Minimum standards for designing and implementing Electronic Monitoring systems in Indian Ocean tuna fisheries

H. Murua[1], F. Fiorellato[2], J. Ruiz[3], E. Chassot[2], V. Restrepo[1]

ABSTRACT

In addition to catch and effort fishery-dependent information collected through logbooks and/or port-sampling of commercial vessels, observer data is key to compile, complement and verify fishery activity information. Electronic monitoring (EM) using cameras and other sensors is a proven technology that has been widely used for various purposes on fishing vessels, primarily in industrial fleets. EM systems include equipment that tracks a vessel's position and activity, together with cameras that record key aspects of the fishing operations. EM has been used extensively for this purpose to obtain reliable information on catches and their composition, as well as to monitor and collect data on bycatches of protected species (ETP).

EM pilot tests in different regions on tuna purse seiners and longline vessels, as well as in small-scale artisanal fisheries, have demonstrated the validity of this technology to improve the collection of fishery. However, before considering the wide application of any EM in general, and particularly in tuna fisheries, EM minimum standard for the installation, collection, analysis and storage of data are needed. Moreover, it is also particularly important to assess the congruence between EM and observers-collected fishery data, to verify the capability, and ensure the replicability and accuracy of the information collected through EM (e.g. collection of the same data fields, with information comparable to those collected by human observers) with the purpose of improving the stock assessment and management process.

Thus, this document aims to progress on the development of EM minimum standards, including specifications and procedures, for the implementation of Electronic Monitoring Systems for IOTC fisheries, as well as evaluate EMS' capabilities to collect the ROS minimum standards data fields as per latest requirements.

[1] International Seafood Sustainability Foundation (ISSF), Washington, USA: hmurua@iss-foundation.org
[2] Indian Ocean Tuna Commission (IOTC), Seychelles.
[3] Marine Research, AZTI BRTA, Sukarrieta, Basque Country (Spain).

RÉSUMÉ

En plus des informations sur les prises et l'effort de pêche, dépendantes des pêcheries, recueillies par le biais des journaux de bord et/ou de l'échantillonnage au port des navires commerciaux, les données des observateurs sont essentielles pour compiler, compléter et vérifier les informations sur les activités de pêche. La surveillance électronique (SE) utilisant des caméras et d'autres capteurs est une technologie éprouvée qui a été largement utilisée à diverses fins sur les navires de pêche, principalement dans les flottes industrielles. Les systèmes de SE comprennent des équipements qui suivent la position et l'activité d'un navire, ainsi que des caméras qui enregistrent les aspects-clés des opérations de pêche. La SE a été largement utilisée à cette fin pour obtenir des informations fiables sur les captures et leur composition, ainsi que pour surveiller et collecter des données sur les prises accessoires d'espèces protégées (ETP).

Les essais-pilotes de SE dans différentes régions sur des thoniers senneurs et des palangriers, ainsi que dans la petite pêche artisanale, ont démontré la validité de cette technologie pour améliorer la collecte des données halieutiques. Cependant, avant d'envisager l'application à grande échelle de la SE en général, et en particulier dans la pêche au thon, il est nécessaire d'établir des normes minimales de SE pour l'installation, la collecte, l'analyse et le stockage des données. En outre, il est également particulièrement important d'évaluer la congruence entre la SE et les données de pêche collectées par les observateurs, de vérifier la capacité et de garantir la reproductibilité et l'exactitude des informations collectées par la SE (par exemple, collecte des mêmes champs de données, avec des informations comparables à celles collectées par les observateurs humains) dans le but d'améliorer le processus d'évaluation et de gestion des stocks.

Ainsi, ce document vise à faire progresser le développement de normes minimales de SE, y compris les spécifications et les procédures, pour la mise en œuvre des systèmes de surveillance électronique pour les pêcheries de la CTOI, ainsi qu'à évaluer les capacités du Système de surveillance électronique (SSE/EMS) à collecter les champs de données des normes minimales du MRO, conformément aux dernières exigences.

KEYWORDS

Electronic Monitoring, Minimum Standards, EM Program, EM Equipment

Table of Contents

1. Introduction

The scientific advice and management recommendations on the status of any fish stocks are based upon the results of fisheries stock assessments which depend on the analyses of the available and appropriate fishery information (FAO, 1999). Fishery-dependent and independent data are, therefore, needed to estimate abundance of populations and exploitation rates exerted on those populations but also to monitor fishery interaction with non-target species (FAO, 1997) and for assessing the effectiveness of management measures. In addition to catch and effort fishery-dependent information collected through logbooks and/or port-sampling of commercial vessels, observer data is key to compile, complement and verify fishery activity information (McElderry, 2008). Observer programs have been widely established in fisheries to improve the scientific data collection of catch composition by species, catch and fishing effort, size composition of the catch, vessel and fishing gear characteristics, bycatch and discards and interactions with Endangered and Protected Species (ETP), biological information (e.g. otoliths for age determination and gonads to identify the sex of fishes and fecundity studies). The information collected is determined by the objectives of each observer program. Moreover, observer data is sometimes also used to verify compliance with management measures as a means to strengthen the Monitoring and Control Surveillance (MCS) system and to increase the transparency in the fisheries (Ewell et al., 2020). For example, it has been shown that catch statistics, and bycatch discards, are more accurately reported in the logbooks and that compliance with management measures is improved when observers are onboard (Morrell, 2019). Ideally, scientific observer programs

should be separated from those for compliance in order to ensure that information is collected objectively without pressures on the observer (Nolan, 1999). However, in practice many observer programs cover both roles such as the observer programs established in the Inter-American Tropical Tuna Commission (IATTC) under the Agreement on the International Dolphin Conservation Program (AIDCP), International Commission for the Conservation of Atlantic Tunas (ICCAT) under Recommendation 19-02, and the Western Central Pacific Fisheries Commission (WCPFC). In the particular case of IOTC, the Regional Observer Program established under Resolution 11/04 aims to collect verified catch data and scientific information.

Observer coverage is very diverse between regional management bodies. For example, only 3 out of 17 Regional Fishery Management Organizations (RFMOs) investigated by Ewell et al. 2020 require 100 % of observer coverage on their large scale vessels. Although it has been shown that observer coverage requirements for bycatch species should be between 20 and 50 % or even larger for rare species (Babcock et al., 2003; NMFS, 2004), most of the fisheries worldwide have lower observer coverage. Similarly, for compliance purposes, 100 % of observer coverage may be needed. When considering tuna RFMOs, there is a 100 % requirement for human observers in large scale Purse Seiners (class 6 vessels) in the Inter-American Tropical Tuna Commission (IATTC) under the Agreement on the International Dolphin Conservation Program (IDCP) and the Western and Central Pacific Fisheries Commission - WCPFC (CMM 2018-01), and 100% for human and/or electronic monitoring systems in the International Commission for the Conservation of Atlantic Tunas - ICCAT (ICCAT, 2019). On the other hand, the Indian Ocean Tuna Commission (IOTC) requires the collection of independent data on fishing activity through human observers for at least 5 % of the operations for each gear type (Resolution 11-04). However, the observer coverage requirement for smaller purse seiners as well as other type of fishing vessels is between 5 and 10 % in tuna RFMOs, which is not enough to obtain reasonably accurate scientific data on fishing activity. There are, however, several difficulties to increase the human observer coverage on some of those fleets and these usually have to do with the high costs involved in observer placement, debriefing and data handling, and with the limited availability of space onboard as well vessel seaworthiness.

For fisheries or fleet segments where observer coverage is low, and even in cases of high observer coverage, Electronic Monitoring could be a good alternative, and complement or replace human observers, (i) to increase the observer coverage by avoiding many of the practical difficulties in placing human observers on board smaller vessels; (ii) to improve monitoring by increasing observation coverage onboard and collecting new data; (iii) to calibrate and verify reporting from human observers; (iv) possible to reduce some costs, and (iv) to ensure observer's safety (Gilman et al., 2020).

Electronic monitoring (EM) using cameras and other sensors is a proven technology that has been widely used for various purposes on fishing vessels, primarily in industrial fleets (Murua et al., 2020b, 2020a; Ruiz et al., 2015). EM systems include equipment that tracks a vessel's position and activity, together with cameras that record key aspects of the fishing operations. EM has been used extensively for this purpose to obtain reliable information on catches and their composition, as well as to monitor and collect data on bycatches of protected species (ETP).

EM pilot tests in different regions on tuna purse seiners and longline vessels, as well as in small-scale artisanal fisheries, have demonstrated the validity of this technology to improve the collection of fishery information (Bartholomew et al., 2018; Emery et al., 2019a, 2019b, 2018; McElderry, 2008; Ruiz et al., 2015). In some fisheries, EM systems have been fully integrated as a monitoring tool as in the cases of the West coast of Canada and USA (Jannot et al., 2020; NOAA, 2017; van Helmond et al., 2019) and in the East coast of Australia, for the tuna longline fishery (AFMA, 2015). In both cases, there is a significant level of acceptance by fishers and fishing management agencies of the EM systems introduced in the fisheries. However, before considering the wide application of any EM in general, and particularly in tuna fisheries, minimum standard for the installation, collection, analysis and storage of data are needed (Emery et al., 2018; van Helmond et al., 2019). Moreover, it is also particularly important to assess the congruence between EM and observers-collected fishery data, to verify the capability, and ensure the replicability and accuracy of the information collected through EM (e.g. collection of the same data fields, with information comparable to those collected by human observers) with the purpose of improving the stock assessment and management process (Emery et al., 2018; Gilman et al., 2020; van Helmond et al., 2019).

Most tuna RFMOs have at least initiated preliminary discussions towards the development of EM minimum standards, for example:

- ICCAT: the Commission adopted EM minimum standards for purse seine vessels (Ruiz et al., 2017) in the main body of its 2017 annual Commission report, but not as part of a conservation and management measure. At the 2019 annual meeting, ICCAT adopted a new conservation measures for tropical tunas (Rec 19-02) that calls for increasing observer coverage on longline vessels from 5% to 10% and for the development of EM minimum standards for longline to be done jointly by the Standing Committee on Research and Statistics (SCRS) and the Integrated Monitoring Measures (IMM) working group.
- IATTC: at its 2019 annual Commission meeting, the *Resolution on Observers for Longline Vessels* requested the IATTC Scientific Staff to prepare a draft proposal for progressing on the development of minimum standards for the implementation of EMS for the longline fleets, taking into account the experience of CPCs that are implementing EMS on longline vessels and progress made in other tuna RFMOs. These draft minimum standards for purse seines and longlines were presented to the SAC meeting in 2020 (Roman et al., 2020).
- WCPFC: the Commission has established an ER/EM working group for developing EM standards, which is in the process of producing a draft consultative proposal for a Conservation and Management measure for a regional E-monitoring programme (ERandEMWG4-2020-02) and a Minimum Standards for a regional E-monitoring programme (ERandEMWG4-2020-03) to be presented to the annual meeting of WCPFC in December 2020. Also, the Pacific Islands Forum Fisheries Agency (FFA) has agreed on a draft regional longline fisheries electronic monitoring policy, which includes standards on EM systems, data management, data ownership and access, and data security and confidentiality.
- IOTC: in 2017 the Commission preliminarily adopted a set of minimum EM standards for purse seiners willing to introduce EMS to increase observer coverage. As was the case for ICCAT, this was endorsed in the main body of the Commission report but not

as part of a specific conservation measure. Eventually, IOTC SC in 2018 recommended the development of minimum standards for EMS for all IOTC tuna fisheries (including small-scale and artisanal fisheries).

As part of the IOTC Regional Observer Scheme (ROS), a Pilot Project (Resolution 16/04) was launched in 2016 to promote the ROS and improve data collection and reporting of scientific observer data to the IOTC.

In 2019 the Commission endorsed the ROS minimum standard data fields for scientific observer data collection, however, as of today no specific minimum data collection standards for electronic monitoring systems have been identified (in terms of minimum coverage levels for both observation and analysis) nor an evaluation has been attempted to determine whether EMS can effectively collect all of the adopted ROS minimum standard data fields.

Moreover, due to the difficulties of embarking at-sea observers due to the covid pandemic, requirements for observer coverage both in IOTC Regional Observer Scheme and transshipment Regional Observer Program has been suspended (IOTC Circular 2020-14). Therefore, the development of electronic monitoring systems for use on fishing and carrier vessels, which would allow technology to complement human observers, or if necessary, replace them if there are similar situations in the future should be urgently prioritized.

Thus, this document aims to progress on the development of EM minimum standards, including specifications and procedures, for the implementation of Electronic Monitoring Systems for IOTC fisheries, as well as evaluate EMS' capabilities to collect the IOTC ROS minimum standards data fields as per latest requirements.

The paper focuses on EM standards that would aid to standardize Electronic Monitoring Systems in the Indian Ocean region, from the point of view of installation onboard (number and position of cameras, component installation, software requirements, etc.), the type of data to be collected, and how this is achieved, policies on data usage, revision and ownership.

2. Objectives and Scope

The objective of implementing an Electronic Monitoring Programme (EMP) in the IOTC, in line with IOTC data requirements from Res. 15/01 and 15/02, as well as Res. 11/04 ("On a Regional Observer Scheme"), is to collect verified catch data and other scientific information related to the fisheries for tuna and tuna-like species in the IOTC area of competence, and to support the implementation of the conservation and management measures adopted by the Commission.

The purpose of IOTC EMP is to allow IOTC CPCs to complement other monitoring tools currently in place in the region (e.g. ROP) and to collect data where observer coverage is low or non-existent, that will improve the quantity and quality of fishery data and the monitoring of IOTC fisheries addressing data gaps in the collection and verification of fishery data. Ultimately, the assessment and management of IOTC stock as well as their ecosystems will be enhanced.

There is a large diversity of fisheries, fleets and CPCs operating under the IOTC, with each of them showing large differences in relation to data collection programmes and compliance with IOTC mandatory fishery statistics data requirements. In order to improve the collection of scientific data, IOTC regulations are mainly directed at fishing vessels of different gear types, operating in the IOTC area of competence and of 24 meters (or above) of length overall (LoA), and under 24 meters of LoA if fishing outside the Exclusive Economic Zone (EEZ) of their flag state. EM systems to collect the necessary fishery data as well as EM minimum standards should be tailored to each specific fishery and thus, the EM minimum standards proposed in this document provide a framework for the development of EMS in the following IOTC fisheries:

- Purse-seine vessels over 24 meters overall length,
- Longline vessels over 24 meters overall length,
- Gillnet vessels over 24 meters overall length,
- Pole and line vessels over 24 meters overall length,
- Other gear types under 24 meters (when fishing in the high seas).

There would be areas of the proposed minimum EM standards that are applicable to all vessels irrespective of their gear type and/or LOA, but other aspects would be specific to each gear and vessel category. Thus, the EM Programme should be designed to account for all the differences in terms of technical specifications, analysis rates, data collection requirements specific of the different categories of fisheries considered (see above) while being flexible enough to address the multiplicity of objectives of the EM Programme.

3. IOTC mandatory fishery statistics requirements

The IOTC mandatory fishery statistics requirements are intended to standardize the collection and reporting of all fishery data on catches, fishing efforts, size frequency of target and non-target species, as well as interactions with Endangered, Threatened, or Protected (ETP) species that will allow assessing and managing IOTC stocks and fisheries in a sustainable way. Gear characteristics as well as details on fishing activities and aggregated operational data (e.g. interaction with Fishing Aggregating Devices,) are also mandatory to collect and report to IOTC.

Following is a non-exhaustive list of the main IOTC Resolutions in relation to data collection and reporting requirements.

3.1. Resolution 15/01 on the recording of catch and effort data by fishing vessels in the IOTC area of competence

This Resolution calls all CPCs to ensure that all purse seine, longline, gillnet, pole and line, handline and trolling fishing vessels flying its flag and authorised to fish species managed by IOTC implement data recording system. As such, it states that all vessels shall keep a paper or electronic logbook to record the minimum information outlined by the different Annexes of the resolution, including (i) information on vessel, trip and gear configuration for purse seine, longline, gillnet and pole and line, which shall only be completed once for each trip, unless the gear configuration changes during the trip; (ii) information for purse seine, longline, gillnet

and pole and line operations and catch, which shall be completed for each set/shot/operation of the fishing gear, and (ii) specifications for handline and trolling gears.

Moreover, the Resolution requires CPCs to provide data for any given year to the IOTC Secretariat by June 30th of the following year, on an aggregated basis. The confidentiality rules set out in Resolution 12/02 Data Confidentiality Policy and Procedures (or any subsequent superseding Resolution) for fine–scale data apply.

3.2. Resolution 15/02 Mandatory IOTC mandatory fishery statistics requirements

This Resolution calls all Contracting Parties and Cooperating Non-Contracting Parties (CPCs) to regularly submit to the IOTC Secretariat several fishery statistics on their fleets operating in the Indian Ocean as these are collected through logbooks (see Resolution 15/01) or other approved means, focusing in particular on:

- **Total catch data:** estimates of the total catch by species and gear, if possible quarterly, that shall be submitted annually (separated, whenever possible, by retained catches in live weight and by discards in live weight or numbers) for all species under the IOTC mandate as well as the most commonly caught elasmobranch species according to records of catches and incidents as established in Resolution 15/01 on the recording of catch and effort data by fishing vessels in the IOTC area of competence.

  Concerning cetaceans, seabirds and marine turtles data should be provided as stated in Resolutions 13/04 on Conservation of Cetaceans, Resolution 12/06 on reduction the incidental bycatch of seabirds in longline fisheries and Resolution 12/04 on the conservation of marine turtles (or any subsequent superseding resolutions as well as in Resolution 15/01.

- **Catch and Effort data:**
  - **For surface fisheries**: catch weight by species and fishing effort shall be provided by 1° grid area and month strata. Purse seine and pole and line fisheries data shall be stratified by fishing mode (e.g. free swimming schools or schools in association with floating objects). The data shall be extrapolated to the total national monthly catches for each gear. Effort units reported should be consistent with those effort requirements of Resolution 15/01.
  - **Longline fisheries**: catch by species, in numbers or weight, and effort as the number of hooks deployed shall be provided by 5° grid area and month strata. Effort units reported should be consistent with those effort requirements of Resolution 15/01.
  - **For coastal fisheries**: catches by species, fishing gear and fishing effort shall be submitted frequently and may be provided using an alternative geographical area if it better represents the fishery concerned. Effort units reported should be consistent with those effort requirements of Resolution 15/01.

Provisions on catch and effort data is applicable to all species under the IOTC mandate as well as the most commonly caught elasmobranch species according to records of catches

and incidents as established in Resolution 15/01 on the recording of catch and effort by fishing vessels in the IOTC area of competence.

- **Size frequency data:** Size data shall be provided for all gears and for all species according to the *Guidelines for the reporting of fisheries statistics to the IOTC*. Size sampling shall be run under strict and well described random sampling schemes which are necessary to provide unbiased figures of the sizes taken. Sampling coverage shall be set to at least one fish measured by ton caught, by species and type of fishery, with samples being representative of all the periods and areas fished. Alternatively, size data for longline fleets may be provided as part of the Regional Observer Scheme where such fleets have at least 5% observer coverage of all fishing operations. Length data by species, including the total number of fish measured, shall be submitted by a 5° grid area by month, by gear and fishing mode (e.g. free swimming schools or schools in association with floating objects for the purse seiners).
- **Fish Aggregating Devices (FADs) and support vessels**: the following data shall be provided by CPCs with purse seines:
    - The number and characteristics of purse seine support vessels: (i) operating under their flag, (ii) assisting purse seine vessels operating under their flag, or (iii) licensed to operate in their exclusive economic zones, and that have been present in the IOTC area of competence;
    - Number of days at sea by purse seine and purse seine supply vessels by 1° grid area and month to be reported by the flag state of the supply vessel;
    - The total number set by the purse seine per quarter, as well as:
        - The positions, dates at the time of setting, FAD identifier and FAD type (i.e. drifting log or debris, drifting raft or FAD with a net, drifting raft or FAD without a net, anchored FADs and other FADs e.g. Payao, dead animal etc.;
        - The FAD design characteristics of each FAD (consistent with Annex 1 of the Resolution 19/02] Procedures on a fishing aggregating devices (FADs) management Plan, including a limitation on the number of FADS, more detailed specifications of catch reporting from FAD sets, and the development of improved FAD designs to reduce the incidence of entanglement of nontarget species).

  These data would be for the exclusive use of IOTC Scientific Committee and its Working Parties, subject to the approval of the data owners and in accordance with Resolution 12/02 Data confidentiality policy and procedures, and should be provided in a timely fashion.

3.3. Resolution 19/01 On an Interim Plan for Rebuilding the Indian Ocean Yellowfin Tuna Stock in the IOTC Area of Competence

Moreover, in relation to Fish Aggregating Devices fisheries, Resolution 19/01 on yellowfin rebuilding plan calls CPCs to report the number of FADs that were deployed in 2018 and 2019 by purse seine vessels and associated support vessels per 1°x1° grid.
In addition, Resolution 19/01 also requires that CPCs submit their catches of yellowfin disaggregated for vessel 24m overall length and over, and those under 24m if they fish outside

the EEZ as per resolution 15/02 in order to simplify the process of monitoring Yellowfin tuna catches according to the criteria expressed in paragraphs 13 - 15.

3.4. Resolution 19/02 Procedures on a Fish Aggregating Devices (FADs) Management Plan

Resolution 19/02 specifies the data requirements and submission to IOTC in relation to Fish Aggregation Devices (FADs), both drifting and anchored. In this regard, CPCs shall ensure that all fishing vessels record fishing activities in association with FADs using the specific data elements found in Annex III (DFAD) and Annex IV (AFAD) in the section of the "FAD-logbook" of the resolution.

Annex III and Annex IV specify that for each activity on a FAD, whether followed by a set or not, each fishing and support vessel shall report the following information:

- Vessel (name and registration number of the fishing, support or supply vessel)
- Position (as the geographic location of the event (Latitude and Longitude) in degrees and minutes)
- Date (as DD/MM/YYYY, day/month/year)
- DFAD/AFAD identifier (FAD marking or beacon ID)
- For each activity on a FAD the type of the activity
    - In the case of DFADs: deployment, visit, hauling, retrieving, loss, intervention to service electronic equipment, etc.
    - In the case of AFADs: repair, intervention consolidation, etc.
- And for the particular case of DFADs
    - The type of DFAD (drifting natural FAD, drifting artificial FAD),
    - And DFAD design characteristics, including dimension and material of the floating part and of the underwater hanging structure.

If the visit is followed by a set, CPCs shall report the results of the set in terms of catch and bycatch, both retained and discarded (dead or alive), aggregated by month and 1x1 degrees grids.

Additionally, in the case of DFADs fishing vessels (purse seines and support vessels) have to annually submit the number of operational buoys followed by vessel, lost and transferred (total number of DFADs tagged at sea, by deploying an instrumented buoy on a log or another vessel DFAD already in the water).

CPCs shall submit all this information consistent with the IOTC standards for the provision of catch and effort data aggregated by month and 1 x1 degrees grids ,as per Resolution 15/02 and under the confidentiality rules set by Resolution 12/02.

Moreover, and in order to support the monitoring of compliance with the limitation established in the Resolution, while protecting business confidential data, the instrumented buoy supplier company or the CPCs shall, starting 1 January 2020, report (or require their vessels to report) daily information on all active FADs to the Secretariat: such information shall contain, date, instrumented buoy ID, assigned vessel and daily position, which shall be

compiled at monthly intervals, to be submitted with a time delay of at least 60 days, but no longer than 90 days.

Finally, the Resolution stipulates that CPCs having vessels flying their flag and fishing on FADs shall submit to the Commission, on an annual basis, Management Plans for the use of FADs, both DFADs and AFADs, following the minimum guidelines provided in Annexes I and II of the Resolution.

3.5. Resolution 11/04 on a Regional Observer Scheme

With the objective of collecting verified catch data and other scientific information, the IOTC introduced its Regional Observer Scheme which - among other things - aims at reaching at least 5% of coverage of the total number of operations/sets foreach gear type. The resolution applies to vessels of 24 meters LoA and above fishing in the IOTC area of competence, and to vessels of less than 24 meters LoA if they fish outside their EEZ. The resolution also requests that artisanal fishing vessels landings be monitored at the landing place by field samplers with a coverage of the total levels of vessel activity (i.e. total number of vessel trips or total number of vessels) that should gradually increase to at least 5% of the total levels of vessel activity.

This Resolution provides basic details on the elements that observers should collect, and requests that the Scientific Committee elaborates a detailed operational manual and a template for reporting observer data to IOTC, including a list of minimum data fields.

A summary of IOTC data requirements applicable to species managed by the IOTC and the timeline of implementation of IOTC data resolutions is presented in Table 1 and 2.

Table 1. Summary of IOTC Data Requirements applicable to species managed by the IOTC (from IOTC-2019–WPDCS15–07).

<table>
<tr><th></th><th>Coastal fleets: EEZ vessels less than 24 m LOA</th><th colspan="3">Industrial surface and longline fleets: Vessels with LOA ≥ 24 m and all high seas vessels</th></tr>
<tr><td rowspan="2">Annual catches (Nominal catch + Discards)</td><td colspan="4">Nominal catches (weight) by IOTC species, main species of pelagic sharks, other bycatch, per IOTC area, gear, species and year</td></tr>
<tr><td colspan="4">Discard levels of IOTC species, sharks, seabirds, marine turtles, cetaceans per IOTC area, gear, species and year (in number and weight)</td></tr>
<tr><td>Active fishing craft statistics</td><td>Number of fishing craft per boat gear type category, per year</td><td colspan="3">Individual vessel data for all fishing ships catching IOTC species</td></tr>
<tr><td>Catch-and-effort (CE)</td><td>CE data by fishery (type of boat gear), area and period</td><td>Surface fisheries: CE by fishery, 1° grid and month Longline: CE by fishery, 5° grid and month</td><td>FADs anchored and drifting: CE by 1° grid and month (PS- BB)</td><td>Supply vessels: Effort 1° grid and month</td></tr>
<tr><td>Size data</td><td colspan="4">Individual lengths of IOTC species sampled by fishery, species, 5 ° area and month</td></tr>
<tr><td>Scientific observer data</td><td>Samples of catches landed to cover at least 5% of vessel activities</td><td colspan="3">Sample of catches at-sea to cover at least 5% of fishing operations</td></tr>
</table>

Table 2. Timeline of implementation of IOTC Data requirement Resolutions as an indication of the year since which they are in force (from IOTC-2019–WPDCS15–07).

Res.	Description	Fisheries	Species	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
15/02	Nominal catch	All fisheries	IOTC species																								
			Main sharks																								
	Catch-and-effort	All fisheries	IOTC species																								
			Main sharks																								
	Size data	All fisheries	IOTC species																								
			Main sharks																								
	FADs and Supply vessels requirements	Purse seine	N/A																								
15/01	Minimum data requirements: Logbooks	Purse seine	IOTC species and main sharks																								
		Longline																									
		Pole-and-line; gillnet																									
		Handline; trolling																									
18/07	Non-fulfilment of data reporting obligations	All fisheries	All species																								
19/02	FAD logbook reporting requirements	Purse seine, pole-and-line	As 15/02																								
11/04	Regional Observer Scheme	Coastal fleets	As 10/02																								
		Industrial fleets >=24m LOA	All species																								
		Industrial fleets <24m LOA	All species																								
05/05	Sharks	As per 15/02	Main sharks																								
13/06	Oceanic whitetip shark	Authorised vessels	Oceanic whitetip																								
12/09	Thresher shark		Thresher sharks																								
13/05	Whale shark		Whale shark																								
12/06	Seabirds		Seabirds																								
12/04	Marine turtles		Marine turtles																								
13/04	Cetaceans		Cetaceans																								

4. Regional Observer Scheme (ROS)

Fisheries observer data are important for fisheries management, as they provide a source of detailed information on fishing activities that is independent from logbooks.

Following the establishment of the first Resolution *On a Regional Observer Scheme*, the IOTC Scientific Committee in 2010 reviewed and endorsed a preliminary observer manual, including a set of guidelines, standards and supporting information for observer data collection, reporting and training, an observer trip report template containing the minimum reporting requirements in aggregated form, and a set of data reporting forms supporting the minimum data collection requirements. These were approved, in provisional form, by the Commission in 2011. Moreover, Resolution 11/04 also requested the IOTC Scientific Committee to elaborate an observer working manual, a set of templates to be used for reporting purposes (including minimum data fields) and a training program.

However, submissions of observer data using those agreed observer trip report at that time incurred in various issues, such as low data resolution (e.g. effort reported for an entire trip), areas of duplication, misunderstanding of data fields and lack of standard categorisation and

coding; resulting in inconsistent data entries and in the practical impossibility to use the provided information to populate a dedicated ROS database.

To address these issues, the Scientific Committee introduced in 2014 a set of changes to the observers' data reporting requirements and templates, aiming at improving the quality of ROS data submissions and their ability to support stock assessments and other scientific work as requested by the IOTC Scientific Committee.

Following a consultation workshop in 2018, convening experts from several oceans and fisheries, the IOTC Scientific Committee developed new Regional Observer Scheme Program Standards that the Commission endorsed *in principle* in 2019. This endorsement allows the Secretariat to continue with the implementation of the ROS and its pilot programme, however the Commission could also request to review the standards based on the comments and feedback received during the implementation phase.

The Regional Observer Scheme Program Standards includes, among others, requirements about observer coverage, observer program verification by IOTC, observer programme performance, observer registration, observer curricula and training, observers coordination, equipment and materials, observer manuals, insurance and liability, safety at-sea, and several other administrative and scientific aspects.

One of the key aspects of this revision process was the definition of updated Regional Observer Scheme *minimum standard data fields* (see below) that were adopted by the IOTC Commission in 2019. This standard describes the minimum mandatory data to be collected and reported to IOTC as well as supplementary information that could be collected but not necessarily shared with the IOTC Secretariat.

4.1. ROS minimum standard data fields

The IOTC Regional Observer Scheme requires observers to record and report fishing activities, verify positions of the vessel, estimate catches and catch by species, monitor discards, by-catches and size frequency; record the gear configuration, mesh size and attachments employed by the master to enable the cross-checking of entries made to the logbooks (species composition and quantities, live and processed weight and location, where available); and carry out any other scientific work (for example, collecting biological samples), as requested by the IOTC Scientific Committee.

To harmonize observer programs among CPCs, the Scientific Committee developed a set of minimum data fields standards (Tables 4) for the collection and reporting of observer data according to the ROS specifications.

These minimum data fields group each type of information under two distinct categories: a) for reporting and b) for collection purposes. Fields marked as for reporting purposes are expected to be reported to the IOTC Secretariat, whereas those marked as for collection purposes should remain at exclusive availability of the national institutions, when collected.

Furthermore, the minimum data reporting fields standards categorize the field in the "for reporting purposes" category as a) mandatory and b) optional for reporting purposes. The distinction between these two categories is necessary to identify those fields that observers might not always be able to collect, and therefore could not be submitted to the IOTC Secretariat ("optional for reporting"). In general, fields marked as "for reporting" should always be submitted to the IOTC secretariat when collected.

The table below indicates the requirement (in terms of collection/submission) of each data field category:

Field type Requirements	For collection (suggested)	For reporting	
		Mandatory	Optional
To be collected	When feasible	Always	When feasible
To be reported to the IOTC Secretariat	On a voluntary basis, but not mandatorily	Always	Always (when collected)

It has to be noted that the optional status of some for reporting fields could be potentially misleading, as their reporting is not decided by the national observer programmes but rather to the feasibility of their collection by observer onboards.

Observer data submissions are not in compliance with Resolution 11/04 if all fields marked as "mandatory for reporting" are not provided and may be considered incomplete if those marked as "optional for reporting" are not reported when available and collected. Thus, it is strongly suggested that CPCs also submit data fields collected under "optional for reporting".

Therefore, in light of the purpose of this analysis and of the considerations above, it has to be determined which of the fields marked as mandatory for reporting can be collected through EMS and be included in EMS minimum standards. However, the analysis is also extended to fields marked as "optional for reporting" and "for collection (suggested)" because current National observer programs may be collecting such data and it would be necessary to check if those could be collected through Electronic Monitoring Systems and the IOTC may consider including in both observer and EMS minimum data standards.

5. EM capabilities to collect ROS Minimum Data Standards

As described before, EMS could be used to complement, and even in some cases to replace, human observers. However, before doing so, the capability of EM to collect all IOTC mandatory ROS data requirements, in agreement with the latest ROS minimum data standards, should be evaluated. Moreover, similar to what already done in the case of human observers at-sea, ROS Program Standards for EMS should also be developed and agreed.

In this section, we analyse the capacity of EM to accurately collect all the fields under the IOTC ROS minimum data fields standards, in particular those that are indicated as "for reporting purposes" (regardless of their mandatory/optional status) and those indicated as "suggested for collection". Some of these fields are related to general information about the observer program and fleet/fisheries (e.g. observer identification number, vessel name, number of fishing events/set observed et.c) while others are specific for certain gears or fisheries (e.g. mainline material, tori line length, presence of a power block or purse winch, etc.). Thus, even if all fisheries are included in this section, the focus is on purse seine and longlines, as these are the fisheries where the highest number of EM pilots have been conducted. However, as soon as information on gillnet and pole and line EM pilot projects are available, their comparison will be also done and tables updated.

We also evaluate the ability of EM to collect IOTC data requirements (e.g. FAD fishery data requirements) that are not included in the observer mandatory minimum standards but are required by other standing resolutions such as Resolutions 19/01 and 19/02.

We follow the approach developed by Pacific Community (SPC) data process standard technical workshops in 2017 (SPC 2017) and refined by Emery et al., 2018. The categories for assessing EM systems ability to collect the same information than human observers were:

Table 3. The agreed categories for assessing EM ability to collect ROS data minimum standards developed by (SPC-OFP, 2017) and (Emery et al., 2018).

R1	Ready now or require little work	**P1**	Possible, requires minor work
R2	Ready now but requires significant crew support	**P2**	Possible, requires major work
R3	Ready now but requires dedicated or additional work in the equipment	**NP**	Not possible
R4	Ready Now but inefficient/costly to analyze		

In addition to the above, following the approach of (SPC-OFP, 2017) workshop, the source from and the moment at which each data field could be collected (or not) is identified. These were coded as follows:

- SETUP — Hard-coded or recorded at the time in which the EM equipment is installed on the vessel,
- PRE — Hardcopy reporting or preferably E-Reporting from a pre-trip onsite inspection of the vessel and discussion with owner/captain/crew,
- EM-A — Recorded by an EM-Analyst based on visual reference to images/footage/sensors,
- POST — Hardcopy reporting or preferably E-Reporting from a post-trip onsite inspection of the vessel and discussion with owner/captain/crew,
- AG — Automatically generated by the EM system components,
- EM-A -> AG — A special case of the above where an event is detected by the EM Analyst and the EM system automatically generates the field value,
- CF — A calculated field arithmetically generated from one or more of the above field types

For what concerns the general data requirements, 11 of the total 24 IOTC ROS mandatory reporting data fields, are classified as ready to be collected with EM while the remaining13 are identified as possible to be collected/reported with minor work. Most of these 13 data fields refer to vessel information that could be collected from pre-trip onsite inspection of the vessel and through discussion with owner/captain/crew. Of the 5 IOTC ROS "optional for reporting" and 30 "suggested for collection", 17 are ready to be collected currently, 7 are not needed (i.e. observer information), 8 could be collected with minor work and 3 are not possible to collect. Thus, it seems that EM is well suited to collect the current ROS data fields.

Purse Seines

For purse seines, from the total of 51 IOTC ROS mandatory reporting data fields, 28 are classified as ready to be collected with EM (55%), 7 as ready but require little work, 4 as ready but requires specific requirements of camera/sensors and/or costly/inefficient to analyze, 5 as possible with minor/major work, and only 8 as not possible. Of the 22 IOTC ROS "optional for reporting" and 21 "suggested for collection", 20 are ready to be collected, 6 are ready to be collected but require specific requirements of camera/sensors and/or are costly/inefficient to analyze, 2 are possible with minor/major work and 15 are not possible.

However, many of the fields which cannot be covered through EMS (e.g. operational buoys followed by a vessel, operational buoys lost by a vessel) could neither be collected/reported by observers, as they are related to buoy track/density information which should be provided by buoy providers.

Thus, it seems that EM is well suited to undertake the monitoring of ROS data fields on purse seiners. The EMS ability to collect observer data on purse seine vessels is detailed in the tables below. The assessment of EM capabilities is based on the results of several pilot studies carried out in different regions (Murua et al., 2020b, 2020a; Ruiz et al., 2015), as well as expert knowledge (Table 4). Most of the "m*andatory for reporting*" fields listed in the observer minimum data field requirements could be collected by EM as accurately as human observers can do, or even better under some circumstances.

For example, vessel track and speed, fishing operations including set type (i.e. free school vs FOB set) and set start and end times, FAD deployments, FAD retrievals or total retained catches are ready to be recorded by EM with little or no modification of the vessel or its fishing practices (category R1; Emery et al., 2018). However, there are some items that would require significant assistance from vessel crew (R2), dedicated cameras and/or sensors (R3), or are inefficient or costly to analyze (R4). Other information recorded by observers, mostly non-operational data such as vessel capacity and equipment (radars, echo location equipment, etc.), gear dimensions and configuration, which EM cannot record, could be hard-coded or recorded at the time in which the EM equipment is installed on the vessel, though interviews with captains/owners and/or collected from the IOTC Authorized Vessel Register. Other information such as biological sampling cannot be collected EM.

EM systems are all capable to collect *vessel track* data as they are equipped with an independent Global Positioning System (GPS) which allows constant monitoring of the vessel position, trajectory and speed, at a much more detailed scale than any human observer and

even Vessel Monitoring Systems can do. Moreover, EMS data (images, position, date, time) is tamper proof, which means that cannot be manipulated and therefore are well suited to be used for compliance purposes as well. Moreover, EMS has been proven to effectively monitor set location and set type (Murua et al., 2020b, 2020a; Ruiz et al., 2015). Success rate of EM systems data collection in terms of set type (free school set vs FAD set) is variable between 72% and 100% (Murua et al., 2020b, 2020a; Ruiz et al., 2015). However, the successful identification rate increases to values close to 100% when classifying sets through EMS data if, in addition to the visual evidences (detect a FAD in a picture/video), species composition (detection of characteristic species for a determined type of set) and/or Vessel behaviour (GPS and sensor information) are used during the analysis (Gilman et al., 2019).

The total catch by set can be estimated through EMS with no significant differences in comparison with human observer and crew estimates included in the logbook. This task is easily performed through the analysis of camera footage allowing the correct observation of the fullness of each brail. In this regard, different technical data such as total brail capacity and wells' capacity should be known in advance prior to the installation of EM systems onboard.

On the other hand, pilot studies on purse seine vessels showed that catch composition of target species and their size composition are difficult to estimate through EM (Briand et al., 2018; Chavance et al., 2013; Gilman et al., 2019; Murua et al., 2020b, 2020a; Ruiz et al., 2015). In this regard, the difficulty to identify small yellowfin from bigeye or the way in which individuals are piled (e.g. conveyor belt), are the main challenges. On the other hand, it should be noted that human observers face the same difficulties when estimating the catch by species (Murua et al., 2020b, 2020a). Similar to the EM, the large catch volumes that can result in a set, and the speed at which fish are put into the wells increase the difficulty in producing accurate species composition estimates – especially related to the proportion of bigeye vs. yellowfin– and the size measurements. An improvement to the species composition estimates could be obtained by developing a system that ensures fish pass in one single layer on the conveyor belt, or by improving the placement of cameras to better count and measure more fish by set (or even by brail) which would allow more accurate estimations.

Estimates of bycatch species such as shark, billfish, turtles, rays and other large-sized fin-fishes (such as wahoos) are generally accurate, particularly if the cameras are correctly placed and there are enough cameras both in the main deck and in the below deck. On the contrary, estimation of smaller bycatch species is still difficult (Murua et al., 2020b, 2020a).

Improvements in technology, including the adoption of artificial intelligence and image analysis and recognition software (Gilman et al., 2019), could increase the accuracy of identification of all main species involved in tuna fisheries. Furthermore, one advantage of EM systems over human observers is its ability to simultaneously observe different catch handling places, while a human observer can only monitor either the upper or the below deck, but not both at the same time. This advantage of EM could contribute to increase the number of bycatch individuals whose fate is clearly identified the fate (discarded or retained) as is their release mode and, potentially, status (dead, alive, injured). In this regard, it is recommended that cameras continue recording images for at least some time (e.g. one hour) after brailing ends, the target catch is in the wells and the tow boat is on board.

EM systems are also well suited to collect information on FAD deployment (if the cameras are well positioned) and FAD characteristics and design. EM pilots in purse seines showed that if the EM systems are correctly configured, they're capable of recording data on operations done with FADs such as deployment of a new FAD, retrieval of a FAD or a fishing operation on a FAD.

In the case of a vessel's visit to a FAD without any other FAD operation, except buoy replacement, information from EM may be limited. However, in cases where the FAD is elevated and fully retrieved, EM has been proven to be able to identify its design and the materials used for its construction (e.g. entangling or non-entangling materials). On the other hand, during the monitoring of FAD-related operations, observers can record buoy information (e.g. buoy ID unique number, brand, echo sounder presence and type, etc.) which EM systems are not yet able to collect. It is plausible that EMS could collect these data with the changes in fishing practices (e.g., require FADs to be lifted out of the water, etc.) or, in the future, based on sensors that remotely detect and identify satellite buoys (Gilman et al., 2019; Roman et al., 2020). Similar to observers, EM systems cannot collect all information from FADs fisheries such as number of active FADs followed by purse seines or the trajectory of the FADs which are necessary to collect, report and monitor FAD fisheries as well as to verify FAD regulations. This information, however, can be collected directly from buoy providers.

Longline

In the case of longlines, 24 of the total of 54 IOTC ROS mandatory reporting data fields, are classified as *ready to be collected* with EM (44%), 2 as *ready but require little work*, 7 as *ready but require specific requirements of camera/sensor* and/or are costly/inefficient to analyze, 5 as *possible with major work*, and 16 as *not possible* to be collected. The "not possible" categories relate to key gear configuration information, such as mainline material, type of hook etc., that is used for CPUE standardization and bycatch studies. Of the 19 IOTC ROS "optional for reporting" and 34 "suggested for collection", 22 are currently *ready to be collected*, 13 *could be collected but require specific requirements of camera/sensor* and/or are costly/inefficient to analyze, 2 are *possible with major work* and 16 *not possible* to be collected. In general, it seems that EM is well suited to collect longline ROS mandatory data fields, however, for the collection of more detailed information on line material, hook type and gear configuration, e-reporting mechanisms from a pre-trip, or post-trip, onsite inspection of the vessel, interview/ discussion with owner/captain/crew are needed.

The EM ability to collect observer data on longline vessels is detailed in the tables below. The assessment for the different fields is based on the results of several pilot studies carried out in different regions (Emery et al., 2018; Hosken et al., 2016a) as well as expert knowledge (Table 4). Most of the "mandatory for reporting" data fields of the observer minimum data requirements could be collected by EM as accurately as the observers can do. For example, vessel track and speed, gear characteristics, and vessel operations such as set setting and hauling time/position information, number of hooks deployed, catch per set by species, retained and discarded catch, etc. are ready to be recorded by EM with little or no modification of the vessel or its fishing practices (category R1; Emery et al., 2018; Ruiz et al.,

2019). However, there are some information items that would require assistance from vessel crew (R2), additional cameras and/or sensors (R3), or are inefficient or timely/costly to analyze (R4), which could be limited depending on cost and financial capacity of the vessels (Emery et al., 2018).

For example, non-target species can be released before they're brought onboard, which hinders the EM equipment's ability to count and identify bycatch; hence, to collect this data a camera on the boom to view the retracting line during hauling operations is required to accurately record species discarded at the water level. Other important information, such as hook type and size, distance between weight and hook, and the length of branch and float lines cannot be recorded with current technology (Roman et al., 2020).

Similar to purse seines, other information recorded by observers, mostly non-operational data such as vessel capacity and equipment (radars, echo location equipment, refrigeration method etc.) and gear dimensions and material (mainline/branchline material etc…), which EM cannot record, could be hard-coded or recorded at the time in which the EM equipment is installed on the vessel, by the analyst when analyzing the data and/or collected from the IOTC Authorized Vessel Register. Again, other information such as details on biological sampling cannot be realistically collected by EM.

Pole and Line

In the case of pole and line, and based on a EM pilot study conducted in a pole and line vessel operating in the Gulf of Biscay (Atlantic Ocean) which has a different vessel set up than typical Indian Ocean pole and line vessel (Ruiz et al., 2020a, 2020b), 39 of the total of 54 IOTC ROS mandatory reporting data fields, are classified as *ready to be collected* with EM (72%), 2 as *ready but require little work*, 1 as *ready but require specific requirements of camera/sensor*, and 12 as *not possible* to be collected. However, some of the "not possible" categories related to key gear configuration information, such as pole material, type of hook, number of automatic poles, bait tank capacity, etc.; that could be collected through e-reporting mechanisms from a pre-trip, or post-trip, onsite inspection of the vessel, interview/ discussion with owner/captain/crew or when the EM system is being installed. Other "not possible" fields are mostly related to biological information (maturity of target species and bait biological information) cannot be collected by EMS.

Of the 33 IOTC ROS "optional for reporting" and 12 "suggested for collection", 18 (40%) are currently *ready to be collected*, 4 *could be collected but require specific requirements of camera/sensor* and/or are costly/inefficient to analyze, and 23 *not possible* to be collected. In general, it seems that EM is well suited to collect pole and line ROS mandatory data fields, however, for the collection of more detailed information on line material, hook type and other vessel characteristics, e-reporting mechanisms from a pre-trip, or post-trip, onsite inspection of the vessel, interview/ discussion with owner/captain/crew are needed.

The EM ability to collect observer data on pole and line vessels is detailed in the tables below. The assessment for the different fields is based on the results of several pilot studies carried out in different regions (Ruiz et al., 2020a, 2020b) as well as expert knowledge (Table 4). Although EM pilot study results conducted in a pole and line vessel operating in the Gulf of

Biscay could inform the data fields that can be collected by EM, as it has a different vessel set up than typical Indian Ocean pole and line vessel the EM equipment should be adapted for a pole and line vessel of the Indian Ocean. These pilots have shown that most of the "mandatory for reporting" data fields of the observer minimum data requirements could be collected by pole and line EM as accurately as the observers can do. For example, vessel track and speed, vessel operations such as set number, time/position information, number of pole and lines, bait type, catch per set by species, retained and discarded catch, etc. are ready to be recorded by EM with little or no modification of the vessel or its fishing practices (category R1; Emery et al., 2018; Ruiz et al., 2019). However, there are few data fields that would require assistance from vessel crew (R2), additional cameras and/or sensors (R3), or are inefficient or timely/costly to analyze (R4), which could be limited depending on cost and financial capacity of the vessels (Emery et al., 2018).

Similar to purse seines, other information recorded by observers, mostly non-operational data such as vessel capacity and equipment (bait tanks capacity, refrigeration method etc.) and material of the line, which EM cannot record, could be hard-coded or recorded at the time in which the EM equipment is installed on the vessel, by the analyst when analyzing the data and/or collected from the IOTC Authorized Vessel Register. Again, other information such as details on biological sampling cannot be realistically collected by EM.

EM systems are all capable to collect *vessel track* data as they are equipped with an independent Global Positioning System (GPS) which allows constant monitoring of the vessel position, trajectory and speed, at a much more detailed scale than any human observer and even Vessel Monitoring Systems can do. Moreover, EMS data (images, position, date, time) is tamper proof, which means that cannot be manipulated and therefore are well suited to be used for compliance purposes as well. As such, vessel's activity is more accurately collected than human observers as EM system is continuously monitoring vessel activity, position and speed.

The total catch by set of target species can be estimated through EMS with no significant differences in comparison with human observer. This task is easily performed through the analysis of camera footage allowing the correct observation of the number of individuals caught by each pole and line. It can be anticipated that EM in pole and line would also have difficulties to identify small yellowfin from bigeye. Moreover, pilot studies on pole and line vessels (Ruiz et al., 2020a) showed that the size composition of target species are comparable to that obtained by observers. Similarly, non-target species (other tunas, billfishes and possible ETPs) catch is also possible to estimate through EM.

Table 4. The IOTC ROS minimum standard data fields for all fisheries, and fields specific to longline and purse seine fisheries, including an assessment of EM applicability following SPC (2017) and Emery et al. (2018) categories. Some of the items such as vessel capacity and equipment, gear dimensions and configuration, which EM cannot record, should be collected before EM installation. MR: *Mandatory for Reporting* to be mandatorily collected and reported to the IOTC Secretariat; OR: *Optional for Reporting* to be reported to the IOTC Secretariat when the collection is feasible/practical. "---": *Suggested for Collection,* to be collected by national programmes, based on best practice as agreed by the IOTC, but not mandatory to be reported to the IOTC Secretariat.

GENERAL VESSEL AND TRIP INFORMATION FOR ALL VESSEL TYPES

Data field name	Data field description	Reporting	EM	Source
Observed trip number	Record trip unique identifier. This is the observed trip unique identifier. This should begin with trip's start date (YYYY-MM-DD), followed by IOTC observer number, and vessel main gear code as per IOTC classification (E.g. 2018/01/23-IOTCFRA001-PS).	**MR**	**R1**	**AG**
OBSERVER IDENTIFICATION				
Observer IOTC registration number	Record observer registration number allocated by the IOTC Secretariat to be used on all observer data submissions.	**MR**	**R1**	**AG**
Observer name	Record the name of the scientific observer(s) that collected the data on-board the fishing vessel. Note: print in full. First name First - Last name Last (do not use initials).	**---**	**Null**	
Observer nationality	Record the nationality of the scientific observer as it appears in passport (Table 9).	**---**	**Null**	
OBSERVER TRIP DETAILS				
Location of embarkation	Record the name and/or geographical coordinates of the port where the observer boarded the vessel – also include the country. If the observer embarked via a port launch within port limits, this is still recorded as a port embarkation. If the observer embarked at sea outside port limits via a vessel transfer, record "at sea" and record the position in Latitude and Longitude. Note: latitude and longitude to be recorded mentioning if collected South or North of the equator and specifying units (preferably ±(d)dd.dddd°).	**---**	**R1**	**AG**
Date / time embarkation	Record the date and time that the observer boarded the vessel. Note: specify units (preferably hh:mm and YYYY/MM/DD).	**---**	**R1**	**AG**
Location of disembarkation	Record the name and/or geographical coordinates of the port where the observer disembarked– also include the country. If the observer disembarked via a port launch within port limits then this is still recorded as a port of disembarkation. If the observer disembarked at sea outside port limits via a vessel transfer, record "at sea" and record the position in Latitude and Longitude.	**---**	**R1**	**AG**

	Note: Latitude and longitude to be recorded mentioning if collected South or North of the equator and specifying units (preferably ±(d)dd.dddd°).			
Date / time disembarkation	Record the date and time that the observer disembarked from the vessel. Note: specify units (preferably hh:mm and YYYY/MM/DD).	---	**R1**	**AG**
VESSEL IDENTIFICATION				
Name of the vessel	Record the vessel full name as recorded on vessel official documentation and crosschecked with the name recorded on the vessel itself (any discrepancies are to be reported to the IOTC Secretariat). Note: care should be taken to record the correct spelling of the vessel's name including any corresponding numbers. i.e. "Agnes 83".	**MR**	**R1**	**SETUP**
Vessel flag state (or where chartering occurs, chartering state)[4]	Record the name of country in which vessel is registered as shown on its registration documents (Table 9). Where chartering occurs, record name of the chartering country. Note: vessel flag state (or chartering state when chartering occurs) may not be the same as the nationality from which the vessel originates.	**MR**	**R1**	**SETUP**
Vessel IOTC number	Vessel IOTC number as per the IOTC Record of Authorized Vessels[5] and crosschecked with the number recorded on vessel certificates. Note: any discrepancies are to be reported to the IOTC Secretariat.	**MR**	**R1**	**SETUP**
Vessel IMO or Lloyd's number	Record vessel IMO number. This is the number allocated to the vessel when registered to the International Maritime Organization of the United Nations (e.g.: IMO8814275).	**OR**	**R1**	**SETUP**
International radio call sign (IRCS)	Record vessel radio call sign if available. This is the number displayed prominently on the vessel's side or superstructure.	---	**R1**	**SETUP**
Vessel port of registration	Record the name of vessel's port of registry (also called home port) shown on its registration documents and lettered on the stern of the ship's hull – also include the country.	**MR**	**R1**	**SETUP**
Vessel registration number	Record the number issued by country in which the vessel is registered, shown on its registration documents and written on the hull of the vessel. This may be a	---	**R1**	**SETUP**

[4] IOTC Res. 18/10

[5] http://www.iotc.org/vessels/current

	combination of characters and numbers; record them all (e.g.: CBG303).			
Vessel phone, fax and email	When available, record vessel contact details, taking note of the ocean region code. A vessel may have several contact numbers and email addresses depending on the satellite communications systems installed onboard; record them all.	---	**NULL**	
Licensed target species	Record licensed target species (FAO spp. 3-alpha code) as specified in vessel licences or permit conditions (Table 1, Table 2, Table 3, Table 4, Table 8). Vessels will generally target a narrow range or aggregation of species, however one or more might not be an IOTC species; record them all.	**OR**	**NULL**	
Main fishing gear	Record vessel main fishing gear (Table 10).	---	**R1**	**AG**
VESSEL OWNER AND PERSONNEL				
Registered owner	Record the owner's name, nationality (Table 9) and contact details in full. These can be obtained or cross-checked on the vessel registration forms.	---	**R1**	**SETUP**
Charterer / operator	Where the vessel has been chartered and is operated and managed by a company other than the owner, record operator's full name (company or individual as appropriate), nationality (Table 9) and contact details.	---	**NULL**	
Fishing Master	Record the fishing master name and nationality in full (Table 9).	---	**R1**	**POST**
Skipper	Record skipper name and nationality in full (Table 9). Note: in some instances the fishing master and skipper may be the same person. In such cases record here "N/A" for not applicable.	---	**R1**	**POST**
Crew number	Record the number of crew. This should be cross checked against the vessel's crew list.	---	**NULL**	
VESSEL TRIP DETAILS				
Port of departure	Record the name and/or geographical coordinates of the port from where the vessel sailed – also include the country. If the vessel started a new trip at sea following transhipment record 'at-sea' plus the geographical coordinates corresponding to the location the trip started. Note: latitude and longitude to be recorded mentioning if collected South or North of the equator and specifying units (preferably ±(d)dd.dddd°).	---	**R1**	**AG**
Date / time vessel sailed	Record the date and time the vessel departed from port or from a transhipment location. Note: specify units (preferably YYYY/MM/DD and hh:mm).	---	**R1**	**AG**

Port of return	Record the name and/or geographical coordinates of the port where the vessel returned – also include the country. If the vessel arrived at a transhipment location record 'at-sea' plus the geographical coordinates corresponding to the location the transhipment started. If the observer disembarked before the vessel returned then record expected port of return as provided by the vessel. Note: latitude and longitude to be recorded mentioning if collected South or North of the equator and specifying units (preferably ±(d)dd.dddd°).	---	**R1**	**AG**
Date / time vessel returned to port	Record the date and time the fishing vessel finishes its fishing campaign. i.e. returns to port or to a transhipment location for unloading. If the observer disembarks before the vessel returns then record expected date and time of arrival (ETA) as provided by the vessel. Note: specify units (preferably YYYY/MM/DD and hh:mm).	---	**R1**	**AG**
VESSEL ATTRIBUTES				
Tonnage	The vessel tonnage as specified in vessel registration papers. Note: specify units, i.e. if the vessel is registered using Gross Tonnage (GT) or Gross Registered Tonnage (GRT).	**MR**	**P1**	**PRE**
Length overall	The vessel overall length (LOA) as specified in vessel registration papers. Note: specify units (preferably metres).	**MR**	**P1**	**PRE**
Hull material	Record the vessel hull material (s) (steel, wood, aluminium, fibre glass, etc.) (Table 11).	**MR**	**P1**	**PRE**
Main engines (make and power)	The make (brand) and power of the main engines. Note: specify units (HP, Kilowatt or BHP).	**MR**	**P1**	**PRE**
Fish storage capacity	The vessel total maximum capacity to store catches. This should include blast freezer(s) capacity. Note: specify units (metric Tons (mT.) or cubic metres (m^3)).	**MR**	**P1**	**PRE**
Fish preservation methods	Fish preservation methods: Record the method(s) used by the vessel to preserve the catch (Table 12).	---	**P1**	**PRE**
Fish storage type	Record the type of structure(s) present on-board used by the vessel to store the catch (Table 13).	---	**P1**	**PRE**
Vessel autonomy / range	Record vessel autonomy, expressed by the time (days) a vessel can spend at sea without refuelling. If this information is not available then record vessel range expressed in cruising distance (nautical miles). If a figure	---	**NULL**	

	for the range cannot be obtained, the observer should calculate vessel range as follows. <Vessel range (nm)> = <Vessel average cruising distance per metric ton (nm/mT)> : <Tonnage of fuel carried (mT)> Note: specify units(days or nautical miles)			
VESSEL ELECTRONICS				
Global Positioning System (GPS)	Indicate Yes if on board No if not sighted. Note: a GPS may be an independent unit or linked or incorporated into track plotters and acoustic systems.	**MR**	**P1**	**PRE**
Vessel Monitoring Systems (VMS)	Indicate Yes if on board No if not sighted	**MR**	**P1**	**PRE**
Radars	Indicate Yes if on board No if not sighted. Note: include high frequency radars used by the vessel to search for seabird activity or activity on the sea surface.	**MR**	**P1**	**PRE**
Track Plotter	Indicate Yes if on board No if not sighted	**MR**	**P1**	**PRE**
Depth Sounder	Indicate Yes if on board No if not sighted	**MR**	**P1**	**PRE**
Sonar	Indicate Yes if on board No if not sighted	**MR**	**P1**	**PRE**
Doppler Current Meter	Indicate Yes if on board No if not sighted Note: acoustic doppler current meter is used to ascertain current speed.	**MR**	**P1**	**PRE**
Expendable bathythermographs (XBT)	Indicate Yes if on board No if not sighted. XTBs are usually mounted on the bridge wings. Note: XTBs are periodically used to determine the depth of the thermocline.	**MR**	**P1**	**PRE**
VHF radios	Indicate Yes if on board No if not sighted	**---**	**P1**	**PRE**
HF radios	Indicate Yes if on board No if not sighted	**---**	**P1**	**PRE**
Satellite communication systems	Indicate Yes if on board No if not sighted.	**---**	**P1**	**PRE**
Sea Surface Temperature (SST) gauge	Indicate Yes if on board No if not sighted. SST gauge is usually mounted on the bridge. Note: the vessel may also have access to SST charts received from Fisheries Information Services systems.	**---**	**P1**	**PRE**
Weather facsimile	Indicate Yes if on board No if not sighted. Note: weather information may also be received from Fisheries Information Services systems.	**---**	**P1**	**PRE**

Fisheries information services	Indicate Yes or No if the vessel has access to a Fisheries information service. Note: Vessels may access fishery information services for instant information on weather and oceanographic features (SST, phytoplankton densities or sea height).	---	**P1**	**PRE**
WASTE MANAGEMENT (MARPOL Agreement Annex 5)				
Waste category	Record the category of the waste produced by the vessel (Table 14).	**OR**	**NP (R3&4[6])**	
Storage/Disposal method	Record how the waste was disposed of (Table 15). For example, incinerated, stored in sacks or disposed of overboard.	**OR**	**NP (R3&4[3])**	
OBSERVED TRIP SUMMARY				
Number of fishing events/sets conducted by the vessel while the observer was on-board.	Record the total number of fishing events/sets conducted by the vessel while the observer was on-board, independently of their success and of being sampled or not by the observer. Note: this should not include pole and line bait fishing events/sets.	**MR**	**R1**	**EM-A**
Number of fishing events/sets observed	Record the total number of fishing sets/events monitored by the an observer. Note: this should not include pole and line bait fishing events/sets.	**MR**	**R1**	**EM-A**
Number of days searching	Record the total number of days that the vessel was engaged in actively searching for fish (this includes active fishing days).	**MR**	**R1**	**EM-A**
Number active fishing days	Record the total number of days that the vessel actually fished (i.e. when the vessel had gear in the water). Note: for some fishing events this may be for only a few hours of the day. Alternatively a single fishing event/set may span part of two days."	**MR**	**R1**	**EM-A**
Number of days lost	Record the total number of days where a vessel was unable to fish due to factors such as adverse weather conditions, mechanical failure or other unforeseen events.	**MR**	**R1**	**EM-A**
Reason(s) for days lost	Record the reason(s) a vessel was unable to fish: (i) adverse weather conditions, (ii) mechanical breakdown or inoperative gear or (iii) unforeseen events (specify).	**OR**	**NP**	
Number of days in the fishing area	Record the number of days the vessel spent in the fishing area while the observer was onboard. This does not	---	**R1**	**AG**

[6] Partially can be recorded with extra cameras and/or costly analisis of EM images (e.g. bait plastic boxes for LL or the material of FADs)

	include transit time even if the area being transited is within the fishing area.			
Number of days transiting	Record the number of days the vessel spent steaming or transiting to/between/from fishing areas while the observer was onboard.	**---**	**R1**	**AG**

LONGLINE INFORMATION

Gear specifications[7]

Data field name	Data field description	Reporting	EM	Source
SPECIAL EQUIPMENT OR MACHINERY				
Line setter	Indicate Yes if on board No if not sighted. Many long line vessels will be fitted with equipment or machinery that regulates line setting speed allowing the line to be set at uniform depth.	**MR**	**R3**	**AG**
Line hauler	Indicate Yes if on board No if not sighted. Most long line vessel will be fitted with equipment or machinery that hauls the line in after it has been set.	**MR**	**R3**	**AG**
Bait casting machine	Indicate Yes if on board No if not sighted. Most vessels manually deploy branch lines with the bait. However there are a number of vessels that use automatic bait casting machines.	**MR**	**R3**	**AG**
GENERAL GEAR ATTRIBUTES				
Mainline material	Record the material the mainline is made out of, e.g. kevlar, nylon, nylon multifilament (Table 16).	**MR**	**NP**	
Mainline length	Record the total length of the mainline (i.e. mainline maximum length). This information can be obtained from the Captain or Fishing Master. Note: specify units (preferably 'Kilometres')	**MR**	**P2**	
Mainline diameter	Record the diameter of the mainline. This information can be obtained from the Captain or crew and crosschecked by measuring mainline diameter with callipers. Note: specify units (preferably 'millimetres')	---	**NP**	
Branchline configuration number	Unique number for a specific branchline specification as detailed based on the fields below.	MR	**R3**	
Branchline material	Record the branchline material for each of the four sections where section 1 is that closest to the mainline and section 4 is the leader; note that wire trace may be sheathed by a plastic or nylon coating (Table 16).	---	**NP**	
Branchline length	Record the length of the branchline for each of the four sections where section 1 is that closest to the mainline and section 4 is the leader.	**MR**	**NP**	

[7] Information designed to capture detailed specifications of the different components of the longline gear used by the vessel.

	Note: specify units (preferably 'metres')			
Branchline diameter	Record the diameter of the branchline for each of the four sections where section 1 is that closest to the mainline and section 4 is the leader. Note: specify units (preferably 'millimetres')	**MR**	**NP**	
Branch line storage	Record if the branch lines are coiled up and packed into baskets (BSK), or layered out in tubs (TBS), or coiled up onto reels (RLS).	---	**R3**	
MITIGATION DEVICES				
DMDs used	Record depredation mitigation device/s DMDs used by the vessel (if any) (Table 38).	---	**P2**	
TORI LINE DETAILS	If the vessel was equipped with a tori line provide tori line details below. If no tori line was present on-board fill in NA for not applicable.		**R1**	**AG**
Tori line length	Record the total length of the tori line (not including streamers). Note: specify units (preferably metres)	**MR**	**P2**	
Streamer type	Indicate the type of streamers which are used with the tori line (e.g. paired or single)	**MR**	**P2**	
Streamer line length	Record length of individual streamer lines (minimum and maximum where lengths vary). Record only one length if they do not vary. Note: specify units (preferably metres)	**MR**	**NP**	
No. streamers per line	Record the number of streamers that are attached to a single tori line	**MR**	**NP**	
Distance between streamers	Record the distance between streamers. Note: specify units (preferably metres)	---	**NP**	
Attached height	Record the height hat the tori line is attached above the water level. Note: specify units (preferably metres)	**MR**	**P2**	
Streamers reach surface	Indicate Yes if the streamers are long enough to touch the surface of the water in calm conditions and No if they are not.	---	**P2**	
Towed objects	Record the total number and type of towed objects used to maintain tori line tension and achieve aerial extent when deployed.	---	**NP**	
Diagram	Sketch/complete a diagram containing Tori line key features (e.g. Fig. 1 of IOTC Resolution 12/06).	---	**NP**	

Fishing event[8]

Data field name	Data field description	Reporting	EM	Source
Set number	Record set number. This should be a four digit numerical code beginning 0001. Set numbers should be consecutive from the start of the first line set to the last line set of the observed trip. A unique number is to be allocated to each individual set.	**MR**	**R1**	**AG**
SETTING OPERATIONS				
Start setting date and time	Record the date and the time the first dhan buoy and / or radio buoy is deployed to start the setting of the line. Note: specify units (preferably hh:mm and YYYY/MM/DD).	**MR**	**R1**	**AG**
Start setting position	Record the position in latitude and longitude for the start of the setting operation Note: latitude and longitude to be recorded mentioning if collected South or North of the equator and specifying units (preferably ±(d)dd.dddd°).	**MR**	**R1**	**AG**
End setting date and time	Record the date and the time that the last dhan buoy and / or radio buoy is deployed. Longline vessels often set lines at the night and the setting operation may continue beyond midnight and into the following day. Note: specify units (preferably hh:mm and YYYY/MM/DD).	**MR**	**R1**	**AG**
End Setting Position	Record the position in latitude and longitude for the end of the setting operation Note: latitude and longitude to be recorded mentioning if collected South or North of the equator and specifying units (preferably ±(d)dd.dddd°).	**---**	**R1**	**AG**
Vessel speed	Record the vessel's average speed during setting (knots). Note: Collect vessel speed from the GPS several times during the operation and take the average.	**---**	**R1**	**AG**
Line setter speed	Record the speed setting of the line setter (metres/second).	**---**	**R3**	**AG**
Length of mainline set	Record mainline total set length (i.e. the total deployed length of the mainline for the specific set). Usually calculated by multiplying the total time to set the line and the average line setter speed, taking into account any interruption times. This information can be obtained from the Fishing Master and cross checked against observer calculations. Note: specify units (preferably in Kilometres).	**MR**	**P2**	

[8] Information required for every set/operation.

Branchline clip on time	Record the average time interval in seconds between the "beeps" that indicate to the crew to clip on a branch line. Note: the timing of this is usually controlled by the Fishing Master.	---	**R1**	**AG**
Buoys clip on time	Record the average time interval in seconds between the "beeps" that indicate to the crew to clip on a buoy. Note: the timing of this is usually controlled by the Fishing Master.	---	**R1**	**AG**
Total number of hooks set	Record the total number of hooks deployed for the set. Usually calculated by multiplying number of baskets by the average number of hooks between the baskets. This information can be obtained from the Fishing Master and cross checked against observer calculations. Note: total length of line set and spacing between branch lines can also be used to determine the number of hooks set.	**MR**	**R1**	**AG**
Total number of floats set	Record the total number of floats deployed during the set (this should not include the radio/dhan buoys). Usually calculated by subtracting the number of buoys in their holders before setting by the number of buoys in their holders after setting. This information can be obtained from the Fishing Master and cross checked against observer calculations.	---	**R1**	**AG**
N° of hooks set between floats	Record the number of hooks set between floats. This will correspond to the number of hooks stored in each basket/tub, or on a reel and will be equivalent to the number of branch lines set.	---	**R1**	**AG**
Distance between branchlines	Record the distance between branch lines (i.e. the interval at which they were set along the mainline) in metres. Usually calculated by multiplying 'Branch line clip on time (s)' by the 'line setter speed' (m/s).	---	**R3 & R4**	
Floatline lengths (1, 2 and 3)	Record the different lengths of the floatlines used (1, 2 and 3). Note: specify units (preferably metres).	---	**NP**	
Total radio/dhan buoys set	Record the total number of radio and /or dhan buoys deployed.	---	**R4**	
Attached lights	Record number of lights attached to the branchlines per type (Table 22) and colour (Table 23)."	---	**R4**	
Shark lines set	Indicate Y or No if shark lines were set during the operation. Note: shark lines are branch lines running directly off the longline floats or drop lines, specifically for targeting sharks.	**MR**	**R1**	**AG**

N° of shark lines set	Record the number of shark lines set during the operation. If no shark lines are set then record zero (0).	---	**R1**	**AG**
Target species	Record the target species for the set (FAO spp. 3-alpha code), (Table 1, Table 2, Table 3 and Table 4).	**MR**	**R1**	**AG**
VMS on	Indicate Y or No to sign if he VMS was on or not while setting and hauling.	**OR**	**NP**	
Mitigation measures				
Number of Tori lines deployed	The total number of tori lines deployed during the setting operation. Record zero if none were deployed.	**MR**	**R3**	**AG**
Low light night setting	Indicate Y or No for whether minimum deck lighting is used during night setting (as defined in Table 1. Mitigation measures of IOTC Res 12/06). Note: night setting is binary. i.e. if all hooks are set between dusk and dawn, then night setting was used. If some hooks are set outside of nautical darkness, then night setting was not used. [Consistent with IOTC Res 12/06]	**MR**	**R1**	**AG**
Branchline weighted	Indicate Yes or No if the branch line is weighted. [Consistent with IOTC Res 12/06]	**MR**	**NP**	
Sinker average weight	Record the average weight of weights or sinkers attached to the branchlines (weights deployed on the snood prior to setting). Note: specify units (preferably grams (g)). [Consistent with IOTC Res 12/06]	**MR**	**NP**	
% branchlines weighted	Record the proportion of branchlines weighted (%). If all weighted, record 100%.	**MR**	**NP**	
Hook-sinker distance	The distance of the weights/sinkers from the eye of the hook. Note: specify units (preferably centimetres (cm)).	**MR**	**NP**	
Underwater setting	Indicate Yes or No if the bait is protected on the branchlines until they are a certain depth below the surface.	---	**R3**	
Other mitigation measures used	Record any other mitigation measures observed (Table 38).	---	**R3**	
N° of branchlines set by type	Record the number of branchlines set by type (branchline configuration number. Branchlinline types must be in accordance to types previously defined under the “Gear specifications” section.	---	**NP**	

Hook type	Record the type of hooks used (Table 17).	**MR**	**NP**	
% hooks set by type	Record the percentage (%) of hooks set by type. [As per SC20.23 recommendations]	**MR**	**NP**	
Variations in hook type[9]	Where possible indicate any variations in hook type, hook material and presence/absence of hook ring (Table 17).	**---**	**NP**	
Bait type	Record bait type/condition used (Table 25).	**MR**	**R1**	
Bait species	Record the species of bait used (FAO spp. 3-alpha code) (Table 8).	**MR**	**R3**	
Bait ratio (%)	Record the approximate proportion of bait species and condition used across all hooks in the set (%).	**MR**	**R4**	
Bait dye colour	Record the colour or colours that the different baits are dyed (e.g. blue to avoid bird bycatch). If none, write NONE.	**---**	**R1**	
HAULING OPERATIONS				
Start hauling date and time	Record the date and the time when the first dhan buoy and / or radio buoy is hauled back on-board to start hauling the line. Note: specify units (preferably hh:mm and YYYY/MM/DD).	**MR**	**R1**	**AG**
Start hauling position	Record the position in latitude and longitude for the start of the hauling operation. Note: latitude and longitude to be recorded mentioning if collected South or North of the equator and specifying units (preferably ±(d)dd.dddd°).	**MR**	**R1**	**AG**
End hauling date and time	Record the date and the time when the when the last component of the longline gear (dhan buoy and / or radio buoy) is hauled back on-board. Note: specify units (preferably hh:mm and YYYY/MM/DD).	**---**	**R1**	**AG**
End hauling position	Record the position in latitude and longitude for the end of the hauling operation. Note: latitude and longitude to be recorded mentioning if collected South or North of the equator and specifying units (preferably ±(d)dd.dddd°).	**---**	**R1**	**AG**
Offal management	Record fate given to the offal (fish heads, guts, etc.) and bait produced during the observed set. Indicate if these are retained for **batch disposal (BD)** at a later stage and/or **disposed of ad hoc (AH)** as they accumulate.	**---**	**R3**	

[9] Hooks used in pelagic fisheries are correctly identified and characterised based on type, type variations, material and presence/absence of hook ring. Standardization of hook types and characteristics is therefore very important for data recording and analysis and for scientific studies on their effects on catch rates and post-capture survival.

Position of offal disposal	Record the position where offal and used bait was disposed. Indicate if these are disposed at port side (BB), starboard (SB) or aft (AF).	---	**NP**	
Method/s to stun fish	Record the method/s used to stun fish during hauling (Table 24).	---	**R1**	**AG**
Bird scaring device at hauler	Indicate Yes if a bird scaring device was deployed during hauling operations and No if not. Note: report on the construction and effectiveness of all devices used in the comments section and trip report.	---	**R3**	
Number of bite-offs (by branchline type)	Record for each type of branchline set up previously identified how many have had the hook bitten off. This only includes bite-offs observed while the observer was in a position to observe and record the hooks coming directly out of the water.	---	**R4**	
Number of retrieved hooks observed	Record the number of hooks observed.	**MR**	**R1**	**AG**
Sampling protocol	Indicate sampling protocol followed by the observer (Table 39).	**MR**	**R1**	**EM-A3**
CATCH DETAILS				
Set number	Unique within a specific trip	**MR**	**R1**	**AG**
Catch detail number	Unique within a specific set	**MR**	**R1**	**AG**
Species	Record the species code for each specimen observed using FAO three figure alpha codes (Table 1, Table 2, Table 3, Table 4, Table 5, Table 6 and Table 7). If species FAO code is not available, record the species scientific name. Note: Record "unknown" for species that cannot be positively identified and give it a reference number. Use the same reference number throughout the trip for that species. Retain a sample and / or take a photograph of the unidentified organism for latter identification.	**MR**	**R1**	**AG**
Fate	Specify the fate which includes whether it was retained or discarded and the reason, e.g. "Discarded – too small" (Table 41).	**MR**	**R1**	**AG**
SPECIMEN INFORMATION				
Set number	Unique within a specific trip	**MR**	**R1**	**AG**
Catch detail number	Unique within a specific set	**MR**	**R1**	**AG**

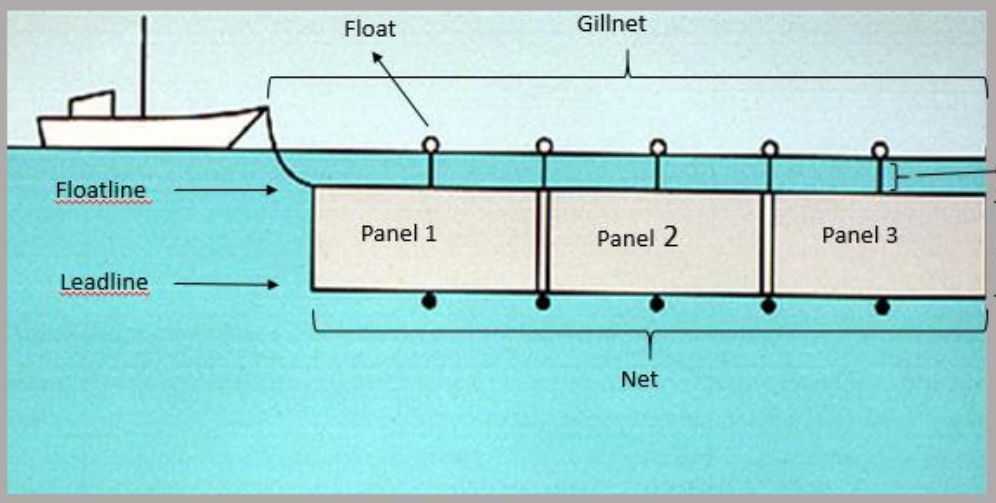
Specimen number	Unique within a specific catch detail	**MR**	**R1**	**AG**
Depredation details	[In agreement with SC18.16 (para. 53)]			
Depredation source	For depredated specimens, record the depredation source based on depredation scar characteristics (Table 45). For non-depredated specimens record NA.	**MR**	**NP**	
Predator Observed	For depredated specimens, record the predator species directly observed and identified (FAO spp. 3-alpha code). If the predator was not observed record UNK (unknown). For non-depredated specimens record NA. Note: species observed in the area may not necessarily be associated with depredation unless directly observed. Similarly for shark and squid damage the species may be difficult to determine.	**MR**	**NP**	
Additional details on non-target species	Catch details on non-target species to be collected where possible and reported to the IOTC Secretariat as recommended by the Scientific Committee.			
Condition at capture	State the condition of the specimen at capture (Table 46).	**OR**	**R3/R4**	
Condition at release	State the condition of the specimen at the time of release (Table 46).	**OR**	**R3/R4**	
Additional catch details on SSIs	Additional catch details on Species of Special Interest (Table 47) to be collected where possible and reported to the IOTC Secretariat as recommended by the Scientific Committee.			
Gear interaction	For SSI only, specify the type of interaction of the specimen with the fishing gear (Table 48).	**OR**	**R1**	**AG**
Hook type	For SSI only, record the type of hook the individual was hauled on (Table 17) [Consistent with IOTC Res 12-04]	**OR**	**NP**	
Bait type	For SSI only, record the type/condition of bait the individual was hauled on (Table 25). [Consistent with IOTC Res 12-04]	**OR**	**R1**	**AG**
Leader material	For SSI only, record the leader material the individual was hauled on (Table 16). [Consistent with IOTC Res 12-04 and IOTC Res. 17/05]	**OR**	**NP**	
Leader thickness	For SSI only, record the thickness of the leader the individual was hauled on.	**OR**	**NP**	

	Note: precise units (preferably millimetres (mm)). [Consistent with IOTC Res 12-04 and IOTC Res. 17/05]			
De-hooker/line cutter	Specify de-hooking or line cutting device used to extract the hook (Table 50). [Consistent with IOTC Res 12-04]	**OR**	**R3**	
Brought on board	Indicate Yes or No, if the specimen was brought on board. [Consistent with IOTC Resolutions 13/04; 13/05; 12/04; 12/06; 12/09]	**OR**	**R1**	**AG**
Hauling method	Detail how the specimen was brought on-board (Table 49). [Consistent with IOTC Res 12-04]	**OR**	**R1**	**AG**
Resuscitation (for turtles only)	For turtles indicate Yes if the release took place with resuscitation and No if not.	---	**R1/R3**	
Photo ID	If a photo is taken, record photo number/code so that it can be linked back to the specimen for onshore examination.	**---**	**R1**	**AG**
BIOMETRIC INFORMATION Details concerning any extra biometric measurements, sex, maturity and the collection of biological samples.				
Sampling methods for the collection of biological information	Indicate the sampling method used for the collection of biological sub-sample (Table 42).	**MR**	**NULL**	
Length code 1	Specify the length code used for the measurement (Table 53).	**MR**	**R1**	**AG**
Length 1	Record the length corresponding to the length type taken rounded to the lower centimetre.	**MR**	**R1**	**AG**
Length code 2	When an additional length measurement is taken, the corresponding length code should be recorded (Table 53).	**OR**	**R1**	**AG**
Length 2	When an additional length measurement is taken, the corresponding length should be recorded rounded to the lower centimetre.	**OR**	**R1**	**AG**
Weight code	Record the code corresponding to the type of processing the specimen underwent prior to weighing (Table 44).	**OR**	**R1**	**CF**
Weight	Record the specimen's weight (in kilograms) corresponding to the specified product type recorded in 'weight code'. If the fish has not been processed, record the unprocessed (or round, whole, live) weight (i.e. RD).	**OR**	**R1**	**CF**

Weight estimation method	Specify the weight estimation method used to obtain the weight (Table 43).	**OR**	**R1**	**EM-A**
Sex	Record the sex of the sampled fish specimen (Table 51). If unknown record UNK.	**OR**	**NP**	
Maturity stage[10]	Record the stage of maturity of the sampled fish specimen according to standard maturity scales approved by the IOTC. If unknown record UNK.	**OR**	**NP**	
Sample collected	Record the following details on the collection of samples: *a)* type (e.g. otoliths, spine clippings, and genetic samples) *b)* preservation method (e.g. alcohol, frozen, etc.) c) destination (i.e. location to be sent/stored)	**OR**	**NP**	
TAG DETAILS Note that all tagged specimens are to be identified to species level and to be sampled for length. Elasmobranches and turtles are also to be sexed and ascertained for maturity.				
Tag release	Indicate Yes or No, whether this individual was re-released with a tag attached.	**MR**	**R1**	**AG**
Tag recovery	Indicate Yes or No, whether a tag was recovered from this individual.	**MR**	**R2**	**AG**
Tag number	Provide the tag number. If a turtle, provide both tag numbers (right and left flipper).	**MR**	**NP**	
Tag type	Record the type of tag used (Table 52).	**MR**	**R2**	**AG**
Tag finder	Record the name and contact details of the person who recovered the tag.	**MR**	**NP**	

[10] Until a standard maturity stage has been approved by the Scientific Commitee, record both stage and scale used.

GILLNET INFORMATION[11]



Gillnet: A vertical panel(s) of netting suspended in the water column which may be attached to free floating buoys and/or a high flier at one end, and tied off to the vessel at the other end. Large mesh netting is stretched between a floatline at the top and a leadline at the bottom, and supported by vertical endlines, or up and down lines on each end. Panels of netting may be separated by a space or escape panel.

Net: A string of panels sewn together. The entire string may be referred to as "the net".

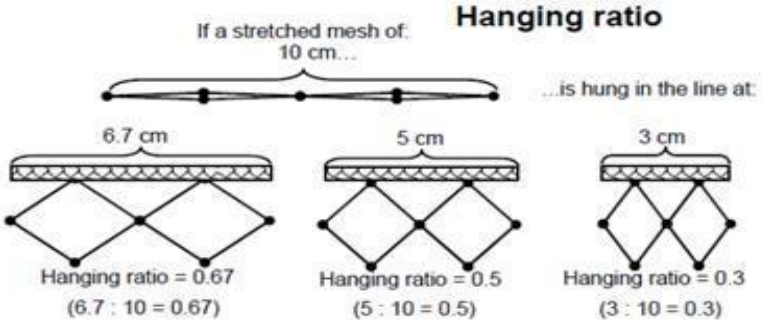
Panel: A section of continuous netting of exactly the same characteristics between two endlines (up and down lines).

Source: Scott.Fish.Inf.Pamp. Fig.30, p.40

Gear specifications

Data field name	Data field description	Rep. Req.
SPECIAL EQUIPMENT OR MACHINERY		
Net drum/hauler	Indicate Yes if on board No if not sighted. Vessels are normally equipped with a hydraulic net hauler; However they can also use net drums to both haul and store the net.	**MR**
GILLNET ATTRIBUTES Detail the specifications of each gillnet present on-board during the observed trip.		
Gillnet sequential number	Specify gillnet sequential number. Note: a unique sequential number is allocated to link each gillnet to its specifications. Any changes to individual gillnet specifications are to be considered a change of gillnet and the "new" gillnet will need to be characterised accordingly.	**MR**

[11] To be completed as soon as EM pilots from Regional Observer Project are available

Total number of panels	Record the number of panels making up the net.	**MR**
Panels stacked	Indicate Yes or No if there are any panels stacked. Note: stacked panels is defined as two or more panels of netting sewn together vertically, one on top of the other, to intentionally fish “double deep”.	**MR**
Net length	Record the net string length. Usually calculated by multiplying the panel average length by the number of panels used in the net. Note: specify units (preferably kilometres)	**MR**
Net depth	Record the vertical height of the net (depth). Usually obtained by measuring the length of the end-line, or up and down line, on the end of a net where the meshes are attached. This information may be used to cross check information provided by the crew. Note: specify units (preferably metres)	**---**
Net material	Record the material of the net webbing (Table 18).	**---**
Stretched mesh size(s)	Record the mesh average stretched lengths (knot to knot) and range. Usually calculated by measuring at least 10 meshes from 5 panels in different areas of the net. Note: specify units (preferably millimetres)	**MR**
Mesh count, vertical	Record the number of vertical meshes of a net in this gear. Usually obtained by counting the number of meshes of the end-line, or up and down line, on the end of a net where the meshes are attached. This information may be used to cross check information provided by the crew.	**---**
Hanging ratio (%)	Record the ratio between the length of the float line and the length of the stretched mesh hanging on the float line. Usually obtained by the following process: 1) counting 10 or 12 meshes horizontally, 2) multiplying the number of counted meshes by average stretched mesh length; 3) measuring the length of the floatline they are attached to, 3) dividing the length of the floatline the meshes are attached to by the length of the stretched meshes counted (see e.g. below). 	**MR**

Net web colour	The colour(s) of the net webbing (Table 19). Note: Different net colours can have an impact on cetacean and turtle bycatch as some colours are more visible than others. [Consistent with SC16.24 (para. 53)].	**MR**
Float type	Record the type of buoyancy aid that is attached to the head-rope (Table 20).	---
Float number	Record an approximate total number of floats used on this gillnet. This number must include the number of floats across a space that may occur at the bridle at the end of a net. This information may be obtained from the crew.	---
Distance between floats	Record the average distance (measured along the head-rope) between the floats used on this gillnet. Note: specify units (preferably metres).	---
Droplines used	Indicate Yes if droplines are used in this gillnet and No if not.	---
Droplines length	If droplines are used in this gillnet, record the length of the droplines. Usually obtained by measuring the distance from the floats (at the water's surface) to the float-line. This information may be used to cross check information provided by the crew. Note: specify units (preferably metres).	---
Sinker type	Record the sinker type (defined accordingly to the material they are made of) attached to the footrope (Table 21).	---
Sinker Number	Record an approximate total number of sinkers attached to footrope. If more than one type of sinker is used, record approximate total number of sinkers/weights per sinker type. This information may be obtained from the crew.	---
Sinker average weight	Record sinker average weight. If more than one type of sinker is used, record sinker average weight per sinker type. Note: specify units (preferably kilograms).	---

Fishing event

Data field name	Data field description	Rep. Req.
Set number	Record set number. This should be a four digit numerical code beginning 0001. Set numbers should be consecutive from the start of the first line set to the last line set of the observed trip. A unique number is to be allocated to each individual set.	**MR**
Gillnet sequential number	Specify gillnet used on this set by recording its sequential number. Note: a unique sequential number is allocated to link each gillnets to its specifications.	**MR**

SETTING OPERATIONS		
Start setting date and time	Record the date and the time that first panel enters the water (i.e. start of the setting of the net). Note: specify units (preferably hh:mm and YYYY/MM/DD).	**MR**
Start setting position	Record the position in latitude and longitude for the start of the setting operation. Note: latitude and longitude to be recorded mentioning if collected South or North of the equator and specifying units (preferably ±(d)dd.dddd°).	**MR**
End setting date and time	Record the date and the time the gillnet is secured to the vessel, to an anchoring device, or completely deployed (i.e. end of net setting). Gillnet vessels often set dusk and the setting operation may continue beyond midnight and into the following day. Note: specify units (preferably hh:mm and YYYY/MM/DD).	**MR**
End setting position	Record the position in latitude and longitude for the end of the setting operation Note: latitude and longitude to be recorded mentioning if collected South or North of the equator and specifying units (preferably ±(d)dd.dddd°).	**---**
Vessel speed	Record the vessel's average speed in knots during setting. Note: Collect vessel speed from the GPS several times during the operation and take the average.	**---**
Vertical set	Indicate the level the gillnet is set at vertically in the water column, i.e., if the net is set at the surface or sub-surface (Table 27).	**MR**
Setting strategy	Indicate how the gillnet was set (Table 29).	**MR**
Setting shape	Indicate the spatial configuration in which the gillnet was set (Table 28). Note: gillnets can be set in a range of configurations such as pulled straight, in a semi-circle or v-shape as well as many others.	**---**
Mitigation measures		
Mitigation measures	Indicate Yes or No if any bycatch mitigation devices were used during the set.	**MR**
Mitigation devices	Record any mitigation device(s) used during the set (Table 38).	**---**

HAULING OPERATIONS		
Start hauling date and time	Record the date and time at the start of net hauling. This is the time when the hauling equipment is put into gear or when the net starts being hauled. Vessels often haul nets in the early morning after a night soak period. Note: specify units (preferably hh:mm and YYYY/MM/DD).	**MR**
Start hauling position	Record the position in latitude and longitude for the start of the hauling operation. Note: latitude and longitude to be recorded mentioning if collected South or North of the equator and specifying units (preferably ±(d)dd.dddd°).	**MR**
End hauling date and time	Record the date and time at the end of net hauling. This is the time when the gillnet is completely retrieved and onboard the vessel. Note: specify units (preferably hh:mm and YYYY/MM/DD).	**---**
End hauling position	Record the position in latitude and longitude for the end of the hauling operation. Note: latitude and longitude to be recorded mentioning if collected South or North of the equator and specifying units (preferably ±(d)dd.dddd°).	**---**
Net condition	Indicate the condition of the net at haul-back, even if the condition was the same at setting (Table 26).	**MR**
Number of net panels retrieved	Record the total number of net panels retrieved at haul.	**MR**
Number of net panels observed	Record the total number of hauled net panels that are observed.	**MR**
Sampling protocol	Indicate sampling protocol followed by the observer to select which net panels to observe (Table 39).	**MR**
CATCH DETAILS		
Set number	Unique within a specific trip	**MR**
Catch detail number	Unique within a specific set	**MR**
Species	Record the species code for each specimen observed using FAO three figure alpha codes (Table 1, Table 2, Table 3, Table 4, Table 5, Table 6 and Table 7). If species FAO code is not available, the species scientific name. Note: Record “unknown” for species that cannot be positively identified and give it a reference number. Use the same reference number throughout the trip for that species. Retain a sample and	**MR**

	/ or take a photograph of the unidentified organism for latter identification.	
Fate	Specify the fate which includes whether it was retained or discarded and the reason, e.g. “Discarded – too small” (Table 41).	**MR**
Sampling methods for obtaining total catch estimates per species	Indicate the sampling method used to obtain total catch estimates per species (Table 40).	**MR**
Number	Record the number of individuals per species for each specified fate. If weight is recorded, insert NA here (for large fish, record number of individuals).	**MR**
Weight	Record the weight corresponding to the specified species and fate category. If number of individuals is recorded, insert NA here (for small fish, record weight). Note: specify units (preferably tons).	**MR**
Weight estimation method	Indicate the weight estimation method used to collect weight (Table 43). Note: If number of individuals is recorded, insert NA here.	**MR**
Weight code	Record the type of processing the species underwent prior to weighing (Table 44). If the species has not been processed, record the code for unprocessed (or round, whole, live) weight (i.e. RD). Note: If number of individuals is recorded, insert NA here.	**MR**
Depredation details		
Depredation source	For depredated specimens, indicate the depredation source based on depredation scar characteristics (Table 45). For non-depredated specimens record NA.	**MR**
Predator Observed	For depredated specimens, record the predator species directly observed and identified (FAO spp. 3-alpha code). If the predator was not observed record UNK (unknown). For non-depredated specimens record NA. Note: species observed in the area may not necessary be associated with depredation unless directly observed. Similarly for shark and squid damage the species may be difficult to determine.	**MR**
SPECIMEN INFORMATION		
Set number	Unique within a specific trip	**MR**

Catch detail number	Unique within a specific set	**MR**
Specimen number	Unique within a specific catch detail	**MR**
Additional details on non-target spp.	Catch details on non-target species to be collected where possible and reported to the IOTC Secretariat as recommended by the Scientific Committee.	
Condition at capture	State the condition of the specimen at capture (Table 46).	**OR**
Condition at release	State the condition of the specimen at the time of release (Table 46).	**OR**
Additional catch details on SSIs	Additional catch details on Species of Special Interest (Table 47) to be collected where possible and reported to the IOTC Secretariat as recommended by the Scientific Committee.	
Gear interaction	For SSI only, specify the interaction of the specimen with the fishing gear (Table 48).	**OR**
Brought on board	Indicate Yes or No, if the specimen was brought on board. [Consistent with IOTC Resolutions 13/04; 13/05; 12/04; 12/06; 12/09]	**OR**
Hauling method	Specify how the specimen was brought on-board (Table 49). [Consistent with IOTC Res 12-04]	**OR**
Resuscitation (for turtles only)	For turtles indicate Yes if the release took place with resuscitation and No if not.	---
Photo ID	If a photo is taken, record photo number/code so that it can be linked back to the specimen for onshore examination.	**---**
BIOMETRIC INFORMATION Details concerning any extra biometric measurements, sex, maturity and the collection of samples.		
Sampling methods for the collection of biological information	Indicate the sampling method used for the collection of biological sub-sample (Table 42).	**MR**
Length code 1	Specify the length code used for the measurement (Table 53).	**MR**
Length 1	Record the length corresponding to the length type taken rounded to the lower centimetre.	**MR**
Length code 2	When an additional length measurement is taken, the corresponding length code should be recorded (Table 53).	**OR**

Length 2	When an additional length measurement is taken, the corresponding length should be recorded rounded to the lower centimetre.	**OR**
Weight	Record the weight corresponding to the specified species and fate category. If number of individuals is recorded, insert NA here (for small fish, record weight). Note: specify units (preferably tons).	**OR**
Weight estimation method	Indicate the weight estimation method used to collect weight (Table 43). Note: If number of individuals is recorded, insert NA here.	**OR**
Weight code	Record the type of processing the species underwent prior to weighing (Table 44). If the species has not been processed, record the code for unprocessed (or round, whole, live) weight (i.e. RD). Note: If number of individuals is recorded, insert NA here.	**OR**
Sex	Record the sex of the sampled fish specimen (Table 51).	**OR**
Maturity stage[12]	Record the stage of maturity of the sampled fish specimen according to standard maturity scales approved by the IOTC. If unknown record UNK.	**OR**
Sample collected	Record the following details on the collection of samples: *d)* type (e.g. otoliths, spine clippings, and genetic samples) *e)* preservation method (e.g. alcohol, frozen, etc.) f) destination (i.e. location to be sent/stored)	**OR**
TAG DETAILS Note that all tagged specimens are to be identified to species level and to be sampled for length. Elasmobranches and turtles are also to be sexed and ascertained for maturity.		
Tag release	Indicate Yes or No, whether this individual was re-released with a tag attached.	**MR**
Tag recovery	Indicate Yes or No, whether a tag was recovered from this individual.	**MR**
Tag number	Provide the tag number. If a turtle, provide both tag numbers (right and left flipper).	**MR**
Tag type	Record the type of tag used (Table 52).	**MR**
Tag finder	Record the name and contact details of the person who recovered the tag.	**MR**

[12] Until a standard maturity stage has been approved by the Scientific Commitee, record both stage and scale used.

PURSE-SEINE INFORMATION

Gear specifications

Data field name	Data field description	Reporting	EM	Source
SPECIAL EQUIPMENT OR MACHINERY				
Power block	Indicate Yes if on board No if not sighted.	**MR**	**R1**	**AG**
Purse winch	Indicate Yes if on board No if not sighted.	**MR**	**R1**	**AG**
GENERAL GEAR ATTRIBUTES				
Maximum length of the net	Record the maximum length of the net according to the net specifications. This corresponds to the length of the topline. Note: specify units (preferably metres)	**MR**	**P1**	**POST**
Maximum depth of the net	Record the maximum fishing depth according to the net specifications. Note: specify units (preferably metres)	**MR**	**P1**	**POST**
Bag stretched mesh size	Record the mesh average stretched lengths (knot to knot) of the bag of the net. Usually calculated by measuring 3 stretched mesh lengths and calculating the average. Note: specify units (preferably centimetres)	**MR**	**P1**	**POST**
Mid-net stretched mesh size	Record the mesh average stretched lengths (knot to knot) of the mid-net. Usually calculated by measuring 3 stretched mesh lengths and calculating the average. Note: specify units (preferably centimetres)	**MR**	**P1**	**POST**
Maximum Brail Capacity	Record the maximum weight capacity of a full brail in metric tonnes (Mt).	**MR**	**R1**	**SETUP/ PRE**
Skiff Power	Record the skiff engine power. Note: specify units (HP, KW).	**---**	**P1**	**POST**

Fishing event

Data field name	Data field description	Reporting	EM	Source
Set number	Record set number. This should be a four digit numerical code beginning 0001. Set numbers should be consecutive from the start of the first line set to the last line set of the observed trip. A unique number is to be allocated to each individual set.	**MR**	**R1**	**AG**
OPERATIONS				

Set type[13]	Free school set, FAD set, etc. (table 34)	**MR**	**R1**	**AG**
Start setting date and time	Record the date and time the skiff is launched to start the setting operation. Note: specify units (preferably hh:mm and YYYY/MM/DD).	**MR**	**R1**	**AG**
Start setting position	Record the position in latitude and longitude for the start of the setting operation. Note: latitude and longitude to be recorded mentioning if collected South or North of the equator and specifying units (preferably ±(d)dd.dddd°).	**MR**	**R1**	**AG**
Beaufort	Record the force of the wind according to the Beaufort scale (Table 37).	---	**R1**	**AG**
School sighting cue and school type	Report up to the first three cues which lead the vessel to detect the presence of the tuna school and specify the type of tuna school detected (Table 35).	**MR**	**NP/R4**[14]	**EM-A**
First detection method	Record how the vessel first detects the tuna school, floating object or birds (Table 30). If more than one method is used record only what first made the vessel change course.	**---**	**NP**	
School size	Provide an estimation of the size of the tuna school being targeted (in tonnes). This information can be requested from the bridge officers.	**---**	**NP**	
Time net pursed	Record the time (hh:mm) when the net is fully pursed. All rings are up.	**MR**	**R1**	**AG**
Time start brailing	Record the time that brailing starts (hh:mm).	**---**	**R1**	**AG**
Time end brailing	Record the time that brailing ends (hh:mm).	**---**	**R1**	**AG**
Time skiff onboard	Record the time when the skiff comes on board and the set is over (hh:mm).	**---**	**R1**	**AG**
Maximum closing net depth (m)	Record the real, measured, closed net depth (m). To be recorded only if depth gauge is used. Use information from middle gauge if more than one gauge is present.	**---**	**NP**	
Object Details	For sets conducted on FADs (natural or artificial), the following detailed information should be collected where possible and reported to the IOTC Secretariat.			

[13] This is included in the ROS Minimum Data Requirements collectively with "school sighting cue" (see below) data field name but it would be better to identify the school type separatedly from the "school sighting cue".

[14] Could be inferred from post-hoc analysis of speed, direction, and ancilliary information from EM System collected data.

Buoy ID	For every activity involving artificial or a natural FADs equipped with a buoy report BUOY ID (i.e. Buoy marking or any information allowing identifying the owner). [Consistent with IOTC Res 18/08]	**OR**	**NP/P2**	
Buoy equipped with artificial lights	Report if devices equipped with artificial lights are deployed and/or recovered. [Consistent with IOTC Res 16/07]	**OR**	**R3/R4**	
Artificial FAD design	Characterize artificial FAD design using codes provided to describe raft (floating part) and tail (underwater hanging structure) materials (Table 36). [Consistent with IOTC Res. 12/04 and Res 18/08]	**OR**	**R1/R2**	**AG**
Cetaceans and whale sharks sightings during setting	Details on cetaceans and whale sharks sightings during purse-seine setting are to be collected where possible and reported to the IOTC Secretariat. [Consistent with IOTC Res 13/04 and 13/05]			
Sighting occurred before setting	Indicate YES if the sighting occurred before setting or NO if it occurred after.	**OR**	**NP**	
Species	The species code for the sighted specimen/s (FAO spp. 3-alpha code). If species FAO code is not available, the species scientific name.	**OR**	**NP**	
N° sighted	The number of individuals sighted per species.	**OR**	**NP**	
Caught inside the net	Indicate YES or NO whether sighted specimen/s was/were caught inside the net once the purse line was closed.	**OR**	**R1**	**AG**
Support vessel details	Details on support vessel/s present/participating to the observed fishing set.			
Support vessel presence	Record if a supply vessel is present during the observed set.	---	**NP**	
Support vessel name	Record the name of the support vessel present during the observed set.	---	**NP**	
Support vessel participation	Support vessel participation: Record if the Supply Vessel takes part in the setting operation (YES/NO). If YES, describe it (e.g. acting as floating objet, etc.).	---	**NP**	
Details on the current	Details on sea current that might influence set performance.			
Current direction	Record current direction using cardinal points (E, W, SW, SSW, etc.). This information is to be requested from bridge officers.	---	**NP**	

Current speed	Record current speed in knots. This information is to be requested from bridge officers.	---	**NP**	
Current depth	Record current depth in metres. This information is to be requested from bridge officers.	---	**NP**	
CATCH DETAILS				
Set number	Unique within a specific set	**MR**	**R1**	**AG**
Catch detail number	Unique within a specific catch detail	**MR**	**R1**	**AG**
Species	Record the species code for each specimen observed using FAO three figure alpha codes (Table 1, Table 2, Table 3, Table 4, Table 5, Table 6 and Table 7). If species FAO code is not available, the species scientific name. Note: Record "unknown" for species that cannot be positively identified and give it a reference number. Use the same reference number throughout the trip for that species. Retain a sample and / or take a photograph of the unidentified organism for latter identification.	**MR**	**R1/R3**[15]	**AG**
Fate	Specify the species fate which includes whether it was retained or discarded and the reason, e.g. "Discarded – too small" (Table 41).	**MR**	**R1**	**AG**
Sampling methods for obtaining total catch estimates per species	Indicate the sampling method used to obtain total catch estimates per species for the catch detail (Table 40).	**MR**	**R1**	**EM-A**
Number	Record the number of individuals per species for each specified fate. If weight is recorded, insert NA here (for large fish, record number of individuals).	**MR**	**R1**	**AG**
Weight	Record the weight corresponding to the specified species and fate category. If number of individuals is recorded, insert NA here (for small fish, record weight). Note: specify units (preferably tons).	**MR**	**R1**	**AG**
Weight estimation method	Indicate the weight estimation method used to collect weight (Table 43). Note: If number of individuals is recorded, insert NA here.	**MR**	**R1**	**EM-A**
Weight code	The code corresponding to the type of processing the specimen underwent prior to weighing (Table 44). If the	**MR**	**R1**	**EM-A**

[15] R1 for all species but an R3-additional camera may be needed in the conveyor belt to record all species caught in a set.

	fish has not been processed, record code for unprocessed (or round, whole, live) weight (i.e. RD). Note: If number of individuals is recorded, insert NA here.			
Additional details on non-target spp.	Catch details on non-target species to be collected where possible and reported to the IOTC Secretariat as recommended by the Scientific Committee.			
Condition at capture	State the condition of the specimens at capture (Table 46).	**OR**	**R1**	**AG**
Condition at release	State the condition of the specimens at the time of release (Table 46).	**OR**	**R1**	**AG**
SPECIMEN INFORMATION				
Set number	Unique within a specific trip	**MR**	**R1**	**AG**
Catch detail number	Unique within a specific set	**MR**	**R1**	**AG**
Specimen number	Unique within a specific catch detail	**MR**	**R1**	**AG**
Additional details on non-target spp.	Catch details on non-target species to be collected where possible and reported to the IOTC Secretariat as recommended by the Scientific Committee.			
Condition at capture	State the condition of the specimen at capture (Table 46).	**OR**	**R1**	**AG**
Condition at release	State the condition of the specimen at the time of release (Table 46).	**OR**	**R1**	**AG**
Additional catch details on SSIs	Additional catch details on Species of Special Interest (Table 47) to be collected where possible and reported to the IOTC Secretariat as recommended by the Scientific Committee.			
Gear interaction	For SSI only, specify the interaction of the specimen with the fishing gear (Table 48).	**OR**	**R1**	**AG**
Brought on board	Indicate Yes or No, if the specimen was brought on board. [Consistent with IOTC Resolutions 13/04; 13/05; 12/04; 12/06; 12/09]	**OR**	**R1**	**AG**
Hauling method	Specify how the specimen was brought on-board (Table 49). [Consistent with IOTC Res 12-04]	**OR**	**R1**	**AG**
Resuscitation (for turtles only)	For turtles indicate Yes if the release took place with resuscitation and No if not.	---	**R1**	**AG**

Photo ID	If a photo is taken, record photo number/code so that it can be linked back to the specimen for onshore examination.	---	**R1**	**AG**
BIOMETRIC INFORMATION Details concerning any extra biometric measurements, sex, maturity and the collection of samples.				
Sampling methods for the collection of biological information	Indicate the sampling method used for the collection of biological sub-sample (Table 42).	**MR**	**NP**	
Length code 1	Specify the length code used for the measurement (Table 53).	**MR**	**R3/R4**	
Length 1	Record the length corresponding to the length type taken rounded to the lower centimetre.	**MR**	**R3/R4**	
Length code 2	When an additional length measurement is taken, the corresponding length code should be recorded (Table 53).	**OR**	**R3/R4**	
Length 2	When an additional length measurement is taken, the corresponding length should be recorded rounded to the lower centimetre.	**OR**	**R3/R4**	
Weight code	Record the code corresponding to the type of processing the specimen underwent prior to weighing (Table 44).	**OR**	**R3/R4**	
Weight	Record the specimen's weight (in kilograms) corresponding to the specified product type recorded in 'weight code'. If the fish has not been processed, record the unprocessed (or round, whole, live) weight (i.e. RD).	**OR**	**R3/R4**	
Weight estimation method	Specify the weight estimation method used to obtain the weight (Table 43).	**OR**	**R1**	**EM-A**
Sex	Record the sex of the sampled fish specimen (Table 51).	**OR**	**NP/R3**[16]	
Maturity stage	Record the stage of maturity of the sampled fish specimen according to standard maturity scales approved by the IOTC. If unknown record UNK.	**OR**	**NP**	
Sample collected	Record the following details on the collection of samples: *g)* type (e.g. otoliths, spine clippings, and genetic samples) *h)* preservation method (e.g. alcohol, frozen, etc.) i) destination (i.e. location to be sent/stored)	**OR**	**NP**	

[16] NP for target tuna species and other fish bycatch but it could be ready (R2) for some bycatch species such as sharks

TAG DETAILS Note that all tagged specimens are to be identified to species level and to be sampled for length. Elasmobranches and turtles are also to be sexed and ascertained for maturity.				
Tag release	Indicate Yes or No, whether this individual was re-released with a tag attached.	**MR**	**R2**	**AG**
Tag recovery	Indicate Yes or No, whether a tag was recovered from this individual.	**MR**	**R2**	**AG**
Tag number	Provide the tag number. If a turtle make sure to provide both tag numbers (right and left flipper).	**MR**	**NP**	
Tag type	Record the type of tag used (Table 52).	**MR**	**R2**	**AG**
Tag finder	Record the name and contact details of the person who recovered the tag.	**MR**	**NP**	
Well	The well number from which the tagged fish has been recovered, if the fish is recovered during shifting, transhipping or unloading. (Note: this information will allow tracing back tagged fish to the location where it was caught).	**MR**	**NP**	

Purse-seine vessel daily activity information

The following information is to be collected on a daily basis for every fishing set and at every 2 hours (from sunrise to sunset) to allow to reconstruct vessel route and for every fishing set.

Data field name	Data field description	Reporting	EM	Source
Date	Record the date. Note: specify units (preferably YYYY/MM/DD).	---	R1	AG
Time	Record time at the start of every fishing activity and every two hours from sunrise to sunset. Note: specify units (preferably hh:mm).	---	R1	AG
Position	Record vessel position at the start of every fishing activity and every two hours from sunrise to sunset. Note: latitude and longitude to be recorded mentioning if collected South or North of the equator and specifying units (preferably ±(d)dd.dddd°).	---	R1	AG
Activity	Record vessel activity at the start of every fishing activity and every two hours from sunrise to sunset (Table 33).	---	R1/NP[17]	AG
Comments	Record short commentaries on exceptional events that could not be described by the previous data fields.	---	NP	

[17] Not all activites from Table 33 could be recorded by EM

Purse-seine FAD activities

The following information is not included in the ROS Minimum Data Requirements but are requested under FAD related IOTC Data Requirements (Resolution 15/02, 19/01 and 19/02). ROS Minimum Data Requirements could also be updated to request observer to collect these data, whenever possible.

Data field name	Data field description	Reporting	EM	Source
Set number	As above	MR	R1	AG
Type	Type of floating object (flotsam, natural object, FAD)	---	R1	AG
Floating structure: dimensions	Length, width and height of the floating structure		R1	AG
Submerged structure: shape			R2	AG
Submerged structure: depth			R2	AG
Components when encountered	Components of floating and submerged structures when encountered		R2	AG
Components when left	Components of floating and submerged structures when left		R2	AG
Object encounter	Date, time, position		R1	AG
FAD activity: deployment	Date, time, position		R1	AG
FAD activity: visit	Date, time, position		R1	AG
FAD activity: hauling	Date, time, position		R1	AG
FAD activity: retrieving/removed	Date, time, position		R1	AG
FAD ID	If FAD is marked		NP	
Buoy ID	Serial number of satellite buoy		NP	
Origin	Origin of object (e.g. FAD ownership)		P2	
Operational buoys followed by vessel			NP	
Operational buoy lost by vessel			NP	

POLE AND LINE INFORMATION[18]

Gear specifications

Data field name	Data field description	Reporting	EM	Source
SPECIAL EQUIPMENT OR MACHINERY				
Live bait tanks capacity	Record the total volume of the tanks used to keep the live bait, in cubic metres (m3).	**MR**	**NP**	**SETUP/ PRE**
Number of automatic poles	Record the total number of automatic poles that are fixed on a vessel.	**MR**	**NP**	**SETUP/ PRE**
GENERAL GEAR ATTRIBUTES				
Number of anglers	Record the maximum number of anglers observed during the trip.	**MR**	**R1**	***EM-A***
Pole material	Specify the material the pole is made of: bamboo, fibre glass or carbon. If made of another material, describe it.	**MR**	**NP**	**SETUP/ PRE**
Hook type	Indicate the type of hooks used for the observed trip (Table 17).	**MR**	**NP**	**SETUP/ PRE**
Type of lures used	Record Yes if the vessel uses lures or jiggers during the observed trip and No if it doesn't. If Yes, record lures or jiggers type, make (brand) and hook type (Table 17).	**---**	**NP**	**SETUP/ PRE**

Fishing event

Tuna fishing event

Data field name	Data field description	Reporting	EM	Source
Event number	Record event number. This should be a four digit numerical code beginning 0001. Event numbers should be consecutive from the start to the end of the observed trip. Note: Each time the vessel activates its sprayers, starts chumming and/or actively catching fish, the observer should record this as event even if no fish is caught.	**MR**	**R1**	***EM-A***
TUNA FISHING OPERATIONS				
Event date and time	Record the data and time that the first line enters the water. Note: specify units (preferably hh:mm and YYYY/MM/DD).	**MR**	**R1**	***AG-A***
Event start position	Record the position in latitude and longitude at the start of the fishing event. Note: latitude and longitude to be recorded mentioning if collected South or North of the equator and specifying units (preferably ±(d)dd.dddd°).	**MR**	**R1**	***AG-A***

[18] To be completed as soon as EM pilots from Regional Observer Project are available

Beaufort	Record the force of the wind according to the Beaufort scale (Table 37).	---	**NULL**	
Event end time	The time when the last line comes out of the water. Note: If the vessel stops fishing for a period of at least 10 minutes then it should be considered that the fishing event ended, even if fishing is to restart shortly after wards on the same school.	**MR**	**R1**	***AG-A***
School sighting cue and school type	Record up to the first three cues which leads the vessel to detect the presence of a tuna school and the type of school detected (Table 30).	**MR**	**NP**	
Target Species	Record the species in the school being targeted using FAO three figure alpha codes (Table 1).	**---**	**R1**	***EM-A***
Maximum lines fishing at the same time	Record maximum number of lines fishing at the same time. These should include lines deployed from manual and automatic poles. Specify if other lines are deployed and include them in the total count. Note: This should be one count taken when the fishing activity is well established (not right at the beginning or right at the end).	**MR**	**R1**	***EM-A***
Bait used	Indicate Yes or No regarding whether any bait was used during the fishing event.	**MR**	**R1**	***EM-A***
Bait type	Specify the bait type/condition used during the fishing event (Table 25).	**MR**	**R3**	***PRE/EM-A***
Bait species	Record the species of bait used during the fishing event using FAO three figure alpha codes (Table 8).	**MR**	**NP**	
Number of hooks lost	Record the total number of hooks lost during the poling operation.	**MR**	**NP**	
Weight of bait used	Record the estimated quantity of bait used in the poling operation (in kg). If no bait was used record zero (0). Note: Request this information from the fishers in charge of live bait.	**---**	**NP**	
Object ID	For every activity involving artificial FAD (DFAD/AFAD) report FAD identifier (i.e. FAD marking or beacon ID or any information allowing identifying the owner).	**OR**	**NP**	
Buoys equipped with artificial lights	For every activity involving FADs (natural and/or artificial) report if device is equipped with artificial lights.	**OR**	**NP**	
Sampling protocol	Indicate sampling protocol followed by the observer to select which lines to observe (Table 39).	**MR**	**R1**	
CATCH DETAILS				

Event number	Unique within a specific observed trip	**MR**	**R1**	***AG-A***
Catch detail number	Unique within a specific event	**MR**	**R1**	***AG-A***
Species	Record the species code for each specimen observed using FAO three figure alpha codes (Table 1, Table 2, Table 3, Table 4, Table 5, Table 6 and Table 7). If species FAO code is not available, the species scientific name. Note: Record "unknown" for species that cannot be positively identified and give it a reference number. Use the same reference number throughout the trip for that species. Retain a sample and / or take a photograph of the unidentified organism for latter identification.	**MR**	**R1**	***EM-A***
Fate	Specify the fate which includes whether it was retained or discarded and the reason, e.g. "Discarded – too small" (Table 41).	**MR**	**R1**	***EM-A***
Sampling methods for obtaining total catch estimates per species	Indicate the sampling method used to obtain total catch estimates per species for the observed set (Table 40).	**MR**	**R1**	
Number	Record the number of individuals per species for each specified fate. If weight is recorded, insert NA here (for large fish, record number of individuals).	**MR**	**R1**	***EM-A***
Weight	Record the weight corresponding to the specified species and fate category. If number of individuals is recorded, insert NA here (for small fish, record weight). Note: specify units (preferably tons).	**MR**	**R1**	**CF**
Weight estimation method	Indicate the method used to estimate weight (Table 43). Note: If number of individuals is recorded, insert NA here.	**MR**	**R1**	**EM-A**
Weight code	The code corresponding to the type of processing the specimen underwent prior to weighing (Table 44). If the fish has not been processed, record code for unprocessed (or round, whole, live) weight (i.e. RD). Note: If number of individuals is recorded, insert NA here.	**MR**	**R1**	**EM-A**
Depredation details	[In agreement with SC18.16 (para. 53)]			
Depredation source	For depredated specimens, indicate the depredation source based on depredation scar characteristics (Table 45). For non-depredated specimens record NA.	**MR**	**NP**	

Predator Observed	For depredated specimens, record the predator species directly observed and identified (FAO spp. 3-alpha code). If the predator was not observed record UNK (unknown). For non-depredated specimens record NA. Note: species observed in the area may not necessary be associated with depredation unless directly observed. Similarly for shark and squid damage the species may be difficult to determine.	**MR**	**NP**	
SPECIMEN INFORMATION				
Additional details on non-target spp.	Catch details on non-target species to be collected where possible and reported to the IOTC Secretariat as recommended by the Scientific Committee.			
Condition at capture	State the condition of the specimen at capture (Table 46).	**OR**	**R1**	***EM-A***
Condition at release	State the condition of the specimen at the time of release (Table 46).	**OR**	**R1**	***EM-A***
Additional catch details on SSIs	Additional catch details on Species of Special Interest (Table 47) to be collected where possible and reported to the IOTC Secretariat as recommended by the Scientific Committee.			
Gear interaction	For SSI only, specify the interaction of the specimen with the fishing gear (Table 48).	**OR**	**R1**	***EM-A***
Brought on board	Indicate Yes or No, if the specimen was brought on board. [Consistent with IOTC Resolutions 13/04; 13/05; 12/04; 12/06; 12/09]	**OR**	**R1**	***EM-A***
Hauling method	Specify how the specimen was brought on-board (Table 49). [Consistent with IOTC Res 12-04]	**OR**	**R1**	***EM-A***
Resuscitation (for turtles only)	For turtles indicate Yes if the release took place with resuscitation and No if not.	---	**NULL**	
Photo ID	If a photo is taken, record photo number/code so that it can be linked back to the specimen for onshore examination.	**---**	**NP**	
BIOMETRIC INFORMATION Details concerning possible extra biometric measurements, sex, maturity and the collection of samples.				
Sampling methods for the collection of biological information	Indicate the sampling method used for the collection of biological sub-sample (Table 42).	**MR**	**R1**	***EM-A***
Length code 1	Specify the length code used for the measurement (Table 53).	**MR**	**R1**	***EM-A***
Length 1	Record the length corresponding to the length type taken rounded to the lower centimetre.	**MR**	**R1**	***AG-A***

Length code 2	When an additional length measurement is taken, the corresponding length code should be recorded (Table 53).	**OR**	**R1**	
Length 2	When an additional length measurement is taken, the corresponding length should be recorded rounded to the lower centimetre.	**OR**	**R1**	***AG-A***
Weight code	Record the code corresponding to the type of processing the specimen underwent prior to weighing (Table 44).	**OR**	**R1**	
Weight	Record the specimen's weight (in kilograms) corresponding to the specified product type recorded in 'weight code'. If the fish has not been processed, record the unprocessed (or round, whole, live) weight (i.e. RD).	**OR**	**R1**	***CF***
Weight estimation method	Specify the weight estimation method used to obtain the weight (Table 43).	**OR**	**R1**	***EM-A***
Sex	Record the sex of the sampled fish specimen (Table 51).	**OR**	**NP**	
Maturity stage[19]	Record the stage of maturity of the sampled fish specimen according to standard maturity scales approved by the IOTC. If unknown record UNK.	**OR**	**NP**	
Sample collected	Record the following details on the collection of samples: *j)* type (e.g. otoliths, spine clippings, and genetic samples) *k)* preservation method (e.g. alcohol, frozen, etc.) l) destination (i.e. location to be sent/stored)	**OR**	**NP**	
TAG DETAILS Note that all tagged specimens are to be identified to species level and to be sampled for length. Elasmobranches and turtles are also to be sexed and ascertained for maturity.				
Tag release	Indicate Yes or No, whether this individual was re-released with a tag attached.	**MR**	**R1**	**AG**
Tag recovery	Indicate Yes or No, whether a tag was recovered from this individual.	**MR**	**R2**	**AG**
Tag number	Provide the tag number. If a turtle make sure to provide both tag numbers (right and left flipper).	**MR**	**NP**	
Tag type	Record the type of tag used (Table 52).	**MR**	**R2**	**AG**
Tag finder	Record the name and contact details of the person who recovered the tag.	**MR**	**NP**	

[19] Until a standard maturity stage has been approved by the Scientific Commitee, record both stage and scale used.

Bait fishing event

Data field name	Data field description	Reporting	EM	Source
Event number	Record event number. This should be a four digit numerical code beginning 0001. Event numbers should be consecutive from the start to the end of the observed trip.	**MR**	**R1**	***EM-A-AG***
Event start date and time	Record the data and time when chumming for bait starts. Note: specify units (preferably hh:mm and YYYY/MM/DD).	**MR**	**R1**	***EM-A-AG***
Event start position	Record the position in latitude and longitude at the start of the fishing event. Note: latitude and longitude to be recorded mentioning if collected South or North of the equator and specifying units (preferably ±(d)dd.dddd°).	**MR**	**R1**	***EM-A-AG***
Event end date and time	Record the data and time at the end of the bait fishing event, when the last brail is scooped from the net. Note: specify units (preferably hh:mm and YYYY/MM/DD).	**---**	**R1**	***EM-A-AG***
Event depth	Record the depth of the place where the net is being deployed. Note: specify units (preferably metres).	**MR**	**NP**	
Distance from the coast	Record the distance from the coast to which the bait fishing is being carried out. Note: specify units (preferably nautical miles).	**---**	**R1**	***CF***
Beaufort	Record the force of the wind according to the Beaufort scale (Table 37).	**---**	**NP**	
School sighting cue and school type	Record up to the first three cues which leads the vessel to detect the presence of a tuna school and type of school detected (Table 30).	**MR**	**R1**	***EM-A***
Detection method	Select the detection method/s used to detect bait fish school (Table 31).	**---**	**R1**	***PRE***
Fishing method	Indicate the fishing method during the specific bait fishing event (Table 32).	**---**	**R1**	***EM-A***
N° of fishers	Number of fishers that participate to the bait fishing event.	**---**	**R1**	***EM-A***
Object ID	For every activity involving artificial FAD (DFAD/AFAD) report FAD identifier (i.e. FAD marking or beacon ID or any information allowing identifying the owner).	**OR**	**NP**	
Buoys equipped with artificial lights	For every activity involving FADs (natural and/or artificial) report if device is equipped with artificial lights.	**OR**	**NP**	

Sampling protocol	Indicate sampling protocol followed by the observer to select which lines to observe (Table 39).	**MR**	**NULL**	
CATCH DETAILS				
Event number	Unique within a specified trip	**MR**	**R1**	***EM-A-AG***
Catch detail number	Unique within a specified event	**MR**	**R1**	***EM-A-AG***
Species	Record the species code for each specimen observed using FAO three figure alpha codes (Table 1, Table 2, Table 3, Table 4, Table 5, Table 6, Table 7 and Table 8). If species FAO code is not available, the species scientific name. Note: Record "unknown" for species that cannot be positively identified and give it a reference number. Use the same reference number throughout the trip for that species. Retain a sample and / or take a photograph of the unidentified organism for latter identification.	**MR**	**R1**	***EM-A***
Fate	Specify the species fate which includes whether it was retained or discarded and the reason, e.g. "Discarded – too small" (Table 41).	**MR**	***R1***	***EM-A***
Sampling methods for obtaining total catch estimates per species	Indicate the sampling method used to obtain total catch estimates per species for the observed set (Table 40).	**MR**	***R1***	***EM-A***
Number	Record the number of individuals per species for each specified fate. If weight is recorded, insert NA here (for large individuals, record numbers).	**MR**	**NULL**	
Weight	Record the weight corresponding to the specified species and fate category. If number of individuals is recorded, insert NA here (for small fish, record weight). Note: specify units.	**MR**	***R1***	***EM-A***
Weight estimation method	Indicate the method used to estimate weight (Table 43). Note: If number of individuals is recorded, insert NA here.	**MR**	**R1**	***EM-A***
SPECIMEN INFORMATION				
Event number	Unique within a specified trip	**MR**	***R1***	***EM-A-AG***
Catch detail number	Unique within a specified event	**MR**	***R1***	***EM-A-AG***

Specimen number	Unique within a specified catch detail	**MR**	***R1***	***EM-A-AG***
Additional details on non-target spp.	Catch details on non-target species to be collected where possible and reported to the IOTC Secretariat as recommended by the Scientific Committee.			
Condition at capture	State the condition of the specimen at capture (Table 46).	**OR**	**R1**	***EM-A-AG***
Condition at release	State the condition of the specimen at the time of release (Table 46).	**OR**	**R1**	***EM-A-AG***
Additional catch details on SSIs	Additional catch details on Species of Special Interest (Table 47) to be collected where possible and reported to the IOTC Secretariat as recommended by the Scientific Committee.			
Gear interaction	For SSI only, specify the interaction of the specimen with the fishing gear (Table 48).	**OR**	**R3**	***EM-A***
Brought on board	Indicate Yes or No, if the specimen was brought on board. [Consistent with IOTC Resolutions 13/04; 13/05; 12/04; 12/06; 12/09]	**OR**	**R3**	***EM-A***
Hauling method	Specify how the specimen was brought on-board (Table 49). [Consistent with IOTC Res 12-04]	**OR**	**R3**	***EM-A***
Resuscitation (for turtles only)	For turtles indicate Yes if the release took place with resuscitation and No if not.	---	**NULL**	
Photo ID	If a photo is taken, record photo number/code so that it can be linked back to the specimen for onshore examination.	**---**	**NP**	
BIOMETRIC INFORMATION Details concerning any extra biometric measurements, sex, maturity and the collection of samples.				
Sampling methods for the collection of biological information	Indicate the sampling method used for the collection of biological sub-sample (Table 42).	**OR**	**NP**	
Length code 1	Specify the length code used for the measurement (Table 53).	**OR**	**NP**	
Length 1	Record the length corresponding to the length type taken rounded to the lower centimetre.	**OR**	**NP**	
Length code 2	When an additional length measurement is taken, the corresponding length code should be recorded (Table 53).	**OR**	**NP**	
Length 2	When an additional length measurement is taken, the corresponding length should be recorded rounded to the lower centimetre.	**OR**	**NP**	
Weight code	Record the code corresponding to the type of processing the specimen underwent prior to weighing (Table 44).	**OR**	**NP**	

Weight	Record the specimen's weight (in kilograms) corresponding to the specified product type recorded in 'weight code'. If the fish has not been processed, record the unprocessed (or round, whole, live) weight (i.e. RD).	**OR**	**NP**	
Weight estimation method	Specify the weight estimation method used to obtain the weight (Table 43).	**OR**	**NP**	
Sex	Record the sex of the sampled fish specimen (Table 51).	**OR**	**NP**	
Maturity stage	Record the stage of maturity of the sampled fish specimen according to standard maturity scales approved by the IOTC. If unknown record UNK.	**OR**	**NP**	
Sample collected	Record the following details on the collection of samples: *m)* type (e.g. otoliths, spine clippings, and genetic samples) *n)* preservation method (e.g. alcohol, frozen, etc.) o) destination (i.e. location to be sent/stored)	**OR**	**NP**	
TAG DETAILS Note that all tagged specimens are to be identified to species level and to be sampled for length. Elasmobranches and turtles are also to be sexed.				
Tag release	Indicate Yes or No, whether this individual was re-released with a tag attached.	**OR**	**NULL**	
Tag recovery	Indicate Yes or No, whether a tag was recovered from this individual.	**OR**	**NULL**	
Tag number	Provide the tag number. If a turtle make sure to provide both tag numbers (right and left flipper).	**OR**	**NULL**	
Tag type	Record the type of tag used (Table 52).	**OR**	**NULL**	
Tag finder	Record the name and contact details of the person who recovered the tag.	**OR**	**NULL**	

Pole and line vessel daily activity information

The following information is to be collected on a daily basis for every fishing event and every 2 hours (from sunrise to sunset)

Data field name	Data field description	Reporting	EM	Source
Date	Record the date. Note: specify units (preferably YYYY/MM/DD).	**MR**	**R1**	**AG**
Time	Record the time every two hours (from sunrise to sunset) and at the start of every fishing activity. Note: specify units (preferably hh:mm).	**MR**	**R1**	**AG**
Position	Record vessel position every two hours (from sunrise to sunset) and at the start of every fishing activity. Note: latitude and longitude to be recorded mentioning if collected South or North of the equator and specifying units (preferably ±(d)dd.dddd°).	**MR**	**R1**	**AG**
Activity	Record vessel activity every two hours (from sunrise to sunset) and at the start of every fishing activity (Table 33).	**MR**	**R1/NP[20]**	**AG**
Comments	Record short commentaries on exceptional events that could not be described by the previous data fields.	---	**R4**	

[20] Not all activites from Table 33 could be recorded by EM

VESSEL TRANSHIPMENT INFORMATION[21]

Information on all transhipments that take place during the trip should be collected. Most commonly this will entail transhipping processed catch to a carrier vessel or another fishing vessel. If fish or fish products are move to or from another vessel (carrier or fishing vessel), observers must record details of the transhipment.

Bear in mind that the collecting this information is not necessary if an observer is present on a carrier vessel monitoring the transhipment for the IOTC Regional Observer Programme (ROP)[22].

Data field name	Data field description	Reporting	EM	Sournce
Date	Record the date the transhipment takes place. Note: specify units (preferably YYYY/MM/DD).	---	**R1**	**EM-A-AG**
Start time	Record the time the transhipment of fish starts. Note: specify units (preferably hh:mm).	---	**R1**	**EM-A-AG**
End time	Record the time the transhipment of fish ends. Stores, bait or fuel may also be transhipped. The time and details of this must not be confused with the time that fish or fish products are being transhipped. Note: specify units (preferably hh:mm).	---	**R1**	**EM-A-AG**
Position	Record the position of your vessel, during transhipment. Note: latitude and longitude to be recorded mentioning if collected South or North of the equator and specifying units (preferably ±(d)dd.dddd°).	---	**R1**	**EM-A-AG**
Category	Record if your vessel is transhipping to or from, (i.e. receiving fish from) another vessel (carrier/fishing vessel) or if loading or allowing to load fish from the net (this may occur if a purse seiner has pursed more fish than its present loading capacity).	---	**R1**	**EM-A-AG**
Product transhipped	Observers deployed on-board a purse-seine, pole and line or gillnet vessel are to record the quantity of fish products transhipped (per species) using FAO spp.3-Alpha and IOTC "Product" categories (Table 44). Observers deployed on-board longline vessels are only to request to their vessel Captain a copy of the signed declaration form, which will have all the required information. Note: specify units (preferably tonnes).	---	**R1/P2[23]** **NP**	

[21] Information designed to capture information on all transhipments that take place during the trip.
[22] As per SC14 (para. 104)
[23] R1: total weight transshiped and P2: total weight transhipped by species

Name of carrier/fishing vessel	Observers deployed on-board a purse-seine, pole and line or gillnet vessel are to record the name and registration details of the carrier/fishing vessel they are transhipping to/from (i.e. name, national registration number, port of registry, flag and call sign). Observers deployed on-board longline vessels are only to request to their vessel Captain a copy of the signed declaration form, which will have all the required information.	---	**R4/P1**	

6. EM standards

Several pilot studies have been conducted to determine the effectiveness of EM technology in purse seines (Briand et al., 2018; Chavance et al., 2013; Murua et al., 2020b, 2020a; Ruiz et al., 2015) and longline (Emery et al., 2019b, 2019a, 2018; Hosken et al., 2016a, 2016b; ISSF, 2016). Although the systems developed by different vendors showed diverse strengths and weaknesses, in general they demonstrated that this technology has great potential as a monitoring tool in both the tuna purse seine and longline fisheries as seen in the tables above. The results indicated that, after some adjustments, EM can be a valid tool to monitor most of the data fields required by IOTC ROS minimum standards which are used for estimating fishing effort, total catch by set, and bycatch. Moreover, EMS can be more effective at collecting certain data fields compared to human observers and less efficient for others.

Considering that EM pilot studies have demonstrated the capabilities of EM systems to collect several of the IOTC ROS minimum data fields, the next logical step should be the development of EMS minimum standards and EM Programme objectives (e.g. scientific monitoring and/or compliance), before proceeding with a systematic implementation of EM Systems in IOTC fisheries. Similar to what was already done in the case of ROS observers, the IOTC Commission should adopt EM Program Standards and EM Minimum Data requirements: these would help framing the procedures through which EM systems should be installed, determine the data to be collected/analyzed/reviewed and the data to be stored, clarify and agree data ownership, and should be viewed as minimum specifications that the EM system and program participants should meet (Michelin et al., 2020).

These standards are needed to create compatibility among the different participants of a regional wide EM program network, so as all video data collected and analyzed/reviewed is reported/stored by IOTC as well as to develop specific requirements for an EMS program in order to enforce compliance with its implementation (Michelin et al., 2020).

EM standards should address questions arising from the overall program design (EM Program Standards), including the objectives and coverage rates, technical considerations such as the definition of the entire flow of EM data (EM Data Standard) from EM installation, collection of images to the submission of data to the IOTC. The program objectives should inform the standards and the minimum data requirements to be collected by any EM system/programme, which will ensure the data is collected and submitted accurately and in due course to the IOTC for their analysis.

As such, we can differentiate between **EM Program Standards,** which describe how the institutional structure and management of the program (regional or country based) is organized and defines the objectives of the program, and **EM Data Standards** which -in addition to the minimum data requirements to be collected- indicates the technical specifications and requirement of the EM system to record, retrieve, review, store, access, report data to the IOTC.

For example, the minimum standards should standardize/establish the protocol for installation of EMS from different manufacturers, ensuring that the systems can collect useful and comparable information for fisheries monitoring and management. In addition, minimum standards are needed to ensure that these data share a standard format and can be integrated into the traditional data flows.

While EMS also have great potential for other types of fishing vessels (e.g. gillnet and pole and line), the focus of this document is to define the minimum standards for the implementation of the EMS in IOTC purse seine and longline fisheries in the Indian Ocean (similar standards are being currently developed for purse seines and longlines in the IATTC, ICCAT, and WCPFC. (AFMA, 2020; European Fisheries Control Agency, 2019; Restrepo et al., 2014; Roman et al., 2020; Ruiz et al., 2017, 2016) developed guide documents on EMS minimum standards for tropical tuna purse seine and longline fisheries which could be used to draft the EMS IOTC minimum standards. However, the proposed EM standards and recommendations will be also valid for other IOTC fisheries.

6.1. EM Program Standards

6.1.1. Objectives

The objectives of the EM program must be clearly agreed to prevent repetition and sub-optimal use of resources, as well as to collect the necessary data in a cost-efficient manner. Considering IOTC Resolution 11-04 on Regional Observer Scheme, the objectives of the EM Program should be to collect verified catch data and other scientific information which indicates its target is more related to science rather than compliance. However, if decided by IOTC Commission, the EM program could also be used to monitor compliance with different IOTC Resolution.

The observer's tasks under the IOTC Regional Observer Scheme (IOTC Resolution 11/04) can be summarized as: record and report fishing activities, verify positions of the vessel, estimate catches as much as possible, identify the catch species composition, monitor discards, by-catch and size frequency, record the gear type, mesh size and gear configurations employed by the fishing master, and carry out such scientific work (e.g. collecting biological samples), as requested by the IOTC Scientific Committee. Those requirements are defined by the ROS data minimum standards as described above.

The objectives of the program should also define the characteristics of the fleets that are subject to the initiative, the minimum fraction of said fleets that is required to install EM systems onboard, the expected level of coverage of the fleet activity that should be recorded and reviewed. The goal in many fisheries is to install EM systems in 100% of the fishing vessels

and to record 100% of the fishing activities, as once EM systems are installed, the additional cost associated to the recording of all activities is low in comparison to the installation of the system. Moreover, recent analysis has shown that when all activities are recorded and hence could be reviewed, then the incentive for the crew for accurate data reporting increases (Emery et al., 2019a; Michelin et al., 2020). Emery et al. (2019a) found that discards and interactions with protected species recording in the logbooks increased significantly when EM was installed onboard vessels: in the Australian longline fishery, 100% EM recording is mandatory for all vessels, and a 10% review rate is expected, which may increase through a risk-based assessment.

When designing an EM program, the cost and benefits of reviewing the EM-collected data should be appraised. This represents the most expensive component of the EM program (around 50% of the total cost) and hence EM program objectives should be aligned with the amount of data to be reviewed/extracted (Michelin et al., 2020). For example, a base review rate of 20% could be established for bycatch estimation, increased up to 50% for rare bycatch species. Alternatively, a risk-based approach could be developed so as the review rate is increased in those vessels where discrepancies between EM data and logbook reported ROS mandatory data are identified.

6.1.2. Institutional Structure and management of the Program

Similar to the Regional Observer Scheme, IOTC should decide if a regional program (i.e. RFMO-wide), several national programmes or a mix between regional and national programmes has to be established. The different types of programs will have implications in terms of organizing the technical standards, as well as set up the data review centers etc. Each type has its advantages and disadvantages, but this should be discussed from the beginning of the program because it has associated cost implications. For example, a regional program coordinated by IOTC will require a centralized data analysis center and the associated cost that it requires. On the other hand, national programs pooled between countries may require clear minimum and harmonized quality requirements for data analyst and reviewers. In any case, it is important to develop a single harmonized system, where databases, standards, procedures and protocols are agreed and compatible with IOTC and wider best practices (Roman et al., 2020).

When agreeing on the organizational structure of the EM Program, it is very important that the EM Program Standards consider various management issues required to efficiently run the Program. EM program standards should describe how the various EM programs will be coordinated, who will store and for how long the video footage raw data, who and how will design and maintain the databases to incorporate EM analysed data (in this case, it is likely to be the IOTC Secretariat), how to perform quality assurance of EM review centers, who will be responsible for training the EM analysts (and how), how to perform the inspection of all EM equipment installations, how to collect and submit EM records, who will be responsible to approve EM service providers, who owns the data etc.

For example, EM program managers should ensure that the qualifications and requirements of on-land or office observers are specified in EM Program Standards. These qualifications and requirements should ensure sufficient knowledge and experience in fishing and catch

handling operations, species identification, proven experience accurately recording all data required by the programme, ability to properly use image analysis software, etc. Moreover, capacity building in the region with regards to "land" observers should be developed to ensure that expertise is available, and updated regularly, to review the video footages.

The analysis of the data recorded through EMS is not an easy task, and should be done by institutions, organizations and independent companies which have a proven track record in working with on-board observers and either centralized data review centers under the regional program, or authorized institutions identified by the national programs. These entities should be familiar with the end users' data needs, IOTC management measures and data reporting obligations, as well as with the on-board operations and conditions. Data analysis procedures should be written and approved, to assure a good traceability of data.

The EM Program Standards should also establish proven and accountable data ownership and confidentiality rules, to protect business confidential data embedded within the EM records. These should be built upon the confidentiality rules dictated by IOTC through Resolution 12/02, so as to enable fair use of publicly disseminated aggregated information without causing commercial damage to the parties involved.

6.2. EM Data Standards

EM pilot studies on purse seiners, longlines and pole and line vessels have shown that EMS is more than just "installing cameras" on a vessel. In addition to this requirement, there are several other considerations that these systems should cover (e.g. GPS receiver, supplementary hydraulic and/or rotation sensors to distinguish between fishing and non-fishing time). EM data standards should standardize the minimum/core technical specifications of EMS systems, including installation and maintenance of the equipment, data collection and storage process, transfer and management of EM records, and finally data analysis, extraction, submission and integration into IOTC databases.

6.2.1. EM System and equipment

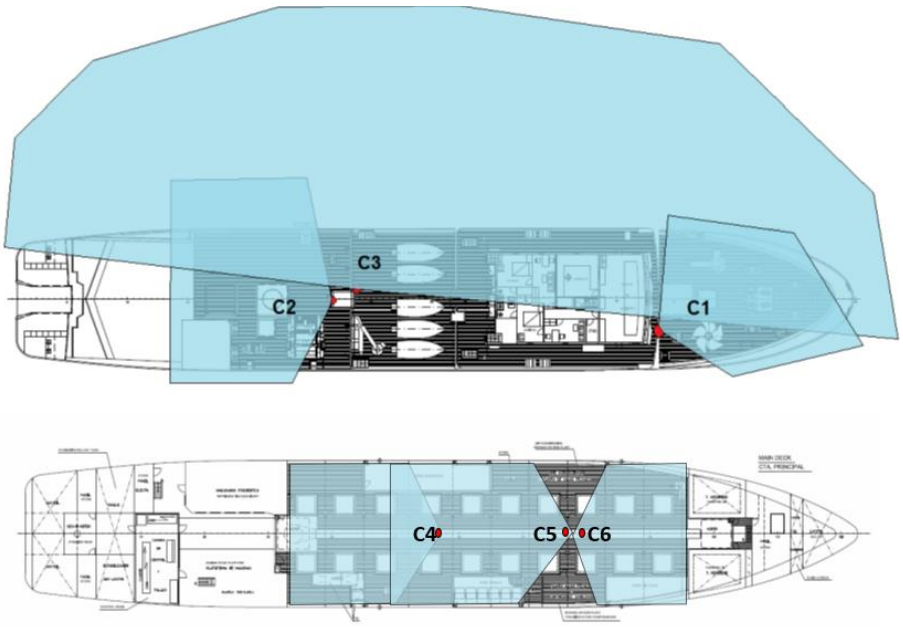
The specifications for selecting, installing, operating and maintaining EM systems and their equipment (cameras, sensors, data storage devices, etc.) as well as the associated software deployed onboard vessels should be based on performance standards rather than being prescriptive in terms of pure technical requirements (e.g. number and type of cameras) (European Fisheries Control Agency, 2019; Michelin et al., 2020). The standards need to be specific in terms of what the system should be recording, while at the same time avoiding the specific details of the number and placement of cameras. As such, the system should be customized and tailored to each individual/type of vessel with no standard configuration expected to all vessels in a given fleet, with each installation being rather customized at single vessel level.

Considering the objective and the minimum data fields of the IOTC ROS, the EM system should be designed to record information on retained catches and discards as well as gear configuration and vessel activities. Therefore, the areas/actions that should be covered by the camera's field-of-views (FOV) could be identified on a general level, although they could

vary from vessel to vessel. In this regard, crew cooperation is crucial; it is necessary that ship owners authorize appropriate access to the vessel to install EMS effectively, and that the crew get involved on the camera placement selection.

On purse-seine vessels, the minimum areas that cameras should cover are the working deck (both port and starboard sides), the net sack and the brailer, the foredeck or amidships, and the well deck and conveyor belt (Restrepo et al., 2018). Cameras must cover the following actions: brailing, net hauling, FAD activities, bycatch handling and release, tuna discards, catch well sorting (process of putting the catch in the hold or wells) (Figure 1 and Table 5). In large purse seines, at least 6 cameras are needed to cover fishing and fish handling operations, however, less cameras (e.g. 4 cameras) could cover the activity to collect the data required of small purse seines (e.g. 300-400 tonnes capacity). Digital video is the preferred option but photographs can be also an option to capture images during the various phases of the vessel activity. In the case of photographs, the minimum requirement should be that a picture is taken by the camera with view of the fish management areas at least every 2 seconds when fishing action occurs (Restrepo et al., 2018). Image quality should also be such as to permit correct species identification.

A



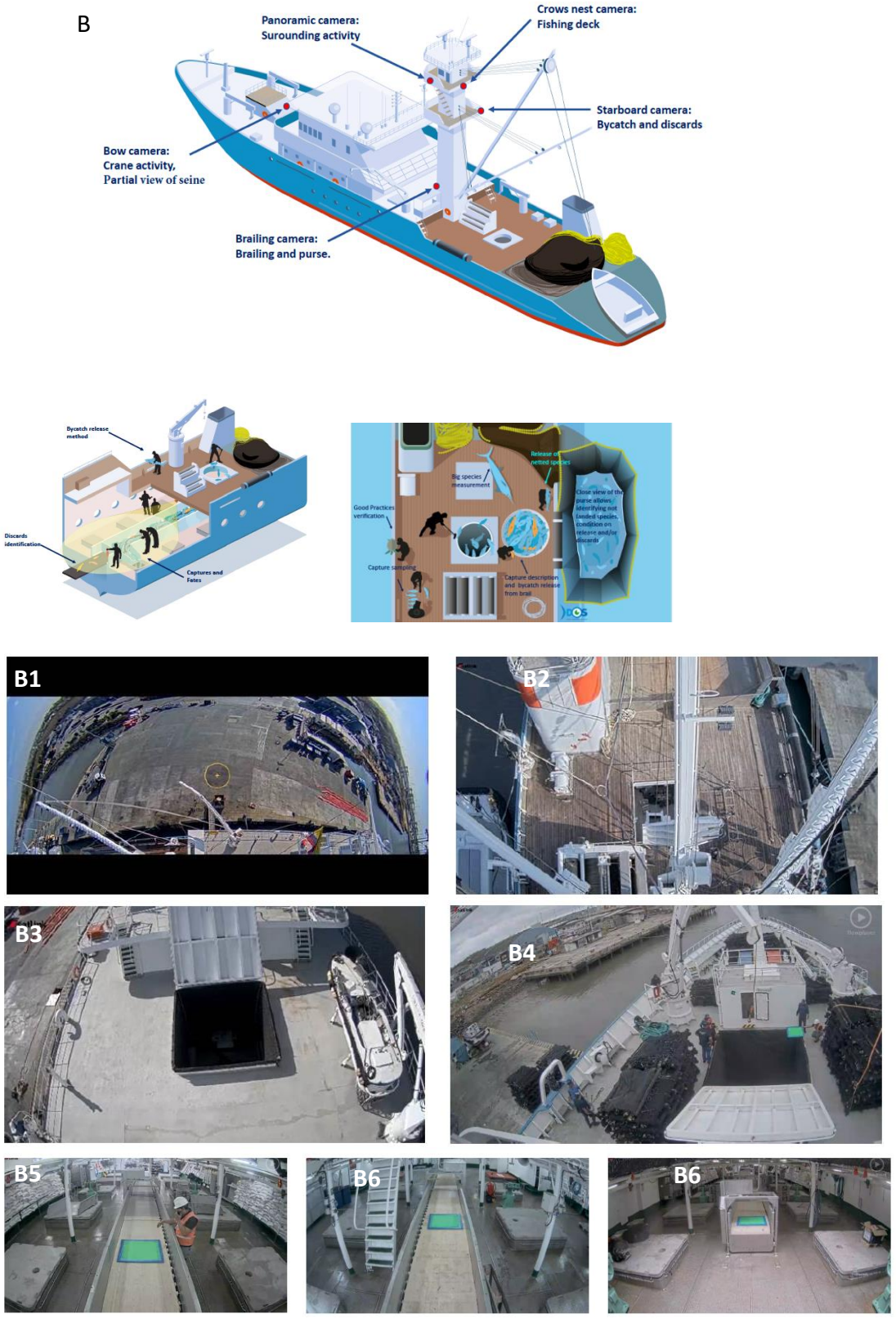


Figure 1. (A) 6-cameras EM system installed in a purse seine covering main areas of fishing and fish handling operations (from Murua et al., 2020b) and (B) 7-cameras EM system (4 in the upper deck and 3 in the well deck) installed in a purse seine covering main areas of fishing and fishing handling operations including 1 more camera in the conveyor belt: (B1) 360˚ Panoramic view camera (e.g port side view), (B2) Crows nest stern view camera, (B3) Working deck crane camera view , (B4) Foredeck view camera, (B5) Conveyor belt stern camera view, (B6) Conveyor belt middle camera, and (B7) Conveyor belt bow camera (source: Digital Observer Services).

Table 5. Minimum areas and actions that should be monitored (adapted from Ruiz et al., 2017).

Area covered	Action covered	Purpose	Minimum data requirements to be monitored
Work deck (port side)	Brailing	Total catch by set Species composition	Number of brails & fullness by brail. Weight, size and species of retained tuna
	Tuna discards	Total tuna discards by set	Weight, size and species of discarded tuna
	Bycatch handling	Bycatch estimates	number of individuals handling mode Species ID
Work deck (starboard side)	Bycatch handling	Bycatch estimates	Handling mode
	Bycatch release	Total bycatch by	Number of individuals and species ID
In-water purse seine area	Brailing	Total catch by set	Number of brails & fullness by brail
	Bycatch handling of big species (whale sharks, manta rays…)	Best practices	Handling mode
	Bycatch release of big species (whale sharks, manta rays…)	Total bycatch by set Best practices	Number of individuals and species ID
Foredeck or amidships	FAD activity (deploying, replacement, reparation…)	Total number of FAD activities by trip	Number, material (natural or artificial), and FAD characteristics (entangling or no entangling)
Well deck and conveyor belt	Catch well sorting	Species composition	Weight, size and species of retained tuna.
	Bycatch handling	Best practices	Handling mode
	Bycatch discarded, released or retained	Total bycatch by set Species composition Best practices	Number, size or weight of individuals, species ID and fate

On longlines, the cameras should provide a view of the setting of the longline, bait information, whether mitigation techniques are being used (e.g. tori lines), hauling of the longline, all hooked species (both retained and discarded) and the size of the specimens. In tuna longline EMs, the minimum areas, therefore, that cameras should cover are the area of setting the longline (usually vessel stern site camera), the area of hauling the longline and the working deck where catch is handled. On most of tuna longlines, at least 3 cameras are needed to cover fishing activities and fish handling operations: one capturing images when setting the longline, one to record the hauling and boarding of the catch, and other mounted over the processing deck to record species, size of specimens and fate (Figure 2).

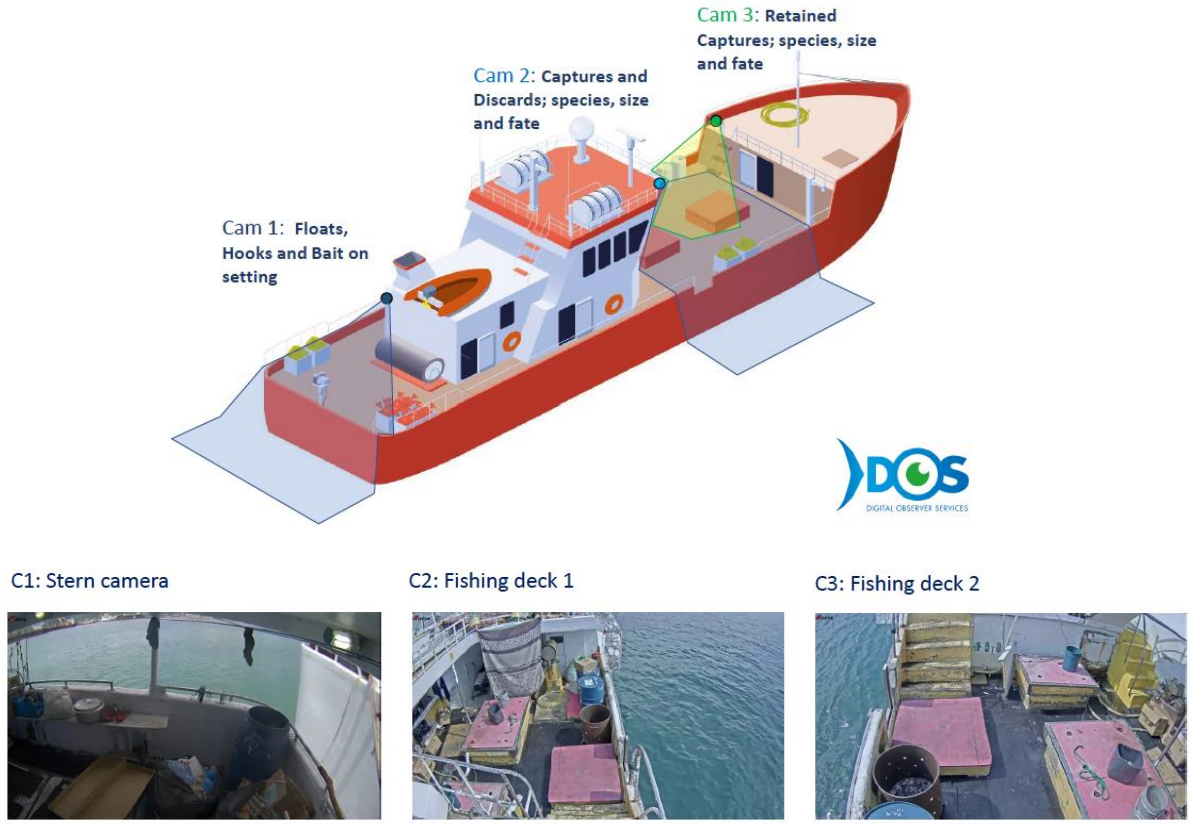


Figure 2. 3-cameras EM equipment installed on a longline covering main areas of fishing and fish handling operations. View of the 3 cameras: (left panel) Stern camera - setting longline providing information on hooks, floats, mitigation techniques and bait; (middle panel) Fishing deck 1 - hauling information, captures and discards, species ID, size and fate; and (right panel) Fishing deck 2 - fate of the species, size, species ID (source: Digital Observer Services).

On pole and line vessels, the minimum areas that cameras should cover are the area of bait fishing activity, the area of the fishing set and pole and line fishing activity (vessel stern site camera) and the working deck where catch is handled. On a typical Indian Ocean pole and line vessels, this will require at least 2 or 3 cameras to cover main fishing activity areas, fish handling operations and bait fishing (Figure 3).

Figure 3. 3-cameras EM equipment installed on a Bay of Biscah (Atlantic Ocean) pole and line vessel covering main areas of fishing activity and fish handling operations. View of the 3 cameras: (left panel) Vessel bridge camera stern view – pole and line activity; (middle panel) Fish handling - catch storage; (right panel) Vessel bridge camera bow view - bait and pole and line fishing activity (source: Marine Instruments).

EMS users can choose between a wide variety of equipment manufactured by different vendors, with new manufacturers regularly entering the market. As long as their offer meets the minimum specifications, all vendors should be considered as equally valid, although each will have advantages and disadvantages over the others. However, all systems should be tested and certified by third parties, preferably through pilot studies before being implemented in a monitoring program. Once it is verified that there are no significant differences between EMS and observer's data collection, the equipment could be introduced in a real monitoring program. In order to test the effectiveness of EMS in addition to human observers, there are -at least for some key variables - several other data sources that can be included in the comparison (e.g. activity and set logbook, FAD logbook, port sampling, etc.). Periodic audits are recommended once the efficacy and accuracy of a system has been initially proven to ensure that EM system is correctly configured to collect the necessary data.

EM systems should be capable to withstand rough and adverse conditions at-sea with minimum human intervention. In many cases, proper maintenance and inspection can be only achieved at port, in-between long fishing trips, therefore crew assistance may be required to clean the camera lenses when necessary.

Due to the importance of the information they capture, EM system components and data need to be tamper-proof (or at least tamper-resistant) and designed to prevent access or manipulation of information by non-authorised persons, to ensure full system and data security. Having its own internal auxiliary batteries is important to ensure that EM systems can work even in the event of a vessel power outage. An inviolable system solution with encrypted data, near-real-time remote online EMS alerts that assure the data is recorded during the trip and GPS linked imagery (date, time and coordinates) must be included. Moreover, alerts or mechanisms to track and report any evidence of tampering are also required.

Any EMS should be, to the extent possible, independent from the crew during the trip. If image recording is not continuous (24 h/day), different sensors (e.g. rotation, hydraulic sensors, GPS speed) should be implemented in charge of automatically identifying a fishing-related activity and, acting as a trigger, start the image recording process. Even though the system is expected to work independently, some basic maintenance (such as cleaning the camera lens) must be performed by the crew.

6.2.2. EM Data collection, storage and submission

As noted above, EM systems could generally record several of the ROS minimum mandatory reporting data fields, as well as most of those indicated as "*optional for reporting*" and "*suggested for collection*", some of them automatically and with a higher frequency than what human observers can do. For those data fields that could not be currently collected, EM systems should be further developed so as to be able to collect these data in the future. For some data fields, such as biological sampling, human observer programs are still required and should be implemented.

The system should have enough autonomy and storage capacity to store all recorded imaged and sensor information for a certain period of time, that should be at minimum a complete trip, whose duration will depend on the vessel operational characteristics and that could range from 4 months (in the case of purse seiners) to 12 months or more (in the case of longliners).

It is necessary to find the balance between the image quality and the EMS data storage capacity and reliability (which comes at a non-negligible cost). For this reason, it is recommended that EM systems revert to using solid state storage devices (SSD) which have no moving mechanical components, and therefore are more resilient to adverse at-sea conditions. It is also recommended that the system includes separate, duplicate backup devices to ensure that data are not lost if one storage device fails.

Data are extracted (or hard drives are replaced) by technicians between trips, and a system to recover the hard drives and send them to the designated review and analysis centers should be developed. This is something that can be centralized by the IOTC Secretariat if a regional EM Program is developed, or that can be implemented by EM service providers when the vessels enter the port for unloading. In any case, the chain of custody of the EM system hard drives should be assured. Ideally, to guarantee assurance of the chain of custody, it is necessary that the hard drives are retrieved and submit by a third party with no conflict of

interest (such as the IOTC Secretariat if regional EM program is implemented, and/or at sea observers, technicians in charge of installing EMS systems, land observers for a national program).

6.2.3. EM data analysis, extraction and submission to IOTC

In addition to the hardware components, an integral part of every EMS should be a dedicated software to facilitate the review of images in an effective and efficient way. This software shall enable the analysis of all stored data, images and sensor information in a synchronized way, performing all analysis and reporting efficiently. Ideally, the analysis software should allow to identify and record all IOTC ROS "*mandatory reporting*" data fields and its output format, including the results of the image analysis process, should be compatible with current IOTC databases or flexible enough to enable exporting the collected information through several different file templates.

6.2.4. EM Ownership, management and confidentiality

The ownership of data may depend on the scope and scale of the Program (either regional or national), but should be agreed before EM systems are implemented, irrespective of the type of EM Program arrangement (Dunn and Knuckey, 2013).

In case of a regional program, one option would be that the IOTC owns the data (or co-owns, with the flag state) and the vessel/flag state is requested to facilitate its collection through the implementation of the EM regional program. Alternatively, as for other types of fishery statistics data in IOTC, the vessel/flag state owns the data but is requested to report to the IOTC for analysis and subsequent disposal following agreed IOTC aggregation levels for fishery statistics reporting and confidentiality rules. However, in both cases the final responsibility for data management and dissemination (according to the agreed confidentiality rules) will be IOTC's.

Not only data ownership, but systems' ownership should also be agreed. In both the cases of Regional or National EM Program, the best approach would be that the ownership of the equipment (and the cost) is responsibility of the vessels' owner, similar to what already happens for the procurement of other equipment such as Vessel Monitoring Systems. In this case, the EM Program should be implemented through a mandatory regulation of the IOTC, and this approach could contribute to an improved maintenance of the equipment by vessel owners.

When reviewed and analysed data is incorporated in IOTC databases, it should be agreed what to do with the large volume of video images. Although it is normal practice to delete raw video images or to overwrite video images within a few months after analysis unless there is a specific requirement to retain for a longer period (e.g. compliance issues), considering the technological progress it would be possible to enlarge the video storage in cloud servers to keep records for future revisions and analysis of data (e.g. compliance, changes in fishing practices). This should be agreed upon considering whether it is a regional or national EM program as well as the objectives of the EM program and who, how frequent and for what

will have access to the data once the review and analysis have been performed (CEA, 2020). The cost associated to the long-term video storage could be supported by the IOTC if a Regional "ownership" program is established; alternatively, if national program "ownership" is agreed the member states could support the cost.

6.2.5. EM Maintenance

The EM equipment should be programmed to send automatic alerts of malfunctioning in real time to EM Program management. In this regard, the vessel owners should be responsible to maintain the system properly functioning and report back as soon as possible any problem with the system. The vessel owners should also be responsible to keep the cameras in good state so as they can record images of enough quality for ulterior analysis.

7. Recommendations for EM implementation in IOTC

7.1. General

Electronic Monitoring Systems are capable of collecting several of the key ROS data collection and reporting fields, and that therefore it could be considered an alternative monitoring system to both complement and/or replace human observer programs for IOTC fisheries.

It is recommended the management of EM Program is done through existing IOTC Regional observer programs or National Observer Programs.

7.2. Objectives

The aim of IOTC EM Implementation should be to collect verified catch data and other scientific data related to fisheries for tuna and tuna-like species in the IOTC area of competence. Additional objectives could be added for monitoring purposes of current IOTC Resolution on data as well as management of IOTC Species.

7.3. Minimum requirements for a standard EM System

The IOTC Scientific Committee, closely with the IOTC Secretariat, should lead the development of Electronic Monitoring Minimum Standards and EM Data Standards, with the Scientific Committee presenting the results of the process to the Commission for its discussion.

Customized to vessel level: There is not a standard configuration that will cover all vessels from fleets operating in the Indian Ocean region, therefore each EMS installation must be customized at the vessel level. An EM system to be installed on board of a fishing vessel should consist of a control system connecting a number of different sensors and a number of cameras to collect and record images to address the objectives of the EM Program. The number of

cameras and sensors should be tailored to each vessel based on performance-standards to meet overall objectives of the program rather than being too prescriptive.

Include sensor: include sensors and indicators that monitor gear usage and fishing activity to show when fishing occurs. This will facilitate image revision and analysis.

Include Global Positioning System (GPS): to monitor vessel position, route, speed and provide information on date/time and location of fishing activities.

Tested (and certified) by a third party: All vendors should be equally valid, but all systems should be tested through pilot studies for a particular type of fleet (e.g. longline, purse seine, etc..) before being implemented and EMS providers certified by a third party (e.g. by IOTC).

Compatibility: the EMS should be capable of integrating with other Monitoring, Control and Surveillance (MCS) tools (e.g. Vessel Monitoring System).

Robust System: EMS components installed outdoors (such as cameras/camera housing and sensors) should be capable to resist rough conditions at-sea and harsh environment on board the vessels.

Secure System: Tamper proof system with encrypted data, near-real-time remote online "status checks " and GPS linked data/imagery.

Cameras: Digital, high-resolution when possible, cameras covering all areas of interest according to the vessel and fishing operations are recommended. The view and collection of the imaged must assure the detection of both catch and bycatch species, species correct ID, and other fishing activities. The system should be able to record activities in low natural light conditions.

Independence: The system needs to be self-governing with the exception of minimal maintenance by crew (e.g. cleaning senses). The system should incorporate a self-test function to allow remote verification of its functionality at all times to collect all information. The master should ensure that the system is working properly before leaving port.

Data storage and autonomy: The system should have enough autonomy, and storage capacity, to store all recorded images a minimum of the duration of a common trip (around 4 months for PS and 12 months for LL).

Maintenance: The master should report to the competent authority (IOTC and flag state) when the system is malfunctioning in port or at sea and should be recorded any failure in the logbook. Rules of Procedures should be established for the vessels when the system fails.

Data retrieval: ideally, it is recommended that the data is automatically transmitted via mobile networks, Wi-Fi, or satellite and when video footage is too big it should be transferred via hard drive exchange. Hard drive exchange and transmission should be regulated and centralized by the IOTC, when possible.

EM records backup: if data is automatically transmitted electronically, operational procesures for the receipt and back-up of EM records should be implemented taking into account any necessary chain of custody arrangements.

Hard drives chain of custody: The system must ensure traceability of every hard drive and information recorded on-board.

Frequency: the method and frequency (e.g. after the trip) of EM records transmission to data review centers should be established by CPCs/IOTC.

Dedicated image analysis software: EM System should provide dedicated software to facilitate the review of images and to produce a common output format for exchange/submission to IOTC. It is also recommended that the analysis software could analyse data collected from different EM systems or vendors.

EMS data analysis and reporting: Data analysis and reporting should be done by institutions, organizations and independent companies with proven expertise and experience (e.g. work experience with on-board observers). This analysis could be centralized in a "regional image review center" when implementing a regional program or could be carried out by national organizations.

EMS data analysis quality check: EM record analysis should be quality controlled including data entry checks, automatic error identification, and debriefing as required and EM data analysis is checked for inconsistencies, quality and accuracy prior to reporting to the IOTC Secretariat.

EM coverage and risk based review analysis: EM system should be incorporated in a level agreed by the Commission (e.g. 100% of vessels), however, in the case that a 100% of EM is implemented, it is not recommended to review 100% of the images. IOTC should agree whether a fix coverage rate (e.g. 20% for bycatch species) or risk based review rate analysis is implemented. It is recommended that the vessel data and video footage review should be based on risk-analysis in order to meet the goal of the EM program. Although not the primary objective of the EM Program, unless decided otherwise by IOTC Commission, this risk-based approach could contribute to monitor compliance with IOTC Data Resolutions. At a minimum observer coverage required is that specified by the Commission in Resolution 11/04.

EM data: EM system should collect at a minimum, the ROS Minimum Standard Data Fields using IOTC standard codes and EM will be submitted to the IOTC Secretariat according to the time frame specified in Resolution 11/04, or any superseding Resolution. Data confidentiality requirements outlined in Resolution 12/02, Data Confidentiality Policy and Procedures, or any superseding Resolution, shall apply to all EM data.

Office observers' training: EM data analysts must have specific qualifications which should be integrated in the EM program standards. The data analyst/reviewers should participate in specialised and regularly updated training courses to ensure EM analysis high-quality standards and level playing field.

Office observer's qualifications: EM data analysts must have the ability to review and record data accurately on IOTC Resolutions, are familiar with fishing activities and are capable to identify (i) IOTC species and species of especial interest, (ii) IOTC Fishing methods and (iii) IOTC mitigation methods among other questions.

Compatible with ongoing standardized data flow and databases: Compatible data output format (including usage of standardized, well-established code lists) to exchange collected information with current IOTC data reporting format and standards and consistent with IOTC data rules. EM record will be submitted in an approved electronic data reporting format to the IOTC Secretariat, using IOTC standard codes and units

Data Storage and retention: Legal provisions on data protection, storage and retention by IOTC should be developed and agreed whether it is an EM Regional Program or National Program.

Data Ownership: if an IOTC EM regional program is established, EM system data (raw video footage) should be property of IOTC. Otherwise, if EM National programs are developed within a region, the EM system and raw data ownership is of the vessel owner/flag state but should provide IOTC with the EM analysis data outputs to incorporate in IOTC database for use, analysis, and disposal.

Hardware/software ownership: irrespective of the scope of the program, it is recommended that hardware and software ownership (and maintenance) is of the vessel owner.

EM implementation: to advance on the implementation of EM Program in IOTC and to progress on the development of EM Program Standards as well as EM Data Minimum Standards, it is recommended to establish an ad-hoc Working Party on Electronic Monitoring to develop further the recommendations above and EM Program Standards to be presented to IOTC Scientific Committee and Commission for their approval.

8. Terms and definitions

Electronic Monitoring (EM): the use of electronic devices to record and monitor fishing vessel's activities using video technology integrated with Global Position Systems (GPS).

Electronic Monitoring System (EMS): all the vessel and shore-based components for collecting, analysing and reporting of EM records and implement EM Program.

EM program: a process administered by a national or regional administration that regulates the use of EM systems on vessels to independently collect and verify fisheries data and information responsible through a n implementing of an EMS in a defined area and/or fishery.

EM Program standards: the agreed standards, specification and procedures governing the establishment and operation of an EM Program, applicable to all components of the EM system.

EM Data standards: the agreed data requirements by the Regional Observer Scheme that should be collected by the EM System.

EM records: Imagery and sensor data recorded by an e-monitoring equipmen that can be analysed to produce e-monitoring data.

EM Data: data produced through analysis of e-monitoring records that conforms with the EM data standards.

EM equipment: a network of electronic cameras, sensors and data storage devices installed on a vessel and used to record the vessel's activities.

EM analysis: the analysis of EM records to produce EM data.

EM analyst: a person qualified to analyze EM records, record and produce EM data in accordance with the EM Data standards and analysis procedure.

EM review center: local, national, or regional office facility where EM records are analyzed to produce and record EM data.

EM coverage: the proportion of vessels (or effort) by fleet that have an e-monitoring equipment and system installed and operational.

EM review rate: the proportion of e-monitored records (of vessel/fleet) that are reviewed/analysed to produce EM data.

EM service provider: a third-party provider of EM equipment (and/or system), technical and logistical services.

EM service certified: a third-party organization which is accredited by the appropriate national or regional authority to inspect and approve EM systems and equipment to ensure that EM data standards can be collected.

9. Acknowledgements

We are thankful to all scientist that have previously worked, and are currently working, on Electronic Monitoring projects and analysis from whom we have learnt and borrowed their expertise/experience.

10. References

AFMA, 2020. Electronic Monitoring Program. Australian Fisheries Management Authority.

AFMA, 2015. Australian Fisheries Management Authority Electronic Monitoring Program: Program Overview. Aust. Fish. Manag. Authority, Canberra, ACT, pp. 26.

Babcock, E.A., Pikitch, E.K., Hudson, C.G., 2003. How much observer coverage is enough to adequately estimate bycatch? Methodology 1–36.

Bartholomew, D.C., Mangel, J.C., Alfaro-Shigueto, J., Pingo, S., Jimenez, A., Godley, B.J., 2018. Remote electronic monitoring as a potential alternative to on-board observers in small-scale

fisheries. Biol. Conserv. 219, 35–45. https://doi.org/https://doi.org/10.1016/j.biocon.2018.01.003
Briand, K., Bonnieux, A., Le Dantec, W., Le Couls, S., Bach, P., Maufroy, A., Relot-Stirnemann, A., Sabarros, P., Vernet, A.L., Jehenne, F., 2018. Comparing electronic monitoring system with observer data for estimating non-target species and discards on French tropical tuna purse seine vessels. Col Vol Sci Pap ICCAT 74, 3813–3831.
Chavance, P., Batty, A., McElderry, H., Dubroca, L., Dewals, P., Cauquil, P., Restrepo, V., Dagorn, L., 2013. COMPARING OBSERVER DATA WITH VIDEO MONITORING ON A FRENCH PURSE SEINER IN THE INDIAN OCEAN . IOTC-2013-WPEB09-43 1–18.
Dunn, S., Knuckey, I.A., 2013. POTENTIAL FOR E-REPORTING AND E-MONITORING IN THE WESTERN AND CENTRAL PACIFIC TUNA FISHERIES. WCPFC10-2013-16_rev1.
Emery, T.J., Noriega, R., Williams, A.J., Larcombe, J., 2019a. Measuring congruence between electronic monitoring and logbook data in Australian Commonwealth longline and gillnet fisheries. Ocean Coast. Manag. 168, 307–321. https://doi.org/https://doi.org/10.1016/j.ocecoaman.2018.11.003
Emery, T.J., Noriega, R., Williams, A.J., Larcombe, J., 2019b. Changes in logbook reporting by commercial fishers following the implementation of electronic monitoring in Australian Commonwealth fisheries. Mar. Policy 104, 135–145. https://doi.org/10.1016/j.marpol.2019.01.018
Emery, T.J., Noriega, R., Williams, A.J., Larcombe, J., Nicol, S., Williams, P., Smith, N., Pilling, G., Hosken, M., Brouwer, S., Tremblay-Boyer, L., Peatman, T., 2018. The use of electronic monitoring within tuna longline fisheries: implications for international data collection, analysis and reporting. Rev. Fish Biol. Fish. 28, 887–907. https://doi.org/10.1007/s11160-018-9533-2
European Fisheries Control Agency, 2019. Technical guidelines and specifications for the implementation of Remote Electronic Monitoring (REM) in EU fisheries European Fisheries Control Agency 1–43.
Ewell, C., Hocevar, J., Mitchell, E., Snowden, S., Jacquet, J., 2020. An evaluation of Regional Fisheries Management Organization at-sea compliance monitoring and observer programs. Mar. Policy 115, 103842. https://doi.org/https://doi.org/10.1016/j.marpol.2020.103842
FAO, 1999. Guidelines for the routine collection ofcapture fishery data. In Prepared at the FAO/DANIDA. Expert Consultation. Bangkok, Thailand, 18–30 May 1998. FAO Fisheries Technical Paper. No. 382. FAO, Rome. 113 pp.
FAO, 1997. FAO TECHNICAL GUIDELINES FOR RESPONSIBLE FISHERIES 4. FAO Tech. Guidel. Responsible Fish. No. 4. Rome, FAO. 1997. 82 p. 82p. https://doi.org/10.1017/CBO9781107415324.004
Gilman, E., De Ramón Castejón, V., Loganimoce, E., Chaloupka, M., 2020. Capability of a pilot fisheries electronic monitoring system to meet scientific and compliance monitoring objectives. Mar. Policy 113, 103792. https://doi.org/https://doi.org/10.1016/j.marpol.2019.103792
Gilman, E., Legorburu, G., Fedoruk, A., Heberer, C., Zimring, M., Barkai, A., 2019. Increasing the functionalities and accuracy of fisheries electronic monitoring systems. Aquat. Conserv. Mar. Freshw. Ecosyst. 29, 901–926. https://doi.org/10.1002/aqc.3086
Hosken, M., Vilia, H., Agi, J., Williams, P., Mckechnie, S., Mallett, D., Honiwala, E., Walton, H., Owens, M., Wickham, C., Zaborovskiy, E., Cheung, B., 2016a. Report on the 2014 Solomon Islands Longline E-Monitoring Project.
Hosken, M., Williams, P., Smith, N., 2016b. Update on the implementation of electronic monitoring (EM) and electronic reporting (ER_ technologies in the WPCO. WCPFC-SC12-2016/ST IP-04.
ISSF, 2016. Summary report of the I nternational Workshop on Application of Electronic Monitoring Systems in Tuna Longline Fisheries. ISSF Tech. Rep. 2016-07.
Jannot, J.E., Richerson, K., Somers, K.A., Tuttle, V., McVeight, J.T., 2020. Pacific Halibut Bycatch in U . S . West Coast Groundfish Fisheries, 2002-18. NOAA Tech. Memo. NMFS-NWFSC 152.
McElderry, H., 2008. At-Sea Observing Using Video-Based Electronic Monitoring. Backgr. Pap. Prep.

by Archipel. Mar. Res. Ltd. Electron. Monit. Work. July 29–30, 2008. Seattle WA, Held by North Pacific Fish. Manag. Counc. Natl. Mar. Fish. Serv. North Pacific Resea.
Michelin, M., Sarto, N.M., Gillett, R., 2020. Roadmap for Electronic Monitoring in RFMOs Roadmap for Electronic Monitoring in RFMOs. CEA Rep.
Morrell, T.J., 2019. Analysis of "Observer Effect" in Logbook Reporting Accuracy for U.S. Pelagic Longline Fishing Vessels in the Atlantic and Gulf of Mexico. Master's thesis. Nova Southeastern University. Retrieved from NSUWorks, . (511) https://nsuworks.nova.edu/occ_stuetd/.
Murua, H., Herrera, M., Morón, J., Abascal, F., Legorburu, G., Hosken, M., Roman, M., Panizza, A., Wichman, M., Moreno, G., Restrepo, V., 2020a. Comparing Electronic Monitoring and human observer collected fishery data in the tropical tuna purse seine operating in the Western and Central Pacific Ocean. WCPFC-SC16-2020/ST-IP-09.
Murua, H., Herrera, M., Morón, J., Abascal, F., Legorburu, G., Roman, M., Moreno, G., Hosken, M., Restrepo, V., 2020b. Comparing Electronic Monitoring and human observer collected fishery data in the tropical tuna purse seine operating in the Pacific Ocean. IATTC SAC-11 INF-G.
NMFS, 2004. Evaluating bycatch: a national approach to standardizing bycatch monitoring programs. NOAA Tech. Memo. NMFS-F/SPO-66. 66.
NOAA, 2017. Electronic monitoring and reporting implementation plan – West Coast Region spring 2017 1–9.
Nolan, C.P., 1999. Proceedings of the International Conference on Integrated Fisheries Monitoring. Sydney, Australia, 1-5. FAO. 1999. 378p. February.
Restrepo, V., Ariz, J., Ruiz, J., Rubio, A.J.-, Chavance, P., 2014. Updated Guidance on Electronic Monitoring Systems for Tropical Tuna Purse Seine Fisheries. ISSF Tech. Rep. 2014-?-08 Updat. 1–9.
Restrepo, V., Justel-Rubio, A., Koehler, H., Ruiz, J., 2018. Minimum Standards for Electronic Monitoring Systems in Tropical Tuna Purse Seine Fisheries. ISSF Tech. Rep. 04, 12.
Roman, M., Lopez, J., Lennert-cody, C., Ureña, E., Aires-da-Silva, A., 2020. An Electronic Monitoring System for the tuna fisheries in the eastern Pacific Ocean : objectives and standards. Doc. SAC-11-10 1–23.
Ruiz, J., Batty, A., Chavance, P., McElderry, H., Restrepo, V., Sharples, P., Santos, J., Urtizberea, A., 2015. Electronic monitoring trials in the tropical tuna purse-seine fishery. ICES J. Mar. Sci. 72, 1201–2013. https://doi.org/10.1038/278097a0
Ruiz, J., Depestris, M., Grande, M., Tserpes, G., Carbonara, P., Bach, P., Duparc, A., Cauquil, P., Krug, I., Spedicato, D., Capello, M., Gaertner, D., Mugerza, E., Thasitis, I., Garibaldi, F., Mariani, A., Santiago, J., Murua, H., Pascual-Alayón, P., Baez, J., Abascal, F., Uranga, J., Baidai, Y., 2019. Strengthening regional cooperation in the area of large pelagic fishery data collection. . EU MARE/2016/22. Final report.
Ruiz, J., Krug, I., Justel-Rubio, A., Restrepo, V., Hammann, G., Gonzalez, O., Legorburu, G., José, P., Alayon, P., Bach, P., Bannerman, P., Galán, T., 2016. Minimum Standards for the Implementation of Electronic Monitoring Systems for the Tropical Tuna Purse Seine Fleet. IOTC 2016 WPDCS 12-23.
Ruiz, J., Krug, I., Justel-rubio, A., Restrepo, V., Hammann, G., Gonzalez, O., Legorburu, G., Pascual-Alayón, P., Bach, P., Bannerman, P., Galán, T., 2017. MINIMUM STANDARDS FOR THE IMPLEMENTATION OF ELECTRONIC MONITORING SYSTEMS FOR THE TROPICAL TUNA PURSE SEINE FLEET. SCRS/2016/180 Collect. Vol. Sci. Pap. ICCAT 73, 818–828.
Ruiz, J., Oyarzabal, I., Santos, M., Santiago, J., 2020a. Estudio piloto de monitoreo electrónico para flota de bajura. Inf. Final. IM-19-EMSBAJU 56.
Ruiz, J., Oyarzabal, I., Santos, M., Santiago, J., 2020b. Estándares mínimos para el uso de sistemas de monitoreo de electrónico (SME) en flotas de curricán y cebo vivo del Cantábrico. Inf. Final. IM-20-SGP-EMS 54.
SPC-OFP, 2017. E-MONITORING PROCESS STANDARDS FOR OBSERVER DATA FIELDS ON PURSE SEINE CURRENT VERSION. CPS 17/801.

van Helmond, A.T.M., Catchpole, T., Mortensen, L.O., Plet, K.S., Zimmermann, C., Ulrich, C., Needle, C.L., Oesterwind, D., Kindt, L., Mangi, S., Jakob, H., Nick, O., Heidrikur, B., Jørgen, B., Elson, J., Hosken, M., Peterson, L., Mcelderry, H., Ruiz, J., Pierre, J.P., Dykstra, C., Jaap, J., 2019. Electronic monitoring in fisheries : Lessons from global experiences and future opportunities. Fish Fish. 1–28. https://doi.org/10.1111/faf.12425

11. Annexes

11.1. Draft IOTC Regional EM Programme Standards

DRAFT POLICY PROGRAMME STANDARDS FOR THE IMPLEMENTATION OF THE IOTC REGIONAL ELECTRONIC MONITORING PROGRAMME (REMP)

General

- IOTC Regional Electronic Monitoring Programme (REMP) shall be coordinated by the IOTC Secretariat.
- National data collection programmes using electronic monitoring systems that are certified as meeting the objectives, procedures and data minimum standards of the EMP as adopted by IOTC could be included within IOTC REMP.

Objectives

- The objective of implementing IOTC REMP is to collect verified catch data and other scientific information related to the fisheries for tuna and tuna-like species in the IOTC area of competence, and to support the implementation of the conservation and management measures adopted by the Commission.

Purpose:

- The purpose of IOTC REMP is to allow IOTC CPCs to complement other monitoring tools currently in place in the region (e.g. ROP) and to collect data where observer coverage is low or non-existent, that will improve the quantity and quality of fishery data and the monitoring of IOTC fisheries addressing data gaps in the collection and verification of fishery data.

Scope:

- IOTC's REMP provide a framework for the development of EMS in the following IOTC fisheries:
    - Purse-seine vessels over 24 meters overall length and under 24 meters LOA when fishing outside their EEZs,
    - Longline vessels over 24 meters overall length and under 24 meters LOA when fishing outside their EEZs,
    - Gillnet vessels over 24 meters overall length and under 24 meters LOA when fishing outside their EEZs,
    - Pole and line vessels over 24 meters overall length and under 24 meters LOA when fishing outside their EEZs,

    - Other gear types under 24 meters (when fishing in the high seas).
- IOTC's REMP, or any National EMP under IOTC's REMP, shall ensure that the data collected through EMS are documented and that all "Mandatory Reporting" as well as Optional for Reporting fields of IOTC Regional Observer Scheme minimum data standards fields, if necessary complemented with any additional monitoring programme (e.g. port sampling, biological sampling, etc.), are collected by EM.

Definitions:

- ***Electronic Monitoring (EM)***: the use of electronic devices to record and monitor fishing vessel's activities using video technology integrated with Global Position Systems (GPS).
- ***Electronic Monitoring System (EMS):*** all the vessel and shore-based components for collecting, analysing and reporting of EM records and implement EM Program.
- ***EM program***: a process administered by a national or regional administration that regulates the use of EM systems on vessels to independently collect and verify fisheries data and information responsible through a n implementing of an EMS in a defined area and/or fishery.
- ***EM Program standards***: the agreed standards, specification and procedures governing the establishment and operation of an EM Program, applicable to all components of the EM system.
- **EM Data standards**: the agreed data requirements by the Regional Observer Scheme that should be collected by the EM System.
- **EM records**: Imagery and sensor data recorded by an e-monitoring equipmen that can be analysed to produce e-monitoring data.
- **EM Data:** data produced through analysis of e-monitoring records that conforms with the EM data standards.
- **EM equipment**: a network of electronic cameras, sensors and data storage devices installed on a vessel and used to record the vessel's activities.
- **EM analysis**: the analysis of EM records to produce EM data.
- ***EM analyst***: a person qualified to analyze EM records, record and produce EM data in accordance with the EM Data standards and analysis procedure.
- ***EM review center***: local, national, or regional office facility where EM records are analyzed to produce and record EM data.
- ***EM coverage***: the proportion of vessels (or effort) by fleet that have an e-monitoring equipment and system installed and operational.
- ***EM review rate***: the proportion of e-monitored records (of vessel/fleet) that are reviewed/analysed to produce EM data.
- ***EM service provider***: a third-party provider of EM equipment (and/or system), technical and logistical services.
- ***EM service certified***: a third-party organization which is accredited by the appropriate national or regional authority to inspect and approve EM systems and equipment to ensure that EM data standards can be collected.

Data:

- Resolution 12/02 on Data confidentiality policy and procedures applies for the data collected/submitted by Regional or National EMPs with regards to data stratification,

policy for publishing the data in the public domain, and procedures for the safeguard of records.

- Data collected via EM should be provided in compliance with the requirements established by the Commission in Resolution 15/01 on the recording of catch and effort data by fishing vessels in the IOTC area of competence, Resolution 15/02 on mandatory statistical reporting requirements for IOTC Contrating Parties and Cooperating Non-Contracting Parties (CPCs) and Resolution 11/04 on a Regional Observer Scheme.
- EM National Programmes data ouputs should be submitted following data format specificartions provided by IOTC Secretariat to make them compatible with IOTC databases.

EM Systems

- EMS should be certified and accredited by IOTC Secretariat to ensure that minimum standards of the Programme including EM equipment installation, data minimum standards collection, accredited EM record analysis by companies/organizations, and independence of EM system are maintained.

Roles

- *IOTC Commission:*
    - To monitor and oversight the implementation of REMP, including those implemented through National Programmes, including the adoption and revision, when necessary, of minimum standards for EMS and data minimum standards.
    - To agree on overall EM implementation coverage objective as well on the analysis rate by fleet/CPCs.
    - To agree and develop an REMP implementation plan.
    - When necessary, the Commission may service REMP records to be reviewed by Regional review centers.
    - To ensure sufficient financial resources to effectively administrate IOTC's REMP.
    - To review IOTC's REMP after an initial period (e.g. 3 years) of IOTC's REMP implementation.
- *IOTC CPCs:*
    - To ensure that fishing vessels under its flag comply with the requirements established by the Commission for the purpose of IOTC's REMP implementation and are equipped with EMS to collect/analysis/submit data minimum standard fields to IOTC following aggregation levels required in Res 15/01 and 15/02.
    - To ensure that EM equipment are installed in their vessels to comply with the coverage objectives agreed by the Commission.
    - To ensure that EM implementation is consistent with IOTC's REMP and its minimum standards.
    - To collaborate to ensure national EM programmes are compatible and harmonized where necessary.
    - To ensure that national EM programmes are independent, transparent and

accountable.
    - To document the roles and responsibilities of fisheries government authorities and vessel owner/crew with respect to inter alia installing and maintaining equipment, routine cleaning of cameras, sending storage devices, access to E-Monitoring records and data, responses to mechanical or technical failure of E-Monitoring system.
    - The CPC shall provide the IOTC Secretariat with the contact details of their EM Programme Coordinator/s.
- *IOTC Secretariat:*
    - To certify EM National Programmes as meeting IOTC's REMP EM minimum standards.
    - To collaborate with the Commission and CPCs to ensure that EM national programmes are consistent and compatible with REMP and meet IOTC's REMP EM monitoring standards.
    - To summarize and provide annual reports about the progress of REMP, including EM national programmes, to the Commission and its Subsidiary Bodies.
    - To recommend improvements and adjustment to the REMP to ensure that data and monitoring requirements of IOTC Commission are met.
    - To coordinate EM activities with other tunaRFMOs as required by the Commission.

Guiding principles for operationalize IOTC's REMP

- CPCs should apply to the IOTC Secretariat to have its own national EM programme recognized as part of IOTC's REMP so as to comply with ROS data minimum standards.
- IOTC Secretariat shall audit, or facilitate audit by third parties, the national EM programmes against the EM minimum standards and, if EM national programme meets the minimum and quality requirements, the programme shall be considered accredited by IOTC.
- EM national programmes shall be reviewed and subject to regular and periodic audites as agreed by IOTC Commission.

11.2. Draft IOTC Regional EM Minimum Standards

MINIMUM STANDARDS FOR THE IMPLEMENTATION OF THE IOTC REGIONAL ELECTRONIC MONITORING PROGRAMME (REMP)

The IOTC Scientific Committee, closely with the IOTC Secretariat, should lead the development of Electronic Monitoring Minimum Standards and EM Data Standards..

Any EM National Programme to meet IOTC's REMP minimum standards shall require:

TECHNICAL MINIMUM STANDARDS of EM System

Customized to vessel level: There is not a standard configuration that will cover all vessels from fleets operating in the Indian Ocean region, therefore each EMS installation must be customized at the vessel level. An EM system to be installed on board of a fishing vessel should consist of a control system connecting a number of different sensors and a number of cameras to collect and record images to address the objectives of the EM Program. The number of cameras and sensors should be tailored to each vessel based on performance-standards to meet overall objectives of the program rather than being too prescriptive and should include a sufficient number of cameras. Previous experience has shown that at least 6 cameras are needed in large purse seines and 3 cameras in longline and pole and line vessels.

Include sensor: include sensors and indicators that monitor gear usage and fishing activity to show when fishing occurs. This will facilitate image revision and analysis.

Include Global Positioning System (GPS): to monitor vessel position, route, speed and provide information on date/time and location of fishing activities.

Tested (and certified) by a third party: All vendors should be equally valid, but all systems should be tested through pilot studies for a particular type of fleet (e.g. longline, purse seine, etc..) before being implemented and EMS providers certified by a third party (e.g. by IOTC).

Compatibility: the EMS should be capable of integrating with other Monitoring, Control and Surveillance (MCS) tools (e.g. Vessel Monitoring System).

Robust System: EMS components installed outdoors (such as cameras/camera housing and sensors) should be capable to resist rough conditions at-sea and harsh environment on board the vessels.

Secure System: Tamper proof system with encrypted data, near-real-time remote online "status checks " and GPS linked data/imagery.

Cameras: Digital, high-resolution when possible, cameras covering all areas of interest according to the vessel and fishing operations are recommended. The view and collection of the imaged must assure the detection of both catch and bycatch species, species correct ID,

and other fishing activities. The system should be able to record activities in low natural light conditions.

Independence: The system needs to be self-governing with the exception of minimal maintenance by crew (e.g. cleaning senses). The system should incorporate a self-test function to allow remote verification of its functionality at all times to collect all information. The master should ensure that the system is working properly before leaving port.

Data storage and autonomy: The system should have enough autonomy, and storage capacity, to store all recorded images a minimum of the duration of a common trip (around 4 months for PS and 12 months for LL).

Maintenance: The master should report to the competent authority (IOTC and flag state) when the system is malfunctioning in port or at sea and should be recorded any failure in the logbook. Rules of Procedures should be established for the vessels when the system fails.

LOGISTICAL MINIMUM STANDARDS of EM System

Data retrieval: ideally, it is recommended that the data is automatically transmitted via mobile networks, Wi-Fi, or satellite and when video footage is too big it should be transferred via hard drive exchange. Hard drive exchange and transmission should be regulated and centralized by the IOTC, when possible.

EM records backup: if data is automatically transmitted electronically, operational procesures for the receipt and back-up of EM records should be implemented taking into account any necessary chain of custody arrangements.

Hard drives chain of custody: The system must ensure traceability of every hard drive and information recorded on-board.

Frequency: the method and frequency (e.g. after the trip) of EM records transmission to data review centers should be established by CPCs/IOTC.

DATA ANALYSIS MINIMUM STANDARDS of EM System

Dedicated image analysis software: EM System should provide dedicated software to facilitate the review of images and to produce a common output format for exchange/submission to IOTC. It is also recommended that the analysis software could analyse data collected from different EM systems or vendors.

EMS data analysis and reporting: Data analysis and reporting should be done by institutions, organizations and independent companies with proven expertise and experience (e.g. work experience with on-board observers). This analysis could be centralized in a “regional image review center” when implementing a regional program or could be carried out by national organizations.

EMS data analysis quality check: EM record analysis should be quality controlled including data entry checks, automatic error identification, and debriefing as required and EM data analysis is checked for inconsistencies, quality and accuracy prior to reporting to the IOTC Secretariat.

EM coverage and risk based review analysis: EM system should be incorporated in a level agreed by the Commission (e.g. 100% of vessels), however, in the case that a 100% of EM is implemented, it is not recommended to review 100% of the images. IOTC should agree whether a fix coverage rate (e.g. 20% for bycatch species) or risk based review rate analysis is implemented. It is recommended that the vessel data and video footage review should be based on risk-analysis in order to meet the goal of the EM program. Although not the primary objective of the EM Program, unless decided otherwise by IOTC Commission, this risk-based approach could contribute to monitor compliance with IOTC Data Resolutions. At a minimum observer coverage required is that specified by the Commission in Resolution 11/04.

EM data: EM system should collect at a minimum, the ROS Minimum Standard Data Fields using IOTC standard codes and EM will be submitted to the IOTC Secretariat according to the time frame specified in Resolution 11/04, or any superseding Resolution. Data confidentiality requirements outlined in Resolution 12/02, Data Confidentiality Policy and Procedures, or any superseding Resolution, shall apply to all EM data.

Office observers' training: EM data analysts must have specific qualifications which should be integrated in the EM program standards. The data analyst/reviewers should participate in specialised and regularly updated training courses to ensure EM analysis high-quality standards and level playing field.

Office observer's qualifications: EM data analysts must have the ability to review and record data accurately on IOTC Resolutions, are familiar with fishing activities and are capable to identify (i) IOTC species and species of especial interest, (ii) IOTC Fishing methods and (iii) IOTC mitigation methods among other questions.

Compatible with ongoing standardized data flow and databases: Compatible data output format (including usage of standardized, well-established code lists) to exchange collected information with current IOTC data reporting format and standards and consistent with IOTC data rules. EM record will be submitted in an approved electronic data reporting format to the IOTC Secretariat, using IOTC standard codes and units

Data Storage and retention: Legal provisions on data protection, storage and retention by IOTC should be developed and agreed whether it is an EM Regional Program or National Program.

Data Ownership: if an IOTC EM regional program is established, EM system data (raw video footage) should be property of IOTC. Otherwise, if EM National programs are developed within a region, the EM system and raw data ownership is of the vessel owner/flag state but should provide IOTC with the EM analysis data outputs to incorporate in IOTC database for use, analysis, and disposal.

Hardware/software ownership: irrespective of the scope of the program, it is recommended that hardware and software ownership (and maintenance) is of the vessel owner.

EM implementation: to advance on the implementation of EM Program in IOTC and to progress on the development of EM Program Standards as well as EM Data Minimum Standards, it is recommended to establish an ad-hoc Working Party on Electronic Monitoring to develop further the recommendations above and EM Program Standards to be presented to IOTC Scientific Committee and Commission for their approval.