INTER-AMERICAN TROPICAL TUNA COMMISSION

WORKSHOP OF AN ELECTRONIC MONITORING SYSTEM (EMS) IN THE EPO: TECHNICAL STANDARDS AND DATA COLLECTION PRIORITIES

4TH MEETING

(by videoconference)
12-14 December 2022

DOCUMENT EMS-04-02

DATA COLLECTION PRIORITIES OF AN EMS

CONTENTS

1. INTRODUCTION AND BACKGROUND

The Inter-American Tropical Tuna Commission has acknowledged and endorsed that electronic monitoring (EM) is a promising tool for monitoring, addressing data gaps, and improving data collection for both purse-seine and longline vessels that do not carry onboard observers, as well as for vessels with observers onboard as a mean to complement the observer's data-collection (Resolution C-19-08; Document SAC-07-07f.i; Gilman et al., 2019). Accordingly, per request of the Scientific Advisory Committee during its 10th meeting in 2019, and pursuant to paragraphs 9 and 10 of Resolution C-19-08, the IATTC staff prepared for consideration by the Commission the document SAC-11-10 "*An electronic monitoring system for the tuna fisheries in the eastern Pacific Ocean: objectives and standards*". This document, which received positive feedback from several global experts on the matter, was presented at the 11th meeting of the SAC in 2020. However, during that meeting it was not possible for Members to provide in depth comments and suggestions. Thus, it was proposed that a workshop be held in 2021 to further discuss some of the elements contained in SAC-11-10, as well the presentation of a workplan for the implementation of an EM system (EMS) in the eastern Pacific Ocean (EPO), which was provided in EMS-01-02-Rev. The Commission endorsed this concept during its 96th meeting (extraordinary) and agreed that the 1st Workshop on Implementation of an Electronic Monitoring System (EMS) should be held in April 2021, before the SAC 12th meeting.

Prepared also for the 1st Workshop, the document EMS-01-01 recommended a number of actions for endorsement by the Commission. Among these was a workplan formulated by IATTC staff (EMS-01-02-Rev), which proposed a series of workshops to consider and analyze the EMS components and subcomponents in a hierarchical and chronological order. To provide structure for these workshops and other activities related to the EMS implementation process, the staff also recommended the adoption of Terms of Reference (ToR) for the EM workshops and a set of working definitions. The associated TORs and a set of definitions were adopted through the Resolutions C-21-02 and C-21-03, respectively, during the 98th Meeting of the IATTC. The workplan was also adopted with a minor modification to show flexibility on a potential starting date for the EMS in the EPO (EMS-01-02-Rev).

Subsequently, during the *2nd Workshop of an Electronic Monitoring System (EMS) in the EPO: Institutional Structure, Goals and Scope of the EMS,* held virtually in December 2021, the IATTC staff addressed a number of organizational issues, rules and procedures relating to the institutional structure (document EMS-02-01) as well as to the goals and the scope of an EMS (document EMS-02-02 Rev) for tuna fisheries in the EPO which are subject for adoption by the Commission. A summary of the discussions from the 2nd Workshop is available here.

A *3rd Workshop of an Electronic Monitoring System (EMS) in the EPO: Management Considerations,* was held by videoconference in April 2022, where the IATTC staff focused on several subcomponents and considerations related to the management of an EMS: i) Coordination and Compatibility, ii) Confidentiality, iii) Compliance, iv) EM equipment, and v) EM coverage and review rate (document EMS-03-01). A summary of the discussions from the 3rd Workshop is available here.

This document was prepared for the 4th workshop of the series planned under the adopted EMS workplan (EMS-02-02 Rev), focusing on the data collection priorities (Figure 1) (technical standards are described in document EMS-04-01). Throughout the remainder of this paper, the IATTC staff presents, within a series of outlined text boxes, a number of preliminary recommendations on topics to be considered by the workshop. The preliminary nature of these recommendations deserves special emphasis. One of the primary purposes of this series of workshops on EMS is to facilitate discussions and generate ideas that will inform the formulations of future IATTC staff recommendations on EMS, recommendations from CPCs, and recommendation from other IATTC bodies like the SAC or the newly established *ad hoc* working group on EM (EMWG) (Resolution C-22-07). That is, these preliminary recommendations are intended to serve as starting points for stimulating discussion, and they are not intended to preempt or limit meaningful discussion or alternate approaches.

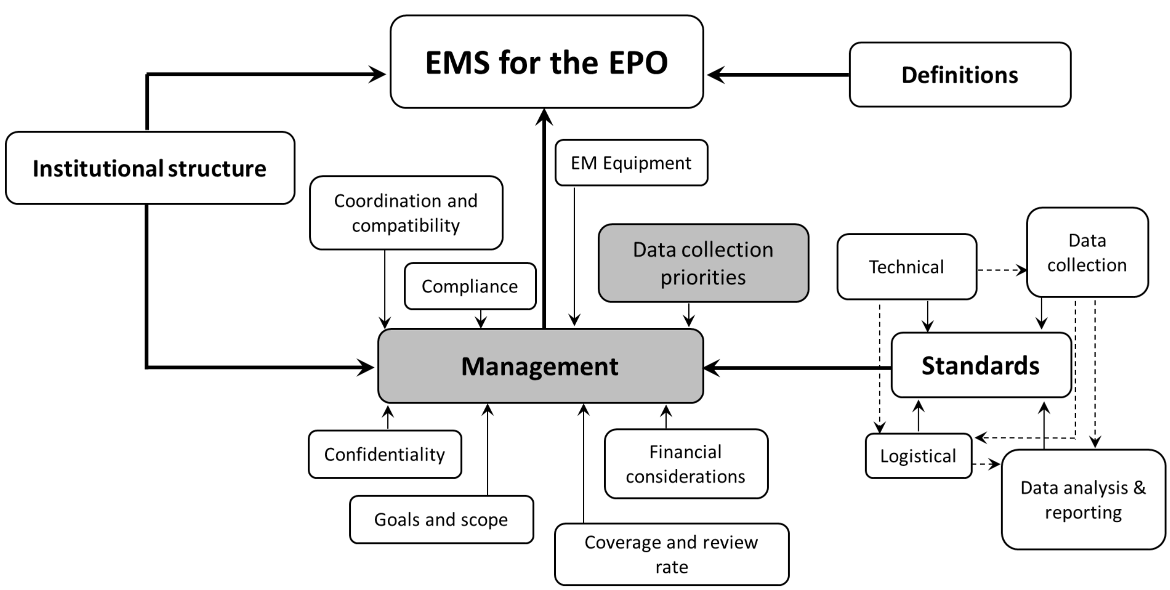

FIGURE 1. Structure of the EMS for the tuna fisheries in the EPO, emphasizing (in gray) data collection priorities, an EMS management considerations' subcomponent discussed in this document.

2. OVERVIEW OF PRIORITIES IN DATA COLLECTION

The fundamental objective of implementing an EMS in the EPO is to improve the quality and availability of data that the staff needs to carry out the functions stipulated in Article XIII of the Antigua Convention. The entry into force of the Convention in 2010 expanded the Commission's mandate to cover bycatch species and the ecosystem approach to management, but some of the data the staff requires as a basis for its recommendations for the conservation and management of such species, and to enable it to take the ecosystem into account in those recommendations, are either not collected or are not accessible to the staff. There are large disparities among fisheries and fleets in terms of data availability (see sections 3 and 4), and several aspects of the provision of data are still governed by resolutions that antedate the current Convention, and no longer reflect fully the staff's and/or the Commission's priorities or needs, or changes within the fishery. The staff's work and data needs under the Antigua Convention are derived from the IATTC Strategic Science Plan (SSP), a dynamic and adaptive plan reflecting the Commission's goals and priorities.

If the objective is to identify the best species management options, including where necessary, measures to conserve bycatch and non-target species, the data of greatest value to the staff are the amounts of catches and discards of target and non-target species, by species and size, along with information on fishing effort and details of fishing operations. Operational data of particular interest include, for the longline fishery, start and end times and positions of setting and hauling and line-shooter speed, and for the purse-seine fishery, set type, start and end times of key set-related activities, and any activities involving fish-aggregating devices (FADs), such as deployments and satellite buoy replacements and removals. Without these data, several of the tasks assigned to the staff by the Commission, especially about bycatches and the FAD fishery, are not feasible.

As noted previously (e.g., EMS-01-01), EM cannot fully replace a human observer, but there is considerable overlap in the abilities of each to collect some types of data. In some cases, one or the other might be better suited to some data collection tasks than the other. On vessels with an observer aboard, EM and human observers can fulfill complementary roles, but on vessels without human observers, the EM should focus on high-priority tasks. Data and task priorities may shift over time along with objectives, but a novel ecological risk assessment (ERA) approach, recently developed by the IATTC staff (Griffiths et al. 2019) to better identify vulnerable species and thus enable them to be prioritized for data collection, research and management, would be useful for defining priorities among bycatch species. High-priority bycatch species are typically elasmobranchs, turtles, and other species of slow growth, late maturity and, importantly, large size, since EM is better at identifying species of large size (Ruiz et al. 2014).

Therefore, the EM system, and the data collection priorities in particular, would need to be flexible, and in line with the evolving Commission's priorities, the SSP, and the staff's needs for specific scientific tasks. Differences in the priority of the type and amount of data fields to be collected and the level of coverage could vary by vessel size, gear, and fishery, but would also need to be adaptable to a specific objective. For estimating tuna catches, for instance, collecting target species information and a 20% coverage may suffice, but for many bycatch species, especially those less frequently encountered, a broader consideration of species and much higher levels of coverage would be needed.

Given the potential benefits of EM, and that one of the goals of the IATTC SSP is to "*investigate the use of new technologies to improve data quality*", in 2018 and 2020, pilot studies (Project D.2.a and C.2.b) were initiated in purse-seine and longline vessels, respectively. Whereas project C.2.b is still ongoing, project D.2.a was finalized in 2021 (e.g., SAC-10-12, SAC-11-10). In preparing this document, in addition to the experience gained through these projects, the staff took into account the progress, procedures and/or proposals of CPCs, other t-RFMOs, non-governmental organizations (NGOs), the industry, and other initiatives in implementing EM. However, the IATTC is unique institutionally and structurally, which may affect how EM might be implemented and managed.

Because the costs associated to EM analysis could be significant if all the EM records were to be analyzed for all activities, the EPO-EMS, as any electronic monitoring program, should be designed to minimize the program costs by focusing data collection and analysis on prioritized data aspects (Garren et al., 2021). Although technology, in particular the promise of AI technology, applied to EMS is constantly advancing and is expected to make EM analysis more efficient and less costly, initial priorities in data collection would need to be identified, and modified as required, consistent with the Antigua Convention, the IATTC SSP and the status and vulnerability of the different stocks and species.

> Priorities for EM data collection should be established, taking into account, among others, the provisions of the Antigua Convention, the IATTC Strategic Science Plan, the status and vulnerability of species, and the needs for compliance monitoring.

EM holds great promise for resolving many problems with collecting fisheries data, but it cannot fully substitute for a human observer. Its principal limitation is that the cameras record only what is in their field of view and cannot prioritize among elements in the images they are recording. Also, its ability to identify species and sizes during the loading of the catch, for example, is limited (e.g., purse-seine operations with mixed catch). However, it is likely that improvements in artificial intelligence, machine learning/deep learning algorithms, hardware and software will mitigate this situation. For example, advances in technology, such as image analysis and recognition software (Gilman et al., 2019; Murua et al., 2020), as well as the incorporation of different fishing activity sensors could not only expedite EM data collection and analysis but also increase the accuracy and reliability of the information produced. By the same token, Garren et al. (2021) also deemed important that the service provider contracting structures used by the fishing industry or managing bodies align providers' incentives with the desired outcome of continual quality and performance improvements.

Although research to improve data collection is currently under development in the IATTC (e.g., tuna and non-tuna species identification using new algorithms and techniques, project B.1.a, Meek et al., 2022; exploring technologies for remote FAD identification, project D.1.a), EM should also help to resolve some important shortcomings in the current data-collection system. For the longline fishery, the lack of bycatch and discard data, the limited observer coverage, and the delay in receiving catch data, and for the purse-seine fishery, inter alia, the inability to identify individual FADs, accurately estimate dolphin mortalities or the exact size of the catch (i.e., the later also applies to transshipments via weight sensors in the brail/scale). Advances in this fields could involve developing proposals in collaboration with stakeholders and EM providers involved in the EPO tuna fishery. In this regard, it is important the IATTC scientific staff is supported with the resources needed to conduct these studies in a successful manner.

> The Commission should support and ensure the funding of research activities that would improve EM data collection for scientific and compliance purposes (e.g., sensors that could remotely identify satellite buoys attached to FADs, accurate identification of certain fishing activities, other fishery components).

3. PURSE-SEINE VESSELS

The IATTC has three main sources of data for the purse-seine fishery: (1) the Commission's field offices in major tuna ports in Latin America abstract vessel logbooks at the end of each fishing trip, and sample the species and size composition of the catch of a subset of trips by these vessels during unloading in port (port sampling); (2) the international observer program, established originally by the IATTC in 1978, and later expanded under the 1992 La Jolla Agreement and the 1999 Agreement on the International Dolphin

Conservation Program (AIDCP); and (3) data submitted by CPCs in accordance with the requirements of several resolutions, from the general (C-03-05 on data provision, for instance) to the specific, such as C-19-01 on the collection and analyses of data on FADs. Additionally, some data are obtained from the tuna fishing and processing industries and from published sources.

However, the data from these sources do not cover all purse-seine vessels equally. Under the AIDCP program, every trip by large (Class-6) purse-seine vessels is accompanied by an observer, who collects detailed data on the activities of vessels at sea, and particularly data on incidental catches (bycatches) of non-target species and discards of target species, both of which are vital to the staff's stock assessments and ecosystem studies. Smaller (Class 1-5) purse-seine vessels are generally not required to carry observers, so the principal source of information for these vessels is their logbook records and the port-sampling program. The data from these sources are limited in that they contain little or no information on bycatches or discards or FAD operations (Román et al. 2016). Some detailed operational data are available from a recent, voluntary scheme in Ecuador in which several smaller vessels carried observers, and from a small number of Class-5 vessels that have been required to carry observers for limited periods under the AIDCP.

As noted above, one of the goals of the IATTC Strategic Science Plan is to "investigate the use of new technologies to improve data quality". Along Emery et al. (2018), the pilot study (Project D.2.a) to test EM on purse-seine vessels provided a baseline for evaluating which data fields might be reliably recorded by EM as a basis for subsequent analysis, and whether any additional assistance or equipment is required (Annex 1).

To a great extent, the data that EM can record is dependent on the size and the operational characteristics of the purse-seine vessel. If, as on many large vessels, the catch is dumped into a hopper and then distributed by conveyor belts to the wells, there are several points where a camera could capture detailed and informative images; however, small vessels typically load catches into a well directly from the brailer, and recording useful images would be challenging.

The current capabilities of EM on purse-seine vessels, as determined in the pilot study and Emery et al. (2018), are detailed in Annex 1. Many data items collected by observers on such vessels (set type, set start times, FAD deployments, FAD retrievals, retained catches (but not by species)) could be recorded with EM with little or no modification of the vessel or its fishing practices (category R1; Emery et al. 2018), but others would require assistance from vessel crew (R2), additional cameras and/or sensors (R3), or are feasible but not worth the effort (R4). Based on Emery et al. (2018), EM would be ready to collect the 83.6% of the IATTC purse-seine observer data with little or no further work, whereas the remaining 16.4% would require significant work or cannot be currently collected (Annex 1). Other information recorded by observers, mostly non-operational data such as vessel capacity and equipment, gear dimensions and configuration, which EM cannot record, is available in the Regional Vessel Register and/or other IATTC databases.

In the pilot study (Project D.2.a) and in other initiatives for purse-seine vessels (Gilman et al. 2019, Briand et al. 2017, Ruiz et al. 2014, Chavance et al. 2013), determining the species and size composition of the catch with EM proved difficult. Large-sized species (billfishes, sharks, etc.) are generally correctly identified, but smaller species or size classes (<30 cm) are problematic, especially if, as is often the case, morphologically similar species, such as bigeye and yellowfin tuna, are caught in a set. Improved technology, including image recognition and analysis software (Gilman et al. 2019), will be required to accurately identify all species involved in tuna fisheries.

One matter in which EM could potentially be of great value, not addressed in the pilot study, is the identification of FADs. Each satellite-connected transmitter buoy attached to a FAD has a unique built-in alphanumeric identifier ('buoy ID'), which is used to identify FADs, as reflected in Resolution C-19-01. The IATTC staff, the working group on FADs, and the SAC have repeatedly identified buoy ID as the key data point needed for any scientific study of the FAD fishery, because without it FADs cannot be tracked over time, and related information in different databases cannot be linked. Currently, there are no sensors and/or software available that will automatically and remotely detect and identify satellite buoys, although the technology to do so is under development, and currently being tested in project D.1.a, and could eventually be integrated into the EM equipment (Gilman et al. 2019; Lopez et al. 2018; MRAG 2017; Benelli 2013).

Although EM has not yet been used to collect data on marine mammals, some inferences can be drawn from the staff's experience at sea or in analyzing EM records. For example, some activities unique to dolphin sets, such as the start of the backdown procedure, should be detectable with EM, as should net canopies and collapses and major equipment malfunctions, historically indicators of high-mortality sets. However, if dolphin mortality does occur, cameras would probably be of limited use for documenting and quantifying it.

The following recommendations are exclusively for the data fields that, at present, can be collected reliably (per Appendix 2 of document SAC-11-10 and the advances of the pilot project D.2.a) regardless of the presence of an observer onboard. These following recommendations may be updated in the future as technology improves and the staff's and the Commission's goals and priorities change.

Recognize, on a provisional basis, the need to collect for the purse seine fishery, at a minimum, the fields presented in Annex 3.

4. LONGLINE VESSELS

The status of operational-level longline fisheries data from the EPO is very different (SAC-10-04 REV). The IATTC staff does not typically obtain LL logbook or other catch and effort data directly from vessels: they are collected and analyzed by individual CPCs, and typically provided to the staff in summary form, with limited information on gear characteristics, discards, and bycatches. Under Resolution C-19-08, the staff is now receiving some detailed operational-level observer data, with complete catch and discard information, but coverage by observers is very limited: the resolution stipulates 5% coverage of each CPC's longline effort, far below the 20% minimum repeatedly recommended by the IATTC staff, the Working Group on Bycatch, and the SAC itself (SAC-10- 04 REV), but in some instances not even 5% coverage is realized.

The transshipment observer program, established in 2009, covers carrier vessels to which longline vessels transship catches at sea. Six CPCs participate in the program, which is operated by an external contractor. IATTC staff's role is largely administrative, and other than some limited data on sharks in the transshipped catches, the program does not generate the type of data that is needed for staff's research.

As mentioned above, Resolution C-19-08 establishes the option to use one of two sets of minimum standards for reporting operational data for longline vessels: i) from a set of minimum data fields which are harmonized with WCPFC or, ii) using those data fields found in longline observer forms developed by IATTC. Both sets of standards are very similar to each other. The ability of EM to collect the minimum data fields specified in C-19-08 (option (i)) is summarized in Annex 2 (Emery et al. 2018). EM seems to be, in general, useful for collecting information on special gear characteristics, setting and hauling, and catch per set by species, but 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. Similarly, as for purse-seine vessels, EM cannot record general information on the vessel and its gear (refrigeration method, mainline/branch line material, etc.), although this information is typically collected by vessel authorities, and/or recorded in the Regional Vessel Register, and is thus available, but not always provided.

The size of a vessel, and its operational characteristics will, to a large extent, affect the data that EM can record. For example, some vessels regularly release hooked non-target species before bringing them aboard, which hinders the EM equipment's ability to count and identify bycatch. Some of these issues might be mitigated or resolved by adding cameras in appropriate locations, or by implementing no-release policies.

The staff has begun to review the data collection priorities for longline vessels, and adjust them to match the provisions of the Antigua Convention, the evolving priorities of the SSP and the Commission, and the staff's needs (e.g., SAC-12-09 Annex 1, Appendix 2, IATTC-100-04). As recommended by the SAC (IATTC-97-01), the staff will convene a series of workshops with CPCs to improve data collection with regards C-03-05 taking into consideration the elements presented in document SAC-12-09. The first workshop will consider industrial tuna longline vessels and is scheduled to be held in January 2023. However, the staff has no practical experience of EM on longliners and, since fisheries are region-specific, it will be in a better position to assess the capabilities of EM on longline vessels after the proposed pilot study (Project C.2.b) is completed.

The following recommendations are exclusively for the data fields that, at present, can be collected reliably (per Appendix 3 of document SAC-11-10 and published literature) regardless of the presence of an observer onboard. These following recommendations may be updated in the future as technology improves and the staff's and the Commission's goals and priorities change.

Recognize, in an interim basis, the need to collect for the longline fishery, at a minimum, the fields presented in Annex 4.

5. REFERENCES

Benelli, G. and A. Pozzebon 2013. RFID Under Water: Technical Issues and Applications. Radio Frequency Identification from System to Applications. M. B. I. Reaz. Rijeka, InTech: Ch. 18.

Briand, K., A. Bonnieux, W. Le Dantec, S. Le Couls, P. Bach, A. Maufroy, A. Relot-Stirnemann, P. Sabarros, A.-L. Vernet, F. Jehenne and M. Goujon . 2017. Comparing Electronic Monitoring System with Observer Data for Estimating Non-target Species and Discards on French Tropical Tuna Purse Seine Vessels. IOTC-2017-WPEB13-17. Indian Ocean Tuna Commission.

Chavance P., Batty A., Mc Elderry H., Dubroca L., Dewals P., Cauquil P., Restrepo V. and Dagorn L. 2013. Comparing Observer Data with Video Monitoring on a French Purse Seiner in the Indian Ocean. IOTC- 2013-WPEB09-43, 18 pp.

Emery, T.J., Noriega, R., Williams, A.J., Larcombe, J., Nicol, S., Williams, P., Smith, N., Pilling, G., Hosken, M., Brouwer, S., 2018. The use of electronic monitoring within tuna longline fisheries: implications for international data collection, analysis and reporting. Reviews in Fish Biology and Fisheries. 28, 887-907.

Garren, M., Lewis, F., Sanchez, L., Spina, D., Brett, A., 2021. How performance standards could support innovation and technology-compatible fisheries management frameworks in the US. Marine Policy. 131, 104631.

Gilman, E., Legorburu, G., Fedoruk, A., Heberer, C., Zimring, M., Barkai, A., 2019. Increasing the functionalities and accuracy of fisheries electronic monitoring systems. Aquatic Conservation: Marine and Freshwater Ecosystems. 29, 901-926.

Griffiths, S. P., K. Kesner-Reyes, C. Garilao, L. M. Duffy and M. H. Román (2019). Ecological Assessment of the Sustainable Impacts of Fisheries (EASI-Fish): a flexible vulnerability assessment approach to quantify the cumulative impacts of fishing in data-limited settings. Marine Ecology Progress Series 625: 89-113.

Lopez, J., E. Altamirano, C. Lennert-Cody, M. Maunder and M. Hall (2018). "Review of IATTC Resolutions C-16-01 and C-17-02: available information, data gaps, and potential improvements for monitoring the FAD fishery." FAD-03 INF-A.

Meek, M., Mamoozadeh, N., O'Leary, S., Portnoy, D., Mahapatra, N., 2022. Harnessing advances in artificial intelligence and genomics to enable scalable and field-deployable species identification capabilities. *In* Proceedings of the 72nd Tuna conference. Lake Arrowhead California-USA. https://www.tunaconference.org/_files/ugd/ba25d2_e6398efb660a49ac80221d3970fefc0a.pdf#page=42.

MRAG (2017). "Monitoring of FADs Deployed and Encountered in the WCPO (Consultancy Report) " SC13-FADMgmtOptionsIWG-01.

Murua, H., Fiorellato, F., Ruiz, J., Chassot, E., Restrepo, V., 2020. Minimum standards for designing and implementing Electronic Monitoring systems in Indian Ocean tuna fisheries. URL:https://www.bmis-bycatch.org/system/files/zotero_attachments/library_1/Y8S53TQV%20-%20IOTC-2020-SC23-12E_Rev2.pdf.

Román, M., C. Lennert-Cody, M. Maunder, A. Aires-da-Silva, and N. Vogel. 2016. Changes in the purse-seine fleet fishing on floating objects and the need to monitor small vessels. IATTC. Seventh Meeting of the Scientific Advisory Committee. Document SAC-07-07f.i.

Ruiz, J., Batty, A., Chavance, P., McElderry, H., Restrepo, V., Sharples, P., Santos, J., and Urtizberea, A. 2014. Electronic monitoring trials on in the tropical tuna purse-seine fishery. ICES Journal of Marine Science, doi: 10.1093/icesjms/fsu224.

ANNEXES

Annex 1. Current capabilities of EM, purse-seine fishery. Data items recorded by IATTC observers on Class-6 purse-seine vessels, by category and item, and the staff's assessment of applicability of EM, using the ready/possible categories of Emery et al. (2018). Does not include data items such as vessel capacity and equipment, gear dimensions and configuration, which EM cannot record, and which is available in the Regional Vessel Register and/or other IATTC databases. *Data fields collected from logbooks, Class 1-5 vessels.

R1	Ready	Requires little or no further work	P1	Possible	Requires minor work
R2		Requires significant crew support	P2		Requires major work
R3		Requires dedicated or additional camera/sensor	NP	Not possible	-
R4		Inefficient/costly to analyze			

A	B	C		D
FISHING EFFORT				
Vessel activity	Drifting	Date/time of each DRIFT event		R1
	Searching	Date/time of all SEARCH events (crew with binoculars, bird radar)		NP
	Running	Date/time of all RUN events (no searching)		NP
	Speed	Vessel speed		R1
	Position	Location of vessel during activities other than sets		R1
Set information	Date/time, start of set*			R1
	Date/time, end of set*			R1
	Position*			R1
	Set type*			R1
	Well	Well number	Crew access to wet deck	R1
			No crew access to wet deck	R2/R3
	SST	Sea surface temperature		R3
	Beaufort (wind speed)			R1
	Time, rings up			R1
	Major malfunction			R1
	Minor malfunction			NP
TARGET SPECIES				
Catch, total		Catch per set, all species combined		R1
Catch, by species*		Catch per set, large-sized individuals	Loaded via hopper, conveyor belt	R1
			Straight to well	R2
		Catch per set, medium-sized individuals	Only one species	R1
			YFT & BET	R4
		Catch per set, small-sized individuals		P2
Discards, total		Tonnage discarded and reason, all species		R1
Discards, by species		Tonnage discarded and reason, large species		R1
		Tonnage discarded and reason, medium species	SKJ	R1
			YFT & BET	R4
		Tonnage discarded and reason, small species		P2
NON-TARGET SPECIES				
Large-medium species	Species code	Species caught	By taxonomic group	R1
			By species	R2
	No. species caught	No. of large-medium individuals caught	Loaded via hopper, conveyor belt	R1
			Straight to well	R2
	Length of fish	To nearest cm		R2

	Sex	Determine sex		R2
	Activity when sighted	Motionless but alive/swimming/dead/copulating		NP
	Condition on release	No injuries/seriously injured/dead/unknown (e.g. turtles)		R1
	Fate	Human consumption/released alive/discarded/unknown/other		R1
Small species	Species code	Species caught	By taxonomic group	R1
			By species	R4
	No. species caught	No. of small individuals caught	Loaded via hopper, conveyor belt	R4
			Straight to well	P2
	Fate	Human consumption/discarded/part consumed and discarded		R1
FLOATING OBJECTS/FADs				
Type		Type of floating object (flotsam, FAD)		R1
Floating structure: dimensions		Length, width, and height of the floating structure		R1
Submerged structure: shape				R2
Submerged structure: depth				R2
Components when encountered		Components of floating and submerged structures when encountered		R2
Components when left		Components of floating and submerged structures when left		R2
Object encounter		Date, time, position		R1
FAD deployment		Date, time, position		R1
Location method				R2
Buoy ID		Serial number of satellite buoy		P2/NP
Origin		Origin of object (*e.g.* FAD ownership)		P2
Tag information				P2/NP
Object removed		Object brought aboard the vessel after the encounter		R1
Epibiota		Percentage of object covered by epibiota		R1
Fauna entangled		Number and species of fauna entangled in object		R2

Annex 2. Current capabilities of EM of longline fishery according to the minimum data reporting standards for longline vessels, Option 1, as established by Resolution C-19-08, by category and item, and the staff's assessment of applicability of EM, using the ready/possible categories of Emery *et al*. (2018). Does not include data items such as vessel identification, capacity, mechanical and electronic equipment, gear dimensions and configuration, crew and observer information, which EM cannot record, and which is available in the Regional Vessel Register and/or other IATTC databases.

R1	Ready	Requires little or no further work	**P1**	Possible	Requires minor work
R2		Requires significant crew support	**P2**		Requires major work
R3		Requires dedicated or additional camera/sensor	**NP**	Not possible	-
R4		Inefficient/costly to analyze			

B	C	D
	GEAR AND TRIP DATA	
	The date and time the vessel leaves port to start its fishing trip.	R1
Arrival port, date	Include both the port name and country.	R1
	GENERAL GEAR CHARACTERISTICS	
Mainline material	List the of the mainline used by the vessel (*e.g.* Kuralon, Braided)	NP
Mainline length (specify unit)	The total length of the mainline when it is fully set	P2
Mainline diameter (specify unit)		NP
Branch line material(s)	A branch line can consist of one type of material like monofilament or it can be made up of many different materials like braided nylon wire trace and mono filament, *etc.* If different types are used in different branch line positions, please describe.	NP
	SPECIAL GEAR CHARACTERISTICS	
Wire trace	**At the trip level** indicate "Yes" or "No" -if the vessel uses wire traces on some or all of its lines. If wire traces used on all lines during the trip, then record "ALL LINES." If the vessel used wire traces on certain branch line positions during the trip, describe the configuration. For example, "wire traces were used on first and tenth branch lines of each basket". If the proportion of leaders that are wire varies within a trip, record the average based on a sample of ten total baskets from a range of sets.	R1
Mainline hauler	Does the vessel use an instrument to haul in the main line after it is set or is the line hauled by hand?	R3
Branch line hauler	Does the vessel use a special hauler to coil branch lines?	R3
Line shooter	Does the vessel use a line shooter?	R3
Automatic bait thrower	Does the vessel use a bait thrower or are bait and branch lines thrown overboard manually?	R3
Automatic branch line attached	Does the vessel have an automatic branch line mechanism that attaches the branch at regular intervals or is this done manually?	R3
Hook type	**For each set,** record the type of hook or hooks used, using the codes in the hook catalogue (*e.g.* J hooks, circle hooks, offset circle hooks, *etc.*	NP

Hook size	**For each set,** record the size of the hooks used. If not sure, ask the bosun or refer to a hook catalogue.	NP
Tori Lines	**For each set,** record whether the vessel uses Tori lines when setting; if yes, how many and their length.	R3
Side-setting with bird curtain and weighted branch lines	**For each set,** record whether the vessel used side-setting with a bird curtain in combination with weighted branch lines.	R3
Weighted branch lines-	**For each trip** where weighted branch lines are used, record the mass of the weight attached to the branch line. If more than one type of weighting is used during a trip, describe each type and indicate the proportion based on a sample of ten baskets from a range of different sets.	R3
Shark lines	**For each set,** record the number of shark lines (branch lines running directly off the longline floats or drop lines) observed. Where possible, record the length of this line for each set.	R1
Blue dyed bait	**For each set,** record whether the vessel used blue-dyed bait.	R1
Distance between weight and hook (in meters)	**For each set,** record the distance in meters from where the bottom of the weight is attached on the branch line to the eye of the hook.	NP
Deep setting line shooter	**For each set,** record whether the vessel used a deep setting line shooter	R3
Management of offal discharge	**For each set,** record whether the vessel used the management of offal discharge.	R3
Date and time of start of set	**For each set,** record the date and time the first buoy is thrown into the water to start the setting of the line.	R1
Latitude and Longitude of start of set	**For each set,** record the GPS reading at the time the first buoy is thrown into the water.	R1
Date and Time of end of set	**For each set,** record the date and time the last buoy (usually has radio beacon attached) at the end of the mainline is thrown into the water	R1
Latitude and Longitude of end of set	**For each set,** record the GPS reading at the time the last buoy is thrown into the water	R1
Total number of baskets or floats	**For each set,** record the number of baskets utilized. A basket is the sum of all the hooks set between two buoys on a longline; usually it is the same as the number of floats set minus one.	R1
Number of hooks per basket (number of hooks between buoys)	**For each set,** record how many hooks set from one buoy to another, the number is usually constant along the line, but can vary in some cases, also if the vessel also sets a branch line on the buoy, count this as a hook between floats as well.	R4
Total number of hooks used	**For each set,** record how many hooks were used. This is typically calculated by multiplying number of baskets by the number of hooks per basket	R1
Line shooter speed	**For each set** where the vessel uses a line shooter, record the shooter speed. The shooter will normally have an indicator to show its running speed, as well as a sound indicator or light, that beeps at a regular interval, when it is time to attach a branch line.	R3
Length of float-line	**For each trip,** record **l**ength of the line that is attached to the floats, get a coil and measure the length. It usually remains the same throughout the trip.	P2

Distance between branch-lines	**For each set,** record the distance between branch line attachments to the mainline. This can be determined easily if vessel has a line shooter with electronic attachment indicator.	R3
Length of branch-lines	**For each set, m**easure the length of a sample of the majority of branch lines used, some may vary slightly due to repairs.	NP
Time-depth recorders (TDRs)	Does the vessel use TDRs on its line? If yes record the number of TDRs used it may use and their location along the mainline?	NULL
Number of light-sticks	**For each set,** indicate whether the vessel uses light sticks on its line, record the number used, and where possible, information on the location (*e.g.* "used on first and tenth branch lines from the float").	R4
Target species	What species does the vessel target? Tuna (BET YFT), Swordfish, Sharks, *etc.*	R1
Bait Species	**For each set,** record the bait species used Pilchard, Sardine, Squid, artificial bait, *etc.*	R3
Date and time of start of haul	**For each set,** record the date and time the first buoy of the mainline is hauled from the water to start the haul.	R1
Date and time of end of haul	**For each set,** record the date and time the last buoy of the mainline is hauled from the water to end the haul.	R1
Total number of baskets, floats monitored by observer in a single set	**For each set,** record how many floats or baskets were monitored by the observer?	R1
CATCH AND DISCARDS OF TARGET AND NON-TARGET SPECIES PER SET		
Information on catch per set		
Hook number (location between floats)	For each individual capture, record the hook number that the animal is caught on, counting from the last float hauled on board.	R4
Species	Use FAO species code.	R1
Biometry		
Length of fish	Measure length of specimen, using the recommended measurement approach for the species.	R1
Length measurement code	Reflect the type of length measurement taken using the appropriate measurement code. For example, all tunas are measured from the end of the upper Jaw to fork of the tail, measurement code UF.	R1
Sex	Sex the species if possible. If an unsuccessful attempt is made to sex the individual, record "I" for indeterminate. If no attempt to sex the individual is made, record "U" for unknown.	R2
Condition		
Condition when caught	For bycatch species (*e.g.* sharks, sea turtles, seabird, marine mammals, *etc.*) also reflect hooking location [*i.e.* hooked in mouth, hooked deeply (throat/ stomach), and hooked externally].	R1/R3*
Fate	Record the ultimate disposition of the capture using the appropriate code (e.g. retained, discarded, *etc.*)	R1/R3*
Condition when released	If released, record the animal's status when returned to the sea.	R1/R3*
Tagging		
Tag recovery information	Record as much as information as possible on any tags recovered	R1
SPECIES OF SPECIAL INTEREST		
General information		
Type of interaction	Indicate the type of interaction (*e.g.* entangled, hooked internally, hooked externally, interaction with vessel only, *etc.*)	R1

Date and time of interaction	Record ships date and time of interaction.	R1
Latitude and longitude of interaction	Record position of the interaction.	R1
Species code of sea turtle, marine mammal, or seabird.	Use FAO codes for Species.	R1
Biometry		
Length	Measure length, in centimeters.	R1
Length measurement code	Measure using the measure method determined for that species.	R1
Sex	Sex the animal if possible.	R2
Estimated fin weight (for sharks)	Weigh the fins separately if shark has been finned by crew. If no scales, estimate the weight.	R1
Estimated carcass weight (for sharks)	Weigh the carcass of a finned shark. If no scales available, carcass is discarded, or if it is too large to handle, estimate the weight.	R1
Condition		
Condition when landed on Deck	Record the animal's condition when landed on deck, using appropriate code.	R1
Condition when released	If released, record the animal's condition at the time of release, using appropriate code.	R1/R3*
Tagging		
Tag recovery information	Record as much as information as possible on any tags recovered	R1
Tag release information	Record as much as information as possible on any tags placed on the species before release.	R1

Annex 3. A first assessment of data fields that should be collected, at a minimum, for the purse seine fishery, based on SAC-11-10 and the pilot project D.2.a.

1) **Trip information**
   a) Depart port, arrival port.
   b) Depart date/time, arrival date/time.
2) **Vessel activity**
   a) Speed and geographical position of the vessel every 2 seconds.
3) **Set information**
   a) Type of the set.
   b) Date/time of the start of the set, rings up, and the end of the set.
   c) Position (latitude and longitude, in decimal degrees) of the set.
   d) Wind speed (Beaufort scale).
   e) The time and date, as well as potential reason, of any major malfunction that stops or delays the setting maneuver.
4) **Target species**
   a) Total catch, size and discards per set for skipjack, and for yellowfin and bigeye, as feasible as EM technology allows. In cases where species identification is not possible, the combined catch may be reported. For sizes, weight categories shall be used whenever possible (i.e. small <2.5 kg., medium >2.5 kg.- <15kg., large >15 kg.).
5) **Non-target species**

   Catch, size and fate of individuals: requiem sharks, hammerhead sharks, thresher sharks, lamnid sharks, whale shark, mobulid rays, billfishes, scombrids, carangids, triggerfishes, sea turtles, sea birds, and marine mammals, where each individual will be identified to the lowest taxonomic resolution possible (i.e., species), as feasible as EM technology allows. In cases where species identification is not possible, the animal may be identified to a broader taxonomic resolution (e.g., genus, family). Wherever possible, individuals shall be measured to the nearest cm as follows: sharks in total length, billfishes in post-orbital fork length, fishes in fork length, rays in disc width, turtles in curved carapace length. In cases where individual measurement is not possible, the animal may be classified by size category (i.e., small, medium, large) following IATTC observer practices.
6) **Floating objects/FADs**
   a) Location, date, time for each FAD deployment.
   b) Location, date, time for each FAD retrieval.

Annex 4. A first assessment of data fields that should be collected, at a minimum, for the longline fishery, based on SAC-11-10.

The ability of EM to collect the data specified in C-19-08 (option (i)) is summarized in Appendix 3 of SAC-11-10. However, the staff has no practical experience of EM on longline vessels and, since fisheries are region-specific, it will be in a better position to assess the capabilities of EM on longline vessels after the proposed pilot study (Project C.2.b) is completed. For the purposes of this document, and although it could be revised in the future, the recommendations of the IATTC staff on the observer data fields for longliners that EM should collect, at a minimum, are as follows:

1) **Trip information**
    a) Depart port, arrival port.
    b) Depart date/time, arrival date/time.
2) **Vessel activity**
    a) Speed, geographical position of the vessel, at a minimum, every 2 seconds.
3) **Set information**
    a) Date/time of the start, and the end of the set.
    b) Position (latitude and longitude, in decimal degrees) of the start and end of the set.
    c) Date/time of the start, and the end of the hauling.
    d) Position (latitude and longitude, in decimal degrees) of the hauling.
    e) Haul direction.
    f) Use of blue-dyed bait (Yes-No).
    g) Total number of baskets or floats.
    h) Total number of hooks used.
    i) Wire traces on some or all of its branch lines (Yes-No).
    j) Number of shark lines (branch lines running directly off the longline floats or drop lines).
4) **Target and non-target species**
    a) The species identification of each individual caught.
    b) Size of each individual caught, using the recommended measurement approach and the appropriate measurement code (standard, furcal, post-orbital, width of the disc, etc.) for the species.
    c) The estimated condition of the individual when caught, brought on deck and released.
    d) Fate of the individual brought on deck (e.g. retained, discarded, etc.)
    e) Tag recovery information.

The type of interaction with the catch (e.g. entangled, hooked internally, hooked externally, interaction with vessel only.)