SIOTI SUPPORT FOR IMPROVING INFORMATION ON BYCATCH FOR MANAGEMENT OF THE INDIAN OCEAN PURSE SEINE TUNA FISHERY.

J. Ruiz[1], P. Bach[2], I. Krug[3], H. Murua[1], J. Robinson[4], C. Shearlock[5],

SUMMARY

The Sustainable Indian Ocean Tuna Initiative (SIOTI) is a large-scale Fisheries Improvement Project (FIP) comprising the major purse seine fleets and tuna processors in the region. As part of his Action Plan, SIOTI facilitated a workshop for key institutions involved in bycatch data collection. This paper presents the outcomes of the Purse Seine Observer Program Coordination Workshop, that took place in Pasaia (Spain) during 16th- 17th of April 2018. It includes recommendations for improving information on bycatch for management of the Indian Ocean purse seine tuna fishery. These recommendations revolve mainly around; the observer coverage, the need to standardize the raising methodology of the sampling to the fleet level, and finally some recommendations about the need to standardize EMS (Electronic Monitoring System) programs' output to be able to merge with observers' data.

KEYWORDS: Bycatch, purse seining, Indian Ocean, Observer data, Fisheries Improvement Project

1. Introduction

The Sustainable Indian Ocean Tuna Initiative (SIOTI) is a large-scale Fisheries Improvement Project (FIP) comprising the major purse seine fleets and tuna processors in the region. The FIP is supported by Seychelles and WWF (World Wildlife Fund), formalized the signing of a Memorandum of Understanding with industry representatives in October 2016 and followed by a partnership agreement signed by 17 industry partners in March 2017. The first SIOTI Action Plan was adopted by partners in May 2017 and the FIP has recently submitted first annual progress report to FisheryProgress.org.

Based on pre-assessments and a scoping report for the fishery benchmarked to the MSC Standard, two Improved Performance Goals (IPGs) were identified relating to primary and secondary species bycatch. The goal of IPG9, is to ensure that information on the nature and amount of primary species bycatch taken is adequate to determine the impact by the purse seine fleet and the effectiveness of the strategy to manage the primary species. It sets a target that, annual bycatch reporting is being fully utilized for primary species stock assessment and management purposes, and any information gaps are identified and addressed. Likewise, IPG10 sets that same goal and target for secondary species and the activities for the two IPGS are combined.

In this regard, the first activity identified in the Action Plan for IPG9 and IPG10 was for the FIP to host and facilitate a workshop for key institutions involved in bycatch data collection, management, reporting and analysis for the purse seine fishery, including observer programs and electronic monitoring systems (EMS). This workshop aimed to review the status of information and data collection systems, and to identify gaps and practical measures for SIOTI and its fleet partners to improve bycatch information and its use in management.

[1] AZTI, Sukarrieta (Spain)
[2] IRD, Mahe (Seychelles)
[3] AZTI, Mahe (Seychelles)
[4] SIOTI, Mahe (Seychelles)
[5] Princes Limited, Manchester (UK)

In parallel, the institutes in charge of managing the purse seine observer programs in the Atlantic and Indian oceans have organized an annual meeting for more than a decade, to coordinate the different observer programs on board the tropical purse seine fleet. Knowing that the objectives of both the international coordination meeting and the SIOTI workshop were similar, this year the decision was made to hold a combined meeting to address the needs of both groups.

This working document aims to report the outcomes of this workshop, including conclusions, actions and recommendations for update to the SIOTI Action Plan. Additionally, a second working document (IOTC–2018–WPEB14–15) will present a preliminary analysis of purse seine bycatch levels in the Indian Ocean.

The Workshop on purse seine Observer Programs took place in AZTI (Pasaia, Spain) during 16th- 17th of April, with representatives from IRD (France), IEO and AZTI (Spain), SFA (Seychelles) and Fisheries Ministry of Gabon. Several TORs were discussed which are summarized in the sections bellow:

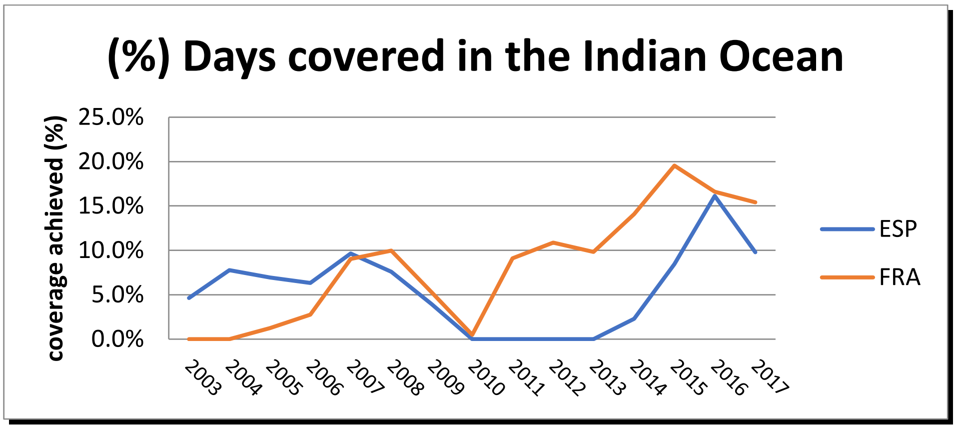
- Analyze the evolution in the historical series of the observer's coverage in the Indian Ocean.
- Update the common observer's manual (based on observers' feedback and data needs)
- Discuss about common tools for data acquisition and data storage (databases)
- Discuss about the new monitoring tools, complementary to human observers (Electronic Monitoring Systems)
- Agreed on the list of recommendations to SIOTI.

2. Evolution of the purse seine observer coverage in the Indian Ocean.

An EU framework for the collection and management of fisheries data was established in 2000, and then reformed in 2008 resulting in the Data Collection Framework (DCF) (Council Regulation (EC) No 199/2008; Commission Implementing Decision (EU)2016/1251). The DCF establishes a harmonized set of EU rules governing the collection, management and use of biological, environmental, technical, and socioeconomic data on the fisheries, aquaculture and processing sectors. It strives to ensure the availability of data to scientists, so that these data can be used to provide advice to end-users and managers. In this context, France and Spain started in 2003 sampling, with observers onboard, the tropical purse seine fleet operating both in the Indian and Atlantic Oceans. This sampling framework has been conducted in a coordinated manner since the beginning, with the collaboration of the three organisms in charge of managing observers; IRD (France), IEO (Spain) and AZTI (Spain).

Figure 1 shows the sampling coverage during the EU DCF period (2003-2017) on French and Spanish vessels operating in the Indian Ocean.

In the Indian Ocean both Spain and France stopped their observer programs in 2009 due to the piracy and safety reasons. Later, France resumed its observer program progressively in 2011, in collaboration with TAAF (Terres Australes et Antarctiques Françaises). Achieved coverage in 2017 was 12.1 % of the trips, 13.7 % of the fishing sets, and 15.4% of fishing days. In the case of Spain, sampling was not resumed until 2014, when 3 trips were sampled in collaboration with TAAF, and since 2015 onwards, both AZTI and IEO, in collaboration with SFA have taken up sampling in the Indian Ocean. Achieved coverage in 2017 was around 10% both for number of sets and fishing days.



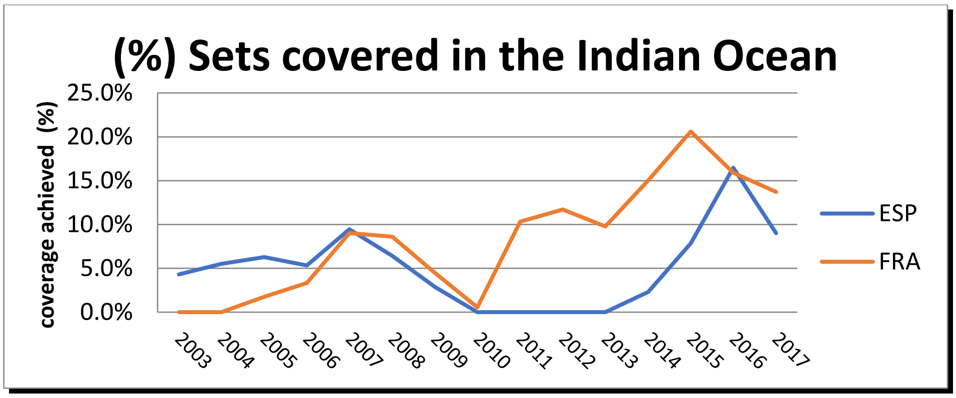


Figure1. Days and fishing set percentage covered by observers under the European data collection Program on the PS (Spanish and French) fleet in the Indian Ocean**.**

Out from the EU-DCF, observer coverage increased significantly since 2014 through private contracts between industry and scientific institutes; French fleet under the OCUP (Observateurs Communs Uniques et Permanents) program (Goujon et al., 2017) and Spanish and Seychellois fleets under the "Best practices Monitoring Program" (Lopez J, et al., 2017). Human observers under these private monitoring programs belong mostly to SFA, and specific trips observed by coastal countries should be added. In addition to this observer sampling coverage, an increasingly important number of trips is being covered through EMS (electronic monitoring system) since 2016. This way, total expected monitoring coverage would be close to 100%. Figures 2 and 3 show the total observer sampling effort by flag and set type respectively (excluding EMS sampling).

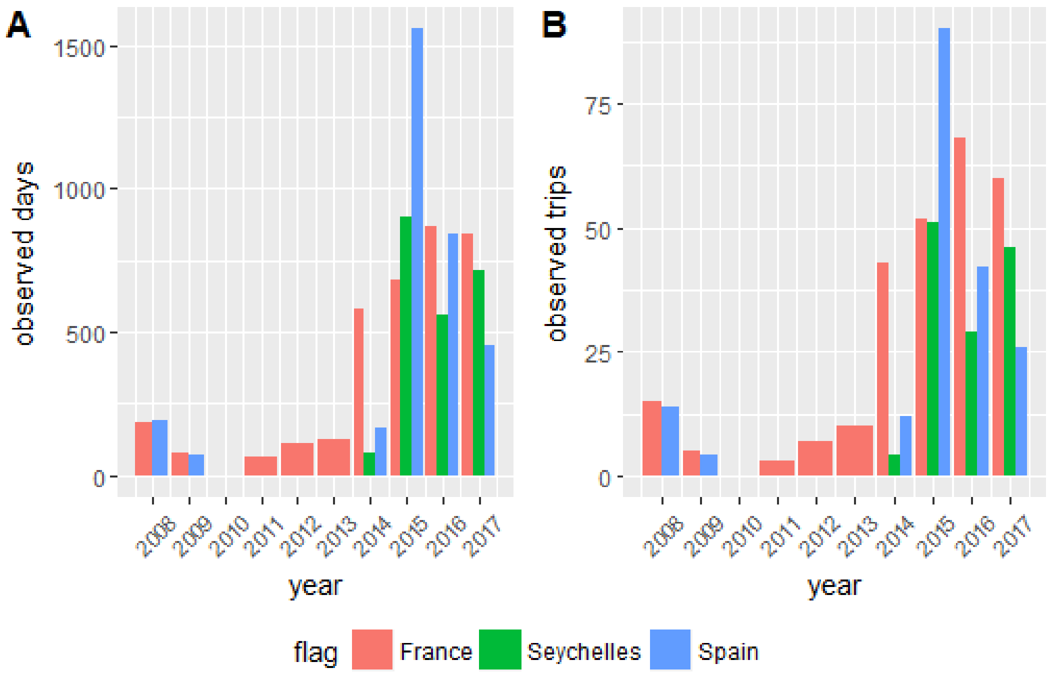


Figure2. Total days and fishing trips covered by observers on the PS (Spanish, Seychellois and French) fleet in the Indian Ocean.

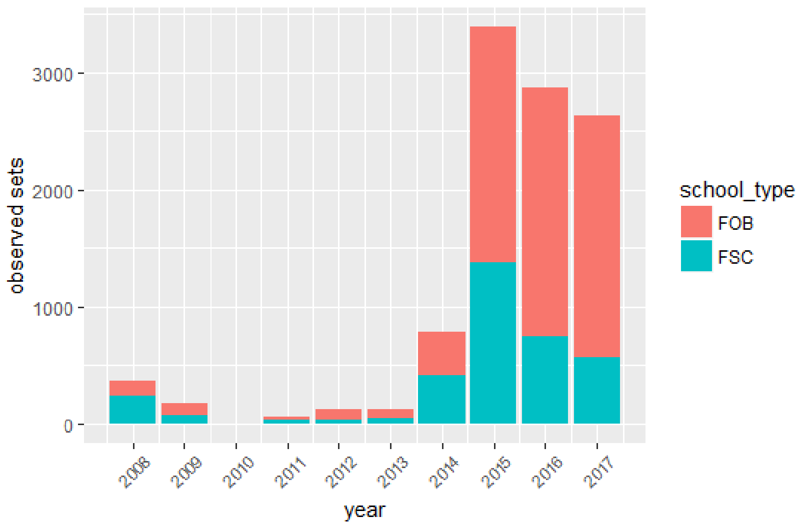


Figure3. Total days and fishing trips covered by observers on the PS (Spanish, Seychellois and French) fleet in the Indian Ocean.

3. Data submission obligations in RFMOs

Data transmission failures to RFMOs was analyzed and presented based on the IOTC feedback (Fiorellato *et al.*, 2017). Main deficiencies referred to bycatch data (partially transmitted), and some pending issues with bycatch (shark and billfish) were identified. These same deficiencies on data transmission failures had already been detected in previous meetings and working groups (Anon, 2017) and it appears that even if the bycatch data (observers' data) have been sent for several years in the ST09 template, this same information was not always sent as nominal catches (raised to the fleet level).

The doubts existing in the choice of the most appropriate sampling stratification (i.e. currently used sampling areas, known as ET areas, are units considered for the target tuna sampling. And may not be appropriate for bycatch analyses), and mostly the existing doubts in the choice of the raising methodology and raising factor (variables to be used as ratio estimator) have been identified as the main reason for not having sent the data in previous years. Some comparisons using different ratio estimators and stratifications were done by Amande *el al.* (2008).

In addition, the low observation coverage in the first part of the time series (figures 2 & 3) has been another reason not to have confident and robust bycatch estimates (Sanchez, 2007). For estimates based on observer data, the coverage level must be considered, and total estimates (declared as nominal catches) must be declared with their variance. Figure 4 shows how the uncertainty is high when observation coverage does not reach a minimum level.

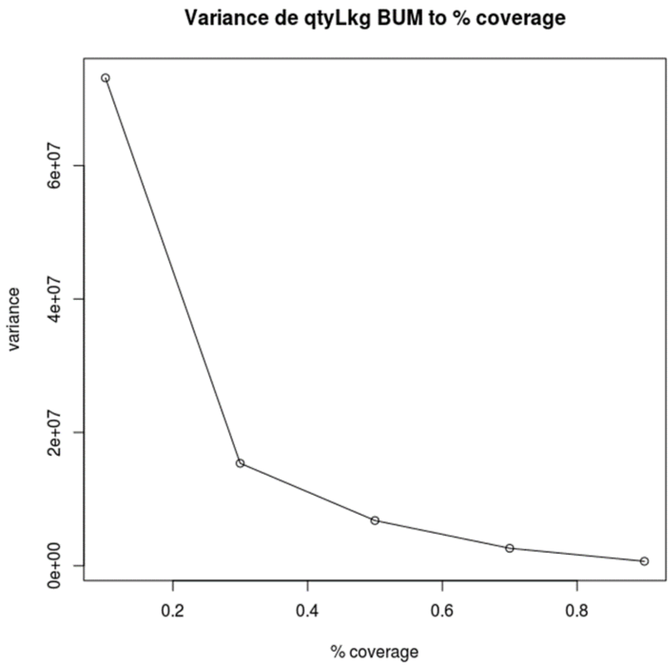


Figure4. Blue marlin variance values based on observation coverage.

As result of these concerns, the group recommended that a workshop on bycatch sampling methodology and raising procedures should be conducted. With the following terms of reference:

a) Identify data requirements and appropriate bycatch sampling strategies and methods (e.g. stratification, mandatory and optional variables, selection of vessels, gears, etc.))
b) Develop guidelines in order to minimise bias and maximise precision.
c) Identify raising procedures which minimise the bias and maximise the precision of estimates taking into account the sampling procedure and the use of the data

4. Common methods and tools for data collection and storage

AZTI, IEO and IRD, have been conducting since 2003 a coordinated observer program as part of the Spanish and French National Programs for the Data Collection, and recently under private contracts funded by the fishing industry. Additionally, other institutions (mainly SFA, but also TAFF and Madagascar) participate in this sampling scheme. This sampling program provides information about the commercial and non-commercial species that are in the catch and could be discarded, which allows studying the biodiversity of the exploited resources. Data collection methods (manual, protocol, paper forms and databases) are fully standardize among institutions and based on Delgado de Molina et al. (1997). During these trips, observers filled in five different data sheets

- Data sheet 1 (FORM A) - Route data and environmental parameters:

Bridge data (position each hour, etc.)

Environmental data (wind speed, sea surface temperature (SST), etc.)

- Data sheet 2 (FORM B)- Fishing operation parameters and catch data

  characteristics of the set (shooting hour, rings up hour, etc.), and

  total catch, both target species and bycatch species catch and fates

- Data sheet 3 (FORM C1)-Size sampling for tunas:

  size sampling for tuna species is collected in these data sheets.

- Data sheet 4 (FORM C2)- Size sampling for accompanying fauna:

  size sampling for bycatch species is collected in these data sheets.

  sampling size by sex when possible for rays, sharks, cetaceans and turtles

- Data sheet 5 (FORM D) - Fishing Aggregator Device

  FAD type, satellite buoy data or fate.

Observers collect route data every hour, and all the fishing operations are sampled throughout the trips. Within each set, the priority of sampling for the observer is (1) estimating discarded tunas (if any) and measuring a subsample, (2) estimating and measuring sharks, billfishes and turtles, (3) estimating the number or weight of smaller bycatch species, measuring a subsample. Retained tuna catch information is recorded directly from the fishing logbook, and logbook information is based on a visual estimate made by the crew. All these data are later stored in ObServe data base (Cauquil *et al*., 2015).

All the details about the improvements made in both the manual and the database are available in the workshop full report. These changes relate mainly to the elimination of obsolete codes and to the update of some Length-Weight relationships.

5. Electronic Monitoring Systems (EMS)

Electronic monitoring (EM) is an emerging field which has been developed rapidly during the last decade, with high potential in fisheries monitoring. The tropical tuna purse-seine fishery joined these initiatives to incorporate EM systems for monitoring purposes in 2012, when a first pilot study was conducted with the aim of validating the efficiency of this technology, comparing it to human observers' data. Since then several pilot studies, involving at least four different EMS vendors, have been carried out. These trials showed that both human observers and EM are complementary each with their own weaknesses and strengths; Although EM is still limited to conduct some duties compared to observers, it could be valuable to increase the coverage achieved by human observers on purse seiners, specifically to; verify positions of the vessel, estimate number of sets (stratified by type), estimate total target tuna catches (including retained and discarded fractions), estimate bycatches and to monitor activities with FADs (fish aggregating devices).

It became clear during the workshop that EMS systems are increasingly important. In some cases, like the French fleet in the Indian Ocean or the Spanish fleet in both Atlantic and Indian Oceans, EMS could cover around 50% of the trips. However, data collected by EM would only be useful if it is collected in a consistent way, so before implementing these programs, it was necessary to develop minimum standards for the use of EM systems onboard tropical tuna purse seiners. Recently, minimum standards for the implementation of the EMS on the tropical tuna purse seine fleet operating in the Atlantic and Indian oceans have been presented. The following minimum standards, developed by Ruiz et al. (2016), were presented and adopted both by IOTC Scientific Committee and ICCAT SCRS:

Before the trip (Installation, certification, audits)

- Customized to vessel level

- Tested (and certified) by third party

During the trip (Data collection)

- Secure System: On board equipment must be adapted to sea conditions and assuring inviolability.
- System and data security: Tamperproof and real-time information to on-land offices.
- Cameras: Must cover all areas of interest according to the vessel and fishing manoeuvres. Recording frame rate must assure the detection of both catch and bycatch species.
- Independence: The system needs to be self-governing with the exception of minimal maintenance by crew.
- Data storage and autonomy: On-board data storage must assure 4 months recording.

After the trip (Data traceability and analysis)

- Dedicated image analysis software: Every EMS must offer an analysis software to allow the information review and analysis.
- EMS data analysis and reporting: Data analysis must be done by authorized entities following approved procedures.
- Office observers' training: Analysts must have passed specific training.
- Compatible with ongoing standardized data flow and databases: Compatible data output format.
- Hard drives chain of custody: The system must assure traceability of every hard drive and information recorded on-board.

Once minimum standards have been adopted, pilot studies have given way to the implementation of several EMS programs (Spanish, French & Seychellois). Currently, these EMS programs account with three different equipment; Spanish boats work with equipment provided both by Marine Instruments (MI) and Satlink. In the first case (MI equipment) AZTI is responsible for analyzing the data, and DOS (Digital Observer Services) in the second. French boats use systems developed by Thalos, and a third company (Oceanic Development) is responsible of analyzing the data in this case.

In order to merge EMS and human observer data, it will be important in the near future to standardize EMS outputs and become them compatible with observer's data. Currently, it is only possible in the case of boats with MI equipment, since the software for the image analysis (known as Beluga) is directly linked to Observe database.

On the other hand, it is well known that the EMS is limited to the collection of certain fields included in the observer's forms. Table 1 (extracted from Ruiz et al, 2017) shows EM strengths and weaknesses to properly monitor activities of interest under IOTC Resolutions, and that might be reported to the IOTC Secretariat. Regardless these general EMS limitations, field that are not covered by the EMS in each of the observer's forms are listed below.

- *Form A*: Fields that are not completed through EMS are the following; "Surrounding activity", "wind speed", "SST", "detection mode", "observed system" and "distance to observed system".

- Form B: Fields that are not completed through EMS are the following; "current speed and direction", "school estimation previous to set", "depth of the gear closing", "well number for target tuna catch".

- Form C1 &C2: Current version of Beluga software do not permit filling in these forms.

- Form D: In general terms, it is not possible to enter information about the property of the DCP, nor any field related to the buoy id.

Table1. EM capability to properly monitor activities of interest under IOTC Resolutions

Item	**Rec(s)**	**EMS capability**	**Strength (S)** **Weakness (W)**
Vessel position	IOTC Res 11/04	EMS Ready	**(S)** Independent GPS, that allows tamper proof data at finer scale than a human observer.
Fishing operation date/time	IOTC Res 11/04	EMS Ready	Both EM and observers are equally valid methods.

Fishing operation type (FAD Vs FSC)	IOTC Res 11/04	EMS Ready	Both EM and observers are equally valid methods. **(W)** EM limited to identify sets associated to whales when the whale is not encircled, or if it escapes at the beginning of the set.
Total catch by set	IOTC Res 11/04	EMS Ready	**(S)** EM estimates independent to the crew
Target species composition by set	IOTC Res 11/04	EMS adjustments are still needed.	Both EM and human observers have the same difficulties. Species composition estimates, especially bigeye and yellowfin proportion, will be more accurate if it is done via port-sampling.
Bycatch estimate (sharks, rays, turtles, birds and marine mammals)	IOTC Res 11/04 IOTC Res 05/05 IOTC Res 12/04 IOTC Res 13/04 IOTC Res 13/05	EMS Ready	**(W)** Number of cameras is limited, and bycatch handling area could change and move out from the camera views punctually. Small size individuals could be underestimated, mainly in those cases where they are not sorted, and are retained in wells. Species id. could be limited sometimes compared to an experienced observer. **(S)** EM allows monitoring two different places (main and well's deck) simultaneously.
Bycatch fate (sharks, rays, turtles, birds and billfish)	IOTC Res 11/04	EMS Ready	**(W)** Number of cameras is limited, and bycatch handling area could change and move out from the camera views punctually. Small size individuals could be underestimated, mainly in those cases where they are not sorted, and are retained in wells. **(S)** EM allows monitoring two different places (main and well's deck) simultaneously.
Discards	IOTC Res 15/06	EMS Ready	**(W)** Number of cameras is limited, and discard area could change and move out from the camera views punctually. If discards are not brailed onboard, EM is limited to estimate fish quantities in the net sack. Moreover, it would not be possible to know reasons for discarding in most of the cases. **(S)** On the contrary, when vessels are equipped with discard belt, EMS might be a better tool for estimating discards, species and volume, as it can be done in an exhaustive way.
Size frequency	IOTC Res 11/04	EMS adjustments are still needed	**(W)** Calibration work is still needed before robust random sampling.

Collection of biological samples (e.g. gonads, otoliths, spines)	IOTC Res 11/04	Cannot be collected via EMS.	**(W)** Cannot be conducted by EM. However, it is not a task done routinely.
Gear characteristics	IOTC Res 11/04	EMS adjustments are still needed.	**(W)** Limited task for the EM. Could be collected by different means: interviews, remaining observers, land base samplers and EMS technicians.
FAD monitoring	IOTC Res 11/04 IOTC Res 15/08	EMS Ready	**(S)** 24/7 easily monitored. Important if deployments are done at night. **(W)** EM cannot record buoy data

In summary, both human observers and EM systems are complementary each with their own weaknesses and strengths. However, if these EMS programs are managed by different organizations, close collaboration between them should exist, in the same way that exists between the different institutes managing human observers' programs.

6. List of recommendations

Finally, based on weaknesses identified by the group regarding bycatch data, three main recommendations that under the umbrella of SIOTI would favor better bycatch estimates in the Indian Ocean were identified.

- **Workshop on raising methods** to produce at least estimates (nominal catches) for bycatch species on interest for IOTC. The group recognized that the submission of estimates of total bycatch species and discards (as Nominal Catches) is an important issue that should be addressed. However, it should be associated with the level of observer coverage. Some preliminary analysis indicated that the increase of the observer coverage implied a clear reduction of uncertainty and possible bias, showing the benefits of increasing the observers' coverage to estimate total catches for species on interest for IOTC (mainly billfishes and sharks). There is no doubt that with the implementation of monitoring programs funded by the industry, coverage has increased significantly in recent years. However, during the observers meeting it was identified, once again, the need to organize a workshop to establish a methodology to raise observer data to fleet level. This workshop should deal with different ratio estimators (total production, number of sets, etc.), different stratification, etc.

- **Workshop to standardize EMS output to be able to merge with observers' data**: In the light of the positive experiences on the use of electronic monitoring onboard the purse seine vessels and the introduction of minimum standards in IOTC the group recommended that efforts should be made to integrate as soon as possible EMS output data, together with human observer's data. In addition to the previous recommendation regarding EMS output standardization, it is necessary to confirm that all organisms in charge of reviewing and analyzing EMS data, are collecting same fields regarding bycatch data. With this objective it would be positive to organize a workshop with the different organizations in charge of reviewing the images from the EM systems; DOS (Digital Observer Services), AZTI and OD (Oceanic Development).

- **Comparison EMS vs Observer data**. Purse seiners operating in the Indian Ocean have currently a variety of EM equipment manufactured by different vendors, and new manufactures could enter the market. After meeting the minimum specifications, all vendors should be equally valid, but each will have advantages and disadvantages over the other. All systems currently implemented in tropical purse seiners have been tested through pilot studies before being incorporated in the monitoring program. These pilot studies have been executed by organizations that run human observer programs, collecting data during punctual trips simultaneously with experienced observers and EMS. Once the efficacy and accuracy of a system has been proven, periodic audits are recommended. Thus, after one year of data collection through both systems, a new and broader comparison of results is needed to verify the effectiveness of the EM systems.

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