A roadmap for electronic monitoring in regional fishery management organisations

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Introduction

Regional fisheries management organisations (RFMOs) play a key role in managing highly migratory fish stocks, such as tunas, that span the jurisdictions of multiple countries as well as the high seas. In order to sustainably manage this valuable resource, RFMOs and their member countries require sufficiently accurate information on target catch, bycatch, fishing effort, and compliance with regulations.

Human observers, who are deployed on fishing vessels to collect data on fishing activities, have played a critical role in collecting this information. Observers collect and record information on a large portion of fishing activity for most of the world's tuna purse-seine fleets, and RFMOs require human observers on all purse-seine trips. However, other fishing fleets, such as the longline fleet, have very low observer coverage targets that they often struggle to meet. The Western and Central Pacific Fisheries Commission (WCPFC) and the Inter-American Tropical Tuna Commission (IATTC) have, for example, a five per cent observer coverage target for longline vessels, but these fisheries often struggle to meet this low level of coverage. A combination of harsh working environments, costs, and the challenging logistics of deploying observers on many longline fleets make it unlikely that observers will ever be able to achieve much higher coverage levels for these fleets. With such low monitoring coverage, there is uncertainty about what longline vessels are catching, which makes it difficult to set and enforce management measures that protect the health of fish stocks and the economic productivity of the fishery.

Even in fisheries with high rates of observer coverage, there are opportunities to enhance the reliability of reported data. Although onboard observers currently represent the gold standard in fishery data collection, observers must take breaks to sleep and eat, and cannot keep track of all activities happening at once. In the worst cases, they may also be subject to intimidation, interference, bribery, and even violence in the name of falsifying reports. These serious issues are one of the reasons observers are sometimes used solely for scientific data collection and not for compliance functions. The recent suspension of observer requirements on purse-seine vessels in the western and central Pacific Ocean (WCPO) in response to COVID-19 has demonstrated that there is still room to improve the reliability of monitoring, even in fisheries with 100 per cent observer coverage.

While observers may be limited in their ability to monitor large portions of tuna fishing for some fleets, the emergence of electronic monitoring (EM) offers a solution to the challenge of increasing the robustness and coverage levels of at-sea monitoring. There are now more than two decades of experience with electronic monitoring in fisheries, with at least 100 trials, and 12 fully implemented programmes.

What is electronic monitoring?

The on-vessel components of EM consist of an integrated system of cameras, gear sensors, video storage, and global positioning system (GPS) units, which capture videos of fishing activity with associated sensor and positional information (Fig. 1). The videos are typically stored on a hard drive that is collected at the end of fishing trips and can then be reviewed by an onshore analyst. Some EM vendors are moving to systems that use Wi-Fi, satellite, or cellular networks to transmit data, some in near real time, instead of physically moving hard drives. An EM system also includes shore-based software and hardware that support the acquisition, analysis and reporting of EM records.

EM requires much more than placing cameras and sensors on vessels, and computers on shore. The hardware needs to be complemented by an EM programme that includes the standards and methods to collect, analyse and store videos of fishing activities, and to share the results with authorised entities (e.g. fishery managers, scientists, vessel owners).

A roadmap for EM in RFMOs

The Pew Charitable Trusts teamed up with CEA Consulting to produce an overview of some of the key steps and design choices that fishery managers need to consider when designing and implementing an EM programme in the

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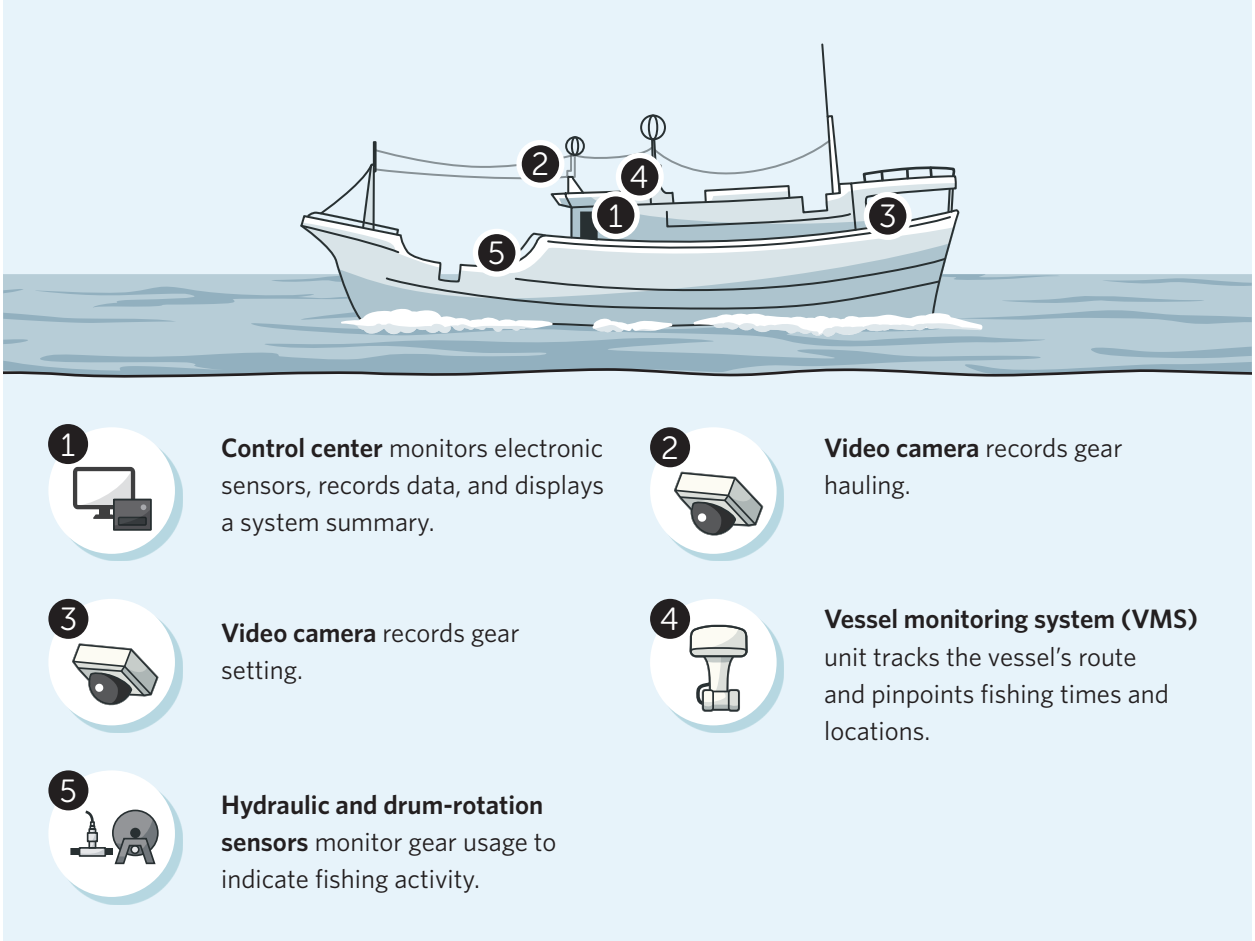


Figure 1. Overview of the on-vessel components of an electronic monitoring system on a longline vessel.

RFMO context. In the past, there have been a handful of reports that summarise the current status of EM in fisheries, and toolkits that outline a process for developing an EM programme. None of them, however, have specifically focused on the unique challenges of designing and implementing an EM programme in an RFMO context, which covers numerous countries, a wide range of vessel sizes, gear types, fishing locations, and catch compositions. The Pew Roadmap explores the necessary elements of a well-designed and effective EM programme and examines the unique considerations for fisheries that are managed by an RFMO.

Strengths, challenges, and opportunities for EM in tuna fisheries

There have been numerous trials and fully implemented EM programmes for tuna fisheries, and these trials have covered both longline and purse-seine fisheries. From these trials, some general conclusions can be reached about the efficacy of EM as a monitoring and compliance tool:

Strengths of EM

1. Provides accurate data on the location and time of fishing activity.
2. Accurately assesses the set type in purse seine fisheries.
3. Accurately estimates total catch per set in purse seine fisheries.
4. Provides good estimates of the catch of main target species in longline and purse seine fisheries.
5. Identifies most endangered, threatened, or protected (ETP) species interactions.
6. Incentivises more accurate reporting of data in logbooks.
7. Covers multiple views of the vessel at the same time, does not require breaks, and video can be reviewed multiple times.
8. Is less prone to intimidation, bribery, or interference in order to falsify reported data.
9. Review of much of the fishing activity can happen at high speed (e.g. >8 x speed).

10. A space-efficient solution for longline vessels with limited room for a human observer.
11. Can sometimes provide cost savings relative to human observers.
12. Helps document conformity with management measures and international obligations.
13. Scalable option to implement on various vessels with different gear types.

Challenges for EM

1. Accurate estimates of non-target species in purse-seine and longline fisheries can be challenging with EM depending on catch-handling techniques and camera placement.
2. Identification of ETP species may only be accurate at higher taxonomic levels (e.g. shark or turtle), but not at the species level. However, additional or higher resolution cameras may be a solution.
3. Accurate identification of juvenile tunas (e.g, small yellowfin and bigeye) is difficult, although this is similarly difficult for human observers.
4. EM systems are not linked to FAD buoy identification systems.
5. EM is not currently suitable for biological data collection (e.g. sex identification, otolith measurement), which could be addressed by complementing EM with dockside sample collection.
6. EM cannot be used to accurately assess the condition or life status of fish.

In general, it is easier to extract detailed information about catch in longline fisheries, where the catch is brought on board one fish at a time, but EM has proven successful in purse-seine fisheries as well.

The growing body of experience with EM has demonstrated that it can complement human observer programmes. For longline fisheries, where low levels of human observer coverage mean that there are little data about what is happening at sea, EM can be a valuable tool to help fill this information gap.

Designing an EM programme

The Pew Roadmap details the 15 elements of an EM programme that should be considered during development and implementation. These elements are:

- Engaging stakeholders
- Establishing programme objectives
- Mitigating challenges to advancing EM
- Defining EM programme standards
- Structuring the EM programme
- Calculating and allocating costs
- Defining programme coverage levels
- Capturing EM records
- Retrieving EM records
- Reviewing EM videos
- Accessing EM videos and data
- Storing EM records
- Maintaining privacy and confidentiality
- Servicing EM hardware systems
- Contracting vendors

In the Roadmap, an overview of each element is presented as well as some of the design choices or options that could be considered. Building an EM programme is an iterative process. Mechanisms should be included for continuous review, refinement and improvements as experience is gained and technology evolves.

Aspects of EM programmes

An interesting point is that almost all stakeholders see positive and negative aspects of EM, but these views vary widely across groups. Table 1 shows some common stakeholders and their perceptions of EM.

Although conditions vary considerably among RFMOs, there are two commonly cited concerns about EM. One is the cost of an EM programme and who will pay for it, and the second is that vessel operators and flag states can be resistant to additional monitoring requirements. Under these two broad headings, there are some related challenges, which are briefly described below:

- For coastal states that license DWFN fleets, there is concern that an EM requirement will drive fleets away from their exclusive economic zone, and they will lose license revenue. This challenge could be addressed with a synchronised implementation of EM across the entire fishery. There is growing recognition that RFMO fisheries need to be better monitored, and fleets that attempt to subvert this trend by moving into high seas areas will be increasingly considered as renegades, which could have repercussions for fleet vessel owners and flag states. International pressure on RFMOs and on the market will also help to mitigate this challenge. Over time, this concern is likely to fade.
- It may be difficult to reconcile coastal states' contention that industry should be responsible for all costs associated with the management of a fishery (including EM), with the industry thinking that the cost of EM is the major constraint of implementation, especially for fisheries that are not very profitable. Addressing this

Table 1. Stakeholders and the potential benefits of and concerns with EM.

Stakeholder	Potential benefits of EM	Potential concerns with EM to address/mitigate
RFMO secretariat staff	◦ Efficient mechanism for encouraging compliance ◦ Monitoring bycatch and catch levels, especially in fisheries with catch quotas	◦ Increase in workload for formulating standards and implementation ◦ Cost of the system and associated costs of increased workload ◦ Alienation of member countries that are reluctant to adopt EM
Coastal states	◦ Monitoring catch levels, especially in fisheries with catch quotas ◦ A mechanism to deter illegal activity that cannot be corrupted ◦ Ability to monitor observers ◦ Deflecting criticism that tuna fisheries are unsustainable ◦ Showing the public that tuna fleets are being effectively monitored	◦ Loss of revenue if vessels move to the high seas to avoid EM requirements ◦ Hesitancy of some coastal states to be an "early adopter" ◦ Increase in workload for programme implementation ◦ Cost of the system (e.g. added costs such as dedicated equipment) that industry does not want to pay for ◦ Pressure by flag states that are reluctant to adopt EM ◦ Concessions that might be made to get distant water fishing nations (DWFNs) to agree to EM
Flag states	◦ Deflecting criticism that tuna fisheries are unsustainable ◦ Showing the public that tuna fleets are being effectively monitored	◦ Pressure from domestic vessel operators that are opposed to EM ◦ Additional enforcement responsibilities and expenses ◦ Cost of the system (e.g. added costs such as dedicated equipment) that industry does not want to pay for
Vessel owners	◦ Avoiding criticism for low human observer coverage in longline fleets ◦ Ability to demonstrate that fishing operations are legitimate ◦ Monitoring quality control ◦ Protection against frivolous claims by observers or crew ◦ Greater management flexibility afforded when vessel is fully monitored	◦ Cost of the system, especially a) if industry is expected to pay all EM expenses, and (b) considering the current low profitability of the fishery. ◦ Fear of minor or unavoidable infractions being taken out of context ◦ Extra work and difficulty of compliance with a whole new set of rules for the fishery ◦ Having to return to port if vessel monitoring system becomes inoperable (i.e. not convinced of reliability of system)
Science agency staff	◦ Ability to efficiently collect many types of data ◦ Greater confidence in collected data ◦ Ability to verify data collected by human observers	◦ Inability to collect some kinds of data (e.g., possibility of loss of human observer coverage and associated opportunities for collection of biological samples)
Major tuna companies	◦ Ability to demonstrate that fishing operations are legitimate ◦ Meeting market demand for sustainably fished product	◦ Fear of minor or unavoidable infractions being taken out of context
Vessel crew	◦ Does not take up as much room as human observer ◦ Elimination of logistical problems and loss of fishing time for observer logistics ◦ Captain has the ability to monitor crew at all times ◦ Protection against frivolous claims by observers ◦ Ability to monitor labour and safety practices	◦ Concerned about always being recorded in their workplace and invasion of privacy (e.g.9 showering, defecating) ◦ Elimination of some income-earning opportunities ◦ Extra work during port calls of dispatching the hard drives ◦ Fear of minor or unavoidable infractions being taken out of context
Observers	◦ Reduction of harassment by vessel crew ◦ Increased observer safety ◦ Possibility of onshore employment as EM reviewer	◦ Unwanted auditing of work ◦ Loss of on-vessel employment

challenge may require some flexibility on the part of coastal states in allocating EM costs, especially during the start of a programme. It may be possible to provide additional incentives to industry or obtain external support for the initial implementation of a new EM programme (e.g. foreign aid, foundation grants).

- Numerous stakeholders may face a "fear of the unknown" or an aversion to change due to uncertainty about system costs, reliability, impact of additional monitoring, and the extra work EM may require. Pilot projects, and effective dissemination of the results, could dispel much of this fear. Inter-RFMO cooperation and exchange of experiences could also help demystify EM.

As experience with EM increases, more mitigating mechanisms for addressing these challenges are emerging. Several stakeholders are likely to be strong supporters of EM for RFMO fisheries, and their support can help positively influence others. These may include:

- early adopting countries, especially those with individuals who are fishery champions;
- coastal states, especially if they anticipate that costs to them will not be great; and
- branded tuna companies, especially those that wish to promote the image that the concerned fishery is transparent and sustainable.

Although it may take some time, there is a growing recognition that better information is required for effective management of RFMO fisheries. This sentiment is growing among even the most reluctant stakeholders. This concept, combined with the push from supportive stakeholders, suggests that other actors are likely to come around.

Once stakeholders agree on objectives for an EM programme, defining standards for an EM programme is a logical step for formalising an RFMO requirement for EM. A few of the RFMOs have developed or are engaged in discussions to create EM programme standards:

- Member countries of the Pacific Islands Forum Fisheries Agency have produced, for future consideration by their governing body, a draft regional longline fisheries EM policy that includes standards on EM systems, data management, data ownership and access, and data security and confidentiality.
- The WCPFC has established a working group for developing EM standards, which were presented to the annual meeting of WCPFC in December 2019.
- In 2019, ICCAT adopted a measure to propose longline EM standards by 2021.
- The Indian Ocean Tuna Commission (IOTC) is conducting EM trials that will eventually inform draft standards.
- The IATTC is developing standards for both longline and purse seine and will be presenting them for discussion to its Scientific Advisory Committee (SAC) in 2020.

EM programmes for international fisheries could have several types of structures, including an RFMO-wide programme, individual national programmes, subregional programmes, or aspects of national programmes being pooled between countries. Each type has its advantages and disadvantages, with the most appropriate type for a region being influenced by the fishery management history, geography and politics of the area. If a region has previously enjoyed an effective network of national observer programmes, countries may feel comfortable staying with that model for an EM programme.

EM costs

Because the costs associated with an EM programme are a concern for many stakeholders, additional attention to expenses is required. To date, most of the costs for EM programmes in tuna fisheries have been paid by non-governmental and international organisations, but this model will not continue forever. Currently, much of the enthusiasm by coastal states for EM is related to the idea that in the future, industry will be responsible for paying for most, or all, of the costs. The draft Regional Longline Fisheries Electronic Monitoring Policy, formulated by FFA member countries, states as a guiding principle: "User pays – full cost recovery as a default." Many segments of the fishing industry feel that costs could be high and are also uncertain about how an EM programme will affect their business. As the group that will be most impacted, they may believe that it is unfair for them to be entirely responsible for funding an EM programme. This difference of opinion on who should pay for EM is seen by many as the most significant impasse for EM implementation.

Data review

The process for reviewing and extracting data from video footage is a critical element of EM programme design. Video review is typically the costliest component of an EM programme – often about 50 per cent of overall programme costs – and decisions about how much video to review and what data to extract need to be guided by and aligned with the overall EM programme's objectives. The more video that is reviewed and the more detailed the data extracted, the more costly it will be. There are different models for assigning responsibility of the video review process, each with their own pros and cons.

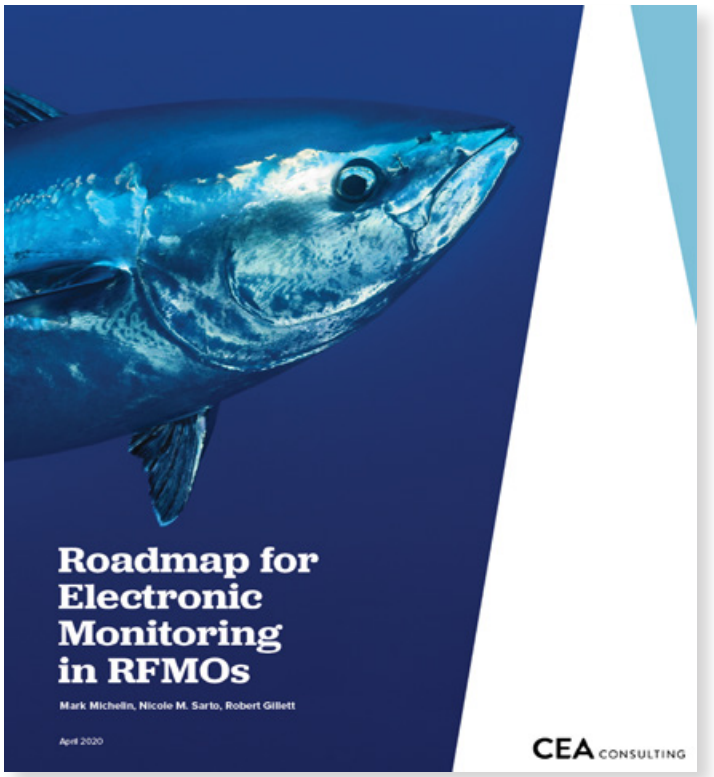
Privacy and access

There are many entities that would like to be able to access raw video footage or processed data from EM programmes, and therefore a data management plan will need to be developed that covers many issues, such as data movement, confidentiality and access. All RFMOs have very detailed data policies in place that cover confidentiality and sharing. Examples of this are the IATTC's "Data Confidentiality Policy and Procedures", ICCAT's "Rules and Procedures for the Protection, Access to, and Dissemination of Data", and the IOTC's "Data Confidentiality Policy and Procedures." Although none of these policies cover EM data, there are procedures in these policy documents for covering new types of data. It is likely that in many RFMOs, the EM data policy and procedures will follow those of the observer programmes.

In conclusion

A clear movement appears to be underway in which demand for better data and accountability in fisheries is increasing. Seafood and fishing companies are taking more action to improve the sustainability of their products driven by market pressure and as a way to mitigate risk of illegal or unsavoury practices in their supply chains. Import regulations, such as the European Union's illegal, unreported and unregulated fishing carding system and the US Marine Mammal Protection Act, are also compelling countries to improve the monitoring and accountability in their fisheries. Many fisheries managers and scientists would also like to have better data so that they can have a clearer picture of the status of fishery resources and how much fish is being caught. These forces appear to be driving a slow but steady increase in monitoring requirements in fisheries, and modern fisheries management is turning towards EM as a tool to help meet these objectives. With thousands of vessels and low rates of observer coverage in some fleets, EM appears to be especially relevant for RFMO fisheries.

There is a growing recognition that better information is required for the effective management of RFMO fisheries, and this sentiment is growing among even the most reluctant stakeholders. Human observers will continue to play an important role in collecting this information, but it is unrealistic that they will be able to cover the required percentage of fishing. The emergence of EM offers a solution to scale up monitoring coverage and to help meet this need for better information. There are real challenges to developing an EM programme, and the characteristics of RFMO fisheries can make this a bit more complex, but these are solvable challenges. Time appears to be on the side of EM and the question is no longer whether EM will become a widely used tool in RFMO fisheries, but when.



Michelin M., Sarto N. and Gillett R. 2020. Roadmap for Electronic Monitoring in RFMOs. CEA Consulting for Pew Charitable Trusts.

The full 41-page report is available at:
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