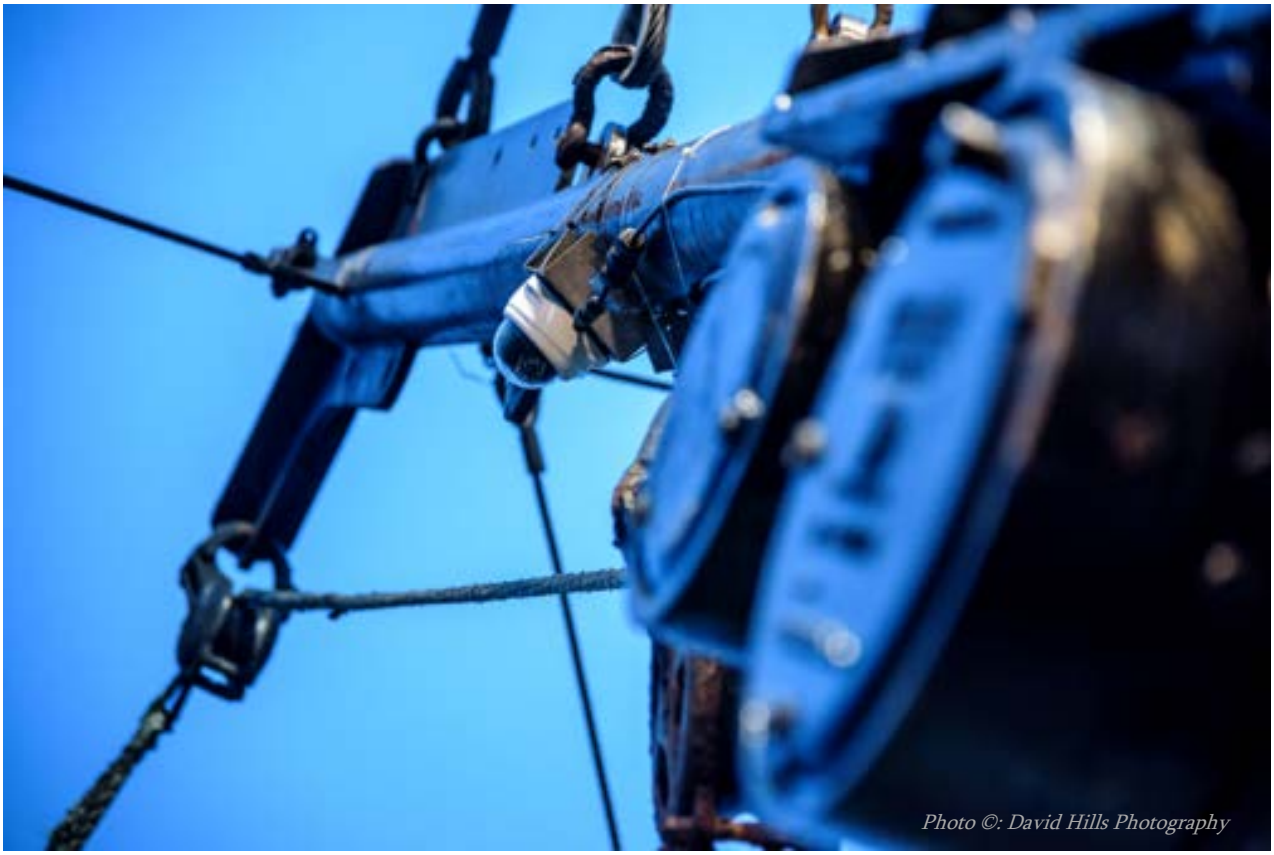

Electronic Monitoring Program Toolkit

A Guide for Designing and Implementing Electronic Monitoring Programs

The Nature Conservancy

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INTRODUCTION

The majority of global fisheries lack the scientific and compliance data necessary for effective management. A variety of approaches and tools can facilitate data collection on the water and help ensure compliance, yet the use of human observers or other reporting or patrol options tend to be infrequently used, subject to bias and misreporting, and are typically expensive to employ. The lack of accurate on-the-water data collection hampers the ability of fishery managers to assess the health of fish stocks and to effectively manage fisheries, potentially resulting in economic losses, declining fish populations, and a degraded marine environment. Accordingly, many fishery managers have begun to look to new technologies to help fill in critical data gaps.

Electronic Monitoring (EM) has the potential to be a scalable solution for collecting critical data and using it to employ new management strategies, enable robust assessment of fish stock health, and facilitate accurate monitoring of vessel compliance with the concomitant reduction of illegal, unreported and unregulated fishing. In fact, EM has been shown to perform commensurately with, or in many instances, outperform, other at-sea monitoring tools (e.g., human observers and logbooks) with regards to accuracy, cost, and data integrity, and EM performance is continuously improving (see Box 1). EM also offers promising applications that are beneficial to industry, such as enhancing crew and observer safety and preventing theft or shrinkage of catch.


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This toolkit presents an overview of key questions and issues that may arise when governmental bodies in general, and fishery managers in particular, are considering the development and implementation of EM programs. For purposes of this toolkit, EM refers to a system that includes cameras, hard drives (or similar data storage or transmission devices), electronic storage and optional gear sensors installed on fishing vessels. The EM system is used in conjunction with GPS data to provide detailed information on fishing locations, times, methods and/or total catch and bycatch (including discards). Other electronic information systems such as e-logbooks may be used independently or in conjunction with EM systems. However, this toolkit is confined to EM systems.

How to Use this Toolkit

This toolkit is a guide that is written in sequence, walking through the main steps to consider when developing an EM program. The toolkit identifies key decision points and potential outcomes, beginning with program planning and system design, followed by program costs, evaluation, and adaptation. Understanding how a general EM program operates, and how a program may be adapted over time, should inform overall program design. The guide may be useful to first review in full, and then revisit separate sections as necessary.

Box 1. EM Performance Compared to Other Vessel Monitoring Options

- EM has proven to be at least as accurate as other methods at estimating the catch of target species and bycatch of species such as turtles, seabirds, and sharks.
- Accuracy of EM data has been shown to improve over time due to improved on-board catch handling practices.
- As the technology improves and experience with EM systems grows, the quality of data is expected to improve.
- The presence of video can change reporting behavior and reduce or eliminate observer effects.
- If vessels fish consistently, the per vessel cost of human observer coverage is generally accepted to exceed the cost of EM coverage.

EARLY CONSIDERATIONS

This toolkit is intended to provide an overview of EM decision points and policy concerns. It is not intended as legal advice and it is important that any authorities considering introducing an EM program consult with their own legal counsel to ensure their program is consistent with national and local laws and precedents. The following analysis is based primarily on U.S. legal principles and case law.

At the very outset, the relevant governmental agency or legislative body must promulgate the legal and regulatory framework that will provide the foundation for the EM program. Among the central issues to be considered are the scope of the jurisdiction of the governmental body or agency that will implement, regulate and enforce the EM program; what territorial waters will be regulated; and what target fisheries or vessels will be subject to regulation. Under an EM framework, "regulatory standards must be in place requiring hardware, software, output and recording minimums."[1] In addition, the legal structure should address privacy rights, confidentiality, data protection and ownership in the context of the EM program. Key legal considerations are outlined in Box 2.

Privacy and Confidentiality Issues

The concept of "confidentiality," which generally refers to an obligation to keep certain information secret, differs from the concept of "privacy," which generally refers to the protection of individuals from intrusion into their personal lives and personal information. Many nations have specific privacy laws governing the treatment of personal information, while others may offer certain guarantees of privacy under common law principles. The strictness of privacy laws and their requirements vary from jurisdiction to jurisdiction.

In the context of EM, the privacy of vessel captains and crewmembers may be implicated, as their images will likely appear in the EM records. Under many privacy laws, these images may be considered the private information of the crewmembers, which cannot be released to third parties without their consent. Under less strict privacy regimes, simply giving notice of the presence of cameras onboard by the posting of signs near the cameras may be sufficient to meet privacy obligations. But under stricter regimes, vessel operators may be required to obtain specific affirmative crewmember consent to being filmed.

> The term "EM records" in this toolkit refers to the raw video footage collected by an EM system and "EM data" refers to the information that results from review and analysis of the EM records.

Because vessels fishing in a particular fishery may originate from many different countries, they may be subject to differing levels of privacy obligations in order to protect images of crewmembers who appear in EM records. One potential option for addressing varying privacy considerations is to specify in the EM regulations or legislation that the vessels are responsible for ensuring compliance with all privacy laws to which they are subject and that failure to do so will be considered a violation of the EM regulations or legislation. Thus, if a vessel is flagged to or fishing in a nation that requires affirmative consent to release of private information, then it would be the obligation of the vessel owner/operator to obtain that written consent before bringing a crewmember onboard a vessel equipped with an operating EM system.

EM records containing information such as fishing location, catch data, and fishing techniques may be considered proprietary by vessel operators, who may seek to keep such information confidential. In order to obtain full fleet cooperation with an EM program, it is likely necessary to provide governmental assurances that the EM records will be anonymized before being made public or treated as confidential, and thereby protected from disclosure to competitors and other third parties. Confidentiality concerns should cause the agency or fishery manager to analyze its government's requirements and consider whether exemptions exist for EM records or can be drafted to protect proprietary commercial information.

Box 2. Legal Considerations

Jurisdiction: The power of governments to regulate their fisheries in general, and EM programs in particular, may be impacted by various legally binding agreements the particular government has with other domestic governmental agencies and international entities as to the nature of their fishing rights.[2] In addition, the jurisdiction of most governments can be further affected if they have entered into cooperative agreements with global and regional organizations.[3] Jurisdiction may also be established as a condition of the issuance of a fishing permit, or pursuant to an access agreement between the governmental authority and the owner of a fishing vessel.

Sources of Legislative and Regulatory Authority: The authority to enforce EM programs may be derived from many sources. For example, in the U.S., much of the National Oceanic and Atmospheric Administration's (NOAA) enforcement authority is based on the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act), which is the primary law governing fisheries in U.S. federal waters.[4] In Australia, the Fisheries Administration Act of 1991 and the Fisheries Management Act of 1991 were amended to give the Australian Fisheries Management Authority (AFMA) express powers to implement an EM program among the Commonwealth fishing concessions and scientific permit holders. In general, implementation of an EM program may be addressed by way of agency regulations enacted pursuant to statutory authority.[5]

Enforcement Issues: To ensure the enforceability of an EM program, a system of administrative, civil and criminal laws must be established. For example, NOAA's Office of the General Counsel prosecutes all civil violations of EM regulations (e.g., penalty cases and permit sanctions) in administrative hearings, and refers all criminal proceedings to the U.S. Department of Justice for prosecution in federal district courts.[6] Whereas, in Australia, the AFMA National Compliance and Enforcement Policy (2013) provides enforcement options including administrative infringement notices, suspension of fishing licenses and referral for criminal prosecution.

Choice of Forum: Adjudication of violations of laws and regulations governing EM programs can occur in administrative, civil and criminal venues. Typically, the choice of forum for the adjudication of a claim or violation will determine the scope of the hearing or trial, the weight of the evidence required to prove a violation, and the extent of penalties that can be imposed. In criminal proceedings, typically the burden of proof is the most rigorous, i.e., beyond a reasonable doubt, whereas in a civil proceeding the standard is a preponderance of the evidence. Administrative proceedings, which employ informal procedures, tend to have the most lenient standard of proof, generally described as a balance of the probabilities that the event or fact occurred or is true.

Admissibility of EM Records and Data in Enforcement Proceedings: An agency or governmental body's ability to use EM records or data as evidence in enforcement proceedings will be determined by the admissibility of the records or data. In most legal systems, key issues to ensuring admissibility will include the following:

> Authentication: Specific evidentiary rules can establish how EM evidence may be authenticated in an enforcement proceeding.[7] Examples of what might be required include demonstrating that the recording device was capable of recording the activity offered into evidence and a showing that the device was operating properly at the time of the recorded evidence.
>
> Reliability: Generally, the reliability of EM records and data must be established if they are to be admissible as evidence. "It is critical that specific protocols, standards and practices be adopted and strictly followed to ensure the admissibility ... when data are intended for use in enforcement of regulations."[8] Video and other electronic data captured should be of good quality, in order to

identify catch and the time and locations where the fish were caught.

Record and Data Integrity: Video records and other EM data have the potential to be inadvertently or intentionally altered. Thus, equipment must be designed to be resistant to tampering and "tamper evident" such that any efforts to tamper with the equipment can be readily identified. U.S. regulations make it unlawful to tamper with one or more components of the EM system or to obstruct the view of the cameras.[9] Physical manipulation, such as moving a monitoring device, and human manipulation or modification of the data captured by the EM system should be made subject to penalties. Admissibility of video evidence into certain proceedings also may be dependent on a showing that there has been no change or tampering from the time of the recording to the time it is admitted into evidence.

Chain of Custody: Proving a chain of custody is, in almost all legal systems, essential to establish the absence of alteration, substitution, or change of condition of the data or records from the time of their creation to the time they are to be admitted at a trial or proceeding. This requires an unbroken trail of accountability, which may be proven by paper or electronic documentation showing custody, control, transfer, analysis, retention and disposition of physical or electronic evidence. Establishing a chain of custody is particularly important for electronic evidence because it can be easily altered either intentionally or inadvertently. According to NOAA, data must have a clear and secure 'chain of custody' from the collection point to the final user to confirm the authenticity and reliability of the data.[10] EM records must thus be "stored, archived, and accessible for further review..." This requires a "secure data storage infrastructure."[11]

PLANNING PHASE

Setting Goals and Objectives

An EM program's goals and objectives can help drive decision making as program development progresses and will allow for early input from industry and other stakeholders, ultimately facilitating more wide-spread consensus when the program is launched. Most programs will have multiple, interrelated goals and objectives, so the task is to understand and prioritize them to determine how best to design, fund, and staff the program. Clarifying program goals and objectives may also assist vendors in offering systems and services that meet those objectives and help evaluate options across vendors.

The primary motivation for most fisheries considering implementing EM programs is the need to fill critical on-the-water data gaps to enable better resource management. Important data for resource management includes data on fishing effort, targeted resources, spatial and temporal effort distribution, retained and discarded catches, biological characteristics of the catch, and interactions with protected species.[12] There are several key objectives commonly identified by government bodies when considering implementing EM programs. Some objectives may apply to all fisheries, while others may be more relevant to one fishery than another.

Compliance/Enforcement: Vessel accountability and compliance with existing management rules and regulations are critical to ensuring the long-term sustainability of a fishery. Information from EM systems provides insight into on-the-water activity and can improve fleet regulatory compliance and facilitate enforcement action when vessels fail to adhere to government regulation.

Scientific Data Collection and Resource Management: Accurate monitoring of harvests, bycatch/discards, landings, and tracking of incidental take as well as interactions with protected species can enable fishery managers to assess and manage the health of resources.

Other: In addition to science and compliance goals, other objectives may include cost reductions relative to human observers, increased confidence in fisheries-dependent data, reduced regulatory burden, and improved crew health and safety.

Stakeholder Engagement

In establishing an EM program, it is helpful to determine what value such a program will have to the fleet. Policy and political barriers may be more easily overcome and industry concerns more effectively addressed when all parties are interested in participating.[13] Deciding on an engagement process may also help in evaluating cost-sharing options (see Box 3).

Additionally, program managers have several options for how they might engage with vendors providing EM systems and services, including but not limited to hardware, system maintenance services, data collection support, and data transmission and review services. A draft of program objectives and a minimum set of data elements required to achieve these objectives should be developed prior to engaging vendors so that vendor roles and responsibilities can be clearly communicated. See two examples for vendor engagement approaches in Box 5.

Box 3. Examples of Stakeholder Engagement Approaches

Advisory Committee: If the EM program is being created as part of an ongoing management process, forming a standing EM advisory committee can help to engage industry participants and other stakeholders in the design of the program. Advisory committee membership can be structured to reflect the makeup of the fishery - covering the range of locations, gear types, vessel sizes, and communities – to source input from a range of affected parties. The committee can be charged with providing recommendations to managers and program implementers. Ideally, the advisory committee should commence while the EM program is in early development and may continue meeting through implementation in order to provide feedback to facilitate adaptation and improvement over time. Advisory committees have been used in the U.S. by several of the regional fisheries management councils during EM program development and implementation, including the Pacific and North Pacific Councils.

Stakeholder Interviews: Another approach for stakeholder engagement is to gather input via surveys and interviews. The interview process can be done in addition to, or instead of, having a standing advisory committee and may allow managers to get a wider range of views beyond the perspectives of people who can commit the time to attending and participating in advisory committees. Interviews or surveys alone are unlikely to provide the same degree of industry buy-in as a process that facilitates and encourages discussion between managers and industry during the program development. Repeated interviews and surveys can provide additional insight into perceptions of the EM system and its value before and after implementation.

Program Structure and Management Choices

The design, implementation, and enforcement of an EM program will be partly determined by the underlying rules, regulatory requirements, and decision-making processes of appropriate governing bodies. Implementing EM requires cooperation across government and science partners, with active participation by industry and EM vendors, and there are a range of different EM program structures that can support that cooperation, including:

Top-down/Full Fishery Manager Control: In this model, rules are implemented through regulations or

laws, which are enforced by a public agency through monitoring, investigations, and civil or criminal enforcement actions. In the context of an EM program, this involves the promulgation of laws and/or regulations relating to all aspects of the EM program; designation of one or more agencies to be responsible for all aspects of overseeing the program, including system installation and maintenance, EM record and data review, analysis and retention; and enforcement.

Government Contractor Model: Under this model, a government assigns some of its responsibility to implement an EM program to one or more contractors. This model presently is the most common in EM programs. The responsible agency or agencies retain some responsibilities for program management (e.g., promulgating technical standards and licensing requirements), and for enforcement, while contracting out other components (e.g., equipment installation, maintenance and/or data analysis) to a qualified vendor or organization. Typically, the government also retains the ability to audit the work of its contractors. This model could also be applied to a range of outside organizations, such as non-governmental organizations (NGOs), community trusts, or quasi-governmental partners. In these structures, the government allocates some or all program responsibilities to that entity, with the partnership roles and responsibilities typically formally set out in a memorandum of understanding or other agreement.

Fleet Managed/Market Driven Programs: Under this type of governance model, the public agencies exercise minimal control over the program, leaving industry to manage the program to meet government-specified requirements. Vessel owners are required, as a condition of the issuance of a fishing license, to retain an authorized third party to install a government-approved EM system on the vessel, receive and review the EM data, submit required reports of fishing activity to the government, and store data to be accessed, if necessary, by governmental auditors or enforcement personnel. Some level of industry self-enforcement may also be established, but ultimately, the responsibility for enforcement, whether civil or criminal, is the domain of the government, regardless of the program model selected. As such, the legal protocols must be established to ensure the data are managed in such a way so as to maintain a clear chain of custody and admissibility of the data as evidence. (See Box 2. Legal Considerations.) This EM model shifts much of the burden of EM program execution from the government to industry, and as a consequence, removes substantial control from the government agency. In low governance environments, there is an increased risk of influence by industry, particularly if they are the source of the payment to vendors. Accordingly, specific vendor qualification guidelines need to be established and clear protocols for government access to EM records and data must be enforced. For an example of this sort of management system, see the rule proposed for the U.S. West Coast groundfish fishery.

Box 4. Examples of Governance Models in Existing EM Programs

United States: For the Atlantic Pelagic Longline EM program, the U.S. has a public-private partnership model. The program is administered by the National Oceanic and Atmospheric Administration (NOAA), which sets legally-binding program requirements for target fisheries. NOAA contracts with a third-party vendor to install and maintain EM equipment and to store the original EM records. NOAA stores copies of the EM data submitted to the agency by the vendor, which NOAA uses for research and management.

Australia: Three of Australia's fisheries, including the Eastern and Western Tuna and Billfish program, are also managed through a public-private partnership. Australia created its EM program with legislation supporting EM for data collection and compliance. The Australian Fisheries Management Authority (AFMA) has contracted with a designated private contractor to install and maintain proprietary EM systems. EM records are submitted directly to AFMA, which stores and retains them, while sending a copy to a third-party contractor for analysis.

SYSTEM DESIGN

Hardware

At its simplest, the on-board components of an EM system are a digital camera and a hard drive, akin to security camera systems. More advanced EM systems typically include several additional key components: multiple cameras; optional hydraulic and laser gear sensors that trigger the operation of the video; a GPS receiver; and/or a satellite communications system. Onboard computer systems with specified software and a constant power supply source to support the system also are typically required. Depending on the EM program structure, the government, vessel owner/operators, a third party, or some combination thereof, may be responsible for acquiring, installing, and maintaining the EM systems.

Photo ©: David Hills Photography

Purchase/Lease and Installation: In some cases, as an incentive to early adopters, governments (or NGOs) may offer to purchase or lease equipment and software and/or pay installation costs, so long as the EM system installation is completed prior to a specified date. In other cases, vessel owners will be responsible for purchasing the equipment from a selected vendor, or the agency may purchase the equipment and can recover its costs through various assessment or licensing mechanisms.

Maintenance and Repair: As part of program design, it is important to identify who is responsible for routine maintenance and what should happen in the event an EM system fails or requires maintenance while the vessel is at sea.

> U.S. and Australian programs have provisions that require vessel operators to maintain their EM system in good working order. This includes ensuring that any technical problems or damage are reported immediately to the governmental agency. While at sea, vessel owners/operators are responsible for ensuring the proper continuous function of the EM system as well as cleaning camera lenses and ensuring views of catch handling and gear deployment are unobstructed and well-lit.

Damaged EM Systems: Program managers should provide proper procedures to be taken if an EM system is damaged while the vessel is at sea. One option is that the vessel could be required to return directly to port and discontinue fishing operations until the system is fully operational. This would have the benefit of motivating vessel operators to keep their EM systems in good repair but could also result in substantial negative economic impacts on the fleet. Alternatively, vessels could be required to immediately contact the fishing authority for instructions. Vessels with strong records of compliance and minimal rules violations might be given an opportunity to continue fishing operations and delay repairs until their scheduled return, while others might be required to cease fishing and return to port.

Data System Design

High quality EM systems are capable of collecting a great deal of raw video data, referred to here as "EM records." The detail of the information collected will depend on the program's goals and objectives. More specifically, it can depend on several factors including the type and quality of the EM equipment, the type of vessel and fishing gear, the quality of the analysis, and decisions as to the percentage of the EM records to be analyzed.

Decisions as to the minimum quality of the EM records to be collected should be made prior to selecting EM systems or setting standards. Simpler systems with lower quality cameras may be useful for monitoring the presence or absence of discards but may not be sufficient for species identification and tallying the catch.[14] This is the case for several Alaska fisheries with EM programs. These programs rely on human observers for species identification and tallying the catch, while the EM system monitors discards. Programs wishing to have more detailed information, whether for use by fisheries managers or industry, will require more sophisticated equipment.

One key decision in any EM program is the level of fleet coverage and record (i.e. video) review. There are two aspects of EM coverage: the number of vessels in a given fishery carrying EM systems and the amount of review of EM records from an individual vessel. If compliance and enforcement are high priority management objectives, a program may choose to require 100% coverage of the fleet using EM and require review of 100% of the recorded video, as this will capture all or nearly all non-compliance events. EM record review of video or images currently requires trained personnel, and the labor costs associated with record review significantly impact EM program costs. While fisheries for which compliance is a predominant goal may be willing to make the investment in more comprehensive EM records analysis, an audit of a random portion of the EM records may act as an adequate deterrent to regulatory non-compliance, provided it is of a magnitude sufficient to create a perceived risk among fishers that prohibited acts will be discovered and penalized. Fisheries for which collection of scientific data for sustainable management is most important may find that lower levels of fleet coverage and randomized audits of EM records produce statistically relevant scientific information at a lower cost than 100% coverage and 100% review of records.[15]

It is important to note that although EM record review is responsible for as much as 40% of EM program costs today, as computer-assisted review improves, it is reasonable to expect that review costs may fall substantially. As technological advances lower costs, the desired percentage of fleet coverage or EM record review may change based on the program's objectives. Program managers may experiment during EM program implementation to adjust fleet coverage levels and record review protocols in order to evaluate and determine the preferred balance between data delivery and cost.

Data/Record Transmission

There are several options for transmitting EM records from vessels to reviewers and analysts. The choice as to which is best for a particular fishery depends on fleet dynamics, program goals and objectives, and cost trade-offs. Transmission options include real or near real-time transmission of compressed records over satellite/internet connection, internet upload via remote connection upon return to port, and delivery of hard-drives to a designated review center/recipient upon return to port. Delivery of physical hard-drives can create somewhat complex logistics for vessels that visit many ports, in some cases across different countries, necessitating cross-agency cooperation. The critical consideration when addressing submission of the EM records is to ensure that the evidentiary chain of custody is maintained.

Record Review, Analysis and Sharing

Based on the legal framework underlying an EM program and the decision-making rules, there are three potential parties that can assume the primary responsibility for record review and analysis: the government, a contractor/third party partner, or the fleet.

Government Responsibility: Under this model, vessel owners or operators submit the raw EM records to the specified governmental agency. At that point, the agency becomes responsible for review and analysis of the records and for retaining the raw video records and analyzed data for a specified period of time,

according to protocols the program has established. This model gives full control to the government, but it may also create issues associated with the public's right of access to governmental records. Consideration of inclusion in or exemption from any government legislation similar to the U.S. Freedom of Information Act (whereby members of the public can require the government to produce documents on requested topics), will be important to industry and EM vendors. Similarly, consideration should be given to government legislation dictating the storage of certain records, given the cost implications of having to maintain and store significant amounts of raw video records.

Contractor/Third Party Partner Responsibility: Under this model, the government selects and contracts with one or more third parties to conduct EM records analysis. The EM records may be sent by the vessel owners or operators directly to the third-party partner or contractor or to the relevant government authority that then passes along a copy of the records to the contractor or third-party partner. The contractor or third-party partner then analyzes the records according to the requirements of its contract with the governmental agency and submits the analysis to the agency. Similar to the first option, consideration should be given to inclusion or exemption from government legislation that could require long-term storage or disclosure of raw video records.

Fleet Lead: Under this model, participants in the fishery retain one or more approved third-party contractors to receive and review the EM records generated by the fleet's EM systems. The contractor produces and submits required reports to the governing agency or agencies, and then stores the EM records and analyzed data under conditions that permit them to be accessed by government auditors and enforcement personnel for a specified period of time.[16] This model shifts the burden of EM record analysis and management to the fleet, but also gives the fleet substantially more control over the information it collects. It also positions the fleet to monetize the data, and therefore may reward the collection of higher quality EM records. Under this model, it is critical that the government agency retains full rights of access to all EM records and data, for audit and enforcement purposes. Furthermore, the fleet must be required to submit the records and data in such a manner and under such conditions that the evidentiary chain of custody is maintained in the event of an enforcement proceeding. Program designers should be aware that there is a risk under this model that, while a government agency may initially be granted access under specific standards, over time the fleet may be motivated to reduce the government's ability to fully access the records and data.

Box 5. Examples of Vendor Engagement Approaches

Single Vendor Option: This approach entails fishery managers selecting a single vendor that provides a proprietary system of EM hardware and record analysis software, and which may also provide EM record review services. The vendor then works with the fleet to install the selected equipment on specified vessels. The advantage of this option is convenience for both government and vessel owners and operators, who will have only one point of contact for an EM vendor and consistency in production and review of EM records from various vessels, which can reduce transaction costs for the government and vessel operators. However, the single vendor option can also limit innovation and lock in non-competitive EM vendor prices, eventually resulting in expensive, outdated EM systems or data delivery.

Standards-based Approach: An alternative approach to the single vendor option is to establish clear EM system performance standards (e.g., frames per second, resolution, and species identification capability), and then qualify two or more vendors that can provide EM systems that meet these standards. This approach allows vessel owners and operators to select between vendors with conforming systems and contract with those vendors independently. This approach can facilitate competition among EM vendors to improve their services and reduce costs. However, under this option, fishery managers can be required to manage the certification and auditing of multiple vendors, which may add complexity to an EM program.

Data Ownership and Access

The question of ownership of the EM records and data is closely related to the questions of data sharing and transmission discussed above. If non-owners have satisfactory access to the information and the records and data are adequately protected from tampering or loss, the question of ownership may not be of enormous concern. However, if there is concern that access may be lost, or that the contractor may not be able to provide accurate or complete reports, then the government may prefer to become the owner of all records and data, offering the fleet access as agreed among them. Presently, some governmental entities are opting for ownership of the data, with varying rights of access granted to vessel owners, thereby assuring the government maximum control of the data.

Fishing vessel owners will have an interest in obtaining access to EM records, because of the potential for assessing catch data against market demand, improving targeting of resources, and reducing risks to their vessels.[17] Providing vessel owners access to EM records can potentially increase fleet support for the EM program. However, due to competitive considerations, protections and/or exemptions to disclosure will likely be needed for proprietary information derived from individual vessel records. Managing agencies will need to determine what information they are willing to release to vessel owners (e.g., analyzed data, analyzed data with compressed video clips, or full EM records and analyzed data) and how such disclosure will be managed and paid for.

Record Storage and Management

As part of the EM program cost analysis and program structuring, a determination should be made as to where and how the records and data will be stored and maintained, and for how long. EM records and data may be stored on local hard drives or servers, or in the cloud (e.g., on remote servers, owned and managed by a third party). EM records require substantially more storage space than analyzed data or reports with compressed video clips attached, but both may be necessary to prosecute violations. Determining storage time should involve legal advice about statutes of limitation for prosecution of civil and criminal acts and regulatory proceedings. In the U.S., NOAA recommends that all records and data be maintained by the entity/agency that collected it for a minimum of five years (civil statute of limitations) to support potential enforcement actions.[18] NOAA may develop separate, specific policies related to the storage, archival, and accessibility of EM records.

Box 6. Examples of Data Storage and Management

United States: In the U.S. Atlantic Highly Migratory Species EM program, EM records are collected and stored on hard drives onboard the vessel. When the vessel returns to port, the hard drives are submitted by the vessel owner/operator according to specific procedures (mailed in protective packaging to specified recipient) and NOAA provides replacement hard drives which must be installed before the vessel leaves port. The EM records are designated confidential. However, if the analyzed data are aggregated with data from at least two other vessels, it may be publicly released. A vessel may not access its own EM data.

Australia: In the Australian Western and Eastern Tuna and Billfish fishery EM program, EM records are collected on hard drives which are mailed monthly in pre-paid packaging provided by AFMA to AFMA's Canberra office (sooner if the drive is 80% full). AFMA provides its contractor with a copy of the EM records for analysis. Replacement hard drives are mailed to the address provided by the vessel. With this program, the EM records are used to verify fisher's logbook information. AFMA's contractor provides it and the vessel's owner or operator with a report on the quality of the video footage and a comparison of the logbook report with what was obtained by the video camera. "E-monitoring video footage is securely stored by AFMA and held for a minimum of six months. After this time, the footage may be erased, and

the data drive reformatted ready for use again. However, if the review of the footage identifies anything of concern, the footage will be kept for a longer time."[19]

PROGRAM COSTS

EM programs have real costs and assessing and addressing the cost burden is an important component of EM program planning and design. Issues relating to EM program costs include the distribution of the cost burden among stakeholders and options for managing costs over time.

There are different expenses associated with starting and operating an EM program. Some costs are one-time start-up related costs, while others are ongoing. EM cost categories include:

- *Program Planning*: data needs and objectives, evaluating data management options (e.g., databases, storage)
- *Program Management*: standards development, auditing, management and support staff
- *Equipment*: EM systems and hardware costs (cameras, sensors, hard drives, monitors and other related components)
- *Field Services and Technical Support*: installation (labor, materials, travel), training for vessels (labor, materials, travel), maintenance and repair, remote technical support
- *Record Transmission, Review, Analysis and Storage:* hard drive mailing fees/data transmission upload fees, training, labor, software licensing, storage fees, government database development and maintenance fees, reporting

Additional costs may depend on the program structure, such as costs associated with hiring and training dockside monitors, costs to vessels in accommodating an EM system and the like.[20]

EM program costs can be shouldered entirely by industry (and its seafood supply chain partners, in some cases), government, or a combination of the two. In a number of existing programs, governments have achieved partial cost recovery from industry through licensing fees or direct payment by the fleet.[21] Several EM programs are considering integration of EM requirements into vessel licensing conditions, putting the cost burden of EM system hardware, installation and maintenance on industry.

Costs can be controlled with reference to program goals and objectives. For example, while some program costs are fixed (e.g., the purchase of cameras and sensors), others are dependent on program objectives. Thus, a program requiring review and analysis of 20% of raw video records will cost substantially less than a program requiring 100% EM record review.[22] Program standards addressing how fast and accurate the records must be, how they are transmitted to the reviewing entity (e.g., satellite transmission or submission of hard drives upon return to port), how comprehensive they must be, etc. will all affect program costs.[23]

Another important factor to consider in program costs is the developing market for EM equipment and services. It is reasonable to assume that EM program costs will come down over the next five to ten years. Although it has the potential to grow rapidly, the EM market is still relatively small, and thus it may be of substantial importance to develop programs that enable and reward innovation and entrepreneurship.[24] For example, machine learning is likely to have significant applications in accelerating the EM record review process, reducing its costs and improving its accuracy. EM program developers should consider options for incentivizing existing vendors to adopt and invest in machine learning and other innovations that will reduce costs while maintaining or increasing the effectiveness of EM programs.

PROGRAM EVALUATION

After an EM program has been implemented, regular review of the program should be conducted to understand whether the program is adequately meeting its original goals and objectives. Review and evaluation of an EM program provides opportunities to implement refinements or adjustments that may be necessary to ensure a balance between program costs and data delivery. Program evaluation can be formal (i.e., scheduled to occur at regular time intervals through a documented process) or can happen informally throughout the program's implementation. Stakeholders that were engaged during the development of the program (e.g., an advisory committee) should be included in the program evaluation. Program managers should expect that technological advances will create opportunities to adjust EM programs, and cost savings and efficiencies can be gained through program evaluation and adaptation.

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[2] See e.g., United Nations Convention on the Law of the Sea (1982); Treaty on Fisheries between the Governments of Certain Pacific Island States and the Government of the United States of America (1987); Niue Treaty on Cooperation in Fisheries Surveillance and Law Enforcement in the South Pacific Region (1992); Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas (1993). (Review of Commonwealth Fisheries: Legislation, Policy and Management, David Borthwick, December 17, 2012, p. 113.)
[3] See, e.g., Organization for Economic Cooperation and Development – Committee for Fisheries; Association for Pacific Economic Cooperation – Oceans and Fisheries Working Group; Asia Pacific Fisheries Commission. *Ibid*.
[4] The regulations specifically governing EM of the Atlantic pelagic longline fisheries are codified in the Code of Federal Regulations. 50 C.F.R. §635.9..
[5] See e.g., 50 U.S. Code Fed. Reg. section 635.9 - Electronic Monitoring.
[6] "Policy for the Assessment of Civil Administrative Penalties and Permit Sanctions," NOAA Office of the General Counsel – Enforcement Section (July 1, 2014)
[7] See e.g., United States, Federal Rule of Evidence 901(a) and 901(b)(9) referencing the admission of video evidence.
[8] Electronic Monitoring and Electronic Reporting: Guidance & Best Practices for Federally Managed Fisheries, *supra* p. 28.
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[16] See NMFS Electronic Monitoring and Electronic Reporting Guidance and Best Practices, Discussion Draft, August 2013; NMFS Proposed Rule concerning EM implementation in the Pacific Coast groundfish fishery, 81 Fed. Reg. 172, pages 61161-61180 (September 6, 2016).
[17] Poseidon, *supra* p. 27.
[18] Electronic Monitoring and Electronic Reporting: Guidance & Best Practices for Federally Managed Fisheries, NOAA National Marine Fisheries Service et. al., Discussion Draft, August 2013, p. 29.
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http://www.afma.gov.au/wp-content/uploads/2014/12/Commonwealth-e-Monitoring-Program_program-overview.pdf
[20] Electronic Monitoring and Electronic Reporting: Guidance & Best Practices for Federally-Managed Fisheries, *supra* pp. 6, 20-24; *see also* Sylvia et. al., page 11.
[21] Poseidon, *supra*, p. 68 identifying AFMA cost recovery system; Sylvia et. al. p.7, indicating the explicit intention of NOAA to move to cost recovery from industry.
[22] Sylvia et. al., *supra*, p.8.
[23] Sylvia et. al., *supra*, p.8; Electronic Monitoring and Electronic Reporting: Guidance & Best Practices for Federally-Manager Fisheries, NOAA Fisheries Office of Policy & Electronic Monitoring Working Group, 2013a.
[24] Sylvia et. al., *supra*, p.6.