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

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ABSTRACT

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 Endangered, Threatened and Protected (ETP) species.

EM pilot tests in different regions on tuna purse seiners and longline vessels, and potentially in small-scale artisanal fisheries, have demonstrated the validity of this technology to improve the collection of fishery data. The IOTC endorsed the use of EM to assist in collection of fishery data to meet the minimum data requirements of Resolution 22/04 (on the Regional Observer Scheme) but requested that the IOTC Scientific Committee to firstly develop minimum standards for the implementation of Regional EM Program by 2023.

In support of this request, this document presents:

- Firstly, key background information on the different components to be covered by standards developed to support implementation of a regional EM program.
- Secondly, draft EM Standards for WGEMS review including:
    a. Draft **Regional EM Program Standards** – covering program objective, purpose, scope, roles/responsibilities, guiding principles and vessel monitoring plans
    b. Draft **EM Systems and Data Standards** – covering the technical standards (for vessel EM systems), the logistical standards (for data retrieval, back up, chain of custody and frequency) and data analysis standards (including data review, quality, coverage, submission, storage, ownership, etc.)
- Thirdly, an assessment of EM capability to collect ROS data in different fisheries. This assessment is important in order to verify the capability and ensure the replicability and accuracy of the information collected through EM (e.g., compared to data collected by human observers) with the purpose of improving the stock assessment and management process.

Thus, this document aims to foster the discussion on the development of EM minimum standards, for the implementation of Electronic Monitoring Program (EMP) for IOTC fisheries to address WGEMS ToRS as well as Resolution 22/04 requirement.

KEYWORDS

Electronic Monitoring, Minimum Standards, EM Program, EM Equipment

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1. Introduction

Observer programs have been widely established in commercial fisheries to augment and improve the scientific information available on catch by species, size composition of the catch, fishing effort, vessel and fishing gear characteristics, bycatch and discards, interactions with Endangered, Threatened and Protected Species (ETP), and 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 are sometimes used to verify compliance with management measures as a means to strengthen Monitoring Control and Surveillance (MCS) systems and increase fisheries transparency (Ewell et al., 2020). For example, it has been shown that catch statistics and levels of bycatch discarded at sea 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 and Central Pacific Fisheries Commission (WCPFC).

In the case of IOTC, the Regional Observer Scheme (ROS) established under Resolution 11/04 aims to collect verified catch data and scientific information. IOTC Resolution 11/04 requires the collection of independent data on fishing activity through human observers for at least 5% of the operations for each gear type. In 2022, the IOTC Commission adopted Resolution 22/04 *on a Regional Observer Scheme* (replacing Res 11/04), which requests "*the **IOTC Scientific Committee, in collaboration with the Compliance Committee, to develop and agree on minimum standards for the use of EMS for purse seine, longline, bait boat (pole and line), handline, and gillnet fleets by 2023 at the latest**, including on modalities of the substitution of the human observer coverage by an EMS, taking into account factors such as, the principles and regulations regarding minimum safe manning requirements. The Commission may consider and adopt these standards by 2024 in a separate Resolution".* Moreover, the Resolution stated that "*Once the **EMS standards are adopted and providing CPCs meet the minimum mandatory ROS data reporting standards, the minimum human observer coverage provided for in paragraph 3 may be complemented or substituted by means of an EMS**. To ensure the minimum mandatory ROS data reporting standards are met, the EMS may be complemented by port sampling and/or other Commission approved data collection methods. And CPCs are encouraged to use an EMS to improve the collection of scientific data before the standards mentioned in paragraph 4 are adopted.*

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 (EMS) 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 to obtain reliable information on catches and their composition, as well as to monitor and collect data on bycatches of protected species, as well as to validate and improve the accuracy of catches reported on logbooks by fishers. However, before considering the wide application of any EM system 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 important to assess the congruence between EM and data from scientific observers, to verify the capabilities 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) to improve the stock assessment and management process (Emery et al., 2018; Gilman et al., 2020; van Helmond et al., 2019). In 2019 the IOTC Commission endorsed the ***ROS minimum standard data fields for scientific observer data collection***, which were further refined in 2021 (IOTC-2021-WPDCS17-11). Therefore, any EM system specifically implemented in the IOTC with the purpose of complying with Resolution 22/04 is expected to collect all required ROS mandatory data fields in those circumstances when EM is the only data collection mechanism available.

Thus, this paper provides draft IOTC EM minimum standards for the implementation of EMS for IOTC fisheries for WGEMS discussion and consideration.

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 EM program requirements, installation onboard (number and position of cameras, component installation, software requirements, etc.), the data fields to be collected and how this is achieved, policies on data usage, and footage revision and ownership. In addition, the document evaluates EMS' capabilities to collect the IOTC ROS minimum standards data fields as per the latest requirements.

2. Objectives and Scope of the IOTC EMP

In line with Resolution 22/04 *on a Regional Observer Scheme*, the objective of implementing an Electronic Monitoring Program (EMP) in the IOTC ***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***. The purpose of IOTC EMP is to allow IOTC CPCs to complement or substitute the minimum human observer coverage of the ROS (i.e., 5% of number of operations/sets) with EM based data collection, provided that minimum standards agreed by the IOTC are met.

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 and observer Programs (IOTC 2021). Resolution 22/04 is 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. EMS to collect the necessary fishery data 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 m LOA (or under 24 m LOA if fishing outside),
- Longline vessels over 24 m LOA (or under 24 m LOA if fishing outside),
- Gillnet vessels over 24 m LOA (or under 24 m LOA if fishing outside),
- Pole and line/handline vessels over 24 m LOA (or under 24 m LOA if fishing outside).

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 Program should be designed to account for all the differences in terms of technical specifications, coverage 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 Program.

3. IOTC ROS minimum standard data fields

Following the establishment of the first Resolution *On a Regional Observer Scheme*, the IOTC Scientific Committee (SC) 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 SC to elaborate an observer working manual, a set of templates to be used for reporting purposes (including minimum data fields) and a training program.

The SC 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 SC.

Following a consultation workshop in 2018, convening experts from several oceans and fisheries, the IOTC SC 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 Program, however the Commission could also request to review the standards based on the comments and feedback received during the implementation phase.

The ROS Program Standards includes, among others, requirements about observer coverage, observer program verification by IOTC, observer Program 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.

The IOTC ROS (Resolution 22/04) requires observers to:

- record and report fishing activities, verify positions of the vessel;
- observe and estimate catches with a view to identifying catch composition and bycatch and to monitoring discards including their fate (e.g., released alive) and size frequency;
- record the gear type, mesh size and attachments employed;
- collect information 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 such scientific work (e.g., collecting samples), as requested by the IOTC SC.

One of the key aspects of this revision process was the definition of updated ROS *minimum standard data fields* that were adopted by the IOTC Commission in 2019 (See Annex 8.1). This standard describes the minimum mandatory data to be collected and reported to the IOTC as well as supplementary information that could be collected but not necessarily shared with the IOTC Secretariat.

4. Background information relation to EM standards

Several pilot studies have been conducted to determine the effectiveness of EM technology in tuna purse seine (Briand et al., 2018; Chavance et al., 2013; Murua et al., 2020b, 2020a; Ruiz et al., 2015) and longline fisheries (Emery et al., 2019a, 2019b, 2018; Hosken et al., 2016a,

2016b; ISSF, 2016) and EM has already been fully implemented by at least one IOTC CPC (AFMA, 2020). Although systems developed by different vendors showed diverse strengths and weaknesses, in general EMS demonstrated the potential of this technology as a monitoring tool in both the tuna purse seine and longline fisheries as seen in the tables below (See Annex 8.1). The results indicate that, with some adjustments, EM can be a valid tool to monitor most of the data fields required by IOTC ROS minimum standards used for estimating fishing effort, total catch by set, and bycatch.

Considering the above, it is advisable that the IOTC Commission further develops and adopts EM Program Standards and EM Minimum Data requirements, as these would help framing the procedures through which EM systems are installed, determine the data to be collected, reviewed and stored, clarify and agree upon data ownership, and be considered as the *minimum* specifications that EM systems and program participants should meet (Michelin et al., 2020).

These standards are necessary to create compatibility among different participants to a region-wide EM program network, so that data collected from the analysis and review of EM video is consistently reported to IOTC, collated in a Regional Database and disseminated in a format that enables comparison of information across similar fleets.

EM standards should address questions arising from the overall program design (EM Program Standards), including the objectives and strategies/details on how to achieve minimum coverage rates, technical considerations such as the definition of the entire flow of EM data (EM Data Standards) from EM installation, collection of images for further analysis, and 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/Program, 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 and scope of the program, and **EM Data Standards** which – in addition to the minimum data collections requirements – drive the technical specifications and requirement for EM systems to record, retrieve, review, store, access, and report data to the IOTC.

For example, the minimum standards should standardize/establish the protocol for installation of EM onboard equipment 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 IOTC data flows so as to ensure the system enables CPCs to submit the EM data in IOTC required standard format.

While EMS also have great potential for other types of fishing vessels (e.g. gillnet), the focus of this document is to define the minimum standards for the implementation of the EMS in IOTC industrial purse seine, longline and pole and line fisheries operating in the Indian Ocean. Similar standards are being currently developed for purse seines and longlines in the IATTC, ICCAT, and WCPFC. Guide documents on EMS minimum standards for tropical tuna purse

seine and longline fisheries developed elsewhere could be used to draft the EMS minimum standards of IOTC (AFMA, 2020; Murua et al., 2022; Restrepo et al., 2014; Roman et al., 2020; Ruiz et al., 2017, 2016).

4.1. EM Program Standards

4.1.1. Objectives

The objective of the IOTC EM program, as described in IOTC Resolution 22-04 on Regional Observer Scheme, is to collect verified catch data and other scientific data related to the fisheries for tuna and tuna-like species in the IOTC area of competence. The observers' tasks under the IOTC Regional Observer Scheme (IOTC Resolution 22/04) are summarized 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. IOTC Resolution 22/04 requests that each CPC shall ensure that all fishing vessels of 24 m LOA and above and under 24 m LOA, if they operate outside the EEZ of the flag CPC and in the IOTC area of competence, comply with the minimum observer coverage of 5% as defined by the number of operations/sets. How this is achieved by EMS should be discussed but ideally it should be representative of the different fleet components of each CPC.

4.1.2. Institutional Structure and management of the Program

CPCs wishing to implement EM on vessels fishing in the IOTC, to help the CPC meet the minimum data requirements of the IOTC ROS, should establish a national EM program either separately to or as part of their national observer programs.

On the other hand, national programs pooled between countries or a Regional EM Program may also be established. In this case, Regional EM Program will 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 national 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 data (i.e. IOTC databases), how to perform quality assurance of EM review centers, who will be responsible for training the EM analysts (and how), how to audit and certify all EM equipment installations, how to collect EM records and submit EM data, 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 EM analyst 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 Program, 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 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.

4.2. EM Data Standards

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.

4.2.1. 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) (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 specific details such as the number and placement of cameras. EM equipment technical specifications should also be general and not very prescriptive to permit the use of future developed technologies. As such, the system should be customized and tailored to each individual vessel (or type of vessel) with no standard configuration expected to be necessarily applied to all vessels in a given fleet, but rather with each installation being customized at the single vessel level.

Considering the objective and the minimum data fields of the IOTC ROS, EM systems 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 field-of-views (FOV) of the imaging equipment can be identified on a general level, although they could vary from vessel to vessel. In this regard, crew cooperation is crucial and it is necessary that ship owners authorize access to the vessels for an effective installation of

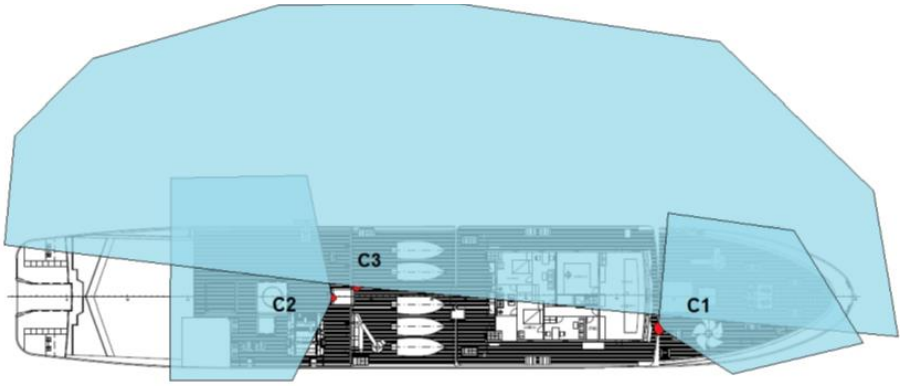
EMS equipment, and that the crew is involved in the process of selecting the best possible placement for the cameras. **Each vessel should develop a "Vessel Monitoring Plan" so as to define how many and where cameras are located to collect the required ROS minimum data fields. Vessel Monitoring Plans should be reviewed by the CPCs fishery management agency and presented to the WGEMS/WPDCS to ensure it meets IOTC standards.**

On purse seine vessels, the minimum areas that cameras are recommended to cover:

- the working deck (both port and starboard sides),
- the net sack and the brailer,
- the foredeck or amidships (e.g., FAD activity),
- and the well deck and conveyor belt (Murua et al., 2022; Restrepo et al., 2018): for the conveyor belt, in more than one place (e.g. at the beginning and at the end of the conveyour belt as a minimum). If a discard conveyor belt exists, it should also be covered.
- Cameras must cover the following actions: fishing set, brailing, net hauling, FAD activities, total catch, catch well sorting (process of putting the catch in the hold or wells), bycatch handling and release, and tuna discards (**Figure 1 and Table 1**).
- In large purse seines, at least 6 cameras are needed to cover fishing and fish-handling operations; however, less fewer cameras (e.g. 4 cameras) could cover the activity to collect the data required of smaller purse seines (e.g. 300-400 tonnes capacity).

The preferred EM equipment configuration would be the one that allows a greater number of images (frames) of higher quality/resolution. Digital video is generally preferred, but still images can also be a viable option to capture information during the various phases of the vessel activity. However, considering that storage capacity is limited, an optimal configuration may have video on certain areas/cameras/moments, while still photos on others. In the case of photographs, the minimum requirement should be that a picture is taken by the camera with viewing angle fully covering the fish management areas at least every 2 seconds when fishing action occurs (Restrepo et al., 2018). Image quality should also be adequate enough to allow accurate collection of all required data field, such as species ID, FAD materials and design, or bait used and, hence, achieve the monitoring objectives.

A


C3
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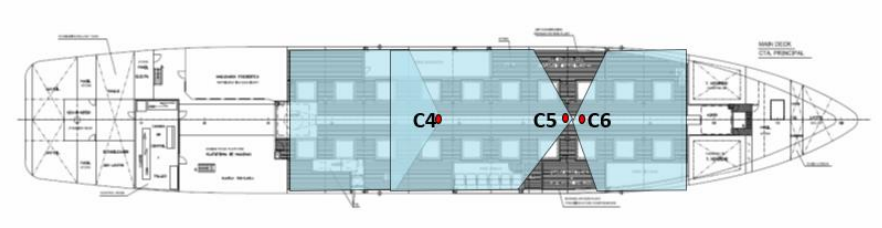
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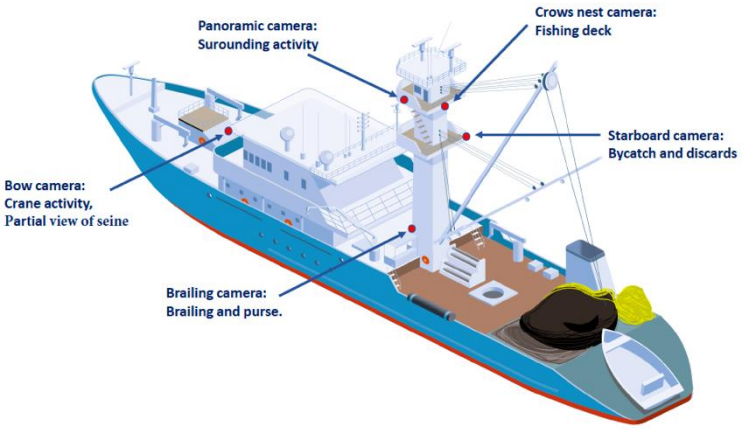
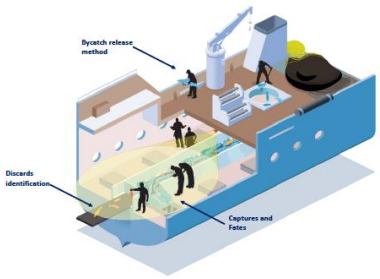
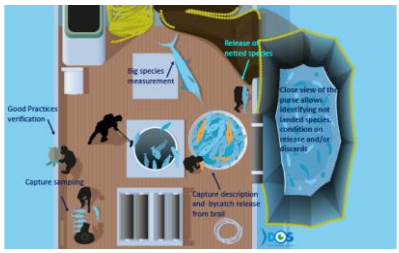

Panoramic camera:
Surounding activity
Crows nest camera:
Fishing deck
Starboard camera:
Bycatch and discards
Bow camera:
Crane activity,
Partial view of seine
Brailing camera:
Brailing and purse.


Bycatch release method
Discards identification
Captures and Fates


Release of netted species
Big species measurement
Good Practices verification
Capture sampling
Capture description and bycatch release from brail

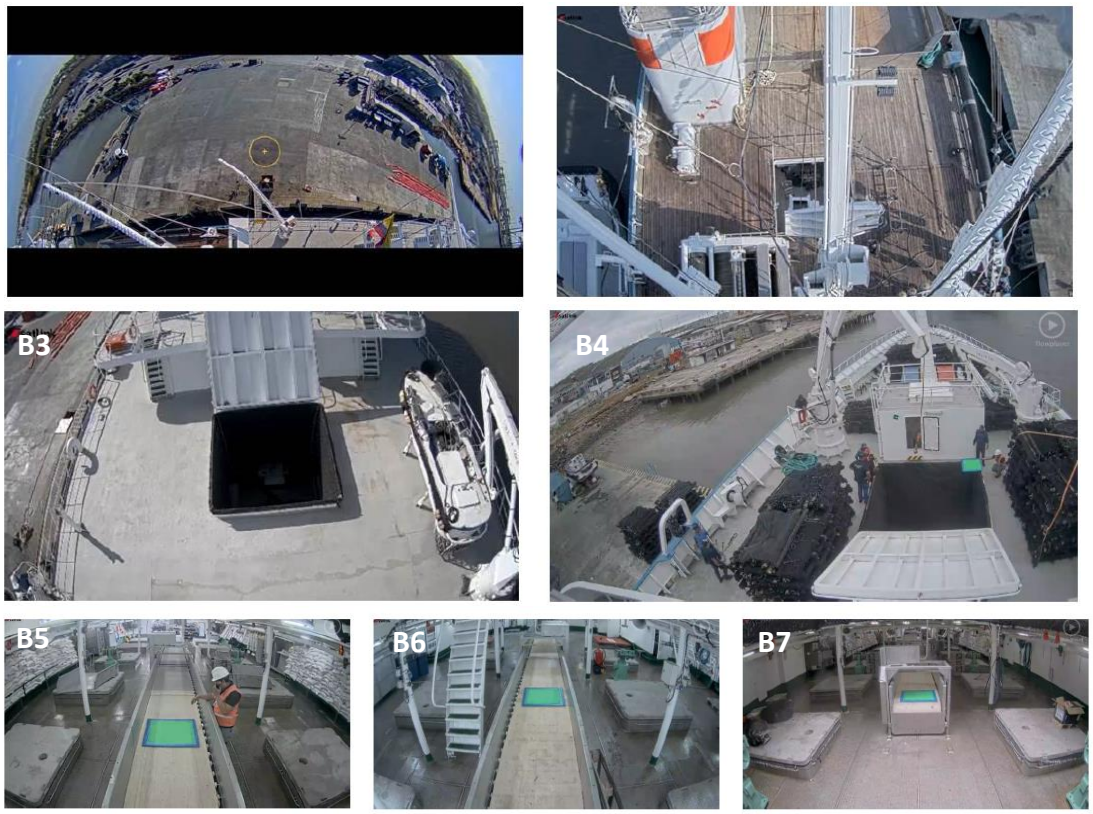


Figure 1. (A) 6-cameras EM system installed in a purse seine covering main areas of fishing and fish handling operations (from Murua et al., 2020b) and (B) 7-cameras EM system (4 in the upper deck and 3 in the well deck) installed in a purse seine covering main areas of fishing and fishing handling operations 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 1. Minimum areas and actions that should be monitored (adapted from Murua et al., 2022; 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 estimation	number of individuals handling mode Species ID
Work deck (starboard side)	Bycatch handling	Bycatch estimation	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 and safe-release of individual animals (whale sharks, manta rays…)	Total bycatch by set . Application of handling and safe-release best practices	Handling mode
	Bycatch release of big	Total bycatch by	Number of individuals and species ID

	species (whale sharks, manta rays…)	set Application of handling and safe-release best practices.	
Foredeck or amidships	FAD activity (deploying, replacement, reparation…)	Total number of FAD deployments, FAD design and 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
	Estimation of bycatch discards, releases or retention	Total bycatch by set Species composition Application of handling and safe-release best practices.	Number, size or weight of individuals, species ID and fate

On longline vessels, the minimum areas and activities that cameras are recommended to cover (**Table, 2, Figure 2**):

- The area of setting the longline (usually vessel stern site camera),
- the area of hauling the longline,
- the working deck where catch is handled,
- and the surrounding water area for those discarded species not brought onboard
- Cameras must cover the following actions: setting of the longline, bait type information, whether mitigation techniques are being used (e.g. tori lines for seabirds), hauling of the longline, all hooked species (both retained and discarded), the fate of the catch, and the size of the specimens.
- On most 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 (Murua et al., 2020a). And additional camera to cover the surrounding water area for those discarded species not brought onboard is also recommended.

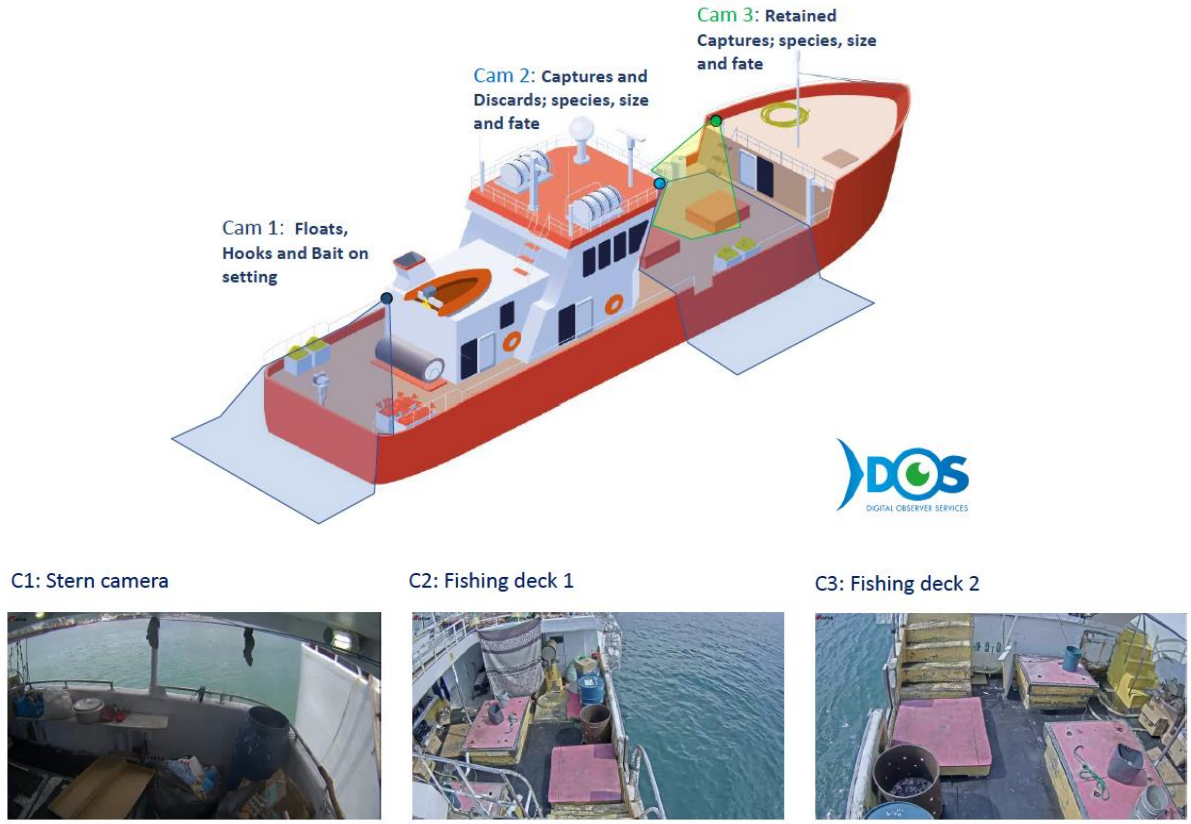


Figure 2. 3-cameras EM equipment installed on a longline covering main areas of fishing and fish handling operations. View of the 3 cameras: (left panel) Stern camera - setting longline providing information on hooks, floats, mitigation techniques and bait; (middle panel) Fishing deck 1 - hauling information,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

Table 2 – General configuration and areas/activities covered by the EM system onboard tropical tuna longline vessels

Area covered	Action covered	Minimum data requirements to be monitored
Stern camera of the boat	Start and end setting operation	Position, date, and time
		Total number of hooks set and between floats
		Total number of floats set
		Bait type
		Bait species
		Bait ratio (%)
		Mitigation measures/marine pollution
Work deck	Catch onboard	Length and weight4 by capture
		Condition
		Fate
		Predator observed

[4] Estimated through length-weight relationships.

	Bycatch discarded, released, or retained	Total bycatch by set and species composition
Processing area	Catch	Total catch by set
		Length and weight1 by capture
		Sex
		Fate
Surrounding water area	Start and end hauling operation	Position, time and date
	Estimation of bycatch discards, releases or retention	Total bycatch by set and species composition
		Species condition and fate

On pole and line vessels, the minimum areas that cameras are recommended to 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 Biscay (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 (e.g., presenting the results of the tests at the IOTC WGEMS or WPDCS for its endorsement), preferably through pilot studies before being implemented in a monitoring program. For example, As the EM system should be customized and tailored to each individual/type of vessel with no standard configuration expected to all vessels in a given fleet, ***an EM Vessel Monitoring Plan customized at single vessel level should be described by the vessels/CPCs to be reviewed by IOTC (e.g., WGEMS/WPDCS) so as to ensure that the EM system is installed to collect the required data and meet IOTC standards.***

EM equipment 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 components and data need to be tamper-evident (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 uninterruptible power supply (e.g., 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.

4.2.2. EM Data collection, storage and submission

As noted above, current EM systems could generally record several of, but not all, the ROS minimum data fields. 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. In some cases, EM data collection should be complemented by observes or samplers at landing site (e.g., biological sampling) to guarantee the fulfilment of all data collection obligations of the IOTC ROS.

EM systems should have enough autonomy and capacity to safeguard and store all recorded images and sensor information for a certain period of time. This should correspond – as a

minimum – to the duration of a complete fishing trip, which depends on the operational characteristics of the vessels and generally ranges from 4 months, in the case of purse seiners, to 12 months or more in the case of longliners.

Therefore it is crucial to guarantee a good balance between EMS image quality and data storage capacity and reliability (which comes at a non-negligible cost). For this reason, it is recommended that EM systems revert on using solid state storage devices (SSD) which have no moving mechanical components, and therefore are more resilient to adverse at-sea conditions although with a generally higher price per GB of capacity when compared to regular HDDs. It is also highly recommended that EMS adopt industry-grade data redundancy mechanisms (regular backups on separate storage units, multiple devices arranged in RAID configurations, etc.) to guarantee that data are not lost if one or multiple storage devices fail.

A protocol to recover storage devices and send them to the designated review and analysis centres should also be implemented. Among other issues, it is important that this protocol establishes the maximum period permitted between the recording and the moment of the analysis (e.g., to meet IOTC data submission guidelines or to facilitate the correction incorrect data). Moreover, IOTC should agree the minimum duration of time for which EM records shall be storage. EM systems must also ensure full traceability of every storage device and all information therein recorded onboard. The chain of custody of the EMS storage devices should be guaranteed, ideally by enforcing that these are retrieved and submitted by a third party with no conflict of interest (such as the IOTC Secretariat, if a regional EM program is implemented, and/or at sea observers, technicians in charge of installing EMS systems, and land observers if a national program is implemented instead).

4.2.3. 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. Such software shall enable the analysis of all stored data, including images and sensor information in a synchronized way, and shall be capable of supporting all analysis and reporting efficiently. Ideally, the software should allow identifying and recording all IOTC ROS data fields marked as "*mandatory for reporting*" and its output format, including the results of the image analysis process (but not the EM records), should be compatible with electronic data reporting requirements of IOTC or flexible enough to support the export of EM data through several different file templates. EMS analysis software should be capable of analysing EM records collected from different EM systems or vendors (and viceversa, EM equipments should be able to store EM records in formats compatible with different EM system analysis software). EM record analysis should be quality controlled, including through redundant data entry checks, automatic error identification, and debriefing as required.

Yet, original video EM records are important assets and, therefore, they should be properly stored for a limited period of time. The duration of EM record storage should be decided by IOTC REMP or the national EM programmes but it is recommended to be, at least, one year. In this regard, and to overcome the inherent issues arising from the limited local storage, uploading video material "in the cloud" should be an encouraged practice (when feasible) to

keep records for longer periods of time when further revisions and analysis of data are a concrete possibility (e.g. compliance, changes in fishing practices).

4.2.4. EM Ownership, management and confidentiality

Similar to the regional observer scheme data, and for other types of fishery statistics data in IOTC, the vessel/flag state owns the raw data (i.e., EM records) but is requested to report to the IOTC the EM data for SC 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 ownership of the equipment (and the cost) is responsibility of the vessels' owner and/or CPC, similar to what already happens for the procurement of other equipment such as Vessel Monitoring Systems or ROS.

4.2.5. EM Maintenance

The EM equipment should be programmed to send automatic alerts of malfunctioning in real time to EM Program managers. 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.

5. Draft IOTC EM Standards

5.1. General

EMS are capable of collecting many 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 as defined in IOTC Resolution 22/04.

EM standards should address questions arising from the overall program design (EM Program Standards), including the objectives and coverage rates, and technical considerations (EM Data Standard) such as the definition of the entire flow of EM data 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/Program, which will ensure that data is collected and submitted accurately and in due course to the IOTC for their analysis.

IOTC EM Program should be managed, similar to the IOTC Regional Observer Scheme, through IOTC regional EM program or EM National Observer Programs.

5.2. IOTC EM Program Standards

General

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

Objectives

- The objective of the IOTC REMP is to collect, via EMS, verified catch data and other scientific data related to the fisheries for tuna and tuna-like species in the IOTC area of competence.

Purpose:

- The purpose of IOTC REMP is to allow CPCs to utilise EM to collect data to assist CPCs in meeting the requirements of Resolution 22/04, including in situations where human observer coverage is low or non-existent. The REMP aims to improve the quantity and quality of fishery data and the monitoring of IOTC fisheries and address gaps in the collection and verification of fishery data. The REMP may also in future help CPCs to meet the requirements of other IOTC Resolutions.

Scope:

- The implementation of EMS in IOTC CPC fisheries is not mandatory. The IOTC's REMP and associated minimum EM standards (including this standard) **apply only to IOTC CPCs who are developing or who have implemented EM as a data collection tool** to meet the requirements of IOTC Resolution 22/04.
- IOTC's REMP provides a framework for the development of EMS in the following IOTC fisheries:
    - Purse-seine vessels over 24 meters length overall and under 24 meters LOA when fishing outside their EEZs,
    - Longline vessels over 24 meters length overall and under 24 meters LOA when fishing outside their EEZs,
    - Gillnet vessels over 24 meters length overall and under 24 meters LOA when fishing outside their EEZs,
    - Pole and line vessels over 24 meters length overall and under 24 meters LOA when fishing outside their EEZs,
    - Other gear types under 24 meters length overall (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 ROP minimum data standard requirement (e.g. "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 Program (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 implementing an 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 an implementing of an EMS in a defined area and/or fishery.
- ***EM Program standards***: the agreed standards, specification and procedures (SSP) 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 IOTC Regional Observer Scheme (ROS) that should be collected by the EM System.
- ***EM records***: Imagery and sensor raw data recorded by an e-monitoring equipment that can be analysed to produce EM data.
- ***EM Data***: processed/analysed data produced through analysis of EM 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 review and analyze EM records, store and produce EM data in accordance with the EM Data standards and analysis procedure.
- ***EM review system***: application software used by the EM analyst to review and analyze the EM records and produce the processed EM data as per the EM data standards.
- ***EM review center***: local, national, or regional office facility where EM records are received and analyzed to produce and record EM data.
- ***EM review provider***: a third-party provider of EM review services to analyse EM records to produce EM data. The same third-party organization can provide both the EM equipment and EM review service but they can also be provided by different providers.
- ***EM coverage***: the proportion of vessels (or effort) by fleet that have an e-monitoring equipment and system installed and operational.
- ***EM review or analysis rate***: the proportion of e-monitored records (of vessel/fleet/trips/sets) 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.

EM Systems

- EMS should be certified and accredited by the IOTC Secretariat (e.g., IOTC WGEMS/WPDCS) and/or CPCs to ensure that the minimum standards of the REMP (and ROS) are met, including EM equipment installation (through a EM Vessel Monitoring Plan), collection of data consistent with ROS minimum data standards, accredited EM record analysis by companies/organizations, and independence of EM system are maintained.

Data:

- Data submitted by Regional or National EMPs are subject to Resolution 12/02 *on data confidentiality policy and procedures* concerning the requirements for sharing data in the public domain (e.g., the level of stratification to apply in order to prevent activity from a single vessel to be clearly identified from the published data) and the procedures for the safeguard of records.
- Data collected via EMS 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 Contracting Parties and Cooperating Non-Contracting Parties (CPCs) and Resolution 22/04 on a Regional Observer Scheme.
- EM National Programs data outputs should be submitted in accordance with the electronic data format specifications provided by the IOTC Secretariat and adopted by the IOTC Commission, in order for data to be incorporated in the IOTC Regional Observer Scheme database, and be properly marked in order to be distinguished from data collected through human observers.

Roles

- *IOTC Commission:*
    - To monitor and provided oversight of the implementation of the REMP, including those implemented through National EM Programs.
    - To adopt and revise, when necessary, minimum standards for EMS Program, technical specifications, and associated data collection.
    - To agree on overall EM implementation coverage objective as well on the review rate by fleet/CPCs, which currently is a minimum observer coverage of 5% of the number of operations/sets by CPCs (i.e., Resolution 22/04).
    - To develop and adopt a 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:*
    - In case they choose EMP to meet Resolution 22/04, 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

required in Res 22/04 and ROP minimum data standard fields following aggregation levels required in IOTC Res 15/01 and 15/02.
    - To require all and each vessel to develop a Vessel Monitoring Plan (see below) to be delivered to the CPC competent authorities.
    - To ensure that EM equipment are installed in their vessels following a Vessel Monitoring Plan to collect the required data and 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 Programs are compatible and harmonized where necessary.
    - To ensure that national EM Programs 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 Program Coordinator/s.
- *IOTC Secretariat:*
    - To certify EM National Programs are meeting IOTC's REMP EM minimum standards.
    - To collaborate with the Commission and CPCs to ensure that EM national Programs 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 Programs, 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 tuna RFMOs as required by the Commission.

EM Vessel Monitoring Plan

- The implementation and operation of EMS on individual vessels must meet the requirements of the IOTC EM System and Data Standard.
- However, there is no a single standard EMS configuration that ensure all vessels can meet that standards. Therefore, to meet IOTC EMS standard, each vessel EMS installation will need to be customized at the individual vessel level to take account of vessel characteristics, so as to optimize sensor performance and the quality of the EM record footage and subsequently the EM data that is collected.
- The vessel specific characteristics of the EMS and how the vessel EMS is optimized to meet the EM System and Data Standard must be recorded on a Vessel Monitor Plan (VMP) for each vessel.

- The Vessel Monitor Plan shall be developed in collaboration with the EMS provider, vessel owner and fishing authorities.
- The Vessel Monitoring Plan will describe the numbers of cameras, position and settings, and key areas to be monitoring for fishing activities, catch handling, species identification, fate and storage of the individuals.
- The Vessel Monitoring Plan should include information on:
    - Contact information: Contact information for the vessel owner, vessel operator and EMS service provider as long as the contract lasts.
    - General vessel information: Basic information about the vessel and its fishing activities and operations (e.g., vessel name, registration number, target fishery, areas, fishing gear, LOA…).
    - Vessel layout: Equipment of the vessel with detailed information, plan of the vessel disposition and different areas (deck, processing, storage, etc.).
    - EMS equipment set up: Description of the settings of the EMS system, such as time running, number of cameras and areas covered, time recording for each of the cameras, number of sensors, software used, control box disposition…
    - A shot of each camera should be inserted in the VMP.
- The VMP should be signed off by the vessel owner and finally approved by the flag State competent authority.
- Any physical changes on a vessel that will affect EMS should be reported to the flag state competent authorities. The VMP should be updated and approved again by the competent authority before the next fishing trip can take place.

<u>Operationalising IOTC's REMP – Accreditation and Auditing of National EMPs</u>

- CPCs should apply to the IOTC Secretariat to have its own national EM Program 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 Programs against the EM minimum standards and, if EM national Program meets the minimum and quality requirements, the Program shall be considered accredited by IOTC.
- EM national Programs shall be reviewed and subject to regular and periodic audites as agreed by IOTC Commission.

5.3. IOTC EM System and Data Standards

As requested by the Resolution 22/04, the IOTC Scientific Committee, in collaboration with the Compliance Committee, shall develop and agree on minimum standards for the use of EMS for purse seine, longline, pole and line, handline and gillnet fleets by 2023.

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

TECHNICAL MINIMUM STANDARDS of EM Systems

The Technical Minimum Standards shall describe the requirements of the EM system. CPCs shall ensure all EM systems installed in their national or subregional programs are consistent with these technical specifications

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. Although it will depend on the configuration of each particular vessel, as a general setup, cameras shall capture the areas stated in **Table 1 and 2 and Figure 1 to 3 of this document**. Each vessel should develop a "Vessel Monitoring Plan" so as to define how many and where cameras are located, and their settings, to collect the required ROS minimum data fields.

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 EM Systems should be equally valid, but all systems should be tested through for a particular type of fleet (e.g. longline, purse seine, etc..) before being implemented.

Compatibility: the EMS should ideally 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: The EM system components and data need to be tamper-resistant and tamper-evident, with encrypted data, such that attempts at unauthorized modification are difficult to hide.

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 images must assure the detection of fishing activities, catch and bycatch species, and enable correct species IDs. The system should be able to record activities in low natural light conditions. The cameras must be water resistant and in a self-contained, weather resistant box.

EM Records: EM records shall contain the following information: EM Record file name including, at a minimum, the vessel name and vessel ID and trip ID, camera number, geolocation data (date, time (UTC), latitude and longitude), sensor data, camera recording status, EM system status, images.

Independence: The system needs to be self-governing with the exception of minimal maintenance by crew (e.g. cleaning sensors and cameras). The system should incorporate a self-test function to allow remote verification of its functionality on real time to collect all information. The master should ensure that the system is working properly before leaving port, and a protocol (checklist) should exist for that purpose. EM should not generate or cause radio frequency interference with other on-board vessel communication, navigation, safety, geolocation devices (e.g., VMS) or fishing equipment

Autonomy: The EM system should have its own uninterruptible power supply to ensure that it can work even in the event of a vessel power outage. The EM system should include separate, duplicate backup devices to ensure that data are not lost if a storage device fails.

Data storage autonomy: The EM system should have enough storage capacity to store all recorded images and sensor information for a certain period of time, which should be at minimum a complete trip. The duration will depend on the vessel's 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).

Interoperability: Generate data that are interoperable and, where possible, integrate with other data collection and monitoring tools.

Maintenance: The master should report to the competent authority (IOTC or flag state and EMS provider) when the system is malfunctioning in port or at sea and should record any failure in the logbook so the system is repaired as soon as possible. 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. For the latter, a protocol to recover the hard drives and send them

to the designated review and analysis centers also should be implemented. EM records should be in storage for at least 1 year by the vessel/company/vendors or for the period established in the national EM programs. When Regional EMP is designed, 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 procedures 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 EM system must ensure traceability of every hard drive and all information recorded onboard. The chain of custody of the EM system hard drives should be assured. Ideally, to ensure the chain of custody of the hard drives, they should be retrieved and submitted by a third party with no conflict of interest.

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 Systems

Dedicated image analysis software: EM System should include 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 and/or could be carried out by national organizations.

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

EM coverage and review rate: As required by the IOTC Resolution 22/04 on Regional Observer Scheme the objective is to have a minimum observer coverage of 5% of the number of operations/sets.

EM data: EM system should collect at a minimum, the ROS Minimum Standard Data Fields using IOTC standard codes. EM data will be submitted to the IOTC Secretariat according to the time frame specified in Resolution 22/04, 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 submitted to the IOTC Secretariat.

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 as required by Resolution 22/04.

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.

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8. Annexes

8.1. 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, etc) 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

General data requirements

For what concerns the general data requirements (i.e. data requirements applying to all fisheries/gears), 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 “general” 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) (Ruiz et al., 2020a, 2020b) which has a different vessel set up than typical Indian Ocean pole and line vessel, 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 Programs, 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. 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 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	**MR**	**R1**	**SET UP**

	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".			
Vessel flag state (or where chartering occurs, chartering state)[5]	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**	**SET UP**
Vessel IOTC number	Vessel IOTC number as per the IOTC Record of Authorized Vessels[6] and crosschecked with the number recorded on vessel certificates. Note: any discrepancies are to be reported to the IOTC Secretariat.	**MR**	**R1**	**SET UP**
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**	**SET UP**
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**	**SET UP**
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**	**SET UP**
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 combination of characters and numbers; record them all (e.g.: CBG303).	**---**	**R1**	**SET UP**
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,	**OR**	**NULL**	

[5] IOTC Res. 18/10

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

	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.			
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**	**SET UP**
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	---	**R1**	**AG**

	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°).			
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 for the range cannot be obtained, the observer should calculate vessel range as follows.	---	**NULL**	

	<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[7])**	
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**

[7] 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)

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 include transit time even if the area being transited is within the fishing area.	**---**	**R1**	**AG**
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[8]

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**	

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

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. Note: specify units (preferably 'metres')	**MR**	**NP**	
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[9]

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	**MR**	**P2**	

[9] Information required for every set/operation.

	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).			
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[10]	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.	---	**R1**	**AG**

[10] 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.

	Note: latitude and longitude to be recorded mentioning if collected South or North of the equator and specifying units (preferably ±(d)dd.dddd°).			
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**	
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**
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 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**
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	**MR**	**NP**	

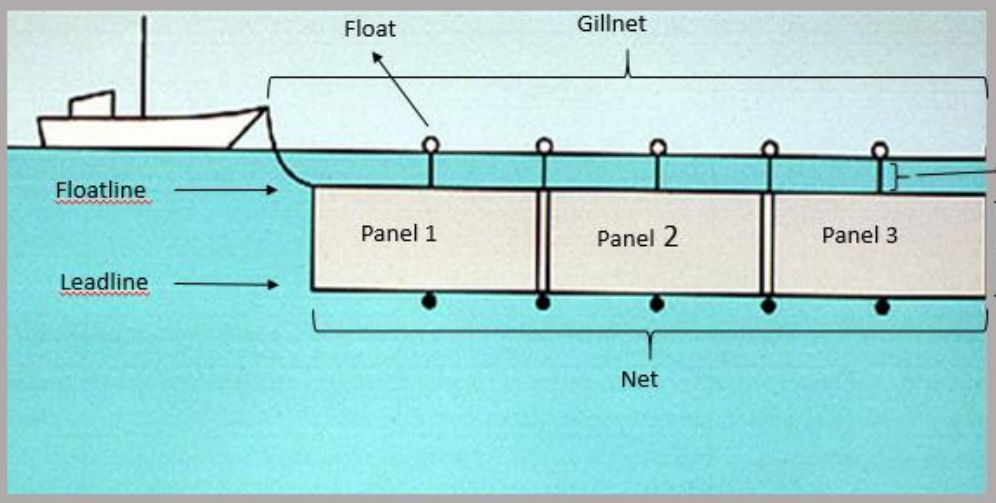
	the predator was not observed record UNK (unknown). For non-depredated specimens record NA. Note: species observed in the area may not necessarily be associated with depredation unless directly observed. Similarly for shark and squid damage the species may be difficult to determine.			
Additional details 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. Note: precise units (preferably millimetres (mm)). [Consistent with IOTC Res 12-04 and IOTC Res. 17/05]	**OR**	**NP**	
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[11]	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**	

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

GILLNET INFORMATION[12]



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".

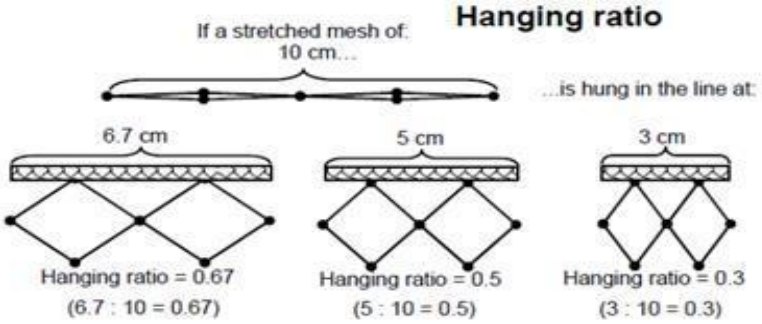
Panel: A section of continuous netting of exactly the same characteristics between two endlines (up and down lines).

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**

[12] 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 / or take a photograph of the unidentified organism for latter identification.	**MR**
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	**MR**

	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.	
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[13]	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**

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

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**

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[14]	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/R 4**[15]	**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**

[14] 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".

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

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.			
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/P 2**	
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**	**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 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**
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**	
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.	---	R1	AG

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

	Note: specify units (preferably YYYY/MM/DD).			
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	

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

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

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**

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

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***
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	Indicate the sampling method used to obtain total catch estimates per species for the observed set (Table 40).	**MR**	**R1**	

for obtaining total catch estimates per species				
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**	

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***

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

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	**MR**	R1	***EM-A***

	sample and / or take a photograph of the unidentified organism for latter identification.			
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 Program (ROP)[22].

Data field name	Data field description	Reporting	EM	Source
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**	