.

During the most recent years, French purse seiners started to increase their traditionally low level of FOB buoy use as a result of the competition among fleets. This increase has always been made within lower limits than those set by t-RFMOs, and mentioned in the FADs annual management plans transmitted by France to ICCAT and IOTC. At the same time, it was decided to refine buoy declarations into "Monthly Buoy Declarations" (MBDs) to allow a closer monitoring of the number of buoys used at sea. The declaration frequency was first reduced to the month (2016) and then to the day (from 2017) and only buoys having emitted a position within 24 hours and drifting at a speed comprised between 0 (at port, on land) and 6 knots (on board) were counted. The policy for shared buoys and for buoys deployed by support vessels remained unchanged.

Table 5 presents an extract of a MBD provided by the main buoy manufacturer used by the French purse seine fleet in the Atlantic and Indian Oceans. Such MBDs are checked using two indicators: (1) the maximal number of active buoys per vessel, so as to ensure that PS do not exceed the limit implemented by ICCAT and IOTC and (2) the average number of buoys active per day and per vessel for a given month, so as to ensure that PS do not exceed the limit implemented in the – more restrictive - French FAD management plan (i.e. in 2019, a strict maximum of 300 buoys per vessel in Atlantic and Indian Ocean, month and fishing company).

Figure 3 presents the average number of active buoys used by French purse seiners of the Indian Ocean over 2012-2018. These numbers indicate that none of the French vessels has ever exceeded IOTC limits of operational buoys per vessel since their implementation.

However, following the implementation of IOTC Res 15/01, the number of active tracking buoys has increased for French purse seiners. Therefore, it was decided to adopt a less strict auto-limitation of the number of active buoys in the French FAD management plan to avoid an unfair competition with other purse seine fleets due to high levels of authorized active buoys adopted by IOTC. Instead of the strict auto-limitation of 150 active tracking buoys per vessel adopted in 2012, it was decided to adopt a limitation of 250 active buoys per vessel on average per fishing company in 2017 and 300 active buoys per vessel on average per fishing company in 2018 and 2019.

In addition, ORTHONGEL and its member fishing companies provide the positions of their buoys and their echosounder buoy data (respectively available from 2007 and 2010) to the IRD. Though these data are not provided for compliance reasons but for scientific purposes (used for example in Maufroy et al. 2015, 2016, Baidai et al. 2018 and Imzilen et al. 2018), this ensures a full transparency of the French and associated purse seine fleet regarding its use of FOBs.

3.2 Improving the monitoring and the control of buoy use

Despite several years of implementation of buoy limits by t-RFMOs and attempts to improve definitions (e.g. Grande et al. 2018), the notion of "active buoy" remains confusing, causing doubts that some buoys are not counted as active while attached to a FOB drifting at sea. So far, ORTHONGEL has been verifying the existence of such "ghost buoys" at sea by controlling the number of activations and deactivations per vessel. In theory, if too many cycles of activation/deactivation are detected in MBDs, this would indicate under-reporting of the number of active buoys. Yet, this methodology does not allow verifying that buoys are not deactivated and reactivated while on a FOB drifting at sea or that buoys are activated on board, in compliance with IOTC Res 19/02.

In addition, transparent declarations of the number of operational buoys are rarely provided to t-RFMOs (an example can be found in Maufroy et al. 2017) and harmonized procedures of control are still necessary. A few procedures of control have been developed based on information transmitted by buoy manufacturers (ORTHONGEL) or on buoy trajectory and FAD logbook data (Santiago et al. 2017). However, such procedures have not been validated by t-RFMOs and control is not carried out by a common and independent body.

In 2019, an improved description of the lifecycle of instrumented buoys was elaborated with ORTHONGEL member fishing companies and buoy providers. Definitions proposed in Grande et al. (2018) were simplified to allow a better understanding by all stakeholders. The sequence of actions corresponding to the deployment of a an activated and transmitting buoy has been described (**Figure 4**) and all potential situations leading to the presence of "ghost FADs" at sea have been listed (**Figures 5-7**). These definitions, prepared for the 2nd Joint t-RFMO FAD Working Group Meeting in May 2019 were refined to take into account the adoption of new resolutions in the Indian Ocean in June 2019 (IOTC Res 19/02).

3.3 Proposed definitions for the monitoring of buoy use

The misunderstanding of the lifecycle of instrumented buoys may lead to inappropriate management decisions which may in turn lead to the presence of "ghost buoys" at sea. In particular, the notion of "buoy activation" (registration of the buoy on the satellite system) is often confused with the transmission of the buoy (only possible when the buoy is registered on the satellite system and switched on) and does not take into account the status of the buoy (deployment at sea on a drifting FOB). As proposed in Grande et al. (2018), the use of the terminology "operational" should be preferred (**Figure 4**) in RFMOs recommendations and resolutions.

The wording used in ICCAT Rec 16-01 and IOTC Res 19/02 have been examined by ORTHONGEL and the following definitions and clarifications have been adopted for the French purse seine fleet in 2020:

Buoy in stock: **instrumented buoy acquired by the buoy owner which has not been made operational.**

IOTC Resolution 19/02 requires a declaration of the number of buoys and their identifier before and after each fishing trip. Any owned buoy present on board a purse seiner or a support vessel will be considered as on stock.

Activated buoy: **the satellite communication service of the buoy has been initialized by the buoy manufacturer at the request of the vessel owner or manager.**

At this stage, satellite communication is possible but the buoy can only transmit if it has been switched on. As agreed by ORTHONGEL member fishing companies, activation of the buoy should only be done on board a purse seiner or a support vessel with the buoy software (not on land from the office). When activated, the buoy should be assigned (i.e. associated) to a purse seiner or a group of purse seiners (not to a support vessel). Activation or assignation of the buoy should not be cancelled as long as the vessel intends to use the FOB that will be equipped with the buoy after switching on.

Transmitting buoy: **after activation, the buoy is switched on by the vessel crew and the electronic system starts.**

This is generally done by the application of the removal of a magnet depending on the model of the buoy. The buoy starts transmitting its position and other information (e.g. echosounder estimates). However, at this stage, the buoy is still on board the vessel and is neither contributing to fishing effort nor to impacts on ecosystems. It should therefore not be counted as operational.

Operational buoy: **buoy that has been activated, switched on and deployed on a drifting FOB and that is transmitting its position and any other available information such as eco-sounder estimates.**

As agreed with ORTHONGEL member fishing companies, activation of the buoy should imperatively occur before the deployment. Otherwise, the buoy is categorized as “ghost” or “unregistered” (the purse seiner and/or the support seiner may wait for sufficient tuna aggregation before starting the transmission of the buoy, however, during this period, the buoy contributes to fishing effort and habitat modification).

For the purpose of monitoring the number of operational buoys, a buoy will be counted as operational if:

(1) The buoy transmits its position and/or echosounder data at least once during the period of 24 h

(2) The buoy drifts at a speed > 0 knots (stranded or at port) and < 6 knots (onboard a vessel)

In addition, to ensure that the transmission of buoys equipping a FOB drifting at sea only stops in the case of technical failures, the whole life history of each buoy should be reported along with the number of buoy activations / deactivations for each purse seiner and each day.

Buoy owner: **any legal or natural person, entity or branch, who is paying for the communication service for the buoy associated with a FOB and/or who is authorized to receive information from the satellite buoy, as well as to request activation / deactivation.**

ICCAT and IOTC limitations of operational buoys only apply to purse seiners. When preparing information on the number of operational buoys, the owner of a given buoy should therefore only be a purse seiner or a group of purse seiners. All buoys activated and deployed by support vessels should be accounted for in the number of operational buoys of a given purse seiner.

Shared buoy: **buoy tracked by a group of purse seiners and their support vessel**

In the case of buoys shared by a group of purse seiners, their contribution to the number of operational buoys of a given purse seiner should be counted as: *contrib = 1/ nb of sharing purse seiners*

The same methodology should apply to the number of buoy activations/deactivations.

Deactivation of the buoy: **act of cancelling satellite communication services, with is done by the buoy manufacturer at the request of the vessel owner or manager.**

The vessel owner or manager or the vessel itself may decide to deactivate the buoy as long as the remote deactivation is not done with the purpose of under-reporting the actual number of operational buoys. Verifications will be done at the moment of reactivation of the buoy.

Reactivation of the buoy: **act of re-enabling satellite communication services by the buoy manufacturer at the request of the buoy owner or manager.**

In this definition the "buoy owner or manager" is understood as the "vessel owner or manager", for reasons of consistency with previous definitions. As for any buoy activation, the reactivation of a given buoy should only occur on board and should only be done by a purse seiner or a support vessel (no activation on land from the office). Also, the reactivation of the buoy should only be possible after the buoy has been brought back to port.

3.4 Proposed minimum standards for the control of operational buoys

To ensure that purse seiners do not use cycles of activation/deactivation or other means to report less operational buoys than those actually at sea, the distance between the first position of the buoy and the position of the purse seiner (or group of purse seiners) and its support vessel could be verified.

Table 6 proposes minimum standards of data reporting that would allow the control of on board activation of buoys before deployment. Among others, information on the position of the buoy and position of the vessel is requested at the moment of first and last transmission. Both positions should be transmitted by buoy manufacturers so as to avoid requesting additional information (e.g. VMS data). The position of the vessel should be acquired through the antenna of the buoy system used on board to avoid incorrect reporting and fraud on GPS positioning of the vessel.

These minimum standards of buoy monitoring and the corresponding control procedure were tested. The feasibility of the procedure, based on the verification of the distance between the first position of the transmitting buoy and the position of the purse seiner or its support vessel, was evaluated with buoy trajectory and VMS data over 2010-2017.

Exhaustive positions of buoys used by the French and associated fleet (Italy, Mauritius, Seychelles) in the Atlantic and Indian Ocean are transmitted to IRD with additional information such as the date of activation of the buoy and the list of vessels to which the buoy is assigned. For every distinct buoy activation date, the earliest buoy position and the list of vessels associated with that activation date were recovered. Then, for all vessels associated to the first position of the transmitting buoy and within ± 6 hours of the activation date, information on the closest purse seiner or support vessel (vessel name, vessel position, vessel distance to the transmitting buoy) was recorded and the number of buoy activations per distance to the nearest associated boat were counted. Finally, for all buoy activations, the absence of VMS data for some of the vessels associated with the activation date was reported, as an indication that missing VMS data might have been the cause of large spatial separations between the first position of the transmitting buoy and associated vessels.

Tables 7 and 8 present the results of the verification of the distance between buoys and vessels at the moment of the first transmission of the buoy. Results indicate that for the vast majority of buoy activations there was either an associated purse seiner (44,380 activations out of 60,901; 73.9%) within 15 km of the buoy activation location. There were also respectively 12,526 (20.7%) for which none of the associated purse seiners had available VMS data at the time of activation. Surprisingly, adding VMS data of support vessels in the analyses only slightly changed the results and allowed detecting 124 additional potentially valid buoy activations. Finally, 90% of potentially invalid activations of buoys (>=15 km from any associated purse seiner or support vessel) were related to partial and total absence of available VMS data (**Table 5**).

The remaining 1,604 activations of buoys (2%, distance > = 15 km, all VMS data available) may be considered as invalid cycles of use. Such potential invalid use of buoys did not seem to be directly related to lacking VMS data for support vessels, nor to the switching on of the buoy long after the activation of the buoy. However, most of problematic activations tended to occur during the earlier part of times series (2010-2014), a period during which assignations of buoy to purse seiners and support vessels were often incorrectly reported in the data.

Though defining the appropriate vessel – buoy distance remains necessary at this stage, these preliminary analyses confirm that a verifying that buoys have only been activated on board is technically feasible with the proposed methodology. This will also require careful reporting of information by buoy manufacturers, as described in section 3.5.1.

3.5 ORTHONGEL procedure for the monitoring of operational buoys in 2020

As the French purse seine fleet operates both in the Atlantic and Indian Oceans, the same procedures should ideally be adopted in the two oceans. The methodology elaborated in 2019 by ORTHONGEL and its member fishing companies has been transmitted to each buoy manufacturer (ORTHONGEL 2019). This methodology is based on the verification of the distance between the buoy and the vessel at the time of first transmission of the buoy (Maufroy et al. 2019) to ensure that buoys have been activated on board a purse seiner or a support vessel (IOTC Res 19/02). In addition, a procedure of declaration of buoys on stock was defined, in compliance with the IOTC Resolution 19/02 stating that:

7. All purse seine vessel, supply or support vessel shall declare to its respective CPC, the number of instrumented buoys onboard, including each unique identifier of the instrumented buoy before and after each fishing trip.

8. Reactivation of an instrumented buoy shall only be possible once it has been brought back to port, either by the vessel tracking the buoy/ associated supply or support vessel or by another vessel and has been authorized by the CPC.

3.5.1 Data transmitted by buoy manufacturers

In 2020, each buoy manufacturer will transmit to the fishing company, ORTHONGEL and the French administration the following information:

Monthly Buoy Declarations (MBDs) that will be used to monitor the number of operational buoys used by each purse seiner for a given day of the month along with the number of activations and deactivations. Data should be formatted as in **Table 4** and should be transmitted no later than there weeks after the end of the month.

Detailed Buoy Reports (DBRs) that will be used to detect inappropriate activations, i.e. activations occurring too far from the group of purse seiners and support vessels receiving the first position of the buoy after its activation and switching on. Data should be formatted as in **Table 6** and should be transmitted no later than three weeks after the end of the month. At this stage, the appropriate buoy – vessel distance is still in evaluation. The data transmitted by each buoy provider will be used to make tests and define the best option by the end of 2019, using the methodology proposed in section 3.4. Each fishing company will also be in charge of defining the appropriate groups of purse seiners and support vessels that will avoid false detections of incorrect use of buoys.

Buoy position and echosounder data that has been used for scientific purposes by the IRD since 2012 and that should be provided quarterly to IRD scientists. Additional information on buoy positions should be made available on real time in some specific areas for the needs of projects such as FAD Watch (Seychelles, Zudaire 2018) or companies conducting seismic surveys (an example of this currently in place in the Gabon EEZ).

3.5.2 Data transmitted by PS and support vessel crews

Fishing/FOB logbooks, as described in section 2 of this document that will be used to ensure that PS and support vessels comply with the French FOB management plan. Fishing/FOB logbooks should be made available at the end of each fishing trip.

Buoy on Stock Reports that will be used in the Indian Ocean in the Indian Ocean to comply with IOTC 19/02 and ensure that buoys are reactivated only after having brought back to port by the owner vessel or another vessel. Purse seiners and their support vessel will be in charge of declaring the number of buoys on stock each day, so as to ensure that the limit of 500 operational + on stock buoys is not exceeded in the Indian Ocean. Detailed Buoy Reports provided by buoy manufacturers will combined with these declarations to verify that only one activation of a given buoy occurs during the period between two dates of presence at port of the buoy. Buoys on stock declarations should be produced at the departing and returning dates of each purse seiner and support vessel. They should be transmitted to the fishing company, ORTHONGEL and the French administration at the beginning and at the end of each fishing trip.

4. Discussion

4.1. Monitoring FOB and buoy activities

In this document, we presented the methodology adopted by ORTHONGEL to meet IOTC requirements in terms of FOB and buoy activities reporting. The FOB component of the logbook has been updated to collect the data requested by IOTC Resolution 19/02 in format that would also meet ICCAT requirements and that would be as close as possible to the format used by observers onboard EU PS and support vessels (ObServe v7). Categories of FOB types, FOB activities and buoy activities have therefore been listed according the recommended CECOFAD classification (Gaertner et al. 2016). This classification presents various advantages such as (i) the use of mutually exclusive categories that ensure good quality data, (ii) the separation of the impacts of FOB fishing in terms of fishing effort (related to all types of FOBs) and in terms of habitat modification (related to FADs), and (iii) the evaluation of the relative contributions of FOB fishing (FADs), other fishing activities (FALOGs) and other human activities (HALOGs) to marine debris. However, it has not been adopted in other oceans where all types of FOBs are generally considered as FADs. In the Indian Ocean, where the French purse seine fleet is also active, IOTC resolution 19/02 that will enter into force in January 2020 states that:

Fish Aggregating Device (FAD) means a permanent, semi-permanent or temporary object, structure or device of any material, man-made or natural, which is deployed and/or tracked, for the purpose of aggregating target tuna species for consequent capture.

Such an imprecise definition or the use of terminologies such as “natural/artificial FADs” does not allow the monitoring of the contribution of DFADs to habitat modification or marine debris. Therefore, the more precise terminology used by ICCAT in the Atlantic Ocean will be used in fishing / FOB logbook of the Indian Ocean as well. In addition, though the definition of “FADs” has recently been modified in IOTC, an harmonization with the more precise definitions adopted in ICCAT could be a good option for IOTC.

On the other hand, t-RFMOs generally require the implementation of “FAD logbooks” by CPCs. While other fleets have adopted this option by introducing separate fishing and FOB logbooks (e.g. Ramos et al. 2017), the choice was made by the French PS fleet to use a combined fishing / FOB logbook, so as to facilitate the declarations by vessel captains. In 2020 however, double recording will still occur for French purse seiners and their support vessels, who will report on FOB and buoy activities in their fishing / FOB logbook and in the ERS3. Corrections of the ERS3 FOB plug-in should therefore be done as soon as possible and similar formats as those defined for the fishing / FOB logbooks should be used. In the meantime, as this situation could induce issues of data quality, assistance will be provided by fishing companies, ORTHONGEL and onboard observers to minimize as much as possible reporting errors. Assistance by onboard observers will be facilitated by the use similar formats and terminologies in the logbook and in Observe v7.

Finally, a description of FAD design characteristics in FOB logbooks is required by IOTC Res 19/02, including information on *materials of the floating part and of the underwater hanging structure* as well as the dimensions of the FAD. For this information, the choice was made to use a predefined list of DFAD designs and to describe the materials used for their construction and their dimensions in more details in the French FOB management plan. To do so, the list of DFAD design should at the same time be as precise (to collect the necessary data) and concise (to avoid reporting errors) as possible. EU fleets are currently listing such designs in the frame of the RECOLAPE project and the results of this collaborative work could be used in the French fishing /FOB logbook, instead of the preliminary list proposed in **Table 4a**.

4.2. Controlling the number of active/operational buoys

The misunderstanding of the lifecycle of instrumented buoys may lead to inappropriate wording in RFMO management decisions which may in turn lead to issues of compliance with existing buoy limits. In particular, confusion exist between the activation of the buoy and its ability to transmit a GPS position and/or echosounder information. This terminology that clearly differentiates the different steps in the use of FOB buoys and explicitly separates buoys contributing to fishing effort and habitat modification from other buoys, has recently been adopted in IOTC Res 19/02 with mechanisms for controlling the number of operational buoys.

Until recently, limitations of the number of active / operational buoys have been implemented in the Indian Ocean without defining the appropriate mechanisms for controlling such numbers. Despite the development of various means of monitoring by scientists or Producer Organizations, this has left room for doubts regarding compliance with existing buoy limits. Though the existence of "ghost buoys" has not be proven so far and losing track of buoys in use at sea may not be an optimal strategy, it is therefore necessary to verify compliance with RFMO buoy limits. Here, two methods for the detection of inappropriate cycles of activation/deactivations of buoys were discussed: (i) a control of the number of activations and deactivations of buoys and (ii) a control based on the verification of buoy positions at the time of first emission of the buoy. A third method, based on the control of buoys at port was proposed by Santiago et al. (2017) for the Spanish purse seine fleet and was recently adopted in the Indian Ocean (IOTC Res 19/02).

The first method, used by ORTHONGEL over 2012-2018 may be the simplest in terms of data collection and reporting as it would only require counting the number of activations and deactivations for a given purse seiner per day. However, this methodology may be difficult to use in practice for other means than for detecting purse seiners with a behavior clearly different from the rest of the fleet, as it is difficult to evaluate how many activations and deactivations of buoys correspond to "ghost buoys". This methodology could be improved by evaluating the frequency of activation/deactivation of each buoy during a given month.

The third methodology is based on the control of buoys at port. Reactivation would be possible for buoys that would have been brought back to port, either by their owning vessel or by another vessel. In the Indian Ocean, where this methodology will be implemented in 2020, with an additional limit of 500 operational + on stock buoys at any time, this will require reporting each day the exhaustive list of buoys present on board. While technically feasible by crews, this will be a time-consuming task and one can already anticipate that the quality of data may not be satisfying. This will also require random controls at port, that will be carried out by ORTHONGEL in 2020 but should be carried out independently from the fleet in the future.

The second methodology, that will be independent from the declarations of PS and support vessel captains, appears to be the most promising tool. Based on the distance between the buoy and the vessel(s) receiving information from the buoy, the methodology explicitly addresses the issue of all types of "ghost buoys" that may occur at sea (deactivated or unassigned for a fraction of their lifetime at sea). In addition, this procedure could be used both (i) in real time by buoy manufacturers who could cancel buoy activation in case of non-conformity and (ii) for post hoc controls of the number of operational buoys. Buoy manufacturers would be in charge of reporting information on the buoy and of the vessel at various moments of use of the buoy (activation, first transmission, last transmission) along with numbers of operational buoys per vessel and per day. Unlike the current monitoring performed by scientists or Producer Organizations, control would be carried out an independent and common body with this harmonized procedure. When, as in the case of the French and Italian fleet, FAD management plans set lower limits than those implemented by RFMOs, compliance with FAD management plans would also be verified.

Finally, an audit of buoy providers, in charge of reporting the data, could be used in complement to verify the validity of their reporting procedures.

As in this document, the procedure of control would require the definition of a valid distance between the buoy and the vessel(s) at the date of first transmission of the buoy. Tests conducted for the French fleet over 2010-2017 tend to indicate that a maximal distance of 15 km may be used for the verification of valid buoy activation-switch on-deployment sequences of buoy use, a distance that seem rather low if one takes in consideration purse seiners' cruising speed. This document is therefore not making recommendations on the appropriate distance vessel-buoy, that should be defined carefully. Besides, errors have been detected in the data, such as invalid or partial assignations of buoys to purse seiners and their support vessels, activations without deactivations or deactivations without activations. In addition, all VMS data were not available for the present study, in particular for vessels not flying the French flag. During the first semester of 2020, additional tests, based on data prepared according to minimum standards defined in **Table 6**, will be carried out.

4.3. Potential effects of a strict control of the number of operational buoys

Since 2012, ORTHONGEL and its member fishing companies have advocated for a control of the use of dFADs through the limitation of the use of FOB tracking buoys. Concerns regarding the increasing use of FOBs and their negative consequences have led to an auto-limitation of operational buoys before the adoption of ICCAT and IOTC buoy limits in 2015. Since 2015, the French FAD management plan is setting more restrictive buoy limits than those implemented by t-RFMOs in the Atlantic and Indian Oceans and the French and Italian fleets are in favor of a further reduction of authorized levels of buoy use.

In concordance with this position, ORTHONGEL and its member fishing companies have worked towards an improved monitoring of operational buoys. The methodology proposed in this document is part of this continuous improvement and of the commitments of the French and Italian towards more sustainable tropical tuna purse seine fisheries. This methodology implies a strict control of the number of operational buoys that would not only grant compliance with existing management decisions but also transparence regarding the use of FOB tracking buoys. Nevertheless, though this strict enforcement a t-RFMO buoy limits is necessary, this may also have unexpected negative consequences. Indeed, the strict prohibition of buoy deactivation/reactivation at sea may lead to more dFADs abandoned at sea when drifting too far from fishing grounds. As the choice has been made to limit the number of FOB buoys used at a given moment and not to limit the number of FAD deployments over a given period, part of the risks of dFAD beaching and pollution (Balderson et al. 2015, Maufroy et al. 2015) cannot be addressed.

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Table 1. Fishing / FOB logbook used by the French PS fleet in the Atlantic and Indian Oceans since 2015.

DEPART / SALIDA / DEPARTURE :		ARRIVEE / LLEGADA / ARRIVAL		PATRON / PATRON / MASTER		NAVIRE / BARCO / VESSEL	FEUILLE HOJA SHEET
PORT / PUERTO / PORT	ABIDJAN	PORT / PUERTO / PORT	ABIDJAN	Dupont DUPOND		Navire : Vessel Pavillon : Français Numéro d'immatriculation : Id Port d'immatriculation : Port Signal d'appel international : XX Numéro OMI : XX Numéro CFR : XX	
DATE / FECHA / DATE	DD/MM/YY	DATE / FECHA / DATE	DD/MM/YY				
HEURE / HORA / HOUR	HH:MM	HEURE / HORA / HOUR	HH:MM	MAREE	XX		4
LOCH / CORREDERA / LOCH	XX	LOCH / CORREDERA / LOCH	XX				

DATE FECHA DATE	POSITION (chaque calée ou à midi) POSICION (cada lance o mediadia) POSITION (each set or midday)	CALEE LANCE SET			CAPTURE ESTIMEE (en tonnes) ESTIMATION DE LA CAPTURA (en toneladas) ESTIMATED CATCH (metric tons)															ASSOCIATION ASSOCIACION ASSOCIATION						Balise Boyas Buoy	DCP DCP FAD	ZEE ZEE EEZ	COMMENTAIRES COMMENTARIOS COMMENTS	T° Mer / Mar / Sea	VENT VIENTO WIND	
		Portant / Positivo / Successful	Nul / Nulo / Nil	Heure / Hora / Time TU	1 ALBACORE RABIL YELLOWFIN			2 LISTAO LISTADO SKIPJACK		3 PATUDO PATUDO BIGEYE		4 GERMON ALBACORA ALBACORE		AUTRE ESPECE Préciser Noms OTHER SPECIES give name(s)			REJETS Préciser le / les nom(s) DESCARTES dar el / los nombre(s) DISCARDS give name(s)			Banc libre/banco libre/Free school	Epave / Objeto / Log N (naturelle/natural) A (artificielle/artificial)	Bateau d'assistance Barco de appoyo / Supply	Balise / Baliza / Beacon	Requin Baleine Tiburon Ballena / Shark Wale	Baleine / Ballena / Wale	Type : Iris M3I M4I Numéro	CRÉER UNE LIGNE PAR EVENNEMENT SUR DCP NATUREL OU ARTIFICIEL MISE A L'EAU DCP ECO CHANGEMENT DE BALISE VISITE AVEC PECHE VISITE SANS PECHE RETRAIT PERTE / FIN TRANSMISSION BALISE	NOM DE LA ZEE (hors zee : indiquer eaux internatio nales)	Problèmes divers Prise accessoire Taille du banc Autres associations Autres remarques		Degrés / Grados Direction / Direccion / Direction / Degree	Vitesse / Velocidad / Speed Noeuds / Nudos / Knots
					YFT+10		YFT-10	SKJ		BET		ALB																				
					Taille Tailla Size	Capture Captura Catch	Capture Captura Catch	Taille Tailla Size	Capture Captura Catch	Taille Tailla Size	Capture Captura Catch	Taille Tailla Size	Capture Captura Catch	Nom Nombre Name	Taille Tailla Size	Capture Captura Catch	Nom Nomb. Name	Taille Tailla Size	Capture Captura Catch													

Table 2a: CECOFAD classification of Floating OBjects (FOBs)

Code	Description	Example	Type of impact
DFAD	Drifting FAD	Bamboo or metal raft	Fishing effort, habitat modification, pollution
AFAD	Anchored FAD	Anchored floating platform	Fishing effort, habitat modification, pollution
FALOG	Artificial log resulting from fishing activities	Nets, wreck, ropes	Fishing effort, pollution
HALOG	Artificial log resulting from other human activities	Wooden board, oil tank	Fishing effort, pollution
ANLOG	Natural log of animal origin	Dead whale	Fishing effort
VNLOG	Natural log of plant origin	Branches, palm leaf	Fishing effort

Table 2b: CECOFAD classification of activities with FOBs and buoys

Code	Name	Description
FOB	Encounter	Random encounter (without fishing) of a FOB belonging to another vessel or not equipped with a buoy
	Visit	Visit (without fishing) of a FOB (known position, owned by the vessel)
	Deployment	Deployment of a FAD at sea
	Consolidation	Deployment of a FAD on a FOB (e.g. to enhance floatability)
	Retrieval	Retrieval of the FOB
	Fishing	Fishing set on the FOB
BUOY	Deployment	Deployment (tagging) of a buoy on a FOB already drifting at sea without buoy or deployment of a FAD equipped with a buoy
	Transfer	Replacement of the buoy owned by another vessel by a buoy of the vessel
	Retrieval	Retrieval of the buoy on a FOB drifting at sea
	Loss	Loss of the buoy/end of transmission

Table 3: Electronic Reporting System v3 FOB plug-in. The structure of the plug-in as well as current issues are presented.

Information	List of categories	Issues and *potential solutions*
Association type	Free Swimming School; Log; Artificial raft; Support vessel; FAD; Birds; Whale shark; Whale; Other	FADs are artificial rafts by definition. *The category "artificial raft" should be removed from the list. Replace "FAD" with "FOB".*
FOB type	Drifting Artificial raft; Anchored Artificial raft; Artificial log related to fishing activities; Artificial log related to other human activities; Natural log of animal origin; Natural log plant origin;	*No issue.*
FOB activity		This information is not requested yet in the ERS3 FOB plug-in. *Add the following list:* *Deployment; Visit (no additional activity); Visit with reinforcement; Visit with fishing; Retrieval; Loss / end of buoy transmission*
FAD materials		This information is not requested yet in the ERS3 FOB plug-in. *Add a list of predefined FAD types.*
FAD entangling risk		This information is not requested yet in the ERS3 FOB plug-in. *Add the following list:* *Mesh < 7 cm; Mesh > 7 cm; No mesh; Unknown* *Information should be collected both for the surface and sub-surface structure of the FAD.*
Buoy type	Radio buoy without echosounder; Radio buoy with echosounder; Satellite buoy without echosounder; Satellite buoy with echosounder; Unknown; Other	Radio buoys are prohibited for the French PS fleet. *Remove the categories related to radio buoys. Replace categories with brands and models.*
Buoy activity		This information is not requested yet in the ERS3 FOB plug-in. *Add the following list:* *Deployment; Transfer (buoy change); Visit; Retrieval; Loss / buoy end of transmission.*

Table 4a. Fishing / FOB logbook to be used by the French PS fleet in the Atlantic and Indian Oceans in 2020.

DEPART / SALIDA / DEPARTURE :			ARRIVEE / LLEGADA / ARRIVAL		PATRON / PATRON / MASTER		NAVIRE / BARCO / VESSEL	FEUILLE HOJA SHEET
PORT / PUERTO / PORT		ABIDJAN	PORT / PUERTO / PORT	ABIDJAN	DUPONT Dupont		Navire : Senneur Pavillon : Français Numéro d'immatriculation : XXXXXXXXXXX Port d'immatriculation : XXXXXXXXXXX Signal d'appel international : XXXXXXXXXXX Numéro OMI : XXXXXXXXXXX Numéro CFR : XXXXXXXXXXX	XX
DATE / FECHA / DATE		01/01/2020	DATE / FECHA / DATE	15/02/2020				
HEURE / HORA / HOUR		14:00	HEURE / HORA / HOUR	7:00	MAREE	XYZ		
LOCH / CORREDERA / LOCH		0	LOCH / CORREDERA / LOCH	8390				

DATE FECHA DATE	HEURE HORA TIME	LATITUDE (chaque calée ou à midi) LATITUD (cada lance o mediadia) LATITUDE (each set or midday)	LONGITUDE (chaque calée ou à midi) LONGITUD (cada lance o mediadia) LONGITUDE (each set or midday)	ZEE ZEE EEZ	T°C	VENT VIENTO WIND		CALEE LANCE SET		CAPTURE ESTIMEE (en tonnes) ESTIMATION DE LA CAPTURA (en toneladas) ESTIMATED CATCH (metric tons)															TYPE DE CALEE LANCE FISHING SET TYPE	ASSOCIATION ASSOCIACION SCHOOL DETECTION MEAN	FOB LOGBOOK	COMMENTAIRES COMMENTARIOS COMMENTS
				NOM DE LA ZEE (hors zee : indiquer eaux internationales)	T° Mer / Mar / Sea	Direction / Direccion / Direction Degrés / Grados / Degree	Vitesse / Velocidad / Speed Noeuds / Nudos / Knots	Portant / Positivo / Successful	Nul / Nulo / Nil	1 ALBACORE RABIL YELLOWFIN			2 LISTAO LISTADO SKIPJACK		3 PATUDO PATUDO BIGEYE		4 GERMON ALBACORA ALBACORE		AUTRE ESPECE Préciser Noms OTHER SPECIES give name(s)			REJETS Préciser le / les nom(s) DESCARTES dar el / los nombre(s) DISCARDS give name(s)						Problèmes divers Prise accessoire Taille du banc Autres associations Autres remarques
										YFT+10		YFT-10	SKJ		BET		ALB											
										Taille Tailla Size	Capture Captura Catch	Capture Captura Catch	Taille Tailla Size	Capture Captura Catch	Taille Tailla Size	Capture Captura Catch	Taille Tailla Size	Capture Captura Catch	Nom Nombre Name	Taille Tailla Size	Capture Captura Catch	Nom Nomb. Name	Taille Tailla Size	Capture Captura Catch				

Table 4b. details on FOBs and buoys in the French fishing / FOB logbook to be used in the Atlantic and Indian Oceans in 2020.

FLOATING OBJECT					**INSTRUMENTED BUOY**				
FOB activity (1)	**FOB type** (1)	**DFAD type** (1,3) (only if the FOB is a DFAD)	**Mesh size – emerged part** (1)	**Mesh size – submerged part** (1)	**Buoy activity** (1)	**Buoy already on the FOB**		**Buoy deployed on the FOB**	
						Type (1,3)	**Id**	**Type** (1,3)	**Id**
Deployment Visit (no additional activity) Visit with reinforcement Visit with fishing Retrieval Loss/end of buoy transmission	Drifting FAD Anchored FAD Artificial log - fishing activities Artificial log - other human activities Natural log of animal origin Natural log of plant origin	French-like surface bamboo FAD French-like surface bamboo + metal FAD French-like submerged FAD Spanish-like surface bamboo FAD Spanish-like surface metallic FAD Spanish-like surface plastic FAD Spanish-like submerged FAD Korean-like FAD	Mesh < 7 cm Mesh > 7 cm No mesh Unknown	Mesh < 7 cm Mesh > 7 cm No mesh Unknown	Deployment Visit Transfer Retrieval Loss / end of transmission				

(1) Choose one option in the list
(2) This list of DFADs does not provide information on the DFAD owner (owner of the buoy equipping the DFAD). It is only used to describe the most common types of DFADs.
(3) The detailed list of buoy brands / model used by the French fleet will be available. For other brands and types, options will be “brand X without echosounder”, “brand X with echosounder

Table 5: Extract of an activation/deactivation report provided by the main buoy manufacturer in 2019 (translated from French). Number of operational buoys are provided as decimal values as they account for shared operational buoys (i.e. the contribution of a given buoy is 1/nb of purse seiners).

MONTHLY BUOY DECLARATION

COMPANY	XX
VESSEL	XX
PERIOD	January 2019

Date	Operational	Activations	Deactivations
01/01/2019	173,8	0,1	0
02/01/2019	173,8	0,5	0
03/01/2019	173,9	0,4	0
04/01/2019	173,8	0,5	1
05/01/2019	171,3	0,1	1,4
06/01/2019	170,3	0	1,1

marine instruments
C.I.F.: A-36.924.140
C Rua dos Padróns nº 4 (vial 3)
Parque Empresarial
Porto do Molle
36350 Nigrán (Pontevedra)
tel: 986 366 360
fax: 986 383 007
www.marineinstruments.es

Table 6: Proposed minimum standards for the reporting and control of numbers of operational buoys

Information	Objective / Description	Format
Buoy identifier	Similar to logbook declarations	
Buoy serial number	Buoy manufacturer id	
Owner vessel	Vessel having activated the buoy	
Assigned vessel	Vessel(s) receiving buoy information	
Support vessel	In case of activation by a support vessel	
Activation Date	Detect the beginning of buoy use	UTC
Position of the vessel at activation	Latitude and longitude	Decimal degrees
First transmission date		UTC
Position of the buoy at the first transmission	Latitude and longitude	Decimal degrees
Position of the vessel at the first transmission	Latitude and longitude	Decimal degrees
Deactivation date	Detect the beginning of buoy use	UTC
Last transmission date		UTC
Position of the buoy at the last transmission	Latitude and longitude	Decimal degrees

Table 7: Distances in km between buoy activations and closest VMS position of an associated purse seiner.

Buoy-VMS distance range (km)	No. buoy activations
[0,1)	9,710
[1,2)	6,280
[2,3)	4,549
[3,4)	4,259
[4,5)	4,069
[5,6)	3,839
[6,7)	3,304
[7,8)	2,782
[8,9)	2,229
[9,10)	1,594
[10,11)	895
[11,12)	482
[12,13)	222
[13,14)	106
[14,15)	60
>=15	4,755
No assoc. vessel VMS data	12,526

Table 8: Distances in km between buoy activations and closest VMS position of an support vessel. Only activations for which there is ni close VMS position o fan associated purse seiner are included in the table.

Buoy-VMS distance range (km)	No. buoy activations
[0,1)	31
[1,2)	6
[2,3)	15
[3,4)	10
[4,5)	10
[5,6)	6
[6,7)	5
[7,8)	14
[8,9)	7
[9,10)	7
[10,11)	2
[11,12)	2
[12,13)	2
[13,14)	3
[14,15)	4
>=15	16,638
No assoc. vessel VMS data	519

Table 8: Counts of availability of VMS data for buoy activations per distance to the nearest purse seine vessel or support vessel.

VMS data availabilty	< 15 km	>=15 km	No associated PS or support vessel
All VMS data	40,346	1,604	0
Some VMS data	4,126	3,059	0
No VMS data	28	11,309	429
No assoc. vessel	4	732	24

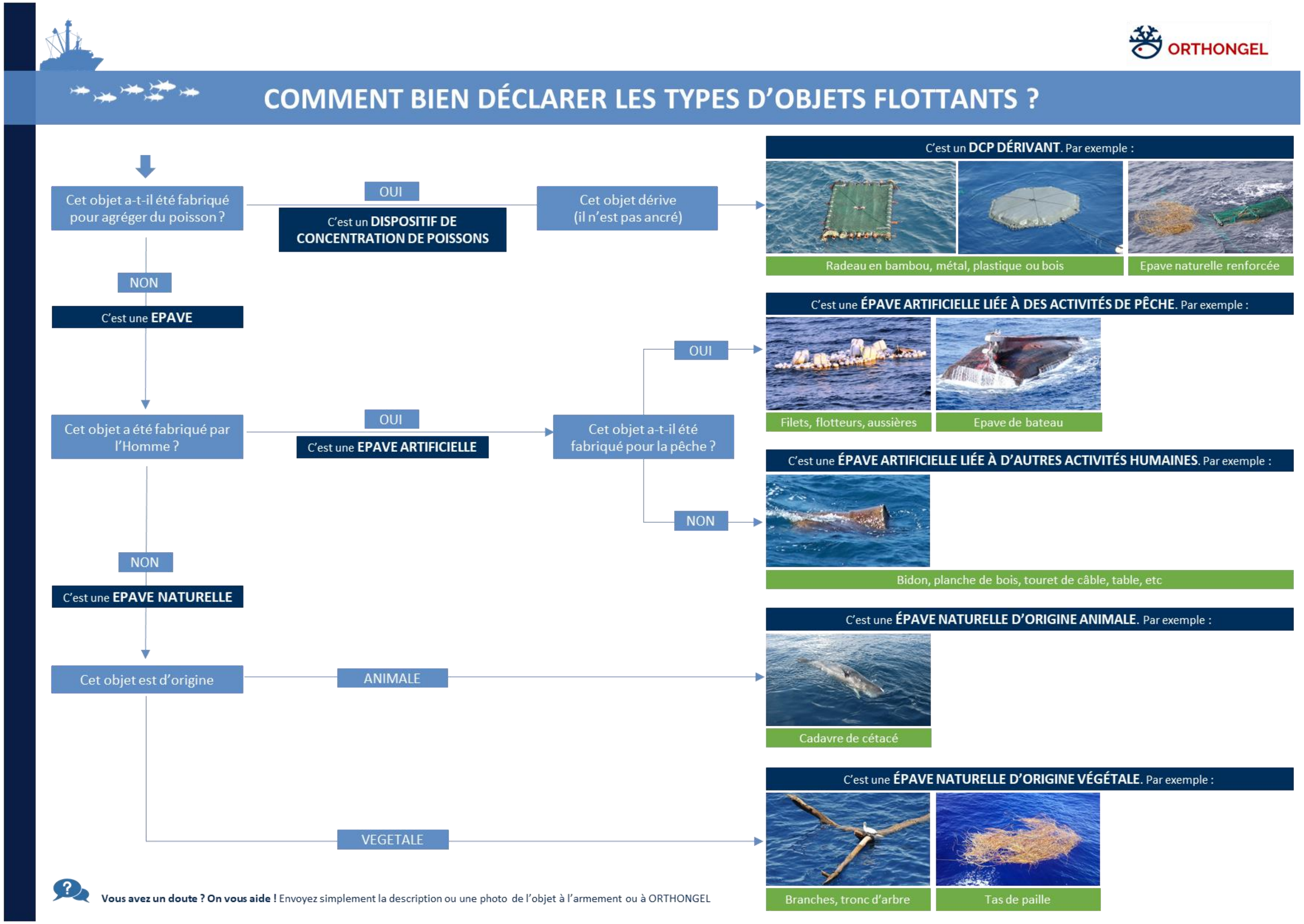

Figure 1. FOB identification key to be displayed on board purse seiners and support vessels (based on the CECOFAD recommended hierarchy of FOBs)

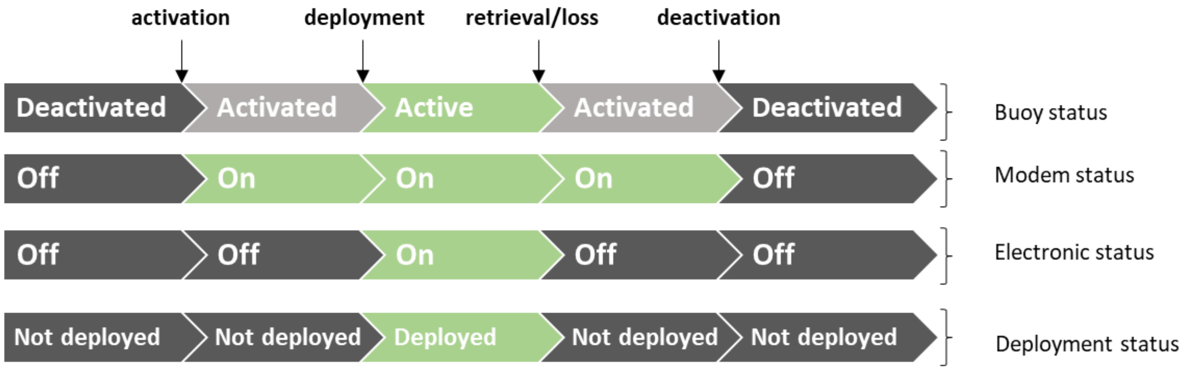

Figure 2. Typology of buoy status used by ORTHONGEL over 2012-2018. This status depended on the modem status (i.e. is the buoy registered on the communication satellite network?), buoy mode (i.e. is the buoy switched on or off?) and deployment status (i.e. if the buoy is switched on, is it deployed on a FOB drifting at sea?).

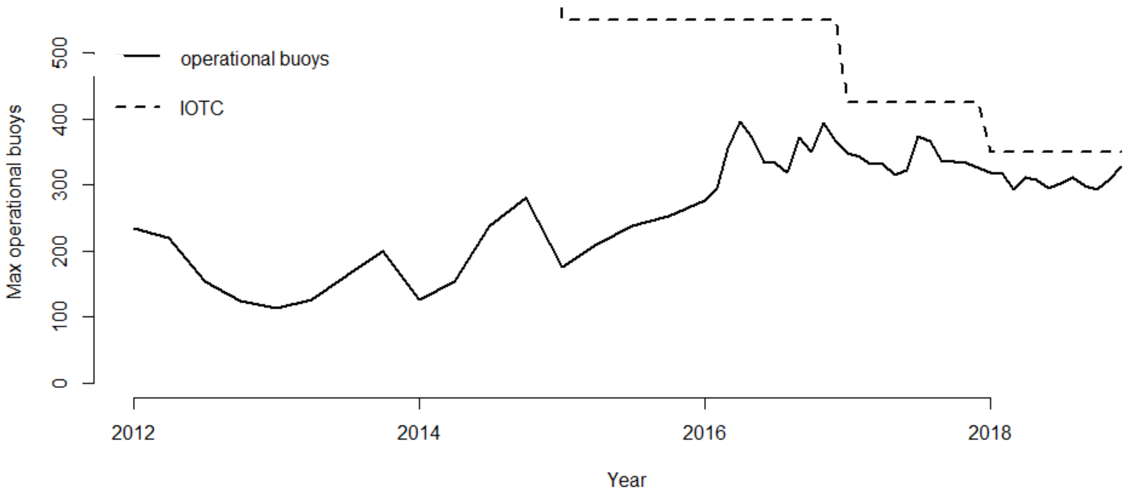

Figure 3. Evolution of the average number of operational buoys per vessel in the Indian Ocean (2012-2018, French purse seiners, solid line) and IOTC buoy limit (dashed line).

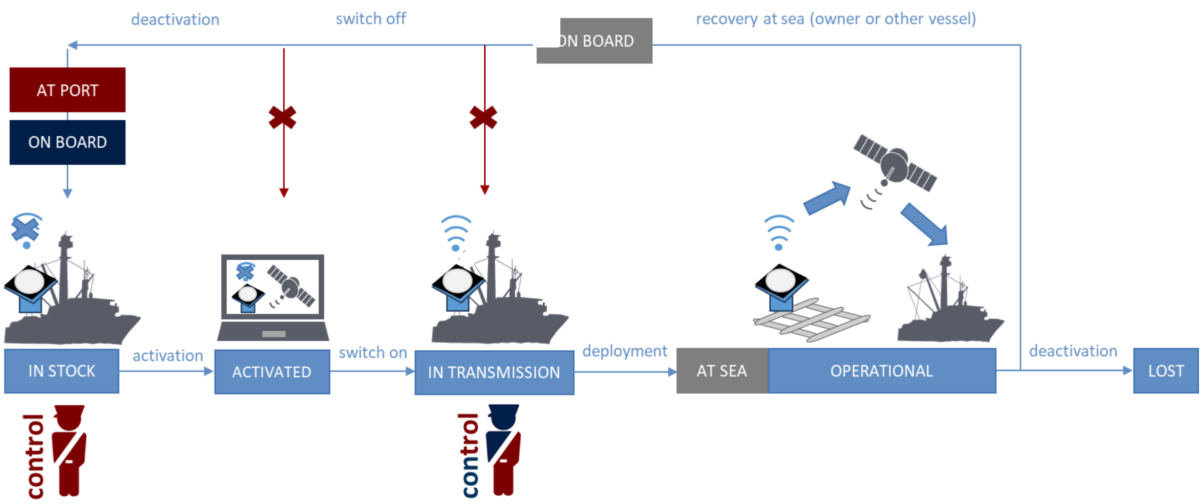

Figure 4. Buoy status and methodology for the control of the number of operational buoys. Means of control to comply with t-RFMO (ICCAT Rec 16-01 and IOTC Res 19/02) and ORTHONGEL procedures are indicated respectively in dark red and in dark blue.

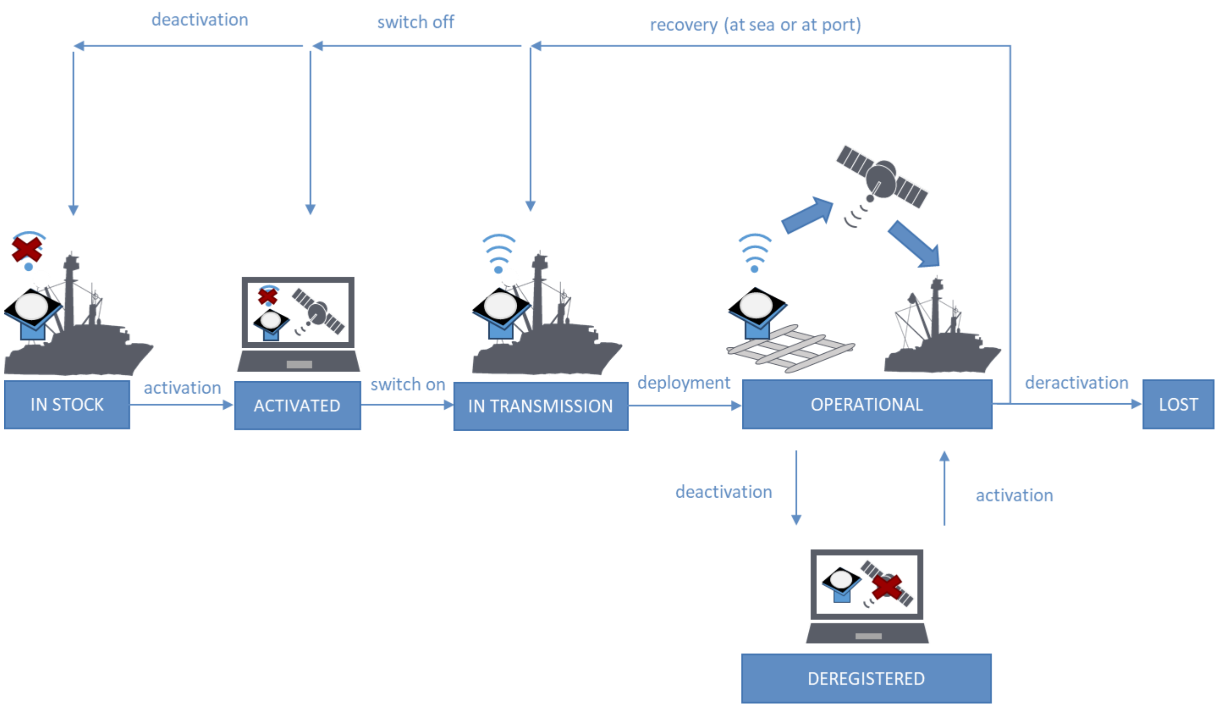

Figure 5. Inappropriate cycle of use: deregistration of the buoy. The buoy is activated, switched on and deployed. When the FOB is drifting too far from seasonal fishing ground, the buoy is deactivated and not counted anymore as operational.

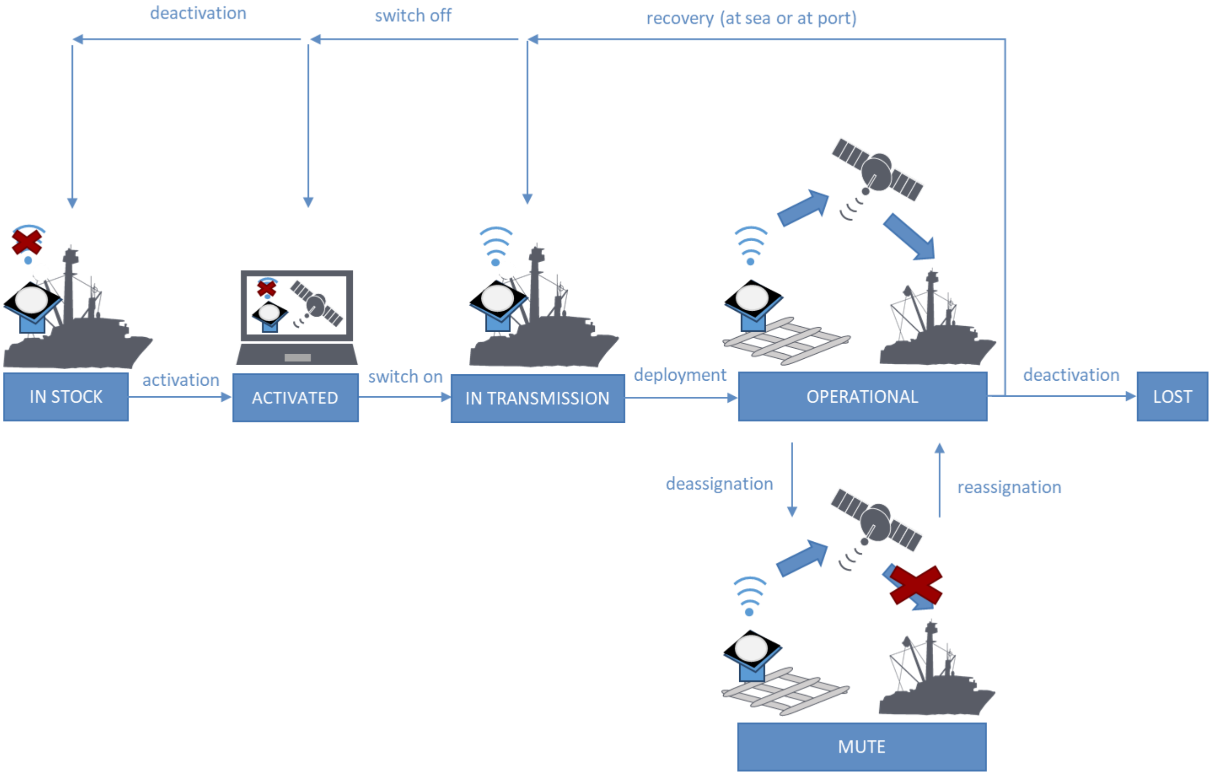

Figure 6. Inappropriate cycle of use: deassignation. The buoy is activated, switched on and deployed. When the FOB is drifting too far from seasonal fishing ground, the vessel(s) can request not receiving information from the buoy. The buoy is still deployed on a FOB drifting at sea and transmitting information to the satellite, but the buoy is not counted as operational.

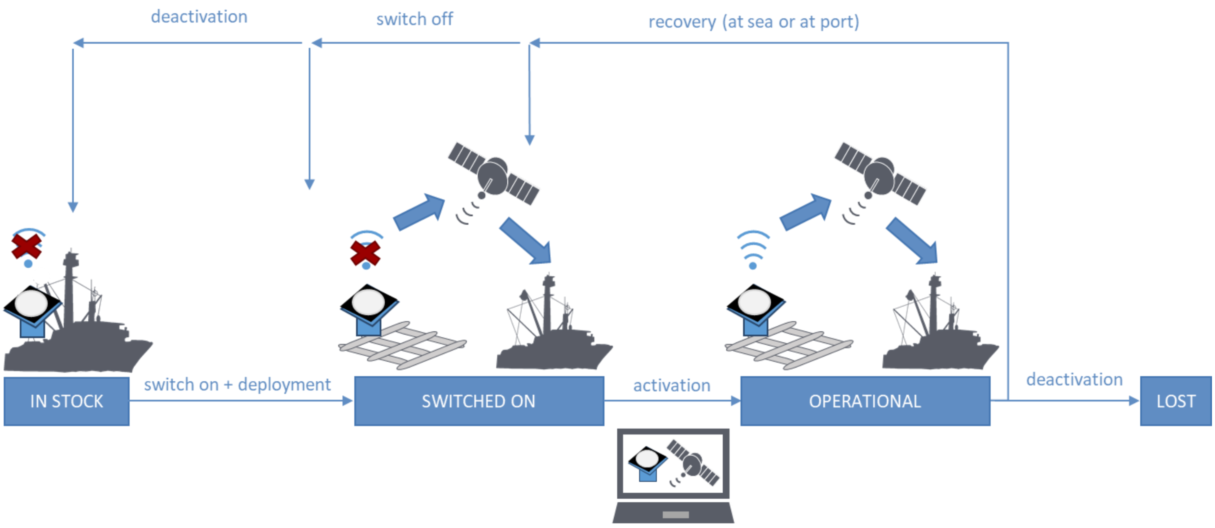

Figure 7. Inappropriate cycle of use: registration after deployment. The buoy is switched on a deployed on a drifting FOB without activation. This may happen mainly for deployment of new FADs to avoid counting the buoy as operational until the FAD has aggregated fish.