Electronic Monitoring Annotated Agenda
CCC Meeting – February 21, 2013
Silver Spring, MD

1. Title of Discussion: Electronic Monitoring: Toward a Cost-Effective and Regionally-Appropriate Strategy for Fishery-Dependent Monitoring

2. Presenter(s): Mark Holliday, Director, Office of Policy, NOAA Fisheries

3. Objective/Purpose: [**Informational & Action**]

The purpose of this agenda item is to seek CCC agreement to work collaboratively with NOAA Fisheries on a more cost-effective and sustainable approach to fishery-dependent data collection that utilizes electronic technologies where appropriate.

4. Background/Synopsis:

- The demands for more frequent, more precise and more types of fishery dependent data for the agency's science, compliance and management use continue to rise every year. Agency budget appropriations, however, have been and will likely to continue to be on the decline. The impact of this combination of trends for data collection is neither economically sustainable nor meeting the needs for quality, timeliness and coverage across fisheries, regions, or regulations.

- Electronic technology data collection methods include electronic reporting (ER) such as electronic vessel trip reporting and e-logbooks and electronic dealer reporting, and electronic monitoring (EM) such as vessel monitoring systems and digital camera video monitoring.

- NOAA Fisheries has initiated a strategic effort to consider the challenges and opportunities associated with the adoption of electronic technologies in fishery-dependent data collection programs. The goal of this effort is to achieve a more cost-effective and sustainable approach, and, in doing so, take advantage of the range of current and emerging technologies. Most notably this includes the potential use of electronic monitoring (EM) using digital video cameras and electronic reporting (ER) using e-logbooks. We would like to pursue this strategic effort in partnership with the Regional Councils, including their Scientific and Statistical Committees and Advisory Panels, as well as in collaboration with the fishing industry.

- To initiate this effort, in January 2012 NOAA Fisheries Leadership agreed in the near-term to develop a series of white papers exploring management, science, policy and enforcement issues impacting adoption of ER/EM, including: (1) Existing Technologies, (2) Enforcement, (3) Confidentiality Concerns, (4) Research and Development, (5) Alignment of Objectives, and (6) Funding Options. These white papers provide information to consider when evaluating EM/ER as a possible method of data collection, including the benefits and

drawbacks of ER/EM options. The white papers, provided in the briefing materials for this meeting,[1] are a starting reference point for future discussion (see: Supplemental materials).

- After reviewing the white papers last Fall, the agency developed three principles for future fishery dependent data collection:
  (1) The agency encourages and endorses the use of electronic monitoring technologies where appropriate;
  (2) Current fishery dependent data collection programs are expected to transition to a state of fiscal sustainability; and
  (3) Regional strategies to consider the possible adoption of EM/ER solutions should be developed for each federally-managed fishery in collaboration with and to meet the needs of the industry, Councils, and the agency.

  These principles are currently being incorporated into an internal policy statement to guide NOAA Fisheries employees. This directive will put forth an overarching vision that embraces both traditional methods such as fishery observers, as well as methods of digital electronic video monitoring and other ER/EM technologies.

- Recognizing the consequences, complexity, and challenges associated with creating these EM/ER strategies, the agency now seeks participation from CCC and Councils on the identification of goals and objectives for data collection programs, evaluation of case study and pilot project results, and development of guidance and best practices for use in the consideration and selection of EM/ER options. Over the course of the next four months we propose working with the Councils to develop a series of workshops, webinars and Council-NOAA Fisheries meetings that can be used to inform the content and scope of these regional strategies. We anticipate that this joint effort will provide:

  - An introduction and description of the challenge and objective(s) for a sustainable fishery dependent data collection program.
  - Process steps and flow of decisions associated with the design and implementation of a fishery dependent data collection program, including one that considers ER/EM.
  - Examples of ER/EM technical guidance, focusing on case studies; equipment, hardware and software choices; subsequent data handling; quality assurance; infrastructure specifications; and other requirements for cost-effective electronic monitoring and electronic reporting.
  - Tools and preferred methods to conduct comparative analyses of ER/EM options.
  - Identification of key policy and decision points in the development of a program that considers ER/EM options.
  - An inventory of short and long term information gaps affecting the successful application of an ER/EM strategy that must be resolved.

[1] The confidentiality white paper is not included in the briefing materials since the agency is currently engaged in a rulemaking implementing confidentiality policy changes driven by the 2006 reauthorization of the Magnuson Stevens Act. The information presented in the document is subject to change based on the content of the final confidentiality regulation.

- At the conclusion of the four month period, we should have accumulated sufficient technical guidance to decide on how and when to consider EM/ER as part of a long term data collection program strategy. From July 2013 and forward the respective NOAA Fisheries Regional Administrators, Regional Council and their stakeholder will apply this information and process guidance to determine which if any fishery would benefit from the adoption of an EM/ER element. Within a year to 18 months we expect the Council and NOAA Fisheries will be applying this information and process to the fisheries in their regions and where appropriate move forward on issuing plan amendments and regulations where EM/ER was found to be relevant and helpful.

In the following proposed timeline we lay out a draft process for developing and applying this guidance, beginning with confirmation from the CCC of the plan and this proposed process.

5. Proposed Timeline for NOAA Fisheries/Regional Council/Industry Collaboration

- *February 2013*: CCC meeting in DC – Deliver white papers. Present then discuss input on process and timeline with Councils. Engage Councils on how best to develop guidance and capture Council and industry input over next four months (e.g., Council/SSC/AP mtgs, workshops, webinars, town halls, etc)

- *February/March 2013:* Starting with a synthesis of white papers, further develop strawman technical and process guidance materials to help discussion of EM/ER options. (White papers serving as appendices)

- *March – June 2013:* Conduct outreach and solicit input from NOAA/CCC EM Working Group/ Councils/SSCs/APs/stakeholders (fishing industry, EM/ER practitioners, etc.) on technical and process guidance.

- *March – June 2013*: Conduct regional E-monitoring workshop(s) - Coordinate w/possible Council/other potential regional workshops. Public input on technical and process guidance creation.

- *April/May 2013*: Managing Our Nations Fisheries III – Poster session on draft EM/ER technical and process guidance.

- *June 2013 Post-symposium*: Finalize technical and process guidance. Execute communications roll-out strategy throughout summer 2013.

- *July 2013-end of year:* Regional Offices/Science Centers/Councils begin applying technical/process guidance to federally managed fisheries in their region to evaluate potential role of EM/ER; goal to develop regional strategy/plan on consideration of EM/ER.

- *September 2013*: American Fisheries Society Symposium on EM/ER – Possible outreach and discussion of NOAA Fisheries/Regional Councils EM/ER planning efforts.

- *October 2013*: Possible national workshop on EM/ER to compare plans, advance and share knowledge base, and resolve problems.

- *2014 and beyond*: As agreed to by NOAA Fisheries/Regional Councils/industry, conduct regional implementation of Plan amendments and/or regulatory changes to adopt EM/ER solutions

6. Supplemental materials - Electronic Monitoring White Paper Topics

- *Existing Technologies (Appendix B)*: This paper provides an overview of existing ER/EM technologies and their applications for U.S. fisheries. The paper documents the current capabilities and limitations of ER/EM technologies; considers pros and cons of implementing ER/EM technologies; provides an overview of costs; and describes how ER/EM technologies can meet management, regulatory, enforcement, and science needs.
- *Enforcement (Appendix C)*: This white paper describes the experiences, challenges, and pros and cons associated with using ER/EM from an enforcement perspective.
- *Research and Development (Appendix D)*: This white paper provides an overview of recent research and development projects for testing the feasibility and potential benefits of implementing new ER/EM technologies, describes the collaborative process that is needed for determining appropriate ER/EM technology standards, and documents how priorities could be set for future research and development.
- *Alignment of Objectives (Appendix E)*: This white paper lays out an example of the type of analysis and process that could be used by Regional Fishery Management Councils, NOAA Fisheries, states, the industry, and private technology developers to align monitoring methods with regulatory needs. The paper also describes how to develop a monitoring regime for both newly established fisheries/regulations and for adjusting regimes, where needed, in those that already exist.
- *Funding Options (Appendix F)*: This white paper identifies potential funding sources for ER/EM, along with advantages and disadvantages for each option and their legal and policy implications. The paper includes the use of appropriations, industry funding, and third-party funding sources.

Electronic Monitoring White Papers

February 15, 2013

Source: NOAA Fisheries Office of Policy &
Electronic Monitoring Working Group

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National Oceanic & Atmospheric Administration
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Appendix B -

Electronic Monitoring White Paper
Existing Technologies

National Oceanic and Atmospheric Administration

National Marine Fisheries Service

February 2013

1. Key Findings

- The decision to invest in ER/EM technologies depends on the fishery, gear type, monitoring and reporting requirements, cost-effectiveness, available funding, and other criteria discussed in this paper.

- Electronic Reporting (ER) and Electronic Monitoring (EM) technologies are significantly different in terms of design, purpose, scope, and application. Collectively, these technologies range from electronic reporting of trip data by fishermen, to catch, landings, and purchase data by dealers or processors, to electronic monitoring equipment such as video cameras which capture information on fishing location, catch, and discards.

- Many ER/EM technologies have been integrated into existing data collections systems, and more potential certainly exists. The decision to adopt any particular technology requires an investment of resources from a limited pool of funds and personnel. Thus, the choice of where to invest is an important one.

- Vessel ER exists in some capacity for many U.S. fisheries, representing a wide range of sectors and fisheries. Dealer ER is used in some capacity throughout the country.

- EM via VMS is used to monitor approximately 4,500 vessels permitted in more than 17 federal fisheries. The system has the potential to be expanded to include transmitting other types of data including e-logbooks, landings information, photo/video data and sensor data.

- Many ER/EM technologies have been successfully integrated into a variety of fisheries. Others are still under development but show promise of being able to meet increasing data requirements in a growing number of fisheries.

- However, despite an increasing number of pilot projects in recent years, many fisheries still lack viable ER/EM technologies for day to day operations. Many fisheries continue to use paper forms for reporting.

- ER is generally considered effective at capturing fishery dependent data. However, as with any self-reported data, including data recorded on paper, it is still possible to submit incorrect information. ER does not completely prevent intentional or unintentional reporting errors. Further engagement with the industry – from fishing vessel operators to truckers – would be helpful to educate and establish buy-in among participants on the data needed to improve the information collected to manage our nation's fishery

resources.

- Cost variations among the regions and systems can be attributed generally to the novelty of the system, the complexity of the system, and its general applicability to other regions or fisheries. The more complex a reporting system is, the higher the initial development costs. But if that system can be easily implemented in another area, those costs generally go down. Once deployed, in order to remain successful, ER systems require ongoing funding for operations, maintenance, and quality checks (QA & QC).

- The goal of video monitoring is to provide a cost-effective monitoring solution capable of collecting data for scientific, management, and compliance purposes.

- Despite numerous past and ongoing video monitoring pilot projects there are currently no operational video monitoring programs in NMFS-managed fisheries where data extracted from video are used for science or management purposes. This is due to operational issues including the ability to accurately identify species, ability to estimate weights of discarded fish, and length of time required to obtain and review video and extract all requisite information.

- To date video monitoring has proven to be most effective as a compliance tool for monitoring crew activities.

- Video monitoring may not be effective for identifying protected or prohibited species.

- Video monitoring projects vary widely depending on the management objectives of the monitoring program, and may not be more cost-effective that observers.

2. Introduction

The National Marine Fisheries Service (NMFS) uses a wide variety of electronic technologies to collect fishery-dependent information from U.S. commercial and recreational fisheries. The MSA requires implementation of annual catch limits to end overfishing which has increased the burden on industry and managers alike to provide more data at the lowest possible cost. Increasing observer coverage requirements, particularly in catch share programs, have high cost burdens that can be problematic for industry-funded programs and difficult for NMFS to fund given current fiscal constraints. Increasingly, the use of electronic technology (monitoring and reporting) is perceived as a mechanism to improve the efficiency and cost-effectiveness of data collection.

The term electronic monitoring (EM) is used broadly, indicating all means of collecting, recording, or reporting data both on shore and at sea. However, EM and electronic reporting

(ER) technologies are significantly different in terms of design, purpose, and application. Collectively, these technologies range from electronic reporting of trip data by fishermen and catch, landings, and purchase data by dealers or processors, to electronic monitoring equipment such as video cameras that capture information on fishing location and catch with variable data storage options. To the extent possible, this paper will provide distinctions between ER and EM while maintaining a cohesive summary of existing technologies. A list of commonly used terms in ER/EM is provided in Appendix 1.

This paper groups data collection methods into five different categories under two main topics:

(1) Electronic reporting, including:
  (a) electronic vessel trip reporting and e-logbooks;
  (b) electronic dealer reporting.

(2) Electronic monitoring, including:
  (a) vessel monitoring systems;
  (b) video monitoring;
  (c) other existing technologies (Table 2).

Each of these data collection tools is described in further detail below including information about the specific fishery/species in which it is used, gear types, information technology (IT) infrastructure requirements, cost, potential sources of bias, and pros/cons of each of the technologies.

3. Objectives/Purpose

The purpose of this white paper is to provide an overview of existing ER/EM technologies and their applications for U.S. fisheries, and to:

- Document the current capabilities and limitations of ER/EM technologies;
- Consider pros and cons of implementing ER/EM technologies;
- Provide an overview of costs;
- Describe how ER/EM technologies can meet management, regulatory, enforcement, and science needs.

In some situations, ER/EM technologies can be used to replace components (paper fish ticket vs. electronic fish ticket, camera vs. observer) or enhance existing systems (electronic reporting by observers through electronic logbooks). Additional factors to be considered prior to adoption of ER/EM technologies are described in “Electronic Monitoring White Paper Alignment of Objectives”, and are not discussed in detail here.

4. Existing Technologies

This section provides information about five broad categories of ER/EM technology. Each of these categories is described in terms of the following:

- Fishery or species monitored
- Gear type monitored
- Infrastructural requirements
- Costs
- Sources of bias
- Effectiveness
- Pros and cons

4.1. Electronic Reporting

4.1.1. Electronic Vessel Reporting and E-Logbooks

In general, NMFS or the states collect data on vessel catch and/or landings using vessel trip reports (VTR) or logbooks. Either of these can be filled out and submitted electronically, and a trip report may or may not be based on a logbook. In the Northeast region, owners or operators of commercial groundfish vessels with federal permits have the option of submitting logbooks electronically (eVTR). In other regions, the submission of a trip ticket, which includes information about catch and landings, is submitted by a permitted dealer with the agreement of the vessel captain. This section will focus only on electronic reporting by vessel captains or crew.

Each region or science center holds the primary responsibility for the collection of fishery dependent information from commercial fishery operations for most federally managed species. Some regions rely on state data collection systems. Data collected by the various programs may include: user identification, socio-economic data, trip data (including whether or not a trip was taken), location, gear used and set type, crew size, effort, catch, landings, and bycatch or discards. Appendix 3a provides a summary of electronic reporting systems around the country.

Fishery/species: Electronic vessel reporting exists in some capacity for many U.S. fisheries, representing a wide range of sectors. Both commercial and recreational sectors may use electronic reporting (Table 2a).

Gear: Most gear types are represented in the fisheries that use electronic vessel reporting: trawl (bottom, mid-water, and shrimp), troll, hook and line, long line, gillnet, purse seine, and pot.

Infrastructures: For electronic reporting, data are collected via web-based or computer based applications. Data are frequently transmitted via a secure website, emailed (which may require

satellite transmission capability), or hand delivered to an agency port agent (via disk or thumb drive). Some systems have a quality control check that flags errors or potential problems at the point of entry and may include a check for completion of mandatory fields. This built-in validation can streamline data entry and virtually eliminates send-backs for correction.

Cost: Costs for ER systems are difficult to quantify. Costs are divided into: development, deployment, and maintenance costs. For vessel reporting systems, development costs vary widely – from several thousands of dollars to over $1 million. Cost variations can generally be attributed to the novelty of the system, the complexity of the system, and its general applicability to other regions or fisheries. If a system can be easily implemented in another area, for instance, where follow-on systems use similar design and source codes, costs would go down for the subsequent area(s) since much of the initial development cost would have been borne by the initial developer. The same holds for number of personnel – teams of one or two to full scale teams of over 10 may be needed to develop a system. Deployment costs are generally lower than development costs, and fewer personnel are needed. Ongoing maintenance of the systems generally requires a staff of one or two. Once deployed, ER systems entail costs for operations, maintenance, and QA & QC. Approximate costs for each region are provided in Appendix 2.

Potential sources of bias: Bias can be introduced into vessel reporting systems by incorrect reporting. There may be incentive to misreport species when limitations (quotas) are being reached. Likewise, misreporting location information can, and has, occurred. However, the potential to misreport locations can be mitigated through automation and integration with a Global Positioning System (GPS).

Effectiveness: As with any self-reported data, it is possible to submit incorrect information. Some items, such as vessel identity, may be accurately reported, but other items, such as the reporting of catch (species and amount) will only be as accurate as the information provided by the person completing the report. Input validation can greatly increase the quality and completeness of the submitted data.

Pros and Cons:

Pros:

- Timely reporting of data to meet the needs of agencies tasked with fisheries management and enforcement;
- Real-time or near real-time reporting enables real-time accounting for catch share programs;
- More timely access to vessel activity data may improve enforcement efficacy and compliance
- Improved data quality;

- Industry access to information;
- Can reduce redundant reporting when multiple agencies can gain real time* access to electronically submitted data;
- Decreased cost to agencies entering data submitted via paper forms;
- Easy to use;
- Eliminates transcription errors;
- Adaptable technologies.

*as compared to manually entered and then shared data.

Cons:

- Timely data dependent upon compliance with requirements and ample enforcement;
- Increased costs to develop and maintain electronic reporting systems;
- Technology failures and technology incompatibility;
- Vague questions such as those requesting "yes/no" answers do not allow for collecting more detailed information (such as defining how much or what kind);
- Limited deployment of some systems limits utility;
- Resistance from industry to new or unfamiliar technology;
- Reporting valid, but incorrect, information;
- Not all partners have implemented all provisions;
- Large numbers of fields makes user interface problematic and confusing.

4.1.2. Electronic Dealer Reporting

Electronic dealer reporting is used in some capacity by all regions. Each region or science center is responsible for collecting fishery-dependent information from commercial dealers for most federally managed species. The fish ticket system on the West Coast relies on state data collection efforts and in Alaska is accomplished through a multi-agency partnership among NMFS, the state, and the International Pacific Halibut Commission. Data collected by the various programs include information regarding catch and landings, vessel trip information, economic data, fish sales, license number, and species. Dealer data are used to track landings for in-season management as well as individual fishing quotas (IFQs), other quotas, and annual catch limit (ACL) accounting. Data are also used to cross-check vessel reported catch and landings through electronic trip reports (Table 2b).

Fishery/species: E-reporting in the Northeast includes all federal and state permitted dealers (in general states in the NE also allow paper reporting). In the Southeast, snapper/grouper, reef fish, and golden crab dealers and those buying king and Spanish mackerel use e-reporting, as well as permitted dealers. The Southwest Region has no dealer reporting requirement. In the Northwest, fish dealers purchasing IFQ fish use e-reporting as do the catch monitors hired by the fish dealers through third party providers. As a means of quality control, fish tickets from the dealers are

compared with the catch monitor fish tickets and differences are reconciled. Typically, observers on board vessels become catch monitors, monitoring and reporting of offloads in processing plants. In Alaska all catcher/sellers and processing plants use e-reporting for groundfish and crab, and electronic reporting is being implemented for the salmon fisheries. In the Pacific Islands fish dealers, wholesalers, and retailers use e-reporting or hard copy report forms. The vast majority of large dealers, wholesalers, and retailers are presently reporting electronically in a timely manner. For Atlantic Highly Migratory Species (HMS), ER will be in place for most tuna, swordfish, and shark fisheries come 2013.

Gear: Most dealers do not report the gear used by fishing vessels, but most gear types are represented in the fisheries that use electronic dealer reporting.

Infrastructure: For IT infrastructure requirements for dealer reporting, see the previous section on Electronic Vessel Reporting and E-Logbooks.

Cost: Generally, if a system is applicable to a wide range of the industry – such as Alaska's eLandings system – the development costs are on the higher end of the range. Similarly, because that system is statewide and Alaska's geography is so expansive, many employees were involved in the initial deployment including NMFS AKR staff, and regional ADF&G staff. Another example would be Atlantic HMS, which requires coordination with all the states and territories, and any system must fit in with existing NMFS electronic reporting.

Potential sources of bias: For potential sources of bias in dealer reporting, see the previous section on Electronic Vessel Reporting and E-Logbooks. In addition, for non-mandatory systems, there may be some bias in that larger companies tend to use electronic systems while smaller entities use paper. The larger companies are more likely to report in a timely manner, but mandatory programs reduce this bias in timeliness.

Effectiveness: For discussion on effectiveness of dealer reporting, see the previous section on Electronic Vessel Reporting and E-Logbooks.

Pros and Cons: For the pros and cons of dealer electronic reporting, see the previous section on Electronic Vessel Reporting and E-Logbooks.

4.2. Electronic Monitoring

4.2.1. Vessel Monitoring Systems

The Vessel Monitoring System (VMS) is a satellite based technology program remotely monitoring fishing vessel locations and other data depending upon the equipment used and the regulatory requirements of the fishery.

Today, the NOAA Office of Law Enforcement (OLE) VMS Program is monitoring over 4,500 vessels, and it transmits position data, including vessel identification data; declarations[1]; and two-way messaging/email.

Uses of VMS data include:

- Tracking, monitoring, and predicting fishing effort, activity, and location;
- Evidence in legal and administrative proceedings;
- Monitoring for illegal, unreported, and unregulated (IUU) operations;
- Monitoring activity and arrivals in port to allocate sampling;
- Supporting catch share and ACL programs;
- Monitoring and enforcing compliance with regulatory requirements and sensitive area restrictions;
- Managing observer programs (safety, deployment and coverage, enforcement);
- Verifying/validating data from other sources;
- GIS mapping;
- Supporting Homeland and National Security initiatives.

Fishery/Species: Currently, VMS is used to monitor vessels permitted in more than 17 federal fisheries. The number of VMS-required fisheries is growing, and will likely include additional High Seas permitted vessels within this year.

Gear Types: VMS is not restricted to specific gear types and is used across a wide variety of platforms. The primary limitation on adoption of VMS is initial cost, but adding vessels to an existing system is relatively low-cost.

Infrastructure: VMS is composed of: (1) On-board transceiver units that transmit positions and may send and receive other data and messages; (2) satellite communications networks that transmit information to and from the vessel and monitoring center(s); (3) surveillance software and its associated systems/processes that interface with the communications providers; (4) monitoring center(s) and staff; and (5) government IT services and systems that parse and store the data.

Sources of potential bias: Power can be turned off to the unit causing lapses in data leading to potential biases. However, non-reporting units can be identified by OLE monitoring staff, which would trigger an investigation into the cause. Fishers would be cited for non-compliance if they are found to have turned the unit off. In some regions (AK, NE) there have been problems with

[1] A declaration is a report submitted by a fisherman to OLE (by phone, interactive voice response, VMS or other method) that specifies the gear type that a vessel will use on a fishing trip. More complex declarations can also include area to be fished or other codes like days at sea etc. Declarations can also be used as hail in/out of the fishery or landing notice.

reliability and data gaps with some vendors' units, which can lead to bias concerns. The polling, or reporting rate should also be considered to ensure the data collected meet management and enforcement needs.

Costs: In most of NOAA's regions, OLE is responsible for the costs of items three through five on the above referenced infrastructure list, and the fishers are generally responsible for items one and two[2]. The OLE's cost to operate and maintain the system is approximately $1.2 million per year which includes annual requirements for vendor software changes and associated installations plus a reimbursement program mentioned below. Also included in that yearly cost are maintenance and support for the surveillance software; communications and VMS unit (transceiver) costs for all units in the Pacific Islands Regional[3]; and vendor-related support. Vendor-related support includes system and unit troubleshooting and assistance with non-reporting units. There are also costs associated with OLE's monitoring and help-desk staff, IT staff, and government-owned IT hardware/software and associated support costs which are in addition to the $1.2 million annually obligated to support OLE's VMS programs.

When new or different VMS regulations are established requiring changes to the VMS reporting requirements of a fishery, vendors may be required to modify the software on all of the units that are in use by fishers. For any one instance requiring vendor modifications it can cost $20,000 (or more) and that cost depends upon the number of units affected by the regulatory change and the complexity of the software changes.

A typical VMS off-the-shelf unit may run approximately $3,100, although costs vary widely depending on the vendor and the capabilities of the unit. NOAA OLE provides a list of approved VMS units that is updated regularly to account for changing technology and requirements[4]. Currently, NOAA offers a one-time reimbursement opportunity for eligible fishers, contingent on availability of funds via a grant managed by the Pacific States Marine Fisheries Commission.

Monthly communications costs are generally incurred by fishers, and those costs vary depending upon the regulatory requirements of each fishery. Monthly communications costs can range from $21.99 for hourly position reports only to $100 per month or more depending on the amount of data sent / received by the VMS unit (e.g. position reports, email). Average communication costs are approximately $50 / month / vessel.

The surveillance software licensing costs and the bulk of the system's implementation costs were one time fees (in 2009, for the current system approximately $1.75 million). Now that the

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[2] OLE is responsible for items one and two in the Pacific Island Region, only.

[3] OLE payment of the cost for units and communications for the Hawaii and American Samoa longline fleets is based on Federal Regulations dating back to the mid 1990's when use of VMS equipment was an "experiment." Those regulatory provisions remain in effect today.

[4] http://www.nmfs.noaa.gov/ole/docs/2012/noaa_fisheries_service_type.pdf.

system is in place and operating, it can accommodate a large number of additional vessels at little to no additional cost[5].

Pros and Cons:

Pros:

- Provides fisheries monitoring, management, scientific, compliance, enforcement and safety benefits.
- Is a proven, well-established technology, and VMS position data are widely used and accepted for enforcement purposes.
- Low system complexity compared to other ER/EM systems (i.e. simple, autonomous, automatic operation; low/no operator intervention required for reporting, no complex analysis of images required, low bandwidth/data requirements, etc.).
- Provides cost-effective monitoring and enforcement options for remote areas that otherwise would have little to no monitoring (Marine Monuments, closed areas, etc).
- Is an effective tool for focusing limited surface or air patrols by other enforcement assets like U.S. Coast Guard patrol platforms.
- Though not a primary rescue alert device, VMS data can be a vital tool in search and rescue efforts in the event of a vessel in distress.
- Can incorporate substantial growth in the number of vessels being monitored for a relatively low cost.
- The system has the potential to be expanded to include transmitting other types of data including e-logbooks, landings information, photo/video data and sensor data. However, such expansion has not been fully assessed and might require expansion of bandwidth, upgrades/changes to software, hardware and increases in communications costs.

Cons:

- While basic operational VMS costs are low relative to other monitoring options, they are not insignificant. Annual costs after implementation can be highly variable depending upon regulatory changes requiring updates to software and/or hardware.
- Current data transmission capability is limited.
- Some approved units have performance issues.
- Time-consuming process to approve new VMS units.
- Like all electronic devices, VMS units are not tamperproof. They are tamper resistant and methods for detecting tampering events have improved.

[5] The addition of a very large number of vessels may cause OLE to incur additional costs in the following areas: communications and transceiver costs in the Pacific Islands; additional monitoring/help-desk staff; monitoring software support; and vendor-related work-requests (e.g. software updates, non-reporting vessel inquiries and communications troubleshooting).

4.2.2. Video Monitoring

NMFS has traditionally relied on observers to collect data on fishing vessels because of their proven reliability, versatility, and quality. Recently there has been a growing interest in the use of video monitoring to offset the cost of observer coverage. This stems in part from the proposed transition to industry-funded observer programs in some regions (NW and NE) and interest from NMFS, fishermen, and Congress to reduce monitoring costs. Video monitoring can potentially provide a cost-effective monitoring solution in some circumstances: (1) Scientific purposes (identifying species composition of catch and bycatch); (2) management (quota monitoring); and (3) compliance (enforcement).

Video monitoring integrates the use of video cameras, gear sensors, and GPS to provide data on fishing methods and gears, fishing locations and times, and catch and bycatch (including discards). The degree of integration depends on the specific objectives of the application. EM is not intended to be used exclusively as an alternative to human observers. In many cases ER and EM may be used to augment and improve monitoring programs. Thus there may be value in using these tools both as alternatives or in conjunction with human observers.

Fishery/Species: Although there have been many pilot projects in the United States (Table 3), video monitoring is currently being used operationally in only three fisheries:

- Amendment 80 to the Bering Sea Aleutian Island non-pollock trawl fishery requires video recording of sorting activity in bins (or an alternative measure) to prevent pre-sorting of the catch before the observer has an opportunity to sample the catch;

- Amendment 91 to the Bering Sea Aleutian Island pollock trawl fishery requires video monitoring of all locations where salmon bycatch is sorted by the crew and the location where the salmon are stored until sampling by an observer.
- Starting in 2013, freezer longliners with endorsements to catch and process Pacific cod with hook and line gear in the BSAI have additional equipment and operation requirements. If vessels are using motion-compensated scales to weigh Pacific cod, they are required to maintain a video system to monitor sorting and flow of fish over the scale.

In all three cases, video cameras are used for compliance monitoring. Cameras record the activities of vessel personnel and provide a record that NMFS can use to enforce requirements. The video is stored on the vessel and made available to NMFS for review upon request. No data are extracted from the images for management, instead, the video provides an audit option to confirm whether sorting standards were met and data provided by observers are unbiased.

There have been numerous past and ongoing pilot projects in the U.S. exploring the potential to extract specific information from video for management purposes. The information derived

from these projects has been instrumental in laying the groundwork for future EM projects and enabled the implementation of current video monitoring in existing programs. However, despite these projects, there are currently no operational video monitoring programs in NMFS-managed fisheries where data are extracted from video and used for science or management (Table 4). This is due to operational limitations such as the inability to accurately identify species, the inability to estimate weights of discarded fish, and the length of time required to obtain and review video and extract all requisite information. These issues need to be resolved before EM can be implemented for quota accounting.

Gear: Video monitoring is generally considered to have potential from a science, management, and enforcement perspective in fisheries where the catch is brought on board individually (gillnet, longline, and hook and line), and each specimen can be identified and total counts at varying taxonomic levels can be made. Video monitoring is less able to identify species (particularly protected species such as fish, birds, sea turtles and marine mammals) that may not be brought on board or that are not viewable in the frame. Video monitoring is also currently ineffective at determining weights aboard vessels that haul in large catches at once (such as trawl gear). However video monitoring may be effective at monitoring compliance in full retention fisheries where species identifications and weights can be determined by dockside monitors.

Infrastructure: Any application where video monitoring data are used for fisheries management will likely be complex and require considerable infrastructure investments for both industry and the government. In the operational programs in Alaska, industry provides the cameras and developed the information storage solutions on board. In other applications, depending on the specific goals of the monitoring program, a variety of data transfer, analysis, and storage issues may need to be resolved. For example, if video data were going to be used for quota management, then a system would need to be developed for moving video data to a facility where they could be reviewed and stored; this could prove challenging from remote locations or where the information is needed quickly. Additionally, data collected for fisheries management is required to be stored, archived, and accessible for further review and/or used in the prosecution of violations. This would likely require an investment in data storage infrastructure. Finally, although initial attempts to automate video data analysis appear promising, considerably more work is needed to automate the video review process. The potential for automation also depends on the specific objectives of the video. For example, automating the counting of fish discards may be possible now, given the right configuration of discard chute and cameras, but automating the identification and weights of those discarded fish appears much more difficult.

Costs: Costs for video monitoring may vary widely depending on the management objectives of the monitoring program. The Northeast video monitoring project estimated costs of $505, $396,

and $539 per trip for longline, gillnet and trawl vessels[6]. By comparison, human at-sea monitor costs average approximately $585-$675 per sea day in the Northeast[7]. Observations in Alaska, on the other hand, indicated that video monitoring costs may be similar to or even greater than observer costs. Bonney et al., 2009, found that video monitoring use may not result in any large scale cost savings for the Gulf of Alaska rockfish fishery, primarily because of the costs associated with the analysis of the EM data (particularly with rare events such as protected species bycatch). In Alaska, NMFS estimated that a fairly simple installation would cost approximately $4,000, whereas a complex installation that would require significant vessel modification would cost approximately $22,000. The Canada hook and line fishery estimated costs of $350 per day based on a review of 10% of the EM data collected and $708 per day for observers. The lower cost per day in Canada is likely the result of the 10% audit rate where only 10% of fishing events on any given vessel are reviewed and used to verify the catch and bycatch reported by the captain.

Sources of Potential Bias: As with observer programs, there may be bias in fisheries where coverage is less than 100%. Bias should be minimized if the selected vessels are required to carry video monitoring equipment 100% of the time. Video monitoring equipment can be deployed on virtually any vessel regardless of size, type, or gear if reliable power is available and sensitive equipment, such as computers, are protected from the weather. Concerns remain about accurate species identification and weight estimation, and one of the lessons learned from many of the EM pilot projects is that camera location and overall system design can be an iterative process tuned to each boat. The deck layout on most vessels is unique, and issues on one vessel may be quite different from another vessel. It is important to work closely with the vessel captain and crew to design a fish sorting system (including discarding) that provides an optimal view for the cameras in order to minimize any potential sampling error or bias.

Effectiveness: To date video monitoring has proven to be most effective as a compliance tool for monitoring crew activity. Working with industry, NMFS is trying to resolve remaining issues of species identification, weight estimation, data processing, and data storage to improve the effectiveness for management, enforcement, and science purposes. A number of ongoing pilot projects are designed to address these concerns. EM may not be effective for identifying protected species, in particular those that are prohibited from being brought on board.

[6]These estimates do not include factors such as shore side infrastructure and support of data collection including the required computing infrastructure and associated positions. The costs do include the cost of reviewing 100% of the video. These costs are consistent with day trips; multi-day trips would increase the costs based on the number of additional tows. Pria et al., 2011.

[7]The cost estimates represent the daily at-sea cost charged by observer and at-sea monitor provider companies and do not include overhead costs such as travel, training, equipment, debriefing, and data management.

Pros and Cons:

Pros:

- Suitability across a wide range of vessel sizes, particularly smaller vessels that may not meet all requirements for carrying observers;
- Interest from industry and support of the technology;
- Fully integrated data collection tools can create a clear and accurate profile of fishing activity at sea;
- 24/7 operation on many vessels (with some exceptions) thereby capturing all events for later analysis or sampling.

Cons:

- Turnaround time for data is currently longer with video technology than observer reporting;
- Inability to accurately identify some species and determine weights, particularly for rare events such as protected species that are not brought on board;
- Inability to collect biological samples needed for stock assessments and to assign injuries and mortalities to species/stocks;
- Enforcement concerns (see Enforcement white paper);
- Costs associated with review of video;
- Video systems are not tamper proof;
- Monitoring is limited to the cameras view;
- Power supply can be challenging;
- Long term storage of video records is expensive and can result in data loss;
- Scattered ports results in higher maintenance and travel costs;
- Malfunctions in equipment could result in mandated returns to port depending on the penalty structure of an EM program;
- Equipment durability.

Although hurdles remain, video monitoring may eventually allow fishermen to be directly involved in their own data collection, allow them to quickly see the results of data collected on their vessels, and improve NMFS' ability to manage fisheries.

4.3. Other Electronic Monitoring/Reporting Technologies

There are a variety of other ER/EM technologies being used for fishery-dependent data collection and reporting. These technologies include handheld devices such as Personal Digital Assistants (PDAs), iPads, ruggedized laptops, electronic measuring boards and calipers, Passive Integrated Transponders (PIT) and PIT tag readers, automated flow scales, motion-compensated scales, satellite phones, and software (Table 4). These tools are used by industry, observers, at-

sea monitors, port agents, state and federal fishery managers, or scientists to collect data. Typically, the systems track catch, gear, as well as biological data about the catch.

In many cases, these tools are intended to reduce the burden on observers or other monitors, while simultaneously improving the quality and timeliness of data collection and reporting. They can also be used in conjunction with other ER/EM technologies described in this paper.

5. References

Bonney, J., Kingsolving, A., McGauley, K. 2009. Continued assessment of an electronic monitoring system for quantifying at-sea discards in the central Gulf of Alaska rockfish fishery. EFP 08-01 Final Report. Available: http://www.fakr.noaa.gov/npfmc/PDFdocuments/conservation_issues/EM909.pdf

Pria, M.J., Bryan, J., McElderry, H. 2010. New England Electronic Monitoring Project 2010 Annual Report. Archipelago Marine Research Ltd. August, 2011. 69 p.

Table 1. Summary table of existing technologies.

Existing Technology	Collection method	Electronic capture of data	Data transmission to NMFS	Data Storage on vessel	Data storage at NMFS	Information extraction	Information distribution	Opportunities
Electronic vessel trip reporting and e-logbooks	variable	Manual entry into NMFS application	Satellite or web	None	Oracle database	query database	via database to NMFS, and web to external clients	Expand within existing fleets
Electronic dealer reporting	variable	Manual entry into NMFS application	Web	None	Oracle database	query database		Expand within existing fleets and/or dealers
Vessel Monitoring Systems (VMS)	GPS on board	Automated polling of the GPS position	Satellite on polling schedule	None	Oracle database	query database	via database to NMFS authorized users	Geo fencing potential, expand to existing fleets
Video monitoring	Camera images	Automated image recording to hard drive	Hard drives are physically retrieved post trip	Database or hard drive	Oracle database	Image review, event recoding, and subsequent storage of resulting data		Improve quality of images, advance automation of info extraction, improve integration with other sensors (GPS)
Other existing technologies	variable	Manual entry into NMFS application	Satellite or web	Database or hard drive	variable	query database		Automate data capture, expand within existing fleets

Table 2. Summary of fishery-dependent vessel and dealer reporting systems. This summary does not include systems entered by Agency personnel, including observers, port agents, or scientists.

a. Electronic Vessel Reporting and E-Logbooks

Region	System(s) Name	FMPs supported	Fishery/Species	Gear	Cost	IT Infrastructure
ACCSP	SAFIS: eTrips; eLogbooks	State fisheries	Commercial, charter/party, and recreational	Hook gear (anglers)	No Data (ND)	Web based, secure transmission, oracle database
Northeast	eVTR -- Fisheries Logbook Data Recording System (FLDRS); eVTR -- Vessel Electronic Reporting System,	All	All	All	ND	Web based, secure transmission through email, oracle database
Southeast	GoMex Snapper/Grouper IFQ system	Gulf of Mexico Reef Fish	Gulf of Mexico IFQ fishermen and permitted dealers	ND	$235k to develop; $150K to maintain	PC based, any browser, Adobe Flash; Postgres SQL database
Southwest	Electronic Troll and Baitboat Logbook (FLDRS); South Pacific Tuna Treaty purse seine fishery logbook and port fish size sampling	HMS and Treaties relating to HMS	South and North Pacific Troll; North Pacific Baitboat; Commercial; U.S. South Pacific Tuna Treaty purse seine	Troll, baitboat,and purse seine	$0-50k to develop $0-20K to deploy	Vessel PC transmits data via email or CD in the mail; Access, Oracle, and Excel databases

Northwest	Pacific Coast Groundfish Quota Share/Vessel Account Balance System	Pacific Coast groundfish	Commercial IFQ Trawl Sector; and all groundfish	ND	Over $1M to develop; $450K to maintain	Fishermen use pc's to manage their vessel accounts and quota share accounts.
Alaska	eLandings - Interagency Electronic Reporting System	BSAI Groundfish FMP; GOA Groundfish FMP; Crab FMP; Salmon FMP	All state and federally managed groundfish fisheries; all halibut and sablefish IFQ fisheries; all rationalized crab fisheries; several state managed crab fisheries; and 50% of all state managed salmon fisheries (implementation in progress); no recreational;	All gear types	$1M to develop; $300k to maintain, includes travel for training, server hosting, licenses, etc. Does not include help desk support.	Web based online forms, web service XML submission; email XML submission; desktop applications for at-sea vessels via email transmission; desktop applications for tender vessels using a jump drive transfer, data are transmitted via ftp or email to oracle database
Pacific Islands	HDAR and WPacFIN Web-Based Reporting for Hawaii Commercial Fishermen	All HI-based FEPs	Commercial sector	ND	ND	Data are entered via a secure website

ND – No data; ACCSP – Atlantic Coastal Cooperative Statistics Program; SAFIS – South Atlantic Fishery Information System; IFQ – Individual Fishing Quota; HDAR – Hawaii Division of Aquatic Resources; WPacFIN – Western Pacific Fishery Information Network

b. Dealer trip reporting

Region	System(s) Name	FMPs supported	Fishery/ Species	Gear	Cost	IT Infrastructure
ACCSP	SAFIS: eDR	State fisheries	Commercial	All	ND	Web based, secure transmission, oracle database
Northeast	Dealer Electronic Reporting File Upload, Dealer Electronic Reporting (Bluefin Data L.L.C.), Surf Clam / Ocean Quahog File Upload System	All	All	All	ND	Web based (HTTPs) , sFTP, oracle database
Southeast	SE Electronic Trip Ticket; GoMex Snapper/Grouper IFQ system	SA snapper/grouper, SA golden crab, Gulf reef fish, Coastal Migratory Pelagic	Commercial sector only; Holder of snapper/grouper, reef fish, golden crab dealer permit or dealer buying king or Spanish mackerel; Gulf of Mexico IFQ fishermen and permitted dealers	ND	$200-235K to develop; $100-150K to maintain	PC based, any browser, Adobe Flash; Postgres SQL database
Southwest	No dealer reporting at this time					
Northwest	Electronic Fish Ticket System; IFQ Catch Monitor System	Pacific coast groundfish	Commercial IFQ Trawl Sector (due to provision that allows gear switching, IFQ trawl sector participants can	Trawl and fixed gear who participate in the IFQ system	$700k to develop (includes cost of catch monitor system); $100k to maintain	Fish Ticket Data are transmitted over the web to an Oracle database; IFQ system uses specially designed software on a notebook p.c.

Region	System(s) Name	FMPs supported	Fishery/ Species	Gear	Cost	IT Infrastructure
			use trawl or fixed gear to fish their trawl allocations)		(includes fish ticket and catch monitoring system, combined)	
Alaska	eLandings - Interagency Electronic Reporting System	BSAI Groundfish FMP; GOA Groundfish FMP; Crab FMP; Salmon FMP	All state and federally managed groundfish fisheries; all halibut and sablefish IFQ fisheries; all rationalized crab fisheries; several state managed crab fisheries; and 50% of all state managed salmon fisheries (implementation in progress); no recreational;	All gear types	$1M to develop; $300k to maintain, includes travel for training, server hosting, licenses, etc., but does not include help desk support.	Web based online forms, web service XML submission; email XML submission; desktop applications for at-sea vessels via email transmission; desktop applications for tender vessels using a jump drive transfer, data are transmitted via ftp or email to oracle database
Pacific Islands	HDAR and WPacFIN HI Web Based Dealer Reporting System	All HI-based FEPs	Commercial sector	ND	ND	Data are entered via Excel on a p.c. and transmitted via email
HMS	eDealer (currently under development)	2006 Consolidated HMS FMP	Atlantic sharks, swordfish, and BAYS tunas	All	$676,000 to develop; anticipated $100K to maintain first year; additional funds needed for potential	Dealer data are entered through web-based or PC-based programs; these are submitted over the web or through an ftp upload to Oracle database

Region	System(s) Name	FMPs supported	Fishery/ Species	Gear	Cost	IT Infrastructure
					enhancements/ maintenance	

ND – No data; HDAR – Hawaii Division of Aquatic Resources; WPacFIN – Western Pacific Fishery Information Network; FEP – Fishery Ecosystem Plan

Table 3. Video Monitoring Projects in U.S. Fisheries

Region	Year	Objective/Purpose	Fishery/Species	Gear	Project Type	Vessels/Sea Days	Cost
Alaska	2002	Protected species/seabirds monitoring	Halibut	Longline	Pilot	2/120	
	2002	Protected Species monitoring	Groundfish	Factory Trawl	Pilot	5/22	
	2002	Protected Species monitoring	Halibut	Longline	Pilot	2/90	
	2004	Catch monitoring	Halibut	Longline	Pilot	3/120	
	2005	Discard monitoring	Rockfish	Trawl	Pilot	10/38	
	2005	Bin monitoring	Groundfish	Factory Trawl	Pilot	1/14	
	2007	Bin monitoring	Groundfish	Factory Trawl	Pilot	4/328	$42,690
	2007	Compliance Bin monitoring	Groundfish	Factory Trawl	Implemented – Amendment 80	11/11,177	
	2007	Bycatch monitoring	Halibut	Longline	Pilot	4/13	
	2007	Discard monitoring	Rockfish	Trawl	Pilot - Phase 1	1/14	
	2008	Discard monitoring	Rockfish	Trawl	Pilot - Phase 2	4/104	$108,380
	2010	Discard monitoring	Rockfish	Trawl	Automated Video Analysis	5/118	$77,830
	2011	Compliance monitoring – sorting of prohibited species	Groundfish	Trawl	Implemented - Amendment 91	20/2,605	
	2013	Compliance monitoring flow scale	Pacific Cod	Longline	Implement – 50 CFR Part 679	20	
Southwest	2006	Protected Species monitoring	Swordfish	Drift gillnet	Pilot	5/58	
	2007	Protected Species monitoring	Swordfish	Drift gillnet	Pilot	1/3	
Northeast	2004	Discard monitoring	Cod/Haddock	Longline	Pilot	4/10	

	2007	Catch monitoring	Groundfish	Longline/Gillnet	Pilot	7/59	
	2007	Catch monitoring	Herring	Small mesh trawl	Pilot	1/10	
	2010	Catch monitoring	Groundfish	Trawl/Longline/Gillnet	Pilot	9/358	
Northwest	2002	Discard monitoring	Pacific hake	Trawl	Pilot	1/13	$30,000
	2004	Discard monitoring	Pacific hake	Trawl	Implemented	26/823	$240,000
	2005	Discard monitoring	Pacific hake	Trawl	Implemented	28/982	$240,000
	2006	Discard monitoring	Pacific hake	Trawl	Implemented	37/1043	$125,000
	2007	Discard monitoring	Pacific hake	Trawl	Implemented	36/878	$212,563
	2008	Discard monitoring	Pacific hake	Trawl	Implemented		$293,050
	2009	Discard monitoring	Pacific hake	Trawl	Implemented		$222,025
	2010	Discard monitoring	Pacific hake	Trawl	Implemented		$230,575
Gulf of Mexico	2008	Catch monitoring	Reef fish	Longline	Pilot	6/148	$90,000
Southeast	2010	Catch monitoring	Reef fish	Bandit gear	Pilot	6/524	
Pacific	2009	Catch monitoring	Swordfish	Longline	Pilot	3/320	

Table 4. Other Existing ER/EM Technologies

Region	Fishery/Observer Program	EM type	EM Activity Details	Critical need	Status
Alaska	North Pacific GroundfishObserver Program	At sea data entry & transmission	ATLAS software used to allow observers to enter catch and sample information used for near real time fisheries management. Able to transmit data using a variety of methods (1998 first deployed). Details available upon Request.	At sea data transmission	Implemented
		Scales	Motion compensated scales to weigh total catch aboard factory trawlers and crab catcher processors.	Catch Weight	Implemented
		Scales	Motion compensated scales used to allow observers to weigh samples	Catch Weight	Implemented
		Scales	Motion compensated scales used to weigh only Pacific Cod aboard factory longliners (2011). Details available upon request.	Catch Weight	In Progress
Southeast	Pelagic longline observer program, Southeast Shark Driftnet and Shark Bottom Longline Observer Program, Shrimp and Reef Fish Observer Programs	PIT tags	Passive Integrated Transponder (PIT) Tag readers to scan sea turtles for existing tags.	Monitor Discard	Implemented
		Satellite phones	Satellite phones capable of data transmission although not used to date. Details available upon request.	Data Transmission	In Progress

Northeast	Northeast Fisheries Observer Program	iPAQ OBSCON and Special Access Program (SAP) Reporting,PDA	Handheld PDA with a data entry program using Microsoft Mobile 5.0 Operating System and secure upload website using Wi-Fi or ActiveSync, to provide accurate and timely observer trip summary and catch information of Species of Concern within 24 hours of landing. Used to examine seaday accomplishments and provide data for quota estimates for the Northeast Regional Office. Details available upon request. Data Entry Program (ObsCon) using Microsoft Mobile 5.0 Operating System and secure upload website using Wi-Fi or ActiveSync, provide accurate and timely observed trip summary information and SAP Species of Concern weights of kept and discarded within 24 hours of landing for seaday accomplishments and SAP data to the Northeast Regional Office for Total Allowable Catch and bycatch monitoring.		
		Electronic Data Entry at Sea (EDES)GPS, computer	Collection of observer data electronically at sea, replacing paper data collection. Uses rugged laptops, Windows XP operating system, C# (data entry screens), My SQL (database conversion), GPS (haul locations), secure upload website, barcode scanner (samples/age structures), and digital cameras integrated into entry screens. Details available upon request.		
		Cooperative Research Study Fleet Project; GPS, computer	The NEFSC is conducting a Study Fleet cooperative research project that includes research and development of an electronic laptop program to collect tow-by-tow self reported catch data including kept and discarded components. The system supports the collection of sub-trip composite records that included all of the Northeast data elements in the existing vessel trip reporting (VTR) requirements for permitted vessels and can track effort on a tow-by-tow basis, are integrated with vessel GPS and VMS systems and include a TD probe fixed to trawl doors. Details and demonstration available upon request.		
		Marel Scale Pilot Project; Digital, motion-compensated scales	The NEFOP is in the field testing phase of the Marel scales. The scales have been tested and compared to the hand-held spring scales, now they are being field tested prior to a more broad scale implementation.	More accurate catch weights	In Progress
Southwest	Southwest Observer Program; California/Oregon drift gillnet fishery	Electronic observer forms;PDA	Using an Allegro PC, HP iPAQ handheld PDA, and HagloffMantaxdigitech electronic calipers in California/Oregon drift gillnet fishery to collect observer data.		
	PacFIN/FIS	Electronic calipers	Electronic calipers in albacore port sampling program		

Pacific Islands Region	NMFS Longline Observer Program	PDA	Proposed project testing the use of Trimble Nomad hand held collection units as a tool to gather at sea data. After testing this using our data forms, it was not practical to continuing with this device.	data transmission	canceled- we have decided to explore other data collection devices (but have not begun to yet)
HQ	Fisheries Scientific Computing System (FSCS)	Computer	This system will enable research scientists and/or observers to capture and store environmental, gear performance, and biological data from survey or commercial fishing operations using any gear type for integration and validation into a quality-controlled Oracle database in near real time. Details available upon request.		In Progress
	Atlantic Highly Migratory Species	PIT tags	PIT Tags used when requested for shark display permits (also use dart tags). Aids in enforcement. Pop-up satellite archive tags (PSAT) used for HMS. Research on migrations and habitat use.		
Northwest	West Coast Groundfish Observer Program	Database	Oracle apex database that uses Oracle express installation, and web-services to transport xml data back to main oracle enterprise server. Data can be entered via a web-based GUI or via a client application on netbooks which then transmit data via broadband cards.	Catch Data and near-real time reporting	Oracle database: implemented
		Scales	Motion compensated scales used aboard West Coast Trawl Catch Share vessels	Catch Weight	Implemented
		PIT tag readers	Pit tag readers used to scan green sturgeon for existing tags.	ESA	Implemented
		Computer	Netbooks, with broadband cards, using Oracle Apex client for data entry at-sea. Data can be transmitted once observer is in range of network which allows near real-time reporting.	Catch data and near real-time reporting	Netbooks: implemented Client application: Development
		Coded wire tag wands	Wands used to scan salmon for coded wire tags.	ESA	Implemented
		Satellite phones	Satellite phones are used to report catch over specified weight to observer program.	Data transmission	Implemented

Appendix C -

Electronic Monitoring White Paper Enforcement

National Oceanic and Atmospheric Administration

National Marine Fisheries Service

February 2013

1. Key Findings

Pros:

- ER systems can:
  - Provide the ability to track users entering data including who they are, the date/time data was entered, when and who edited the data, etc. This change history is beneficial for investigative purposes.
  - Provide the ability to use electronic signatures, which is beneficial for establishing accountability.
  - Provide near-real-time information which can be:
    - Helpful in discovering and addressing compliance issues in a timely manner.
    - Beneficial for addressing ongoing violations.
    - Helpful in improving timeliness of reporting.
- EM systems can:
  - Be a helpful compliance tool for monitoring specific requirements or prohibitions (if the definitions and regulations are clearly written for enforceability). Early engagement of NOAA's Office of Law Enforcement (OLE) and General Counsel Enforcement Section (GCES) during regulatory development can help ensure issues like digital evidence, power supply and tampering concerns, resolution, file format, file storage on board vessel, etc. are considered.
  - Be reliable and highly successful if vessel operator and crew are cooperative and supportive.
  - Provide monitoring in areas that otherwise might have little to no monitoring (like offshore marine monuments) due to the cost and availability of traditional surveillance methods.
  - Offer effective tools for focusing OLE's limited resources as well as the limited assets of OLE's enforcement partners.
  - Be useful to supplement observer data.
  - Be useful for full retention requirements where discards are not allowed or are limited to one location or for monitoring specific crew activities, e.g. real time video monitoring of fish bins fed to observer's work stations allows observer to see if presorting or discarding by crew might be occurring prior to observer's sampling.
  - Be used with sensors on the drums and hydraulic wenches to successfully define fishing events (when used in conjunction with cameras it assists in the analysis of the video footage).
- Flow scales can:
  - Provide supporting evidence of compliance.
  - As demonstrated in Alaska, decrease presorting that would cause observer samples to be biased and decrease the number of observer interference complaints.

Cons:

- With ER, the information collected is susceptible to human error.
- When using video camera monitoring systems:
    - Species identification is still very difficult (and sometimes not possible) unless the fish are recorded individually with high-resolution cameras.
    - Data transmission and retrieval are not currently done in real time.
    - Review and analysis is currently not timely (often taking weeks or months).
    - Real time transmission or faster retrieval of data and faster review and analysis of data can substantially increase costs.
    - Catch and discards from trawlers and factory vessels can be challenging to monitor because most vessels can discard in several places (rail, deck, trawl alley, scuppers, sorting areas, factory, etc.). Ensuring adequate video monitoring coverage to capture potential discards requires adequate camera installation to avoid blind spots throughout the vessel and adequate optics to meet regulatory requirements.
    - Deployment of cameras on large trawl vessels is unique to the vessel.
- ER/EM technologies can be complex and maintaining expertise with the tools, equipment or systems, like VMS, video camera systems or flow scales, requires in-depth training, consistent use and significant OLE resources.
- Video monitoring is not likely to provide complete monitoring for Endangered Species Act, Marine Mammal Protection Act, or other protected species.

Things to Consider:

- Upon consideration of ER/EM technologies currently tested and employed within NOAA, prior to implementing additional or new ER/EM technologies a fundamental question must be answered: does the system need to be fast and accurate or does it need to be inexpensive? As described later in this document, with currently tested ER/EM technologies, if a system is designed to be fast and accurate it tends to be expensive to implement and maintain. On the other hand, if the system is designed for affordability its potential speed and accuracy tends to decrease.
- Reliability and maintenance of video equipment at sea can be challenging – dirt, salt, spray, slime and wind are issues that impact recorded video quality.
    - For these reasons, regulatory standards must be in place requiring hardware, software, output, and recording minimums. Standards must also include specific requirements for what must be viewable, displayed, and/or recorded (i.e., individual fish must be clearly discernible to species and individual).

2. Executive Summary

Electronic reporting (ER) and electronic monitoring (EM) technologies can be useful tools for NOAA's Office of Law Enforcement (OLE) Special Agents (SAs) and Enforcement Officers (EOs) while conducting investigations, providing compliance assistance and during patrolling, inspecting and monitoring activities. ER/EM technologies can be simple, relatively affordable tools or they can be more complex and expensive systems.

ER/EM can provide monitoring in areas that otherwise might have little to no monitoring (like offshore marine monuments) due to the cost and availability of traditional surveillance methods. ER/EM can also be effective tools for focusing OLE's limited resources as well as the limited assets of OLE's enforcement partners.

Video camera monitoring systems can be a helpful compliance tool for monitoring specific requirements or prohibitions. These systems can be useful 1) to supplement observer data; 2) for full retention requirements where discards are not allowed; 3) when tied to sensors on the drums and hydraulic wenches to successfully define fishing events. Species identification is usually required for enforcement purposes and video monitoring systems have as yet not proven reliable for species identification.

Enforcement of video monitoring requirements can be challenging because the monitoring occurs at sea where industry is usually in control of the equipment and its operation. For this reason, regulatory standards must be in place requiring hardware, software, output and recording minimums, etc. Standards must also include specific requirements for what must be viewable, displayed and/or recorded. Historically, video monitoring data transmission and retrieval have not been done in real time. Review and analysis have not been timely, often taking weeks or months to complete. Real-time transmission or faster retrieval of data and faster review and analysis of data can significantly increase costs.

Upon consideration of ER/EM technologies currently employed within NOAA, prior to implementing additional or new ER/EM technologies a fundamental question must be answered: does the system need to be fast and accurate or does it need to be inexpensive? If a video monitoring system needs to be fast and accurate (i.e., quick access to the images, quick review of data, quick turnaround of analysis, be verifiable against observer or other data, avoid blind spots and have the best optics available for potential species identification), it can tend to be expensive to implement, operate and maintain. If the system needs to be affordable, the turnaround time for review and analysis will probably be slower, there may be blind spots due to fewer cameras, and optics may not provide the level of species identification necessary for catch accounting and evidentiary requirements.

Early engagement of OLE and the General Counsel Enforcement Section (GCES) during regulatory development can be beneficial in helping to ensure issues like digital evidence, power supply and tampering concerns, optical resolution, file format and storage on board vessels are considered from a law enforcement and prosecutorial view point. For evidentiary and prosecutorial purposes, addressing these types of issues on a case-by-case, fishery-by-fishery basis is important because the objectives of using ER/EM may vary. Furthermore, OLE's unique experience and perspective can supplement that of the Centers and Regions to optimize the Agency's understanding and adoption of prudent ER/EM technologies.

3. Introduction and Purpose

The purpose of this paper is to describe the experiences, challenges and pros and cons associated with using ER/EM from an enforcement perspective. For purposes of this paper, the term "ER/EM" is synonymous with that used in the "Existing Technologies White Paper;" this paper also differentiates ER and EM as in this white paper.

Since the mid-1990's, OLE has utilized Vessel Monitoring Systems (VMS) to remotely monitor fishing vessels for compliance with U.S. fishery regulations. Since that time, VMS programs have evolved and expanded to incorporate some ER (declarations, pre-landing estimates), and these programs have the potential to include e-logbook data. As the Agency, Commissions, Councils and state partners have moved forward with considering and implementing various ER/EM initiatives, OLE's role has been as a technical facilitator for VMS-based ER/EM. OLE's level of engagement has differed among the various fisheries and the ER/EM initiatives.

4. Electronic Reporting

Each National Marine Fisheries Service Regional Office/Science Center is responsible for collecting fishery-dependent data from commercial fishery and dealer operations, contract fishery observers, catch monitors and others for federally managed species. These data are collected in various ways which are described in detail in Appendix B. For enforcement purposes, access to ER data, which is generally captured near-real-time, is a key benefit to OLE in conducting investigations. ER allows OLE to discover and address compliance issues in a timely manner, thus improving compliance.

For effective enforcement of Federal and/or state mandates, the following planning factors should be considered when using ER:

1) Data must be collected, processed and maintained in an accountable fashion to withstand prosecutorial challenges.

2) 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, for prosecution and other evidentiary needs.
3) NOAA/NMFS should ensure the data collection requirements are consistently applied to help level the playing field.
    1) If data are not submitted as required, the entity requiring the data should work with OLE who will assist in obtaining the data. Actions may range from phone contacts to attempt to gain compliance with reporting requirements to referral to GCES for consideration of an enforcement action.
    2) OLE recommends that all data be maintained by the entity/agency that collected it for a minimum of 5 years (civil statute of limitations) to support potential enforcement actions.
4) The data should be available to OLE when needed for investigative purposes.
5) Agency staff with pertinent information, including observers and/or catch monitors, should be available for debriefing or interviewing by OLE staff.
6) Where the capability for electronic signatures exists, e-signatures are beneficial in allowing OLE to identify who submitted the data (for accountability purposes).
7) As the Agency analyzes implementing ER, implementation and operational costs to OLE should be considered because they can be high and vary between fisheries and regulatory frameworks.

Generally the cost for OLE to obtain access to electronically reported data comes in the form of personnel costs along with computer needs and the time it takes to develop and analyze the data for law enforcement purposes. OLE has supervisors, managers, IT specialists, enforcement technicians and support personnel who assist SAs and EOs in gaining access to, reviewing and analyzing electronically reported data for investigative purposes. For fisheries utilizing ER, OLE managers help analyze, design, develop and troubleshoot electronic data collection systems. For example, during the development and implementation of the West Coast Groundfish Trawl Catch Shares Program, OLE invested substantial staff time assisting the Northwest Region (NWR) and Northwest Fisheries Science Center (NWFSC) in developing and implementing the quota share database and accounting system.

Additional implementation costs for software development and deployment are incurred by OLE when the medium for inputting and/or transmitting the ER is VMS. Software (primarily e-forms) that resides on VMS units, compatible with all type-approved hardware, must be developed and then must be installed on each VMS unit in the fleet. Each amendment or framework revision to a Fisheries Management Plan (FMP) that modifies the ER requirements creates costs for software development and deployment. For example a single regulatory implementation in a single region can cost $20,000 or more. Also, if the ER requirement is for real-time or near-real-time reporting via VMS, there can be substantial aggregate costs (whether borne by the vessel owner or NOAA) for data transmission via satellite airtime.

4.1. ER Pros and Cons

Pros:

- Electronic capturing of data is generally accomplished in real-time (or near-real time) which:
    - Allows OLE to discover and address compliance issues in a timely manner.
    - Assists OLE during investigations of on-going violations.
- Data captured electronically usually provides the ability to identify and track users who enter the data, i.e., who they are (login, passwords, etc.), the date and time the data was entered, when it was edited and by whom, etc.
    - For investigative purposes this type of "change history" can be helpful.
- Direct electronic input of data at or nearest to the source of that data can tend to lessen the potential for transcription errors.

Cons:

- Implementation and operational costs to OLE can potentially be high and vary between fisheries and regulatory frameworks.
- Accuracy of ER data is dependent on the competence and accuracy of those entering the data.

5. Electronic Monitoring

5.1. Vessel Monitoring System (VMS)

NOAA OLE's VMS Program is discussed in detail in Appendix B. Please refer to that paper for more details on OLE's development of NOAA's VMS Program as a compliance and enforcement tool, a summary of its current uses, costs and the pros and cons of using VMS.

5.2. Video Camera and Sensor Monitoring Systems

Based on OLE's involvement with video cameras and sensors monitoring fishing activity, as pilot projects and as implemented via regulations, the following provides a summary of "lessons learned."

5.2.1. Nationally

In general throughout NOAA, OLE and GCES should have input into development of programs that have the potential to use video camera and sensor equipment to ensure the regulations are specifically written for enforceability. Each fishery and the objectives of using ER/EM may vary, so it is important, on a case-by-case basis, for OLE and GCES to address the following types of issues to ensure evidentiary (chain of custody, original evidence) and prosecutorial (best evidence) concerns are taken into consideration:

- What is the digital file format of the video and how is it stored on the vessel?
- Who has access to the video files and data on vessels?
- What frame rate, how many frames per second, is adequate for enforcement purposes?
- Does the video contain a date/time stamp and counter embedded in the video file that cannot be altered?
- How often is the data (hard drive) retrieved from the vessel and who retrieves the data?
- How will enforcement obtain access to data and how does OLE ensure a forensically sound digital transfer from the recording devices storage to OLE's storage for evidence?
- How long can video be stored on the vessel (what is the maximum storage capacity in hours)?
- What is the minimum resolution needed for enforcement purposes?
- Will images be captured in black and white or color?
- What are the low light capabilities of the system and are there alternative light sources?
- What are the power supply requirements and does the system require uninterrupted power supply (battery back-up) to ensure system stays on line?
- What are the operator's responsibilities to ensure the system remains up and running and cameras remain unobstructed due to environmental or other conditions?
- How is the information on the video used to address a possible violation?
- Will the video data be compared to observer data? Or other data? And how long will that take?

5.2.2. Alaska

Within the past five years, NMFS implemented video camera monitoring in three Catcher Processor (C/P) fisheries as a compliance tool and to supplement observer data. These three programs in the Bering Sea Aleutian Island non-Pollock, and Pollock, and Pacific cod fisheries are briefly described in Appendix B.

The key features for enforcement purposes of these monitoring programs are that each vessel carries two observers on board, real-time video is fed to monitors/screens in the observer's sampling station, industry is required to continually verify that their video monitoring system is operating and they must stop fishing (and processing/sorting) if the system fails. The continuous verification and regulations that stop fishing if the system fails are essential for an effective EM system.

As a result, regulations supporting the video requirements exist and are enforceable. Operationally NMFS takes control of the data by extracting it manually so chain of custody concerns are addressed, the U.S. Coast Guard (USCG) provides an additional deterrent by providing periodic at-sea review of some footage, and industry bears the burden of cost and maintenance of the equipment. Tampering has not been an issue because it is detectable in real

time (the observer can see the images) and the industry has a regulatory requirement to keep the system working. When dates and times of potential violations are known or reported by an observer, OLE can review video and quickly corroborate the video evidence. This type of targeted review can greatly reduce the time required to investigate some violations.

EM is in use on approximately 36 Bering Sea and Aleutian Island (BSAI) vessels which range in size from 120' to over 300'. The video feed helps observers ensure species are not presorted or discarded before sampling and it helps minimize sample bias.

OLE currently bears no costs related to operating these video monitoring tools. There are, however, costs involved in utilizing video footage collected from a vessel's video camera monitoring system which can include:

- Investigative travel costs and time for SAs and EOs to collect/seize hard drives from the vessel. Generally SAs and EOs spend one to two hours on the vessel in addition to travel time. Travel time usually involves flights to and from Dutch Harbor, or other remote Bering Sea port, and overnight stays (usually more than one night due to the unpredictability of the vessel return to port, investigative needs, weather delays, etc.).
- Staff costs associated with "mirroring" the original hard drive(s) as evidence and making working copies for the investigative SAs or EOs. It can take up to 48 hours to copy all of the data on a large hard drive.
- Equipment purchases of hard drive(s) capable of holding extremely large video files.
- Staff costs associated with review and analysis of video data. Video review/analysis requires a great deal of time. Video footage may be from multiple camera angles and is recorded on a 24/7 basis for trips at least 120 days. Even with fast play, it takes days of uninterrupted time to properly review video footage.

5.2.3. Northwest

Northwest Fisheries Science Center: In 2004, along the West Coast in the shore-based whiting fishery, the NWFSC began a video monitoring pilot study for at-sea discards and species identification of those discards with Archipelago Marine Research Ltd (Archipelago). This fishery was managed by experimental fishing permits (EFP) and the video monitoring requirement was implemented as a condition of the permit. For enforcement purposes, there were no prohibitions under this fishery.

Initially, based on industry descriptions of their fishing activity, NOAA believed this was a full-retention fishery, but the cameras revealed there were substantial "operational discards" in this fishery. The fleet would net clean, top off their hold and dump the rest of the bag for safety reasons (or shovel through scuppers) or dump the bag before bringing it on board. During this

pilot, camera equipment was able to detect discard events and efforts were made to quantify those discards. However, estimated weights and species identification were accomplished only at the macro level. Underwater video was not attempted so it was not possible to estimate what and how much might have been dumped in the water. Failure of camera and sensor equipment was not easily distinguishable from intentional tampering, and loss of data was prevalent. Successful monitoring and data collection was highly dependent upon fleet cooperation, i.e., the potential for exploitation of equipment existed. Camera optics were not to the quality that species were discernible on an individual level and it was quickly determined that adequate species identification was not possible for management, scientific or enforcement purposes.

Northwest Region/Northwest Enforcement Division (NWED), OLE: In 2008 the West Coast shore-based whiting pilot migrated from a NWFSC project to a NWR/NWED collaboration. Regulations were developed to address the challenge of full retention, and terminology was changed to maximum retention. Maximum retention defined "operational discard" as two baskets per haul which was subtracted from the optimum yield allocation. The by-catch rate (determined by the 20% observer coverage in the fishery) was applied to the estimated discards. Video monitoring equipment and hydraulic sensors were installed on all vessels operating in the experimental fishery.

Significant changes were made to camera installation which improved reliability and helped to detect and eliminate most tampering events. Cameras, computers and their hard drives used to store the video imagery were essentially hard wired to the vessels using tamper proof outlets and plugs. Battery backups were installed to maintain power to the systems when vessel power was intermittently lost due to generator changeovers, voltage surges, etc. A systems-check protocol was initiated and geo fencing[1] was incorporated. With these modifications, the amount of video imagery, GPS, and sensor data captured continued to improve. Data was retrieved at a bi-monthly rate, which entailed a minimum of a two- to four-week analysis period and a minimum of four- to six-week turn around for catch accounting purposes.

Cost of leasing/purchasing, installation and maintenance of video equipment shifted to the fleet. During the 2010 shore-based Pacific whiting fishery, which involved approximately 30 vessels, the annual cost for video monitoring was about $316,550, or approximately $10,500 per vessel. Cost per fishing day varied widely per vessel because of different fixed costs and the wide range of fishing days per vessel. In the last year of the program, the fishery operated for five months, whereas in 2008 the fishery lasted less than one month. Some vessels leased their equipment and others purchased.

[1] Geo fencing creates a demarcation line using latitudinal and longitudinal way points which can be registered by the GPS in the VMS system. If the EM system is operating correctly, the cameras and recording equipment turn on automatically when the vessel passes the pre-established geo fence, which in this fishery was designated somewhere west of the port of call. Upon returning to port, the system shuts down automatically when the vessel passes the geo fence on its return to port.

OLE costs during this pilot project were associated with staff time which included:

- Reviewing and analyzing hard drive data by SAs.
- IT staff hours making copies of hard drives for review and analysis.
- IT staff hours handling and delivering hard drives to Archipelago representatives for use in the Whiting fishery.
- Reviewing Archipelago summary and final reports.
- Meetings with NWFSC, NWR and GCES staff.

The cost of OLE staff time working with hard drives (procurement, maintenance, transport, travel time, shipping, storage, review and analysis) along with the initial hardware costs should be factored into the overall Agency costs because they can be significant. Using SAs and EOs to perform the bulk of the above tasks is not cost effective if the Agency moves forward with potentially increasing the use of video monitoring systems. These functions and others have been performed by SAs and EOs, initially, to help determine the feasibility of using video monitoring as a compliance and enforcement tool, and due to lack of support staff (in OLE and elsewhere) to perform these tasks. However, consideration should be given to identifying more appropriate positions to perform the tasks required in managing video monitoring programs in the future and where those positions should be employed, i.e., as OLE, Regional, or Science Center staff or contracted through outside services, e.g. Archipelago. These costs do not include potential costs for incorporating e-logbook data and transmission via VMS in conjunction with cameras. This program was discontinued in 2011 when the fishery transitioned from an EFP to a catch share program. In the development of the Trawl Rationalization Program on the West Coast, industry, early on, identified 100% observer coverage as a desired program component. OLE continues to support 100% monitoring by human observers as it is currently the Pacific Council's preference. With that said, EM continues to be evaluated with a few new studies underway in the NWR. For example, a prototype using vision based computational monitoring has been developed and is further discussed in the Research and Development White Paper #5.

In 2012, the Pacific States Marine Fish Commission (PSFMC) redeployed cameras on six at-sea whiting catcher vessels delivering to Motherships, six shoreside whiting vessels, and two fixed gear vessels. The video data will be evaluated and compared to the observations made by the on board observers to determine the effectiveness of video monitoring verses human observers. Twelve additional bottom trawl vessels have been identified for camera installations, but at this time lack of funding has prevented expansion of the camera/observation evaluation experiment. Additionally, PSMFC has employed a statistician to evaluate differences in confidence intervals at various levels of monitoring, i.e. 100% or something less.

Costs and effectiveness of these alternative monitoring programs have not yet been fully evaluated because the studies are not completed. Prior to reducing or replacing human

observers, EM effectiveness in meeting management, scientific and enforcement purposes as well as cost effectiveness should be demonstrated. From an enforcement stand point in the NWR, EM has demonstrated it can work well on whiting vessels and fixed gear vessels but EM has not been adequately tested on bottom trawl vessels.

Given the pace of the ongoing studies and the time it takes to implement new regulations, the earliest implementation of any EM in lieu of human observers for participants in the West Coast catch shares program is estimated to be 2015, unless some type of EFP is issued to a subset of the fleet in 2014.

Species identification is usually required when addressing enforcement issues. Within these afore mentioned pilot programs, cameras did not prove to be reliable for species identification. Blind spots in camera coverage missed capturing or discarding protected species. Video monitoring may be a valid method to supplement monitoring of some protected species where the species interactions are fatal, i.e. dead specimens, but biological samples, which tend to be the best evidence for investigations, can only be collected by observers. By-catch harvest of protected species (fish, birds and marine mammals) may be monitored at limited locations onboard vessels if the entire population can be retained, and sorted or monitored down to the individual item.

Video monitoring is not likely to provide complete monitoring for Endangered Species Act, Marine Mammal Protection Act, or other protected species. Live animals are often not brought onboard. When they are brought onboard, biological sampling and/or visual identification by an observer is the best evidence for determining the species for an investigation. Live marine mammal and bird interactions tend to occur at random places on or nearby the fishing vessel and/or gear. The potential camera area of coverage to capture these types of interactions is significantly broad; therefore, adequate or complete video monitoring might be challenging.

5.2.4. Northeast

A Northeast Fisheries Science Center (NEFSC) pilot study testing the use of video camera and sensor monitoring systems was implemented in 2010 to determine if such equipment is capable of monitoring catch and fishing effort in the Northeast Multispecies fishery. The multi-year project is being evaluated as a possible way to reduce the costs of at-sea monitoring in the future. In 2010, ten vessels representative of the three primary groundfish gear types (gillnet, longline, and bottom otter trawl) volunteered to participate in the pilot study.

After the first year of the pilot project, NMFS determined a more robust EM system is required to provide the high-quality data needed for allocation accounting and sub-Annual Catch Limits (ACL) monitoring. The second phase of the pilot study will focus on addressing two system deficiencies identified by NMFS:

1. Obtaining fish weight with a known accuracy and precision to estimate catch weight; and
2. Developing methods to increase species identification.

This project will continue to work to address these system deficiencies so that EM technology can be considered for use in the future.

This pilot focuses on addressing scientific data collection objectives and at this time it does not include any fisheries compliance or enforcement objectives. As the Agency continues to address the above systems deficiencies, consideration should be given to the feasibility of incorporating compliance and enforcement uses.

5.2.5. Southeast

Southeast Enforcement Division (SEED), OLE: The SEED experimented with coupling gear and smoke-stack sensors[2] with cellular-based VMS transceiver units in the mid-1990s. At that time, interactions between different fisheries created significant gear conflicts on the water, so the Gulf Council recommended trying to use restricted areas allowing transiting only for some fisheries. A pilot program was developed to try and monitor vessel activity within the restricted areas as an enforcement tool. The pilot was based on cellular technology, so the data could not be retrieved until the vessel returned within cell phone range. The sensors were difficult to make and weren't commercially available. In addition, they provided minimal reliability because they were easily tampered with. The SEED dedicated two full-time FTEs to implement, troubleshoot and monitor this pilot. The staff costs along with the sensor and cell phone technology issues did not result in an effective enforcement tool, so the pilot was discontinued.

Southeast Region (SER): The SER has experimented with several video monitoring pilot programs. OLE was not actively involved in developing those pilots. Lacking enforcement components, OLE is not able to specifically assess the effectiveness or use of EM technologies as enforcement tools in those fisheries, other than to generally comment that video camera monitoring would need sufficient resolution and adequate camera placement, among other things, to be a significant benefit for enforcement.

The South Atlantic Fisheries Management Council funded a study by the Marine Conservation Institute (MCI) to review current methods of surveillance and enforcement of marine protected areas. The goal was to identify potential improvements to monitoring and enforcement to increase effectiveness of resource protection in marine protected areas in the South Atlantic. MCI's report, entitled "*Review of Surveillance and Enforcement of Federal Fisheries*

[2] Smoke stack sensors were temperature sensors (thermometers) that sense a significant change in the heat within the exhaust system of the vessel. In theory, when a vessel was pulling its shrimp net, the "stress" or load of dragging the gear would cause the exhaust system's temperature to rise. And conversely, when the exhaust temperature was relatively cooler, it signaled that the engine was running easier, i.e. not dragging its gear in the water.

in the Southeastern US[3],” provides a list of existing technologies that have the potential to aid in fisheries enforcement. Additionally the report recommends necessary elements in developing a strong surveillance and enforcement program using advanced technologies. A copy of this report can be found at http://www.marine-conservation.org/media/filer_public/2012/03/23/safmc_serma_final_report.pdf

5.3. Video Camera and Sensor Monitoring Systems Pros and Cons

Pros:

- Video monitoring can be a helpful compliance tool for monitoring specific requirements or prohibitions (if the definitions and regulations are tightly written).
- For enforcement purposes, video monitoring can:
    - Be useful to help observers verify data quality and industry compliance.
    - Be useful for full retention requirements where discards are not allowed or are limited to one location (like Bering Sea catcher processor salmon by-catch) or for monitoring specific crew activities (like crewmembers inside fish bins where presorting and discarding might occur prior to the observer taking samples).
    - Be used, in some fisheries, with sensors on the drums and hydraulic wenches to successfully define fishing events, assisting in the analysis of the video.
- Video monitoring may have utility on small hook and line and pot vessels with no in-season management, as contemplated in certain Alaska fisheries, because on these vessels catch usually comes on board in small groups or one at a time so discards may be monitored. However, this may not be the case in all hook and line fisheries so further assessments would need to be done for general applicability.
- Video equipment and sensors can be made tamper evident.
- The equipment failure rate has improved over the years.
- Success has improved where vessel operator and crew are cooperative.

Cons:

- Species identification is still very difficult (and sometimes not possible) unless the fish are recorded individually with high resolution cameras.
- Data are not transmitted and retrieval is not done in real-time, and doing so by currently tested and available means would generally be cost prohibitive and impractical:
    - Retrieval of hard drives and review and analysis of video data are not timely (currently it takes weeks or months depending upon the fishery).
- Improvement on the analysis turnaround time, of data currently collected, is a function of cost. Faster turnaround equates to increased costs.

[3] Marine Conservation Institute, “Review of Surveillance and Enforcement of Federal Fisheries in the Southeastern US, Report to the South Atlantic Fishery Management Council”, December 2011, Sandra Brooke

- Monitoring for catch discards presents a challenge because most vessels can discard in several places (rail, deck, trawl alley, scuppers, sorting areas, factory, etc.). Ensuring adequate video monitoring coverage to capture potential discards requires adequate camera installation throughout the vessel, which can increase the cost of the system.
- Successful investigative work utilizing video monitoring requires a high degree of species and fishery knowledge along with video systems training and knowledge.
- The success of the monitoring is highly dependent upon fleet behavior. The potential for exploitation exists, so fleet cooperation is required.
    - For example, deployment of cameras on large trawl vessels is unique to the vessel. Depending upon the regulated activity, camera placement can result in blind spots that can and have been exploited by the vessel operations.
- Camera optics need further development/enhancements.
- Cameras not tested for use during night operations in some fisheries. Lighting for use in night-time fishing might be problematic in some fisheries, which may restrict application to day-time fisheries.
- Digital media poses additional chain of custody and evidentiary issues that need to be addressed on a case-by-case basis for each fishery contemplating implementation of video and sensor equipment:
    - Observers can testify in court about the data they collected. They can validate that the data submitted as evidence is the data they collected and/or observed (validation process).
    - Digital validation processes also exist, and it is important to ensure such a process is used when collecting video data, if possible, to strengthen the evidentiary value of the video data.

6. Other Existing Technologies

As described in Appendix B, there are a variety of other ER/EM technologies being used for fishery dependent data collection and reporting, and OLE SAs and EOs already use some of those tools. For example, OLE utilizes ruggedized laptops, PDA's, smart phones, etc., and costs associated with using these tools have included the unit price of each item and service/data plans.

To help OLE SAs and EOs work more efficiently and effectively in the field, additional tools should be considered. Examples include electronic ticket books rather than paper books (Enforcement Action Reports), and other cellular, Bluetooth and/or Wi-Fi connected devices that provide encrypted, secure, real-time access to NOAA, OLE, Department of Justice and other systems and data. OLE is interested in another technology, not discussed in Appendix B, unmanned aerial systems (UAS). OLE is interested in working with the NOAA-UAS program to explore potential enforcement benefits using UAS technology.

In some fisheries, the use of electronic motion compensated flow scales are used to obtain accurate weights of all the catch. There is no cost to OLE to implement use of these scales because they are installed on the vessels at the cost of the vessel owner.

Currently, most catcher processor fisheries in Alaska require flow scales to weigh all catch. Instead of estimating catch weight, vessel operators must record the actual scale catch weight per haul. This requirement limits intentional falsification of haul size which might be motivated by intent to overharvest, to change product recovery rate calculations, or to interfere with or bias observer(s) samples.

Operators must verify the accuracy of the flow scale daily in the presence of an observer. However, flow scales are not tamper proof systems, as recent investigations demonstrated. In coordination with other monitoring and reporting programs and systems, the flow scales deter potential violators. Large manipulations of haul weights occur less frequently because violations are more detectable by observers and OLE. In addition, flow scale systems make it difficult for industry to bias observer samples by methods of mechanical or physical pre-sorting of catch. The flow scale acts as a natural choke point when placed immediately outside of the fish holding tanks. This flow allows the observer to better monitor fish before samples, thereby minimizing sample bias through vessel design or crew tampering.

6.1. Other Existing Technologies Pros and Cons

Pros:

- Mobile technology allows SAs and EOs to work in the field more effectively.
- Allows timely access to information/data while in the field (VMS data, law enforcement data bases, Internet).
- Can assist with more proactive rather than reactive enforcement responses for compliance assistance and investigations.
- Improves timeliness of reporting.
- Once the SA/EO understands flow scale systems and the documents associated with it, a tremendous amount of evidence can be gathered.
- Flow scales can provide strong supporting evidence of proper compliance.
- The documents associated with the flow scales have been helpful to determine if a witness/subject is providing truthful information.
- The flow scale system can be enhanced to provide a more tamper resistant management tool.
- Incorporating the flow scale systems and video (bin) monitoring has dramatically decreased the amount and level of presorting that would cause observer samples to be biased and decreased the number of observer interference complaints.

Cons:

- Security of confidential information.
- Potential costs.
- Flow scales are complex systems requiring advanced knowledge of their operation.

Appendix D -

Electronic Monitoring White Paper Research and Development

National Oceanic and Atmospheric Administration

National Marine Fisheries Service

February 2013

7. Key Findings

- Recent electronic monitoring (EM) R&D efforts have focused on automating the video review process in order to make EM more timely and cost-effective. This includes adapting and developing image processing applications to improve species identification in conjunction with video monitoring and to quantify catch, discards, and other biological characteristics of catch.

- Recent electronic reporting (ER) R&D efforts have focused on adapting existing electronic logbook systems to more fisheries.

- Before ER and EM standards can be developed, minimum levels of performance required for effective monitoring and management of respective fisheries must be identified.

- Based on these minimum levels of performance, standards should be developed for the following: technical architecture, software, data elements, metadata, timeliness of data, data checking and error-correction, and handling of confidential data.

- Priorities for future R&D projects include developing/testing new technologies that address current performance gaps, reducing costs of transmitting data electronically at sea, reducing costs of EM review and transcription, improving integration of electronic data feeds from different sources, and improving accuracy and reliability of automated data collection.

8. Objective & Purpose

The objective of this paper is to briefly provide an overview of recent research and development projects for testing the feasibility and potential benefits of implementing new ER/EM technologies, to describe the collaborative process that is needed for determining appropriate ER/EM technology standards, and to describe how priorities should be set for future research and development.

9. Background & Synopsis

Despite rapid growth of electronic technologies and the myriad of NMFS-sponsored projects to test such technologies, there is still not a set of ER/EM technology standards that can be applied across fisheries. The development of minimum requirements for effective monitoring in specific fisheries and standards for the implementation of ER/EM technologies will require collaborative strategic planning that involves all stakeholders. A collaborative cross-regional planning effort should be established that will include representatives from the regional offices, the science centers, the Office of Law Enforcement, the regional fishery management councils, the interstate fisheries management commissions, the state fisheries agencies, the commercial and for-hire recreational fishing industries, recreational fishing organizations, academia, and non-government organizations. Working together, the various stakeholders should assess the current monitoring capabilities, as well as the additional capabilities needed to support effective management and enforcement of different types of fisheries. Given that different stakeholders may have different assessments of the requirements, it is important that all stakeholder inputs be considered before establishing minimum monitoring requirements, determining ER/EM technology standards, and setting priorities for future research and development.

9.1. Monitoring Program Design Context for EM Development

It is important that each component of a data collection program be based on a sound design. If a census survey approach is used, it is important to ensure that there are procedures in place to minimize and/or account for biases. For example, a mandatory census that collects data on all vessel trips must be designed to assess possible errors that can result from incomplete coverage (e.g., non-registered vessels), non-compliance (e.g., missing reports), inaccurate reporting (e.g., errors in species identification or reported quantities of catch), or inaccurate measurements (e.g., incorrect measurement methods or units of measure). If data is collected from a sampling of vessel trips, it is also important to use a probabilistic sampling design and achieve the desired level of statistical precision by setting appropriate sample sizes and sampling stratification schemes. Regardless of how data are collected, it is important to have a program design that appropriately accounts for all sources of fishing mortality, as well as possible errors due to either bias or imprecision.

In many cases, new ER/EM technologies can be viewed as “enhancements” that facilitate the operation of monitoring programs already in place to deliver timelier, more accurate, and more cost-effective results. In other cases, a new technology may make it possible to collect data from a different source or to provide additional data detail. Such technologies provide the opportunity to explore different, and perhaps more efficient, survey designs than the ones already in place. For example, the development of GPS and VMS technologies has allowed us to collect more accurate fishing vessel location and tracking data than we could collect from the reports of at-sea observers or vessel operators. These new technologies also greatly reduce the potential for data entry or measurement errors and open the door for an automated design that monitors location

without requiring reports from observers or vessel operators. Research and development of ER/EM systems should focus on exploring opportunities for both operational enhancement of current survey designs and implementation of new survey designs to improve compliance monitoring capabilities, catch accounting, and estimation procedures.

9.2. The Need for Multiple Data Sources & Data Integration

Accurate statistics and information on commercial and recreational fisheries are essential for effective fisheries management. Our ability to develop, implement, and regulatory requirements depends on credible information about the resources and the people who use or benefit from them. NMFS partners with the councils, interstate commissions, coastal states, and tribes to collect data and provide appropriate statistics that support the strategic goals of building sustainable fisheries, ensuring recovery and conservation of protected species, protecting and restoring living marine resource habitat, as well as protecting fishery-dependent communities. Good stewardship requires accurate information about the resource itself, as well as information on fishing effort and impacts. This information includes data on fishing participants, fishing effort, targeted resources, spatial and temporal effort distribution, reasons for fishing, fishing methods, retained and discarded catches, and interactions with protected species.

Well-designed data collection programs are needed to ensure the production of accurate fisheries statistics on participation, effort, catch, landings, discards, biological characteristics of the catch, products, economic value, and socio-cultural impacts. It is necessary to collect and integrate data from a variety of sources to achieve complete coverage of fishing operations and to ensure that fisheries statistics are as complete and accurate as possible. In order to obtain the most accurate measures possible for different fishery parameters, we should compare data obtained from different sources to reconcile or explain differences and/or estimate appropriate statistics that take all of the different data feeds into account. Data collection programs may have high rates of non-response; and data are likely to include self-reporting and measurement errors. Therefore, research and development on program design should ensure that we could easily access, integrate, and compare information from multiple sources.

We currently collect commercial fishery-dependent data from a number of different sources in order to get a complete and accurate assessment of fishery impacts:

- Commercial vessel operators - Vessel operators must identify their vessels through mandatory permitting or registration programs that require them to report fishing effort, fishing locations, and landings. In addition, permit programs may also require reporting of discards and protected species interactions. Vessel operators also respond to surveys to provide economic and sociocultural data.
- Seafood dealers and processors – Dealers and processors are required to register or obtain permits that require them to report landings that they purchase and/or process. Landings must be reported at the trip level so that data can be easily compared with what is

reported by vessel operators. In addition, they are required to report the value of purchased landings.

- Fisheries observers – Professionally trained observers report on fishing activities by commercial fishing operations, and coverage may range from a sample of vessel trips to 100% of the trips in a specific fishery. Observers report on landings, discards, protected species interactions, fishing locations, gear types, fishing effort, and both economic and sociocultural data. They are trained to accurately identify finfish catch, finfish discards and protected species bycatch at the species level. They also typically obtain biological data (lengths, weights, otoliths, scales, spines, etc.) on a sample of the catch (landings and/or discards) for stock assessment and scientific studies. Observers are the most reliable source of accurate species-specific catch and bycatch information, and they are also the most reliable source of biological data on the catch.
- Shoreside monitors or samplers – Shoreside samplers may be deployed to collect landings data and biological data on landings.
- Vessel monitoring systems (VMS) – VMS provides the most accurate data on fishing locations.
- EM – EM is now being used as a compliance monitoring tool in some fishing operations. EM data is currently not as reliable or accurate as observer data However, EM technology is being developed and tested to determine if it may prove to be a cheaper way to collect some of the data that is now provided by observers and, as the technology advances, EM functionality can be reevaluated.

We also collect recreational fishery data from a variety of sources to assess the overall impacts:

- Recreational anglers – Anglers who fish from shoreline or on private boats are now required to register through the new federal registry program or through state licensing/registration programs. Anglers who fish only on for-hire boats are not required to register in most states. Both registered and un-registered anglers provide data on their fishing effort by responding to mail or telephone surveys that employ probabilistic sampling methods. In addition, recreational anglers provide data on their catches when intercepted by shoreside access point sampling surveys. Anglers also provide economic and sociocultural data in response to off-site and on-site sampling surveys.
- For-hire vessel operators – Charter boat and headboat operators are required to identify either themselves or their vessels through mandatory federal or state registration programs. In response to sampling surveys or mandatory logbook reporting programs, they provide data on fishing effort (number of vessel trips and numbers of anglers per trip) and/or catch (primarily landings). For-hire operators may also provide data on their catch when intercepted by dockside sampling surveys.
- At-sea samplers – Trained samplers are deployed on the Atlantic coast to collect data on a sample of headboat trips to record accurate counts and obtain biological data on both

kept catch and catch released at sea. Samplers are trained to accurately identify all observed finfish catches at the species level. At-sea samplers are the most reliable source of accurate species-specific catch information, and they are also the most reliable source of biological data on the catch.

- Shoreside samplers – Shoreside samplers are deployed through probabilistic on-site sampling surveys to collect data on both kept and released catch from interviewed anglers. They also collect biological data on a sample of the observed landed catch. Shoreside samplers are the most reliable source of catch data and biological data. They may also obtain economic or sociocultural data from interviewed anglers.

Electronic technologies could facilitate and/or enhance the collection and integration of these different types of data. Future ER/EM R&D should prioritize the data types and sources for which timelier delivery of high quality data is most important.

It is important to recognize that the development of new ER/EM technologies may never fully automate data collection and still provide information at the level of quality needed to support accurate stock assessments and responsible fisheries management. Non-automated, independent sources such as trained at-sea observers or shoreside samplers may always be needed to validate automated data feeds even as technologies become more cost-effective. In the case of EM, video is not likely to completely replace observer data. Rather we could consider using both EM data and observer data in a complemented survey design. As EM technology improves and becomes both more reliable and more cost-effective, observer coverage could be scaled back to a sampling (rather than census) approach that would serve to complement and validate the EM data.

10. Overview of NMFS ER/EM R&D

Selections of recent Agency and stakeholder ER/EM technology projects have been based on strategic decisions made through a collaborative planning process among several Agency and/or non-Agency groups. These projects have focused on developing, testing, or implementing new technologies for ER of commercial fishery landings by seafood dealers or vessel operators, EM of fishing vessel movements, video monitoring of fishing operations at sea, and/or ER by vessel operators, shoreside samplers or at-sea observers. It is important that lessons learned from these various projects be shared, thus leading to a more efficient, cost-effective approach in assessing how we can improve our current monitoring capabilities with existing technologies. Certainly, broader collaboration and communication is necessary to establish minimum requirements and set shared funding priorities for future work.

Within the Agency, several national and regional programs have funded ER/EM projects over the last two years. The National Observer Program (NOP) has funded a number of projects focused on developing and testing video monitoring systems to complement observer data collections on commercial fishing vessels. The Fisheries Information System (FIS) Program has

funded several projects aimed at developing and testing electronic vessel trip reports (or e-logbooks) of commercial landings. The Marine Recreational Information Program (MRIP) has funded one project to test the use of video monitoring for the collection of catch data on private recreational boats and one project to test the use of electronic logbook reporting of catches by charter boat operators. The Catch Share Program has recently funded projects to develop and test both video monitoring and electronic logbook reporting technologies.

10.1. Selected EM Projects

To date, NMFS has funded 31 EM pilot projects in the United States (Appendix B, Table 3). Alaska alone has completed 14 EM pilot projects across four different fisheries. They tested EM in a number of different applications, including estimating halibut discards, monitoring bin activity for presorting, monitoring seabird interactions, and automating the analysis of video data Several of these EM pilot projects were considered successful and have resulted in the implementation of three video monitoring programs that use video as a compliance monitoring tool to accomplish program-specific goals such as providing a "real-time" view for the observer to monitor pre-sorting, crew activities related to sorting prohibited species, and crew activity related to sorting and weight of catch on a flow scale.

The focus of recent EM projects has been on the following:

1. Testing the feasibility of video technology to provide adequate coverage for compliance monitoring.
2. Accurately identifying the bycatch of protected species (birds, marine mammals, turtles, etc.) or fishing interactions with protected species.
3. Accurately identifying finfish species in the discarded catch.
4. Automating the review of video to make EM data processing and utilization more cost effective.

of the largest costs associated with video monitoring systems is the amount of time required to review the video. In one project that looked to address this topic, NMFS contracted with Mamigo, Inc. to test the feasibility of applying machine vision technology to the Rockfish fishery in Alaska. Essentially, this would automate the process of video review to obtain counts and lengths of individual halibut prohibited species catch (PSC). Mamigo, Inc. submitted their final report for this project in October 2010, and demonstrated that their software was able to automate the count of halibut and performed the counts much faster than if a human completed the review.

In the southeast, two EM pilot studies in 2008 and 2010 have served as a foundation for an ongoing EM pilot for the reef fish bottom longline and vertical line fisheries operating in the Gulf of Mexico. On the West Coast, research has focused on the development of an EM monitoring hardware platform consisting of a control box, user interface, and a suite of sensors including GPS, hydraulic, drum, and cameras. This research led to the use of added alarm

systems that have helped reduce lost coverage and additional cameras that have reduced blind spots.

10.2. Selected ER Projects

NMFS funded several ER projects in recent years, many of which had multiple phases and are still on-going. Recent ER projects have focused on the following:

1. Development of more efficient methods for electronically recording data on board a vessel.
2. Development of alternative methods for transmitting recorded data to an appropriate shore location for processing.
3. Development of more cost-effective methods for transmitting data at sea so that shoreside sampling could be used to independently validate electronic vessel trip reports.
4. Adapting existing electronic logbook technology for use in other fisheries and regions.

In 2010, NMFS funded a study on the continued development of the Fisheries Logbook Data Recording Software (FLDRS) v.2.0, a multi-fishery electronic logbook, and its application to the SW Pacific Albacore troll fishery. In 2012, they funded a related study to field test FLDRS v3.0 in several northeast fisheries including the groundfish (trawl, longline and gillnet), tilefish (longline), scallop (dredge), squid (trawl) and fluke (trawl) fisheries.

NMFS also funded a two-phase project in 2009 and 2012 on the implementation of electronic logbooks on headboats operating in the U.S. South Atlantic and Gulf of Mexico to test the feasibility of electronic reporting as an alternative to paper logbooks in the Southeast Regional Headboat Survey. NMFS also funded an electronic logbook pilot study in the Gulf of Mexico for censusing or estimating for-hire catch and effort in 2010, which demonstrated that electronic logbooks were not a feasible mechanism for censusing for-hire catch and effort but may provide utility for estimating catch and effort.

11. Overview of External ER/EM R&D

Funding for ER/EM projects has also come from a number of non-NMFS organizations. The National Fish and Wildlife Foundation funded projects through a competitive grant program with funding from its Fisheries Innovation Fund. These programs have been conducted in partnership with NMFS and other stakeholder groups. In 2012, NFWF funded four projects on ER and EM, including projects on: electronic logbooks in a New England groundfish sector in Maine, video monitoring and computer-aided video review software for full retention fisheries in Washington and Oregon, development and evaluation of image recognition software for screen video images in California, and field-testing new electronic monitoring hardware and software in the small boat halibut fishery in Alaska. In 2011, NFWF funded projects on EM using closed circuit video cameras and gear sensor data collection in Gulf of Mexico reef fish, EM for Alaskan halibut and

sablefish catch share fisheries, ER for cooperative fishing, and EM to facilitate affordable catch shares.

The Nature Conservancy (TNC) has also funded pilot projects to test video based EM and reporting of commercial fishery catches. Beginning in 2007, TNC began work on an electronic reporting system known as "eCatch". The system now digitizes logbook data and can be used by fishermen to monitor catch limits geographic constraints.

The North Pacific Research Board funded several projects using interest earnings from the Environmental Improvement and Restoration Fund as well as funds obtained from the North Pacific Marine Research Institute. One of their recent projects (2007 to 2010) evaluated the ability of EM to characterize bycatch in the Pacific halibut fishery. Although they did not conduct this project under commercial fishing conditions, it did demonstrate the potential to use EM to monitor bycatch.

The Environmental Defense Fund supported projects to test ER systems for both commercial and recreational fishery catches. They funded one of their current projects, the Maryland Blue Crab Accountability Pilot Program, through the Blue Crab Fishery Disaster Fund. The objective of this project is to evaluate a new ER system using cell phones, smartphones, and tablets to submit catch data electronically from the water each day. This pilot project allows for real-time harvest reporting that the commercial crabbing industry hopes will improve management decisions.

The International Pacific Halibut Commission (IPHC) supported projects to test video based EM of commercial fishery catches. For example, in 2008, they contracted with Archipelago Marine Research Ltd. to study the use of video monitoring in a Bering Sea groundfish factory trawler. The system they tested included nine closed circuit television cameras that provided coverage in fish handling areas, GPS, and on-board storage. This system easily detected halibut, but further improvements are needed for detailed assessments of catch composition.

12. Lessons Learned from National and International ER/EM Programs

It will be useful to look at examples of relatively well-designed ER/EM programs that have been developed and implemented in recent years to benefit from lessons learned and to better prioritize future research and development projects. Two domestic examples include the integrated reporting systems in Alaska and the Northeast Region.

The Alaska Interagency Electronic Reporting System (IERS) is a joint effort by the Alaska Department of Fish & Game, the IPHC, and the NMFS Alaska Regional Office. The IERS, commonly called the "eLandings system", provides consolidated reporting of commercial fishery landings, production, IFQ, and other vessel trip information obtained from fishing vessel operators, processors, and dealers. The system is in use for all rationalized crab, IFQ sablefish and halibut, and all groundfish harvest reporting throughout the state, shoreside, and EEZ. The state is currently expanding the system to include coverage of salmon and, in the future, other

fisheries in Alaska. Processors and vessels submit data into the IERS and all three fishery management agencies pull the data from a shared repository database. The system has four visible components:

- eLandings - web-based access for seafood processors
- Agency Interface - locally installed access for NMFS personnel
- seaLandings - locally installed program which provides email-based access for clients with no web access (typically for catcher/processor factory ships which report at sea)
- tLandings - locally installed program for salmon, shellfish, and groundfish tenders with no web access

The current set of electronic commercial fishery reporting applications used in the Northeast Region includes VMS, the SAFIS (Standard Atlantic Fisheries Information System) electronic seafood dealer reporting system, and FLDRS (Fishery Logbook Data Recording Software) for reporting by vessel operators. Ongoing work with this system, as described in the "Recent Electronic Reporting Projects" section of this document, is developing ways to better integrate data from different electronic sources to allow the timely reconciliation of dealer and vessel reports needed to validate self-reported vessel trip reports. Such improvements will better support timely management of fisheries with a catch share approach.

It will also be useful to look at solutions developed by other countries, including Norway's electronic reporting system for commercial fishing vessels. Norwegian fishing vessels greater than 24 meters in length are required to carry VMS for position monitoring, and the Ministry of Fisheries has developed software for vessel operators to use to record catch and activity data on computers while at sea. They can then transmit data via the internet when the vessel returns to shore. Recent research in Denmark tested the integrated use of VMS, closed circuit television cameras, and sensors that gauge the weight of catches; this system tracked caught fish, the size and location of the catch, and the species discarded. Australia has also developed and implemented VMS and electronic logbook reporting systems for commercial fishing vessels.

Canada has instituted a variety of ER/EM technologies. Fisheries and Oceans Canada (DFO) first began using electronic reporting from sea in 1998, and since then has focused on increasing the speed, accuracy, and usability of this approach. Canada's Pacific electronic logbook initiative (E-Log) has been widely implemented for reporting catch information for both commercial and recreational fisheries. The E-Log system has the flexibility to transmit data via internet, cellular telephone, satellite telephone, Iridium satellite modem, and Orbcomm satellite modem. Canada has also implemented EM initiatives, such as through the Commercial Groundfish Integration Program (CGIP). This comprehensive program includes multiple cameras, sensory devices, and a GPS receiver that measures vessel speed and location. The sensory devices monitor the use of fishing gear, and the cameras record all activities.

13. Performance Thresholds

In addition to learning from other ER/EM programs and pilot projects, appropriate performance metrics will be needed for program evaluations and to identify opportunities for improvement in the following key areas:

- Timeliness of data delivery
- Quality of data received
- Capability for integrating data from different sources
- Accessibility of data and statistical results to the various customers
- Costs of operation and maintenance

Once Councils have developed common metrics, Councils and NMFS should collaboratively determine the minimum levels of performance required for effective management of a specific type of fishery. These minimum performance levels should consider trade-offs between further gains that may be possible and the increasing costs of making those gains.

The Agency should review potential new and existing electronic technologies to identify data collection improvement opportunities. Effective sharing of information is important in this effort. As new technologies offering the potential for significant enhancements become available, stakeholders should re-assess the trade-offs between possible performance gains and increased costs to see if they should adjust minimum performance levels to a higher standard.

14. Assessing Priority Areas for Standards Development

With performance thresholds in place, standards should also be set in a number of priority areas, including:

- Technical architecture
- Software
- Data elements
- Metadata
- Timeliness
- Data checking and error-correction
- Handling of confidential data

Technical architecture: The technical architecture of any data collection system should meet certain minimum standards set for the fishery. It is important to create an integrated architecture that facilitates the linkage of data feeds (electronic or not) from different sources. Any implemented ER/EM technologies for vessel reports, dealer reports, automated VMS, on-board observer reports, or shoreside sampler reports should share some common elements that allow easy integration of data into a database management system. In addition, technology implementation should focus on getting the required data and linking data from various

components at the closest point to the source as possible rather than relying on post processing and reworking (i.e., correcting errors) of the data. For example, a specific survey design may require that the vessel transmit fishing data by satellite before the vessel returns to shore to allow error-trapping on data entry and independent verification of reported landings by shoreside sampling surveys.

Software: The software used by any ER/EM technology should meet certain requirements to assure compatibility with other data feeds needed for monitoring the same fishery. The Agency should look for open source code or standards rather than locking into a particular suite of software (e.g., Oracle, SAS, etc.) The recent NOAA Environmental Data Management Conference emphasized the need for use of open source data archiving and sharing of environmental data.

Data elements: Any new ER/EM technology should accommodate the reporting of a certain minimum set of data elements needed for accurate monitoring of the specific fishing performance measure. The Agency's current fishery dependent data collections share many common features, data elements, and needs. These should be identified and form the core of the Agency's ER/EM strategy with regional modules that deal with the unique requirements of each region.

As we move forward to implement changes in the tools used to gather data, it will also be important to periodically reassess the minimum data elements needed to manage fisheries, as well as the best sources of those data. These fundamentals would inform decisions regarding best methods and technologies for the collection of data. For example, it may be that vessel operator reports, dealer reports, and on-board monitoring reports are needed to manage commercial fisheries, but an effort should be made to take a fresh look to see if a different approach is needed. Ideally, a new requirements analysis should precede a determination of minimum data elements or standards.

Metadata: All new ER/EM technologies should support compliance with the Agency's standards for metadata. New technologies should not be implemented without complete documentation of its design and capabilities for data capture, recording, processing, storage, and transmission.

Timeliness: ER/EM technology should be held to certain standards for the timeliness of data capture, data processing, and/or data transmission for the specific fishery survey design that it supports. Due to the potential high costs associated with the implementation of ER/EM technologies, such performance standards should only be set as high as necessary to support the specific regulatory strategy for the particular fishery. Fisheries managed under a catch share program should have higher standards for timeliness. Similarly, fisheries managed by in-season quota monitoring should have higher standards than those managed with annual or multi-year targets. The particular ER/EM technology applied to any specific fishery should be matched to

the timeliness requirement. More costly ER/EM system components should not be purchased if a less costly one is sufficient.

Data and Statistical Quality: It is important to establish minimum standards for assuring and maintaining the quality of the fisheries data needed for effective monitoring. New ER/EM technologies should provide capabilities for checking of data and correction of data entry or transcription errors at the source. Faster data are not necessarily better data. However, faster turn-around of data checks closer to the source of the fishing activity can allow for a considerable reduction of possible response errors (recorded or reported) or measurement errors. Appropriate data checking software should be utilized to assure this in any new ER/EM technology that is implemented.

Standard methods for the checking and validation of self-reported data must be established. Verification of self-reported data using trained samplers or observers with no vested interest in the outcome should be a key consideration. Are reports by seafood dealers required to validate landings reports submitted by vessel operators? Are observer reports of discards or protected species interactions needed to corroborate vessel operator reports? Are video monitoring systems needed to verify compliance with fishing regulations and/or vessel operator reports of landings? Is it necessary to collect both EM records and observer data on at least a sample of vessel trips to allow for cross-checking and resolution of potential discrepancies? These are important questions to address.

Confidentiality: Consistent with MSA requirements, it is important to establish standards on how to protect and secure confidential data in any new ER/EM component. ER/EM technologies should allow data usage and integration but in a manner that protects the confidentiality of the data. If the data collection is mandatory, then the ER/EM component must appropriately transmit data that are either directly linked or can be readily linked to the identity of the permit holder from which data were obtained. If the data collection is voluntary, then the component may need to identify the source anonymously, giving it an identifier that cannot be linked to the specific person, operation, or vessel for which data were obtained.

15. Performance Evaluations

Once fishery monitoring performance metrics and minimum requirements are established, they can be used to predict and track impacts of implementing new ER/EM technologies. This performance monitoring is crucial for assessing the return on investment. Given that new technologies can have significant costs associated with development, testing, and implementation, it is important to have a sound basis for decisions on what is implemented. A significant increase in overall performance may justify a significant increase in costs. However, with limited budgets, there is a need to evaluate the trade-offs between costs and performance to determine acceptable solutions that may perform well below the maximum levels possible with existing technologies.

16. Assessing Priority Areas for Future R&D

In order to determine appropriate priority areas for new research on ER/EM technologies, the Agency should focus on the need to optimize performance of commercial and recreational fishery data collection systems. Continuous market research is important to identify new capabilities that have potential for application in fisheries monitoring. Staff should be focused on monitoring new developments of technologies that could provide better ER/EM solutions. The Agency should also take a broader view of the ongoing research activities to see if there are redundancies, gaps, or weaknesses. There are several priority areas for future R&D, including:

- Reduce redundancies
- Address performance gaps with existing technologies
- Require sound experimental designs
- Emphasize data integration

Reduce Redundancies: Much of the recent ER/EM technology work focuses on developing and testing VMS, electronic video monitoring systems, and electronic trip reporting systems. Many of the projects funded in recent years have been testing similar technologies that perform the same functions, but it is not clear if the results have been adequately shared and reviewed to determine if we can implement an optimal solution. There may be a number of possible solutions that raise fishery monitoring performance to a similar extent. It may not be necessary to standardize methods across a wide variety of fisheries, and there will always be strong arguments for different regions, or different fisheries within a region, having different ER/EM needs. However, there are likely to be significant gains in efficiency that could follow from better sharing of information and collaborative planning to develop some degree of standardization of ER/EM solutions across regions and fisheries.

Address Performance Gaps with Existing Technologies: R&D should be focused on addressing known performance gaps in the way data are collected and managed with existing technologies. Performance gaps will vary depending on the identified objectives. The gaps for existing EM

technologies depend on whether the objective is better monitoring of on-board fishing operations, better monitoring of protected species interactions, better validation of landings totals reported by vessel operators, or better accounting of discards at the species level. The gaps for existing ER technologies depend on how important it is to receive a vessel trip report before the vessel returns to dock. For example, it may be desirable to receive data before the vessel returns to port so that port agents can check and verify the landings.

Some of the known gaps in EM technologies that research and development projects should be addressing are as follows:

- Manual processing of video data is highly labor intensive and costly at present;
- Detection of discards (i.e., catch released at sea) is difficult with current technologies;
- Accurate recording of weight data is not currently feasible using EM (important for catch accounting);
- Accurate identification of discards at the species level is not currently possible in most cases;
- Coverage and resolution of video images is not always adequate to capture and accurately monitor all relevant on board operations;
- Current technologies may effectively address at least some data needs but are too costly to implement on a broad scale;

Some of the known gaps in ER technologies that should be addressed are as follows:

- Recording of discards is prone to error because it is difficult to record data at the time and place where the discards occur. Accurate reporting of data collected at different locations on the boat to a central recording location is very challenging;
- Most current electronic logbook systems do not link to automated recording devices that report accurate location, temperature, and/or fishing depth information;
- Current mechanisms for transmitting data at sea are not sufficiently cost-effective to implement on a broad scale.

Require Sound Experimental Designs: Many of the previous studies of EM and ER have focused on evaluating the performance of a specific technology application and lacked a formal experimental design. This makes it difficult to interpret results and highlights the need for a more formal process when designing and implementing future projects. It is important to determine what questions you are trying to answer, what performance metrics you wish to measure, and what standards you wish to meet before starting a project. The design of any proposed research study should ensure that specific hypotheses can be tested to determine feasibility for applying the technology to address specified needs for improvement.

Emphasize Data Integration: Future research should focus on the development of ER/EM solutions that facilitate better integration of both electronic and non-electronic data feeds from different sources. In most commercial fisheries, it is very important to be able to compare data obtained from seafood dealers, vessel operators, and at-sea observers in order to get accurate statistics on total catch by species. To do this, data must be quickly obtained from all three sources and integrated quickly to reconcile differences in landings numbers (between dealer and vessel trip reports) and combine the reconciled landings with the observer-reported discards. Designing and implementing appropriate ER/EM technologies for each data source ensures that data can be received faster, but it does not ensure that the data can readily be combined unless this requirement is incorporated into the program design.

Appendix E -

Electronic Monitoring White Paper Alignment of Objectives

National Oceanic and Atmospheric Administration

National Marine Fisheries Service

February 2013

1. Key Findings

- Monitoring fisheries has been highly irregular across geographic areas and fisheries. Given the ecological, economic, and social implications associated with the ways fisheries are monitored, the Agency needs to develop a more strategic process to determine the level and type of monitoring (observer, ER, EM or other) that is needed, can be sustainable, and is cost-effective.

- A useful first step in developing a strategic process for establishing or modifying existing monitoring programs is to consider the goals and objectives of the fishery management plan (FMP) and other mandates (e.g., Endangered Species Act, Marine Mammal Protection Act, etc.), and how different monitoring tools can contribute to achieving those goals and objectives.

- Stakeholder involvement in the setting of monitoring goals should be as inclusive as possible, in order to gain support and insight from the diverse stakeholders of fisheries, which includes: fishing managers and scientists, enforcement officers, monitoring experts, and industry members.

- There is a need to improve coordination and consistency of monitoring programs across regions and fisheries. Two possible approaches are described: 1) a Council driven process and 2) a National Steering Committee driven process.

- In general, the goals and objectives for establishing monitoring programs can be categorized as follows: management (e.g., monitoring catch and landings); science (e.g., socio-economic and stock assessment needs); enforcement (e.g., compliance, enforcing regulations); and cost effectiveness. These categories are fundamentally connected and therefore integrated monitoring approaches are critical.

- A variety of decision-making methods exist to evaluate which monitoring strategies work the best to attain the primary goals and objectives of the fishery. For the purposes of this white paper, a utility index was chosen to illustrate a process of identifying which monitoring strategies could work the best.

- Once the primary objectives of the monitoring program have been identified, stakeholders can use the utility index or another structured decision analysis method to determine the most appropriate mix of ER or EM for their purposes. Although it is unlikely that all monitoring objectives can be met by ER or EM programs, this methodology should provide the stakeholders with a good indication of whether ER or EM is a useful, somewhat useful, or less useful alternative to non-ER or non-EM programs.

2. Purpose

This white paper lays out an example of the type of analysis and process that could be used by regional fishery management councils, NOAA, states, the industry, and private technology developers to align monitoring efforts with regulatory needs. The paper also describes how to develop a monitoring regime for both newly established fisheries/regulations and for adjusting regimes, where needed, in those that already exist.

3. Background

In January 2012 NMFS Leadership Council participated in an in-depth discussion about the real and perceived challenges and opportunities associated with electronic reporting (ER) and electronic monitoring (EM). Although ER and EM of marine fisheries may never supplant the need for traditional human- or paper-based monitoring, there is a growing recognition that the current system of catch monitoring is neither economically viable nor consistent across fisheries, regions, or regulations. Therefore, a process is needed to examine alternative mechanisms for achieving cost-effective and sustainable monitoring programs. As part of this process, a re-examination of our regulatory framework may be needed to realign our management alternatives and scientific capabilities with our technical and fiscal monitoring capabilities.

To advance the Agency's understanding and consideration of ER and EM, the Leadership Council identified five topic areas needing further exploration:

1. Existing technologies
2. Enforcement
3. Research and development
4. Alignment of objectives
5. Funding

This document addresses topic four—develop a process for aligning monitoring needs and regulations.

4. Aligning monitoring efforts with regulatory needs

In the past, the Agency's approach to monitoring fisheries has been highly irregular across geographic areas and fisheries. For example, in the United States, observer coverage varies between 0 and 200%[1] (NOAA 2007). In some cases, decisions on coverage, frequency, and method of collection can be disconnected from technical feasibility, statistical integrity, and cost-effectiveness. Given the ecological, economic, and social implications associated with the ways

[1] Some fisheries require two observers on board at all times, which is sometimes referred to as 200% observer coverage.

fisheries are monitored, the Agency needs to develop a more strategic process to determine the level and type of monitoring (observer, ER, EM or other) that is needed and that can be sustainable and cost-effective.

A useful first step in developing a strategic process for establishing or modifying existing monitoring programs is to consider the goals and objectives of the fishery management plan (FMP) and other mandates (e.g., Endangered Species Act, Marine Mammal Protection Act, etc.) (Gregory et al. 2001, Miller and Hobbs 2007, Beechie et al. 2008), and how different monitoring tools can contribute to achieving those goals and objectives. Ultimately, the effectiveness of ER or EM or any other monitoring approach depends on the objectives of the program being identified and effectively implemented (National Observer Program Advisory Team, in prep). In many cases, a monitoring program will have several goals and objectives, each having differing levels of importance to stakeholders that could be prioritized or ranked. Stakeholders are defined here as fishery managers and scientists, enforcement officers, monitoring experts, and fishermen. For the purpose of our example, we have categorized the importance of goals into two bins: primary and secondary goals. Primary goals and objectives are vital for attaining the management goal of the fishery or NMFS' mission.

There can be multiple primary goals and objectives and the monitoring approach will need to be evaluated holistically. For example, if a Regional Fishery Management Council adopts a monitoring program to ensure that new gear requirements are enforced (e.g., bycatch reduction devices), one of the primary goals of the monitoring program is to identify the type of gear being used. Another example of a primary goal, which is not FMP-based, might be to consider the adaptability of the monitoring program, so that as new goals and objectives are identified in the future, they can easily be incorporated into the existing program. Secondary objectives of the program should only be pursued when the additional costs of such objectives are minimal and cost-effective (i.e., when the information cannot be collected through other programs at less cost). Developing integrated monitoring approaches that are capable of collecting the relevant data to achieve multiple goals and objectives is critical. This is not an easy task and will require analysis and robust, transparent dialogue with stakeholders.

A variety of decision-making methods exist to evaluate which monitoring strategies work the best to attain the primary goals and objectives of the fishery. The majority of these decision-making methods can be broken into groupings such as multi-attribute analysis (e.g., Keeney and Raiffa 1976, Moffett and Sarkar 2006, Yang et al. 2011), cost-effectiveness and cost-utility analysis (e.g., Hughey et al. 2003, Beechie et al. 2008), and cost-benefit analysis (Arrow et al. 1996, Kemp and O'Hanley 2010). For the purposes of this white paper, we chose to use a simple multi-attribute analysis, which we call a utility index, to illustrate one way of identifying which monitoring strategies could work the best. We chose this method because the process of weighing the pros and cons of a monitoring program compared to a management objective is

straightforward and easy to score, and the output is an index score that is relatively straightforward to interpret (e.g., EM is very useful, somewhat useful, or less useful). Utility indexes are also flexible and can incorporate additional levels of complexity, such as weighting of different objectives, if needed. Critical to the success of evaluating different monitoring approaches is the active participation of members of the fishing industry. The most desirable approach would be a utility index developed by individuals with expertise in the fishery or the specific monitoring approach being evaluated.

5. Using a utility index to evaluate monitoring strategies

We constructed a utility index based on: (1) common primary monitoring objectives and (2) the utility of ER or EM strategies for a particular objective. We chose to describe the utility of ER or EM in order to highlight the need for an evaluation process that analyzes the trade-offs between different monitoring approaches. We also considered the technical reliability of ER or EM. Technical feasibility is directly addressed through the "Platform suitability" category of the index, which addresses the technical requirements for having ER or EM onboard fishing vessels or other uses. Statistical reliability (e.g., sampling frequency and level of coverage) is not addressed in this paper because it is largely dependent on the fishery and objectives of the monitoring program; thus, we assumed that such decisions are issues that could be considered once the monitoring strategy is selected based on the utility index or other evaluation method. Once the primary objectives of the monitoring program have been identified, stakeholders can use the utility index to determine whether ER or EM is the best option for their purposes. Objectives that are not relevant to stakeholders can be skipped, while those that are relevant should be scored. Although it is unlikely that all monitoring objectives can be met by ER or EM programs (*see White Paper #1 – Existing Technologies*), this methodology should provide the stakeholders with a good indication of whether ER or EM is a useful, somewhat useful, or less useful alternative to non-ER or non-EM programs. It should also allow an evaluation of trade-offs between different types of monitoring approaches, such as comparing electronic logbooks to paper-based systems.

Below we list some of the common monitoring objectives used by stakeholders and review the benefits and challenges of ER and EM programs. We then provide an example of how a utility index could be used to evaluate video monitoring technologies, which was selected because this technology has been more thoroughly reviewed than other types of ER or EM. The same process could be used to evaluate the utility of other monitoring technologies and approaches.

5.1. Common primary monitoring objectives

The goals and objectives for establishing monitoring programs have been categorized as follows:

- Management (e.g., monitoring catch and landings)

- Science (e.g., socio-economic and stock assessment needs)
- Enforcement (e.g., compliance, enforcing regulations)
- Cost effectiveness

However, it is important to note that while we differentiate here among the core goals and objectives of fisheries management, in most cases these goals and objectives are highly interrelated and in some cases overlap, making integrated monitoring approaches potentially the most efficient and effective. For example, the acquisition of vessel position data can and is used by various parts of NMFS in different ways. Enforcement uses it for monitoring closed areas, management uses it for catch by area management, and science uses it to get the specific location of catch and bycatch events. One data point feeds three different users with differing objectives. The interrelatedness of goals will not always be synergistic, where the solution to one goal may prevent another goal from being achieved (e.g., minimize costs versus gathering important but costly information). Thus, tradeoff or optimization analysis will often be needed when deciding on the most appropriate and effective monitoring and reporting program.

Management: One of the primary management objectives of monitoring programs is to track the landings and bycatch/discard of fisheries (i.e., catch). Often the landings and bycatch of species needs to be calculated quickly, especially in catch share programs because these vessels are sometimes not allowed to leave port until their remaining quota is confirmed. In such circumstances, catch share programs usually require almost real-time calculation of catch. In other fisheries, the majority of which are managed in-season by NMFS, catch needs to be calculated usually within 1 or 2 weeks. Once catch is recorded, NMFS tracks or projects when the fishery will attain its quota and closes it before the quota is exceeded and accountability measures are triggered.

Another common management objective is the ability to track the incidental take and/or interactions with protected species in fisheries. Similar to monitoring catch, managers track the incidental take of protected species, which includes threatened or endangered fish species, to better understand overall mortality, but in some circumstances certain levels of take can cause the fishery to be closed. In addition, the level of interaction can also be critical information to collect (e.g., was gear attached when the animal was released).

Science: The science objectives of monitoring programs often revolve around three main data needs:

1. <u>Biological samples and measurements.</u> The collection of biological samples (e.g., fish otoliths or scales), determining the sex of the fish, and biological measurements (e.g., length and weight) are important to many aspects of fisheries management. Often these samples and measurements are used in stock assessments, or, in the case of protected

species, to genetically assign incidental takes to a specific population. Although such information can sometimes be collected dockside or through existing fishery-independent surveys, these types of samples or measurements are sometimes needed before the catch is culled by the fishermen to get a representative sample of the catch or are needed to fill in geographic and temporal data gaps of other surveys.

2. Fishing effort estimates. Like managers, scientists also rely on the monitoring programs to track landings and bycatch of fisheries (i.e., catch), and other important information such as the dates, times, locations, depth, targeted species, trip duration, and type of gear used. Whereas managers use this information to monitor quotas, scientists use it for accurate estimates of fishing effort, a critical component of almost all stock assessments.
3. Socio-economic data. Monitoring programs, especially those conducted by human observers, are one of the most reliable and effective methods of obtaining information on the socio-economics of fisheries. Observer programs collect information on safety questions, trip costs, and crew size from fishing vessel captains/crew or fishing processing plant managers. Additional economic information not available during the trip may be requested via mail in follow-up surveys. Some fisheries have mandatory socio-economic data collection programs by fishermen directly, though data reporting issues have occurred in these situations. Socio-economic information is used to determine the distribution of net benefits derived from living marine resources, as well as predict the economic impacts of existing management measures and alternative proposed management measures.

Enforcement: Accountability and compliance within a fishery is also critical to the long-term sustainability of the fishery. The level of accountability can vary (i.e., individual versus fleet). A number of tools—including at-sea enforcement by the NOAA Office of Law Enforcement (OLE) and the U.S. Coast Guard, Vessel Monitoring Systems (VMS), and observer coverage—are used to identify non-compliance issues in fisheries. These issues include such things as regulations that require the use of certain types of gear in a fishery (i.e., gear compliance), regulations on area fished, and the handling and catch of protected species.

Cost effectiveness: It is likely that several types of monitoring technologies will be able to achieve the primary goals and objectives of a monitoring program. How well these primary goals are met relative to costs is also an important consideration. These cost considerations, however, should not occur until the utility of various technologies have been evaluated so that comparisons among utility and cost-effectiveness can be performed; thus, we do not consider cost effectiveness here because only one technology is evaluated. General cost information for most ER and EM approaches is included in Appendix B.

5.2. Utility of ER/EM

Although there are many types of catch monitoring systems in place, traditional human observer programs are perhaps the most effective. Collectively, onboard and dockside observers provide a method to directly monitor landings and bycatch, collect and process biological samples (e.g., species, length, and frequency), and collect socio-economic data about trip costs and revenues, crews, and communities more generally. Although observer programs provide invaluable data, they also have several drawbacks. From a logistical and social perspective, there is a certain level of unavoidable intrusiveness—for both fishermen and observers. There are also physical safety hazards associated with putting observers on commercial fishing vessels as well as potentially high financial costs. In addition, sampling bias may occur when observer coverage is less than 100%, because fishermen may deviate from normal fishing activities when observers are onboard. While this latter challenge can be mitigated by full coverage or other methods, there is clearly an added cost associated with this approach.

ER/EM represents a potential alternative or supplement to observer coverage that may help negate some of the existing barriers and reduce the economic burden associated with traditional catch monitoring. However, straightforward replacement of observers with electronic technologies is likely not possible or prudent in all fisheries. Due to the rare nature of interactions with protected resources, as well as species identification challenges, EM can be difficult to use in fisheries where there is a higher probability of encountering these species. On the other hand, in these same fisheries, the use of ER could facilitate and speed access to important protected species data and potentially improve the reporting of interactions.

The use of video monitoring technologies can also address some compliance issues that could not be addressed historically. For example, Amendment 80 to Bering Sea Aleutian Island non-pollock trawl fishery requires video recording of sorting activity in bins (or an alternative measure) to prevent pre-sorting of the catch before the observer has an opportunity to sample the catch. Cameras record the sorting activities of vessel personnel and provide a record that NMFS can use to enforce sorting requirements. Another example is the use of electronic reporting for both dealers and fishermen. The use of this ER tool can facilitate cross-checks of data.

Beyond human observer coverage, ER and EM also includes VMS; electronic logbooks and dealer reports; video (including cameras, digital recording systems, and monitors); and the integration of video with other data sources such as radio frequency identification (RFID) tag readers, hydrophones (for testing acoustic pinger functionality), winch sensors, and hydraulic pressure monitors, or any combination thereof (NOPAT, in prep.).

The following is a high-level summary of some of the current tools in use for monitoring U.S. fisheries. For a more detailed description of these tools, including pros and cons, see *White Paper #1 - Existing Technologies.*

Electronic Vessel Reporting and E-logbooks: a system of capturing data relative to a vessel's catch and/or landings by way of vessel trip reports or logbooks. Either of these can be filled out and submitted electronically, and a trip report may be based on a logbook.

Electronic Dealer Reporting: a shoreside reporting system used in some capacity by all regions to obtain critical fisheries data. When dealers use electronic forms to submit these data, it is considered electronic reporting.

Vessel Monitoring Systems (VMS): a satellite-based technology for remote monitoring of at-sea fishing vessels. The program supports a growing number of regulations requiring vessels to report GPS positional, pre-landing and declaration data in the VMS, and allows NOAA's Office of Law Enforcement to monitor compliance and track violators over vast expanses of water.

Video monitoring: the integration of video cameras, gear sensors, and GPS to provide data on fishing methods and gears, fishing locations and times, and landings and bycatch.

The effectiveness of video monitoring was recently described by the National Observer Program Advisory Team (NOPAT 2012) and others (e.g., McElderry et al. 2005, Cahalan et al. 2010, Stanley et al. 2011). Other forms of ER and EM have not been described as well in the scientific literature, and the benefits and challenges of such programs are being evaluated in *Appendix B - Electronic Monitoring White Paper Existing Technologies.* Video monitoring is an attractive alternative or supplement to traditional monitoring strategies because it is often considered less invasive, observer safety at sea issues are absolved, it can be placed on vessels where traditional observer coverage is not feasible, it reduces the chances of observer bias if it is implemented on all vessels, and, in some circumstances, it can monitor underwater takes and interactions that cannot be observed using traditional methods (NOPAT 2012). However, several current challenges exist with the use of this approach.

The challenges observed to-date in video monitoring programs include:

- Reviewing the data can be very time consuming and costly;
- Identifying catch composition, size, and weight is difficult;
- Catch handling may need to be changed;
- Collecting biological samples is not possible without crew involvement;
- Identifying and measuring gear types and actual soak times of the gear can be difficult to monitor;
- Managing video records can be more challenging than paper records because video requires infrastructure changes to store, maintain, and evaluate the data;
- Tampering can be an issue because of exposed cameras and sensors.

5.3. An example of a utility index for evaluating video monitoring technologies

Based on the pros and cons of video monitoring described above, we constructed a utility index that lists the benefits of video monitoring in a column format ranging from "very useful" to "less useful," relative to common monitoring program objectives, which are listed along the rows (see table 1). In some cases, it is known that video monitoring lacks the capability to collect certain types of information that traditional human observers can collect. In these cases, the range of pros and cons considered will list "not applicable (N/A)" in the "very useful" category, because other sampling programs may be needed to fully meet the primary goals of the monitoring program. It should be noted that this example captures the current state of video monitoring. To the extent that advances in technology change video monitoring capabilities in the future, video monitoring would need to be re-evaluated.

To calculate the utility of video monitoring, stakeholders would review the list of monitoring objectives and only score the objectives that relate to their specific interest (i.e., primary objectives). Once the relevant objectives have been reviewed and scored, the average score can be used to give a general idea of how useful video monitoring may be for meeting their monitoring objectives. An average score of 1 suggests that video monitoring would be very useful, while an average score of 3 suggests that video monitoring is less useful. In some cases, however, stakeholders may find that the majority of the objectives are met by video monitoring (i.e., scored 1) but one or more important primary objectives are not met (i.e., scored 3). For these objectives in which video monitoring is less useful, the stakeholders may decide against using video monitoring in its entirety, or might find a solution through a hybrid approach that includes both video monitoring and traditional monitoring coverage that is cost-effective and provides quality data. In situations where certain objectives/requirements are considered fundamental "must haves," a weighting system for the objectives/requirements could be used.

Table 1. An example of a utility index for video monitoring for a sample of potential fishery-dependent goals.

Objectives	1 - Very Useful	2 - Somewhat Useful	3 - Less Useful
Species identification (Commercial, Recreational, or Protected Species)	Species of interest can be easily and reliably identified using video monitoring.	Species of interest can be reliably identified to the genus or family level using video monitoring.	Species of interest cannot be reliably identified (even at the family level) using video monitoring.
Catch needs to be quantified in terms of weight at sea.	Weights of all species of interest can be easily and reliably estimated using video monitoring.	Weights from a majority of the species of interest can be reliably estimated using video monitoring.	Weights of species of interest cannot be reliably estimated using video monitoring.

Objectives	1 - Very Useful	2 - Somewhat Useful	3 - Less Useful
Platform suitability (e.g., small vessels).	The vessel is considered inadequate to safely deploy observers and can meet video power requirements.	The vessel can support observers or video monitoring, but only for short durations due to power requirements.	The vessel is difficult to monitor using video due to power requirements or camera angle setup.
Biological tissue samples	N/A – current technology is not useful.	A small percentage of fishing trips need biological tissue samples taken at-sea or can be taken by other means (e.g., dealer sampling, existing field surveys, etc.)	A large percentage of fishing trips needs biological tissue samples taken at-sea or rare events (e.g., endangered species interactions) require tissue samples.
Biological measurements	Biological measurements of weight or length can easily be calculated using video monitoring.	A small percentage of fishing trips need biological measurements taken at-sea or can be taken by other means (e.g., dealer sampling, existing field surveys, etc.)	A large percentage of fishing trips need biological measurements taken at-sea and video monitoring is not a viable option.
Socio-economic data	All relevant socio-economic data can be collected from video monitoring.	Some of the relevant socio-economic data can be collected from video monitoring.	None of the relevant socio-economic data can be collected by video monitoring.
Effort	Effort can be reliably monitored by video.	Fisheries using multiple gears (e.g., gill nets, pots, hook & line) can only be partially monitored using video.	Observer coverage is required to estimate fishing effort, and the gear and/or fishing activity cannot be reliably monitored by video.
Vessel operation compliance	The fishery operations (e.g., sorting) can be video monitored.		The fishery operations (e.g., sorting) cannot be video monitored.
Gear compliance	The fishery has gear requirements that can be video monitored.		The fishery has gear requirements that cannot be video monitored.

Objectives	1 - Very Useful	2 - Somewhat Useful	3 - Less Useful
Regulatory/ Enforcement Authority	OLE has the ability to enforce regulations with video monitoring technologies.	OLE has limited ability to enforce regulations with video monitoring technologies	OLE has no authority to enforce regulations with video monitoring technologies

5.4. General observations

In general, fisheries where video monitoring would be very useful have the following characteristics:

- Landings can be tracked dockside or through dealer/processor reporting mechanisms.
- Species can easily be identified.
- Bycatch can be easily identified to species, and the length, number, or weight of bycatch can be calculated. This includes commercial, recreational, and protected species.
- Representative biological sampling can be taken dockside or through existing surveys.
- Fishing effort and location can easily be tracked, for both science and enforcement purposes.
- The vessels and gear used in the fishery can be easily monitored with video cameras, and the vessel infrastructure can support a video system.
- Data from video monitoring is not needed for short term (e.g. in-season) monitoring of the fishery.

It is clear from this summary that the utility of video monitoring depends on the primary objectives of the monitoring program. Video monitoring appears to work well for some programs that focus on compliance with discarding or tracking the capture of easily identifiable species. However, when catch data are needed in real-time, or catch needs to be calculated in terms of weight or biological samples need to be taken, electronic monitoring will be heavily dependent on other monitoring approaches to fill the gaps where video monitoring falls short.

6. The process of setting monitoring goals.

We have identified the need to be more strategic in establishing or modifying existing monitoring programs by considering the primary and secondary goals and objectives of the fishery management plan and how different monitoring tools can contribute to achieving those objectives. We have also described one way of evaluating the utility of ER or EM programs for meeting these primary or secondary goals through the use of a utility index, with video monitoring as an example. What we have not discussed, however, is the process of setting monitoring goals as such:

1. Who should be involved in setting monitoring goals?
2. What type of sources should be considered when developing monitoring goals?
3. How to improve consistency and better coordinate monitoring programs?
4. How often should the goals be re-evaluated?

6.1. Who should be involved in evaluating monitoring tools against management goals?

Stakeholder involvement in the setting of monitoring goals is fundamental to this process and should be as inclusive as possible in order to gain support from the diverse stakeholders of fisheries. These stakeholders include:

Fishery managers and scientists: to ensure that management and science objectives are considered in the development of the monitoring program. These stakeholders should also include IT staff and program managers to ensure the system being developed is user-friendly to the end users (e.g., socio-economists, fisheries and protected resources managers, etc.) and those submitting information (e.g., fishermen).

Enforcement officers: to ensure that implemented programs are enforceable and to verify the data collected are consistent with the legal requirements for prosecution.

Monitoring experts: to help ground-truth aspects of the monitoring program.

Industry members: to use their knowledge about the fishery to identify monitoring needs and develop solutions, and help ensure that the monitoring program selected will be supported by the industry.

Without such involvement, it is unlikely that stakeholders would support a program that their own observations do not support. Furthermore, agreement on goals and buy-in for the program can lead to fishermen and fishery representatives taking responsibility for various aspects of the monitoring programs (Zollett et al. 2011).

6.2. What type of sources should be considered when developing monitoring goals?

To identify primary and secondary goals of a monitoring program, stakeholders should consider the current or proposed requirements from sources such as:

- FMPs,
- Biological Opinions,
- Take reduction plans,
- Recovery or rebuilding plans

6.3. How to improve consistency and better coordinate monitoring programs?

There are several ways in which consistency and coordination across the country in the process of evaluating monitoring tools against management goals and objectives could be improved. We describe two possible approaches below though other models exist.

Council Process with Regional and National Approval: The Regional Fishery Management Councils (Councils) serve as a critical component of fishery management in the United States through their transparent and deliberative processes. The existing approach is through the Councils' advisory panels and ad hoc monitoring committees who provide advice throughout the design, development, implementation, and review of a monitoring program. Each region has a different approach and the North Pacific offers a possible model with the use of its Observer Advisory Committee. For example, the North Pacific Council and NMFS hosted a workshop on EM. The workshop was followed by a Council sub-committee working with NMFS to establish EM goals and direction for future work to integrate EM where appropriate. Council processes involve a diversity of stakeholders, which is an important consideration.

When monitoring programs are being developed or existing programs are being modified, these panels/committees can assist NMFS and the Councils in developing the monitoring program in relation to the management objectives. They can also provide input as to the utility of different monitoring programs and perspective on potential costs of monitoring alternatives. The key is to frontload monitoring program discussions as much as possible so all the alternatives can be thoroughly vetted before the program is approved by the Council. In Alaska, this is done by analyzing the alternatives in the Environmental Assessment/Environmental Impact Statement and Initial Regulatory Flexibility Analysis/Regulatory Flexibility Analysis to examine various monitoring options in the specific context of the individual program. In the end, the panels/committees could provide input to NMFS and the Councils' approach to monitoring and monitoring costs, including the distribution of those costs. Whether the monitoring will be funded by industry, NMFS or a combination of both a plan to address funding will need to be articulated as part of any monitoring program. Ultimately, NMFS approves, disapproves, or modifies these actions.

National ER & EM Steering Committee: Another possible approach is to create a national ER and EM monitoring program steering committee. Such approaches are already used in other programs like the Marine Recreational Information Program (MRIP) and various stock assessment scheduling steering committees. The duties of the monitoring program steering committee, which could be made up of NMFS, Council and Commission representatives, would be to review the monitoring needs of federal fisheries each year. Thus, the role of the Council would be to work with its constituents through public meetings or its ad hoc working groups/committees to develop monitoring program proposals. These proposals would be submitted to the steering committee for their review and prioritization for NMFS funding. The

steering committee could then advise NMFS about which monitoring programs should be funded, or determine whether some synergies could be gained from combining monitoring programs or switching to a more cost-efficient method.

Although this approach is used elsewhere, there are several issues to consider. In some situations, this type of national structure composed of regional representatives can result in funding conflicts with representatives only supporting funding for programs in their own area. The diversity of participants in any national committee is critical. Other steering committees like MRIP have a very diverse group of representatives including NMFS, state, commission, and Council Science and Statistical Committee members. Finally, such a process would likely delay implementation of Council actions or court rulings that require some level of monitoring in order to meet the goals of the fishery management plan and other regulations (e.g., ESA, MMPA regulations). Although regulations would be delayed until a decision has been made about the feasibility of the monitoring program and funding availability, implementing regulations that require a monitoring program that is not feasible would waste resources too.

6.4. How often should the goals be re-evaluated?

As time passes, goals change and monitoring technologies improve; thus, the process of setting goals should be reviewed on a regular basis. Internal and external reviews, audits, and evaluations can also be conducted to assess the program's effectiveness at meeting the goals and objectives. (Hilborn 1992). Adjustments should be made as necessary, but it may also be important to re-evaluate the entire monitoring program every 3 to 5 years to ensure that the system as a whole is working, possibly in concert with other reviews such as optimum yield specifications, stock assessment and fishery evaluation reports, safety at sea risk assessments, etc.

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Appendix F -

Electronic Monitoring White Paper Funding Options

National Oceanic and Atmospheric Administration

National Marine Fisheries Service

February 2013

1. Key Findings

- Given the current budget climate and the outstanding requirements for additional data and science, there is little likelihood that sufficient new Congressional appropriations will be forthcoming to satisfy the demand for fishery dependent data collection programs. In addition, the current National economic climate is very challenging. Rising fuel costs and other broader economic trends are impacting the fishing industry, potentially limiting their ability to support fishery dependent data collection programs.
- Recognizing this challenging fiscal climate for both NMFS and industry, opportunities exist to work in collaboration to address funding support for electronic technologies in fisheries management.
- While stakeholders in some fisheries partially share the costs of data collection today through cost recovery, a further share of financial responsibility beyond the government from industry is likely to be necessary to support the costs of future data collection, including the adoption of electronic monitoring/electronic reporting (EM/ER) technologies. Without this overarching approach, the agency will be unlikely to meet the Council's desired monitoring and reporting requirements. That may influence the choice of management strategies that can be considered.
- There are several funding models available for consideration of EM/ER based on an industry funding/user fee principle. Several successful industry funded models have been developed for observer programs and these models could serve as examples for implementing similar cost-sharing approaches for EM/ER. Any such funding model would need to be evaluated within the socio-economic context of the fishery.
- To ensure alignment between data collection policies and funding availability, a protective "no unfunded mandates" policy should be considered to protect the industry and the government from data collection program decisions that are financially unsustainable.
- Accurate and complete cost data on existing data collection programs are difficult to come by, even though these are the most frequently cited determinants of a choice between EM/ER and other data collection methodological options. Therefore, cost templates should be developed and completed to conduct fair and relevant comparisons of future policy options for data collection for a particular fishery. There is no one universally "cheapest" methodology as costs can vary widely for EM/ER, observers and other methods depending on the specifics of the fishery and program design. Initial capital/installation costs for EM/ER should be differentiated from operations and maintenance costs as magnitude and duration of the requirement will affect the choice of funding option.
- Split costs: There is likely no one funding option that meets all requirements. Therefore, a mix of appropriations and industry-funded sources is recommended, consistent with appropriations law.

- Flexibility is essential. Funding options should be scalable to account for different business sizes and economic circumstances, and opt–in/opt-out industry funding choices should be considered and aligned with different management options.
- There are several existing but unused or underutilized funding authorities under the MSA. Efforts should be made to make more/better use of existing authorities to collect user fees as a means of cost recovery and to secure a share of resource value for use in funding data collection, such as:
    - MSA 303a (d) Auctions/other royalty payments for catch shares
    - MSA 303(b)(11) Set-asides;
    - MSA 305 (h) Central Registry Fees
    - MSA 16 USC 1891b Fisheries Conservation and Management Fund
    - MSA 303(b)(4) Requiring Certain Equipment
- New authorities for loan programs should be considered as an option to finance industry debt for EM/ER costs, particularly during periods of transition to new management approaches and during rebuilding time periods.
- Seeking new partners/third party funding for data collection should be evaluated, such as through:
    - Cooperative Research and Development Agreements (CRADA) for R&D work
    - Value-chain partners to adopt EM/ER for certification/traceability purposes
    - One-time philanthropic endowments

2. Objective/Purpose

The cost of monitoring is a major concern to the agency and the fishing industry. This white paper is focused on funding options for EM/ER programs, and will:

1. Identify options for funding EM/ER, along with advantages and disadvantages for each option and their legal and policy implications. The paper will identify opportunities for use of appropriations, industry funding, and other funding sources.
2. The white paper will discuss funding options in terms of their environmental, economic, political, and equity implications, as appropriate. In particular, a focus on the regulatory, policy, and technological implications of each option will be included.
3. This paper will include the potential impact of each option on the different sectors of the industry (e.g., large-scale, gear-based, community-based, etc.), where appropriate.

Context: The costs for collecting catch data adequate to meet the science, management, and compliance needs of the agency continue to outpace the available budget. Adoption of management strategies that require catch accounting of individual allocations and the adoption of annual catch limits in virtually all fisheries has increased the demand for more detailed, more precise, and timelier data on catch, bycatch, discards and landings.

The US economy continues to recover from its struggle with recession conditions where many individuals and businesses were negatively impacted. The fishing industry is no exception. During this time, the fiscal context for NOAA Fisheries deteriorated. As FY 2013 unfolds, the nation is navigating a potential government-wide budget sequestration, challenging federal appropriations decisions, and unknown changes in policy priorities as federal and Congressional leadership adjusts to the outcome of the 2012 elections and ongoing budget deficits. Facing this landscape, NOAA Fisheries continues to adjust to a substantial contraction of our budget since FY 2010. Funding levels for fishery-dependent data collection are supported via several different budget line items, but the general trend has been flat or declining amounts for the last 5 years. Overall, in the last two years the agency absorbed an eleven percent budget reduction through a combination of efficiency gains and program reductions. Further reductions are likely in FY 2013 and future years. Given this context, it seems unlikely to expect an increase in appropriated funds to satisfy the increased demand for funding data collection. Recognizing this challenging fiscal climate for both NMFS and industry, opportunities exist to work in collaboration to address funding support for electronic technologies in fisheries management. This paper thus looks at alternative sources of budget supply, and briefly considers controlling costs and avoiding unfunded mandates.

3. Type of costs to be covered

The costs of data collection reach far beyond the explicit data collection survey instrument of an observer, logbook, or electronic recording device. The costs incurred for a data program are a continuum of statistical design, data collection, auditing, analysis, and quality control, dissemination and archiving, and represents a substantial amount of personnel time and costs.

This paper does not directly evaluate the cost-effectiveness or cost efficiency of different EM/ER designs or technologies as they are covered in other white papers. Rather, it looks at the policy options of alternative sources to cover these costs, whatever magnitude they may be. However, a limited survey of available cost information for existing data collection programs (to identify the scale of costs needing to be funded) revealed that such data are fragmentary, not readily available and difficult to fairly compare. This shortcoming needs significant improvement.

For clarity of analysis of the pros and cons of different funding options, the paper considers two categories of costs: the one-time capital costs associated with a program, and the recurring operational and maintenance costs (recognizing that the one-time costs may actually re-occur as obsolescence and repair/replacement of devices with limited life-spans may require future expenditures). These costs impact both participants and the government. The advantages and disadvantages of various sources of funds also vary depending on if they are used for one-time versus recurring cost purposes.

The other issue related to the type of costs to be covered is the scale/scope of costs the agency is looking to cover, i.e., only EM/ER costs in a fishery versus all data collection costs in a fishery. The paper was initiated to look at funding options for supporting the general adoption of EM/ER, but this task must be evaluated in the larger context of funding other fishery-dependent data collections besides EM/ER. Not all fishery-dependent needs will be covered by EM/ER and how non-EM/ER programs get funded is an equally important policy decision. Although only certain sectors in a fishery may be proposed for adoption of EM/ER technologies, some funding options might only be advantageous if applied across all species, all gears types and/or all sectors of a fishery. For example, recovering costs through landings taxes to recover EM/ER costs for species X only when caught on large vessels or when using otter trawls raises questions of fairness, administrative feasibility, return on investment and regulatory/enforcement complexity. The following evaluations identify funding options where there is a particular strength or weakness in this area of general applicability versus use only for EM/ER.

4. Who bears the burden of funding data collection: government/taxpayer vs. industry?

Who should pay for the costs of data collection? One of the reasons for asking this question is that the current burden of paying for data collection costs differs across the agency by region, and sometimes within a region by fishery.

In the United States, most fishery data collection is funded through appropriations of tax dollars. In some cases, there is legislative authority under the Magnuson Stevens Act to recover the costs of data collection. Most notably, data collection costs associated with a limited access privilege program [MSA Section 303A(e)(2)], or for North Pacific observers [MSA Section 313(a)(2)], can be recovered from the industry participating in these fisheries and retained for use by the Secretary.

However, even when there is authority to use cost recovery, in many cases the authority is not utilized or is not utilized uniformly in the absence of any explicit policy guidance. The reasons for this discrepancy vary. The degree of discretion allowed in implementing the MSA provisions contributes to the situation where some regional offices provide goods and services to the industry for "free" (paid for by appropriated funds) whereas in other regions/fisheries the same services are charged back to the fisherman in the form of a fee [see for example the notable variation in charging for permits under MSA Section 304(d)(1) permit fees].

The funding of the NMFS observer programs exemplifies the different legal authorities and challenges to sustainably managing data collection programs. In the Atlantic coast and Pacific coast groundfish fishery, almost all the cost of observers is currently paid via appropriations, but the amounts are not sustainable. Ultimately costs are planned to be covered by the industry. In the North Pacific, industry funding of observers is the norm. Coverage levels for groundfish observers vary for each fishery (ranging from 20-30 percent to 200 percent). In some fisheries certain vessels are exempted from carrying an observer due to their size, gear type, or other criteria. Each different design element has a cost implication, with the industry responsible for varying amounts in different fisheries and different Council areas. These differences are driven by differing statutory authorities and varying objectives for the respective fishery management plans

The use of cost recovery in the United States is quite different than other major fishing nations across the world. In particular, Canada, New Zealand and Australia have a long and successful history of industry funded support for science, management, and enforcement. For example, cost recovery has been a fundamental feature of the management of Australia's Commonwealth fisheries since the mid-1980s.The commercial industry pays for costs directly related to fishing activity while the government pays for activities that may benefit the broader community, as well as the industry. The total cost of managing Australia's Commonwealth fisheries averaged 7.2 per

cent of the gross value of production between 1992-93 and 1998-99. The industry contribution to the costs of fisheries management has averaged 34 per cent between 1992-93 and 1998-99.[1]

Countering these authorities that enable the use of cost recovery in the United States are the constraints on use of the resulting funds. In general the recovered costs go into a general treasury account rather than being retained by the office or agency executing the service, with no assurance that appropriations ultimately reimburse the governing office. In addition, several laws and associated regulations controlling the use of fees default if there is no specific authorization permitting the use of recovered fees for specific purposes. Both the Anti-Deficiency Act [31 U.S.C. § 1341] and the Miscellaneous Receipts Act [31 U.S.C. 3302(b)] are examples of controls on government preventing an augmentation of appropriations. NOAA may not "augment" appropriations either by raising money instead of seeking and getting an appropriation or by retaining funds collected and using them instead of receiving an appropriation of funds approved by Congress. Specifically, the Comptroller General must provide explicit decisions to agency officials in response to requests involving the use of, and accountability for, public funds [31 U.S.C. §§ 3526, 3529]. Under the Miscellaneous Receipts Act, if any agency collects a debt, the agency must deposit the funds in the Treasury as miscellaneous receipts unless the agency has statutory authority to credit the receipt to an approved account.

This context is a factor to consider when evaluating whether to exercise the authority to charge a fee: can it be retained? If not, how difficult will it be to obtain this authority? Ideally the ability to retain the fee within the agency should not be a factor. The public policy question is whether an individual's private use of a public/common property fishery resource should be conditioned by a requirement to pay for the costs associated with reporting and recordkeeping. However, in practical political terms an inability to retain and utilize recovered fees may become the deciding point of whether or not to pursue implementing the fee program at all.

There is a long history of examples of application of the principle of user-fees in non-fisheries natural resource management (such as federal oil and gas, timber, and grazing fees, and more recently electromagnetic spectrum fees), so there is ample precedent. In several of the options considered below, this principle is applied but tempered by the statutory authorizations and constraints on retaining and using the funds for authorized purposes. In such cases a legislative remedy to authorize retention of the fees is discussed, and an appropriate remark made in the pros/cons evaluation. In addition, since the costs of EM/ER may be only a subset of all the costs that may be recoverable, receiving a share or allocation of a broader user fee or other cost recovery system might satisfy the EM/ER requirements. Finally, a few examples of third-party expenditures to support the costs of fisheries data collection are evaluated in a similar context.

[1] Cost Recovery in Fisheries Management: The Australian Experience, 2000. Anthony Cox, Australian Bureau of Agricultural and Resource Economics GPO Box 1563, Canberra, ACT, 2601, Australia. *Paper presented at* International Institute of Fisheries Economics and Trade biennial meeting, Oregon State University July 2000.

5. Evaluation of the legal and policy implications of various funding options for EM/ER

5.1. Appropriations

An increase of funds: Given the current economic outlook and the state of NOAA's budget, the outlook for increases in appropriations to fund EM/ER adoption in additional fisheries is not optimistic. While there remains a possibility that a specific fishery may generate Congressional support for a directed increase, history has shown that the funds will most likely be redirected away from another existing NOAA or NMFS budget line rather than reflect a true net increase in the budget appropriation. Nonetheless, NMFS should consider preparing and have ready a requirements analysis and related documentation available for EM/ER. This would take advantage of any opportunities in the regular NOAA/DOC budget formulation process or a particular Congressional add-on interest to augment appropriations through the traditional budget process. The absence of a clear and thoroughly documented requirement virtually assures there will be no appropriation increase.

EM has been suggested as a possible substitute for some (not all) of the functions currently performed by observers. Some have also suggested redirecting some observer funds to support EM, remaining cost neutral to the overall budget. There have been no specific analyses conducted to date that support the conclusion that this approach would be programmatically feasible and/or cost effective. There are also no authoritative analyses yet on the relative costs and benefits of parsing the responsibilities and costs of observer programs into a mix of EM and revised observer functions. Programmatically, if observers are retained for a fishery to provide unique functions that cannot be obtained through EM (such as biological samples at sea), then net cost savings can only accrue if there is a net decrease in coverage (sea days sampled). The majority of costs are incurred once a person is deployed on a vessel, even if the scope of duties for a given day at-sea is diminished (as in deferring catch accounting to cameras).

As a practical matter, it remains to be seen if this potential reduction in costs of some observer functions is sufficient to fund deployment of EM since the full costs of EM versus the full costs of observers continues to be an elusive but essential factor in this decision. In addition, as a policy matter, the agency may already have unmet demand for additional observer days (e.g., for functions that cannot be fulfilled by EM) that may be a higher priority for funding than redirecting funds to initiate EM.

Unfortunately, generalizations are not useful in this regard. Very specific benefit-cost analyses are needed to accurately assess the specific circumstances of each fishery. Thus, NMFS should develop a structured cost-analytical approach in any policy evaluation about redirecting funds away from observers to EM. This would be case-specific and include the full range of design, implementation and operational costs for the fishery and the methodological options in question, including the larger context of all data collection priorities. This work should be conducted in

light of reprogramming thresholds and other applicable appropriations law and Congressional reporting requirements.

5.2. Fisheries Management Costs – How could costs be recovered?

The agency faces a significant policy question of whether to continue to rely almost exclusively on appropriations to fund EM/ER or to require the industry to contribute more to the costs of reporting and recordkeeping. If the agency chooses to adopt some form of increased industry funding, how could those EM/ER costs be recovered? This section presents several options for cost recovery, followed by a discussion of options for sharing of the resource value.

Cost recovery is based on the premise that government costs expended on behalf of an individual or group receiving a service or benefit can and should be subsequently recouped from those receiving the benefit. The options for cost recovery in fisheries management fall into two basic categories: (1) user fees or (2) taxes on revenues. There have been numerous proposals generated in the past to utilize these mechanisms generally, most often to fund one or more elements of fisheries science, management and/or compliance, not just for adoption of a data collection methodology. The options below are organized into these two categories, with a brief description of each option and a discussion of its advantages and disadvantages. Requirements for new legislative authority are noted where appropriate.

5.2.1. User Fees

• Permit fees/Access fees – This option would require the collection of fees, usually from fisheries harvesters, based on their access or entry to a fishery. Specifically, to support the costs of EM/ER, harvesters would be required to obtain permits to access or enter a fishery and pay fees beyond the administrative cost of issuing the permit (as currently limited by the MSA).[2] The amount of the fee could be a fixed amount for all participants or computed as a percentage of some economic value to account for differences in ability to pay. Even with the absence of individual economic performance data by vessel, a graduated fee based on some harvest quantity characteristic could account for gross differences in profit margin among different classes of commercial fishermen. In response to the anticipated questions of equity for cost recovery, recreational anglers fishing for federally managed species could also be charged a permit/use fee if they are part of the EM/ER design. Because of the large number of recreational anglers, an access fee of even a modest amount has the potential to generate significant revenues. For

[2] **97-453, 104-297**
MSA Section 304 (d) ESTABLISHMENT OF FEES.
(1) The Secretary shall by regulation establish the level of any fees which are authorized to be charged pursuant to section 303(b)(1). The Secretary may enter into a cooperative agreement with the States concerned under which the States administer the permit system and the agreement may provide that all or part of the fees collected under the system shall accrue to the States. *The level of fees charged under this subsection shall not exceed the administrative costs incurred in issuing the permits.* [emphasis added]

example, collection of a $20 annual fee per marine recreational angler would generate $260 million per year from the estimated population of 13 million marine anglers. The challenge is to forge a strong linkage between the chosen EM/ER method (video cameras, electronic logbooks, etc.), the affected universe of participants, and the amount of costs seeking to be recovered.

Advantages – This option is reasonably feasible since permit fees have already been implemented in certain fisheries and are familiar to most fishermen. Administration and implementation of these recovery mechanisms is straightforward and involves a one-time or annual frequency of collection, and the compliance incentive is clear and strong (no current permit = no fishing). On a relative scale a permit fee would be less challenging to implement politically than implementing some of the non-traditional cost recovery tools such as landings taxes.

Disadvantages – This option does not easily differentiate among fishermen that heavily exploit a fishery versus fishermen that do not, unless the permit fee was tied to some vessel-specific revenue parameter. Setting the appropriate fee is simply based on the capital cost of any initial hardware, software and associated government costs for infrastructure, and the annual or recurring variable costs of government operations to process and manage EM/ER data. These are the government expenditures to be recovered. There are no unique disadvantages of this method when it comes to recovering the costs of government services associated with the EM/ER data collection design, quality control/auditing, communications, data dissemination and archiving. A pro rata share of these costs can be recovered on a per capita basis.

The most significant disadvantage is that fees associated with permits are limited to the administrative costs of issuing them under the MSA. Legislative changes to Section 304(d) to allow fees to be charged in excess of the administrative costs, and new authority to retain and use those funds within the agency, should be considered to improve the utility of this mechanism.

- Vessel fees – A flat fee charged for each commercial and recreational fishing vessel is a variant of the permit/user fee.

Disadvantage – This option is nearly identical to the option of permit/user fees in terms of its target population, focusing on one element of fishing effort as an index of potential economic performance. Although owners of multiple vessels would be charged more than single vessel owners, the program does not differentiate between fishermen with large fishing vessels and small fishing vessels; fishermen would be charged the same fee regardless of how much fish they harvest. Shore-based commercial and recreational fisheries would require another basis for charging a fee besides vessel ownership.

- Processor fees – Using first buyers of fish landings and/or fishing processors to accumulate fees in proportion to landings is a frequently cited option for cost recovery/fee collection and that case is presented below under “Taxes.” Conceptually, processors could also

be charged a fixed user fee for receiving landings of any magnitude. Such use would be primarily as a convenience of capturing revenues from fewer participants (as there are normally fewer processors/dealers than harvesters). However, their use for recovering costs solely for EM/ER is a weaker justification/linkage since the respective processor burden imposed for monitoring catch and discards is minimal.

Advantage – West coast states already impose fees on landings collected at the point of first sale. Thus, experience and infrastructure already exists on developing best practices on the administrative and technical aspects of financial transactions related to landings.

Disadvantage – In its processor user fee form, this approach would recover costs from a population that has not been targeted in the past for fee collection. These costs would be likely passed on to the harvesting sector in the form of reduced ex vessel prices. As a result, there would be opposition from both processors and harvesters. The flat rate option would result in little cost recovery unless the fee or rate was significant since there are a limited number of processors. For example, if each processing plant had to pay an annual fee of $500, only approximately $1.7 million would be generated. The precedent for imposing fees for cost recovery on secondary users of a natural resource is also not widespread.

5.2.2. Taxes

- Landings tax – This option would recover a percentage of the ex vessel value of landings by charging a percentage fee per pound of landings. A tax rate of two percent on the value of all U.S. commercial landings ($3,733 million in 2010) would generate nearly $74.7 million annually. A tax rate of three percent would generate over $112 million annually. See Table 1 for computation of landings tax revenue scenarios.

The current authority to "tax" landings is limited to provisions of cost recovery authorized only for Limited Access Privilege (LAP) programs and Community Development Programs under MSA and the North Pacific Fisheries Conservation Fund (MSA 313(d)) which is currently being used to fund observers. Legislative changes would be necessary to impose an equivalent approach in other fisheries. Determination of the optimal tax rate for supporting just EM/ER requirements would require fishery-specific analyses and guidelines for implementation. For example, a two-tiered system for covering the initial capital costs and the subsequent anticipated lower costs of operation and maintenance would have to be factored into the calculation and design.

Advantage – For LAP fisheries cost recovery is actually mandated by the MSA. However, this may present undesirable incentives to the industry to avoid the adoption of LAPs to avoid paying

for cost recovery. However, it is a NOAA policy to minimize this disincentive by focusing LAP cost recovery on the incremental costs attributable to the LAP[3].

Disadvantage – Currently cost recovery fees under LAP programs are limited to 3 percent of the ex vessel value of the harvest.[4]

- Tax on processed fishing products – If a two percent rate was assessed on the value of processed edible fishing products ($8,513 million in 2010) and industrial fishing products ($509 million in 2010), $180 million annually would be generated (Table 2). A percent rate of three percent on the value of processed edible fishing products and industrial fishing products would generate nearly $271 million annually. Focusing on processed products minimizes the number of firms in the collection system.

Advantage – This option is a progressive fee system since it is directly linked to a quantity attribute of harvest.

Disadvantage – This option discriminates against processed versus unprocessed fisheries products.

- Tax on Imports of Fishery Products – Taxes on the imports of fishery products is not a new idea, in fact, it currently generates between $70-110 million annually in offsets to the NOAA Fisheries budget under provisions of the Saltonstall-Kennedy Act. The resulting funds are intended to be used for industry development. Based on 2010 import data a 2-3 percent tax on the value of just edible fishery products would generate $296-444 million in revenues (Table 3).

In the last Congress there was interest in modifications to the S-K Act to ensure the full value of duties was applied to benefit fisheries rather than used as a budgetary offset to appropriated funds. Several bills had been proposed in the House and Senate. One bill, H.R. 4208/S. 2184 - Fisheries Investment and Regulatory Relief Act of 2012, had a key feature that proposed the creation of Regional Fisheries Investment Committees to develop investment plans to improve the sustainability of fisheries. Comprised of Councils and industry members, the investment plans created would direct the Secretary to disburse up to 70 percent of S-K receipts via grants to

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[3] NOAA Catch Share Policy November 2011, p. 16 "Cost Recovery: It is NOAA policy to compute and recover from participants only the incremental operating costs associated with LAPPs."

[4] MSA Section 304(d)(2)(B) Such fee shall not exceed 3 percent of the ex-vessel value of fish harvested under any such program, and shall be collected at either the time of the landing, filing of a landing report, or sale of such fish during a fishing season or in the last quarter of the calendar year in which the fish is harvested.
(C)(i) Fees collected under this paragraph shall be in addition to any other fees charged under this Act and shall be deposited in the Limited Access System Administration Fund established under section 305(h)(5)(B).

projects consistent with the focus areas of the revised Act. One of those focus areas is the support of EM/ER as follows:

> "(ii) efforts to improve the collection and accuracy of fishery catch data, including--
>
> (I) expanding the use of, and research and development on, catch monitoring and reporting programs and technology, both at-sea and shoreside, including the use of electronic monitoring devices and satellite tracking systems; and"

Advantages – If earmarking some proportion of the existing S-K program funds were chosen to support EM/ER implementation, the authority and infrastructure to support grants is already in place.

Disadvantages – Fees and tariffs on trade are subject to a broader government review for other impacts on trade policies of the United States beyond their benefits for fisheries revenue purposes. The threat of countervailing duties on US seafood products entering foreign markets and issues associated with government subsidization of US fishery products confound the political ease of proposing a new import tax policy. Within the existing S-K fund amounts, it would not be inconsistent with the original purposes of the Act to have a certain percentage set aside for reimbursing the costs of industry (not the government) for some share of the costs of fishery management such as EM/ER.

5.2.3. Utilize Existing MSRA Authorities

Several of the cost recovery options proposed above, while promising, require new legal authorities to fully implement them. There are, however, a number of existing MSRA authorities that are underutilized and bear further exploration to support the costs of implementing and maintaining EM/ER programs.

5.2.3.1 Resource Rents/Royalties –

Resource rent is defined as a surplus value, i.e., the difference between the price at which a resource can be sold and its respective extraction or production costs, including normal returns. Reasons to collect resource rent include ensuring a return to the owner of a resource, avoiding inefficient allocation, and achieving ethical objectives.[5] There is existing precedent where the Federal government has sought to recover some rent from natural resource exploitation. These include: lease bids, rental fees, and royalty payments for oil and gas leases on submerged lands of the Outer Continental Shelf; livestock grazing permits and fees on National Forest Service lands; and bidding and periodic payments for timber sale contracts on National Forest Service lands. Rent recovery should not be confused with cost recovery. Cost recovery aims at

[5] The public interest in resource rent, 2006. Sinner, Jim and Jörn Scherzer Ecologic Foundation Research Report No. 8 December 2006. Nelson, New Zealand.

recovering a variety of costs that arise from resource use, whereas rent is a return to the owner. In the United States the owner of the fishery resources in the EEZ is the federal government, acting in trust for the American public.

The MSA acknowledged this difference between cost recovery and resource rents by authorizing the recovery of costs in Section 304(d) while separately authorizing the collection of resource rents, (a return to the owner of the resource regardless of whether any public funds were expended for their management) in Section 303A(d):

> MSA 303A(d) AUCTION AND OTHER PROGRAMS.— In establishing a limited access privilege program, a Council shall consider, and may provide, if appropriate, an auction system or other program to collect royalties for the initial, or any subsequent, distribution of allocations in a limited access privilege program if—
> (1) the system or program is administered in such a way that the resulting distribution of limited access privilege shares meets the program requirements of this section; and
> (2) revenues generated through such a royalty program are deposited in the Limited Access System Administration Fund established by section 305(h)(5)(B) and available subject to annual appropriations.

This distinction is of more than academic interest because the quantity of resource rents/royalties generated via section 303A(d) is not limited by the 3 percent statutory cap on cost recovery. This is a direct means currently available to fund the costs of EM/ER.

Despite this legal authority, no Regional Fishery Management Council has provided for the collection of royalties by any means, auctions or otherwise. In doing so, the Councils have forgone any of the improved economic values associated with successful implementation of LAP programs. All these benefits/increases in net revenues are left to accrue to the initial recipients of the catch privileges.

The implications for funding EM/ER and/or other fishery-dependent data methods are apparent. The results are a transfer of the value of public resources managed as LAPs to private fishermen, meaning this capacity to fund essential monitoring and reporting technologies to ensure successful implementation of the LAP is unavailable to the agency. The government is left to use general tax revenues to subsidize the fishing industry adoption of EM/ER.

Advantages - There is current authority to collect and use resource rents to pay for EM/ER start up and operational costs. The level of rents captured is not capped. Financial and programmatic guidelines are available to help design responsible and sustainable programs.[6]

[6] See for example "The design and use of limited access privilege programs", 2007. Lee G. Anderson and Mark C. Holliday. NOAA Technical Memorandum NMFS-F/SPO-86 November 2007.

Disadvantages – There is a general lack of comfort and understanding among the industry, Councils and even the agency regarding the meaning of resource rents and the means to collect them, particularly the use of auctions. However, there are other methods to collect these revenues besides auctions such as fees on initial allocations and transfers, analogous to some of the permit user fees described above.

An impediment less amenable to an immediate fix is the circumstance where fisheries are currently overfished and overcapitalized, a condition where resource rents have been dissipated and no surplus presently exists. It could take a number of years for fishermen to actualize the increased value of their allocated privileges, although immediately upon receipt of the privilege they have a value that can be capitalized for loan purposes. This may be more of an impediment for EM/ER methods that have higher initial capital costs such as for deployment of video cameras. Whether transitional support by the government is needed for start up or the initial year remains to be revealed by a specific cost analysis of the fishery in question.

5.2.3.2 MSA Set-asides –

Whereas the collection of resource rents/royalties is only authorized for LAP fisheries, the application of MSA authority for the adoption of set-asides is not limited to any particular management method. The discretionary contents of fishery management plans under MSA 303(b)(11) states:

> MSA Section 303(b) DISCRETIONARY PROVISIONS.—Any fishery management plan which is prepared by any Council, or by the Secretary, with respect to any fishery, may—…
> (11) reserve a portion of the allowable biological catch of the fishery for use in scientific research;

Conceptually a set-aside involves a Regional Council taking an amount off-the-top of the allowable biological catch and selling it to raise cash or offering it as compensation for scientific research purposes. Any Regional Fishery Management Council can use this provision to fund implementation of EM/ER in their fisheries. The Mid-Atlantic Council and New England Councils have made the most extensive use of set-asides to fund a research program. Funding is provided annually by the sale of set-aside allocations for quota managed or days-at-sea (DAS) managed fisheries. This can be a fixed poundage, a percentage of the annual quota, or a number of the year's total allowed fishing days. Money generated by the sale of the awarded quota funds the research grants. Compensation is also provided for vessels harvesting the quota in the form of direct fish sales in the commercial fishing industry or in the form of additional fishing opportunities in the for-hire and charter recreational fishing industry. Current set-asides include programs for Atlantic sea scallops, Atlantic herring, monkfish, and mid-Atlantic multi species which includes Atlantic mackerel, black sea bass, bluefish, butterfish, *Illex* squid, *Loligo* squid, scup, summer flounder, and tilefish.

This variation of a user fee could be used to fund EM/ER catch monitoring and data collection that ultimately contributes to stock assessments, a clear scientific research endeavor.

Advantages - There is current authority to collect and use set-asides to pay for EM/ER start up and operational costs. The costs are borne across all harvesters and in proportion to their original share of the annual catch if such allocation measures were in use. It is applicable to all MSA fisheries, not just LAP programs.

Disadvantages – Depending on the value of the individual species, a resource set aside may not have sufficient value to cover the cost of EM/ER and its administration. Derivation of the initial set aside amount will be politically contentious, especially in fisheries that are overfished and overcapitalized with coincidently small annual allocations to help stocks rebuild. Ensuring the proposed use of EM/ER is justified as scientific research may be challenging if the sole outcome is data for compliance monitoring.

5.2.3.3 MSA Central Registry Fees—

The MSA currently mandates the collection of certain fees for the registration and transfer of title to limited access system permits as follows:

> MSA 305(h) CENTRAL REGISTRY SYSTEM FOR LIMITED ACCESS SYSTEM PERMITS.—
> (5) (A) Notwithstanding section 304(d)(1), the Secretary shall collect a reasonable fee of not more than one-half of one percent of the value of a limited access system permit upon registration of the title to such permit with the central registry system and upon the transfer of such registered title. Any such fee collected shall be deposited in the Limited Access System Administration Fund established under subparagraph (B).
> (B) There is established in the Treasury a Limited Access System Administration Fund. The Fund shall be available, without appropriation or fiscal year limitation, only to the Secretary for the purposes of—
> (i) administering the central registry system; and
> (ii) administering and implementing this Act in the fishery in which the fees were collected. Sums in the Fund that are not currently needed for these purposes shall be kept on deposit or invested in obligations of, or guaranteed by, the United States.

The resulting funds would be available to support the initial and ongoing costs of EM. Despite being signed into law in the 1996 reauthorization of the MSA, there is no Central Registry System in place nor are any fees collected for registration or transfer of limited access system permits.

Advantages - There is current authority to collect and use central registry fees to pay for EM start up and operational costs. The funds must be spent in the fishery from which they came, which will help garner industry support, and they are available to the Secretary without being subject to appropriation or fiscal year limits, two unusually flexible provisions in the current federal budget climate.

Disadvantages – There may be considerable annual variation in the magnitude of fees collected, although it is difficult to forecast exactly because we currently do not monitor these transactions across all fisheries. There will likely be substantial start-up costs in producing the registry system[7] and its upkeep and administration will cut into the share of fees available to support EM or other activities.

5.2.3.4 MSA Fisheries Conservation and Management Fund—

This underutilized provision of the MSA does not generate revenue, but rather provides the authority to retain and disburse funds generated from sources in addition to appropriations. Thus it fills an important authorization function for accepting and using funds that would otherwise be directed to the general treasury. The MSA sets up a fund as follows:

> MSA 16 USC 1891b Fisheries Conservation and Management Fund
> **P.L. 109-479, sec. 208 16 U.S.C. 1891b**
> (a) IN GENERAL.—The Secretary shall establish and maintain a fund, to be known as the ''Fisheries Conservation and Management Fund'', which shall consist of amounts retained and deposited into the Fund under subsection (c).
> (b) PURPOSES.—Subject to the allocation of funds described in subsection (d), amounts in the Fund shall be available to the Secretary of Commerce, without appropriation or fiscal year limitation, to disburse as described in subsection (e) for—
> (1) efforts to improve fishery harvest data collection including—
> (A) expanding the use of electronic catch reporting programs and technology; and
> (B) improvement of monitoring and observer coverage through the expanded use of electronic monitoring devices and satellite tracking systems such as VMS on small vessels;
> (2) cooperative fishery research and analysis, in collaboration with fishery participants, academic institutions, community residents, and other interested parties;
> (3) development of methods or new technologies to improve the quality, health safety, and value of fish landed;
> (4) conducting analysis of fish and seafood for health benefits and risks, including levels of contaminants and, where feasible, the source of such contaminants;
> (5) marketing of sustainable United States fishery products, including consumer education regarding the health or other benefits of wild fishery products harvested by vessels of the United States;
> (6) improving data collection under the Marine Recreational Fishery Statistics Survey in accordance with section 401(g)(3) of the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1881(g)(3)); and
> (7) providing financial assistance to fishermen to offset the costs of modifying fishing practices and gear to meet the requirements of this Act, the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1801 et seq.), and other Federal laws in pari materia.
> (c) DEPOSITS TO THE FUND.—
> (1) QUOTA SET-ASIDES.—Any amount generated through quota set-asides established by a Council under the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1801 et

[7] Initial design requirements of the National Permit System that has been created under the NOAA Fisheries' Fisheries Information System anticipated this requirement as a possible complementary application. Thus, there may be some cost efficiencies available with proceeding with developing a central registry for permits.

seq.) and designated by the Council for inclusion in the Fishery Conservation and Management Fund, may be deposited in the Fund.
(2) OTHER FUNDS.—In addition to amounts received pursuant to paragraph (1) of this subsection, the Fishery Conservation and Management Fund may also receive funds from—
(A) appropriations for the purposes of this section; and
(B) States or other public sources or private or nonprofit organizations for purposes of this section.
(d) REGIONAL ALLOCATION.—The Secretary shall, every 2 years, apportion monies from the Fund among the eight Council regions according to recommendations of the Councils, based on regional priorities identified through the Council process, except that no region shall receive less than 5 percent of the Fund in each allocation period.
(e) LIMITATION ON THE USE OF THE FUND.—No amount made available from the Fund may be used to defray the costs of carrying out requirements of this Act or the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1801 et seq.) other than those uses identified in this section.

The purpose of the fund explicitly identifies funding ER/EM as one of its purposes. To date, no money has been deposited into the fund. The potential sources of deposits include set-asides and appropriations, both of which have already been discussed. The final categorical source of deposits identified (States or other public sources or private or nonprofit organizations) warrants some discussion. In the following section on seeking new partners and third-party funding, several options are discussed that would generate revenues for use in the start up and recurring costs of EM. This provision of the MSA is an existing authority to utilize those funds without the risk of them reverting back to the general treasury or conflicting with laws preventing the augmentation of appropriations.

Advantages – There is current authority to collect and use funds deposited in the Fishery Management and Conservation Fund to pay for ER/EM start up and operational costs. The option allows for a mix of appropriated and other funds to be intermingled. Set asides and/or carryover of unused quota into the fund may be a source of innovative contributions.

Disadvantages – The disbursement rules for the fund require an apportionment to each Regional Council regardless of whether funds were derived from their fisheries or gifts or bequests were donated for use in their region of authority. This may impede deposits in the funds if the apparent inability to designate the funds for specific purposes or fisheries is not resolved through legal analysis or subsequent legislative change. The obvious disadvantage is that the fund needs to be capitalized before it can become operational.

5.2.3.5 MSA Contents of Fishery Management Plans- - Requiring Certain Equipment

This last underutilized provision of the MSA also does not generate revenue streams to pay for ER/EM implementation. However, it does authorize the mandatory use of equipment and devices specified in a fishery management plan as follows:

> MSA Section 303(b)(4) prohibit, limit, condition, or require the use of specified types and quantities of fishing gear, fishing vessels, or equipment for such vessels, including devices which may be required to facilitate enforcement of the provisions of this Act;

For example, this is the authority used to require the use of vessel monitoring systems onboard vessels in federal fisheries. These "black boxes" are tamper-resistant hardware devices and provide vessel position data via satellite communications to NOAA Fisheries law enforcement data centers. Analogous requirements for the use of on-board video recording capabilities or electronic logbook hardware and software could be used to deploy ER/EM without the necessity of appropriated funds; vessels would have to deploy the necessary equipment at their own expense as a condition of participating in the fishery.

It should be noted that NOAA Fisheries adopted a policy[8] to reimburse fishermen for the capital cost of their first VMS unit, while subsequent replacement and operational costs remained the responsibility of the participant. This policy was in response to concerns regarding the ability of fishermen to bear the cost of type-approved VMS units. The policy remains in effect today and the average reimbursement per unit is $3,100.

Another example is in Alaska where MSA Section 313(b)(2) to require vessels to purchase and maintain video equipment and scales for management and enforcement purposes. For this equipment, no reimbursement for the initial purchase or the maintenance of this equipment was given.

A Regional Council could adopt through its fishery management plan provisions a requirement to install and maintain video technology as specified by the Secretary without the responsibility to obtain appropriations to pay for the devices. This is an indirect form of a user fee that requires no transaction between the government and the participant.

Advantages – This authority currently exists. It can be used immediately to require the adoption of EM capabilities without any legal requirement for appropriated funds or requiring any financial transactions with the government. The option's administrative costs are very minimal.

Disadvantages – Since there is some precedent for reimbursing the costs of VMS units, there will need to be a revision or explanation of any contrary policy that does not subsidize the industry cost of equipment. This option does not cover the government costs of program design and quality control, editing and archiving of resultant data.

5.2.4 Existing Authority Questions

What is currently lacking, and should be a priority for NOAA Fisheries to undertake, is that many of the issues and principles associated with user fees for ER/EM must be discussed in the

[8] NOAA Policy Directive 06-102 implemented in 2007 states: "It is NMFS policy to reimburse fishermen for the required purchase costs of VMS systems, subject to appropriations."

larger context of a broad change in public policy, namely, a greater share of industry contributions to the costs of management. While the costs for ER/EM seem likely to be coverable by the fishery value, what about the costs for research and administration, do these exceed the value of the fishery (i.e., are fishermen able to cover these costs and still make a net profit given the fishing costs and revenues of their particular fishery)? Within the United States we do not have a rigorous cost accounting of the elements of management, especially relative to fishery values. In a brief survey of four other countries (Newfoundland, Iceland, Norway, New Zealand)[9] the costs of management as a percent of fishery value ranged from 3 to more than 25 percent. In the United States preliminary analysis of potential LAP fisheries by the Office of Sustainable Fisheries showed that the 3 percent cap on cost recovery would be exceeded in some fisheries, while the cap would not be reached in the generally higher value fisheries, as has been the case in the sablefish and halibut fishery. The two-part question to be answered is does the industry have the ability to pay, and in principle, what share should it pay towards the costs of management?

Until this is answered it will be difficult to justify a change in public policy and garner any political support for the large user fees options such as landings taxes and permit fees requiring new legislation. In the interim, better utilization of existing authorities may be the most productive strategy.

5.3. Seek New Authorities?

The previous sections looked at a variety of options using existing authorities. This section considers potential options for new authorities. One such option would be a national expansion of existing funding authority granted to the North Pacific (MSA 16 USC 1862). This authority is not subject to fiscal year limits.

Whether the agency should proceed with any of the options requiring legislative change requires a more thorough assessment of other desired changes in the Act competing for attention and whether sufficient Congressional, industry, Council, and Administration support for their passage could be generated during the next reauthorization. While the upcoming May 2013 Managing Our Nation's Fisheries III conference could be a venue for discussion of various fee, resource rent and other EM funding options, the specific topic of EM or monitoring is not on the agenda.

5.3.1. New Loan Authority

One new authority that may be worth pursuing immediately is the creation of new loan authority for fishermen to help them raise capital and amortize the costs of ER/EM over a period of years via government backed or subsidized loans.

[9] Cost Recovery and Fisheries Management in New Zealand, 2000. Nick Wyatt, New Zealand Ministry of Fisheries. *Paper presented at* International Institute of Fisheries Economics and Trade biennial meeting, Oregon State University July 2000.

A new loan program authority to finance industry debt for ER/EM costs could be part of a new suite of financial assistance remedies for harvest sectors which need help in stabilizing cyclical fisheries income or dealing with fisheries disasters. Fishing is capital intensive with highly variable biological, environmental, and market components, and generally without access to private markets for long-term debt capital. This is a recipe for industrial instability. NOAA Fisheries could propose to stabilize these cycle component effects by: (1) supplementing the private long-term debt capital market through creation of a working capital loan fund, and (2) creating loan authority and more effective procedures for fisheries disaster relief. When conservation measures (such as implementation of EM) or a fisheries resource disaster reduce catches and ex-vessel revenues, variable harvesting costs decrease as harvesting effort decreases, but fixed harvesting costs always continue unabated. The net effect is working capital depletion (current assets minus current liabilities), leaving those affected unable either to pay current liabilities during the course of paying for the conservation measure or waiting out the rebuilding cycle/disaster to retain enough working capital to resume fishing.

A new $150 million loan authority would provide the extra working capital to provide transitional relief for those fisheries with rebuilding cycles that require deep cutbacks in fishing or faced with paying the costs of observers or EM. The budgetary impact of creating this loan authority would be $250 thousand based on prevailing subsidy rates for other NOAA Fisheries loan programs. By extending debt service periods and reducing interest costs, fishermen will be more able to absorb income cycles, including the impacts caused by industry funding of conservation requirements.

5.3.2. Review of Disaster Relief and Loan Authority

Fishery disaster and/or working capital loans are funding options to be considered for supporting EM/ER. Overcoming the effects of particularly severe biological and environmental cycles and events is the traditional function of fisheries disaster relief. Direct payments and loans have been used historically to help fishermen secure more solid financial footing and help pay their costs of fishing. This option extends the use of such grants or loan authorities to permit inclusion of paying for EM/ER costs. Current statutory authority allows the Secretary of Commerce to declare a fisheries disaster under prescribed rules, however, any funding relief for impacted fishermen still requires appropriations from Congress. Establishing a $100 million loan ceiling through statutory modification of disaster relief programs or creation of a working capital loan program ensures funds can be quickly and efficiently directed to the appropriate recipients. The budgetary impact of creating this loan authority would be based on a subsidy rate derived from performance of past loans and could range from zero to $10 million. Proposed legislative changes to authorize loan ceilings for short-term working capital loans, and modified procedures for distribution of disaster relief funds would need to be developed.

Advantages - This approach expands on familiar legal authorities for loan programs and the value of the loan(s) is directly proportional to the necessary investments by the industry.

Administration of the loans requires no transfer of funds between the agency and the industry.

Disadvantages – New loan authority requires Congressional authorization.

5.4. Seek New Partners for Third-Party Funding

Besides federal appropriations and multiple forms of industry funding, a third means to pay the costs of EM/ER is through the use of third parties. Several examples are presented that highlight the range of motivations for third parties to bring resources to the table that may help fund the start up and recurring costs of EM/ER.

5.4.1. Cooperative Research and Development Agreements

A Cooperative Research and Development Agreement (CRADA) is a written agreement between a private company and a government agency to work together on a project using private capital and public commitments to help create and market a new product. Created as a result of the Stevenson-Wydler Technology Innovation Act of 1980, as amended by the Federal Technology Transfer Act of 1986, a CRADA allows the Federal government and non-Federal partners to optimize their resources, share technical expertise in a protected environment, share intellectual property emerging from the effort, and speed the commercialization of federally developed technology.

In general the federal partner provides personnel, services, facilities, equipment, or other resources toward the conduct of specified research or development efforts. Such research must be consistent with the mission of the agency. The CRADA partner contributes all of the above and funding to the project. A CRADA may be of value in advancing research and development of a particular EM/ER technology, ranging from the development of video image recognition and analysis software to development of videography or electronic logbook hardware and related software and communications components.

Past CRADAs for EM/ER should be evaluated for the lessons learned. For example, n 1997 a CRADA was initiated between the Northwest Fisheries Science Center and a private company for the development of an electronic logbook. That project had mixed results.

Advantages – A CRADA may bring capacity and expertise not available inside the agency to assist in the development of an EM/ER solution, and the associated private sector financial and economic motivations and incentives to ensure a successful outcome.

Disadvantages – Some federal contribution/investment of resources, even if limited to in-kind services, is required.

5.4.2. Collaborate with Value-Chain Partners Interested in Seafood Certification/Traceability

There is expanding interest in the seafood supply chain of documenting the origin and related sustainability of fishery products entering domestic and international marketplaces. Some of these interests are the result of legal requirements for country of origin, seafood safety and species identification labeling, while others are associated with market demands for sustainably-produced seafood products. In many markets, local, regional or species-specific campaigns are underway to trace product from harvester to wholesale/retail points of sale to consumer consumption, and they employ a variety of EM/ER-related tools to validate their product claims.

Third parties such as national supermarkets, exporters, and industrial and food service buyers are partnering with harvesters to adopt EM/ER technologies that trace product by individual fish through the market chain. To date NOAA Fisheries has yet to approach these companies (e.g., WalMart, Costco, Darden Restaurants, Whole Foods) or trade or marketing organizations (e.g., Gulf Wild, National Fisheries Institute, Alaska Seafood Marketing Institute) regarding a partnership in funding EM/ER technologies that could both serve the management and science needs of the agency and the traceability and marketing needs of these value-chain partners.

NOAA Fisheries already has a history of tracing and validating certificates of origin for various species (e.g., Patagonian toothfish, yellowfin tuna) as part of Regional Fishery Management Organization management requirements, and most recently has undertaken new agency responsibilities for tracking elements of US trade in seafood as part of the federal implementation of the International Trade Data System requirements.

The relevancy for funding costs of EM/ER is that multiple government and private sector missions are looking to track catch and landings by species electronically. The agency has the opportunity to work with government and industry partners on a shared system for fisheries management AND value chain purposes – shared in both cost and output of the adoption of EM/ER technology.

Advantages – Economies of scale/cost-sharing, integration of existing regional or species specific efforts, and access to latest technologies from the wholesale and retail seafood industry on traceability.

Disadvantages – The magnitude and continuity of funds may be unknown for any given time period. The administration of how funds flow to support EM/ER may have to rely on direct third-party to industry partnerships (business to business), facilitated by the Regional Councils and the agency, rather than have any funds come directly into NOAA Fisheries. This would

limit the availability of funds for the agency costs of EM/ER implementation unless use is made of the Fisheries Conservation and Management Fund.

5.4.3. One-time Third-Party Endowments

The societal cause for sustainability of fisheries has a wide appeal and several non-profit and philanthropic organizations annually expend significant resources in support of this outcome. To ensure the adoption and success of sustainable management it is possible that such organizations may sponsor a grant or reimbursement program to assist the fishing industry in making the transition to EM/ER. To date NOAA Fisheries has not approached such organizations (e.g., philanthropic foundations) for their interest in establishing such a program. These funds could be an important investment in covering the capital costs of on-board video technology or the deployment of computers, sensors and other technology hardware to improve the timeliness and quantity of data used in management. There is precedent for using third-parties to facilitate adoption of new fisheries technology and innovation, as exemplified by Darden Restaurant's Sustainability Initiative via Fisheries Improvement Projects supporting EM innovations in the Gulf of Mexico Reef Fish fishery, to the National Fish and Wildlife Foundation grants supporting six EM pilot or research and development projects over the last two years.

Advantages – No new authority is necessary to enable EM/ER adoption if grants and reimbursements are made between third parties and the fishing industry or to the Fisheries Conservation and Management Fund. The third parties could develop needs tests and other eligibility factors to ensure small scale or financially needy operators receive preference for this external support if they sponsored direct reimbursement programs.

Disadvantages – Similar to value-chain partnerships, the target, magnitude and continuity of support is outside the direct control of NOAA and the Councils if investments flow straight to the industry.

6. Policy Context for Approving Fishery-dependent Data Programs and Their Costs

One of the factors contributing to the need for this white paper is that previous decisions to adopt data collection methodologies were not always made with agreement on how the methods would be paid for in the long term. Specifically, the high costs for observers in the Northeast and Pacific groundfish fishery management plans, initially paid for by appropriations and planned to be transferred over time to an industry funded system, has triggered significant discussion and dissention on who should pay these costs, and their ability to pay these costs.

From the federal agency perspective, there is little guidance on how to evaluate the agency's ability and obligation to pay for implementation of a reporting requirement, and in particular the linkage to approvability of a fishery management plan or amendment proposed by a Regional Council. The concern is whether the agency would be approving an unfunded mandate to implement an observer program or other data collection program if funds do not exist in the

budget to support implementation. Ultimately, program design attributes should not be recommended or approved by NMFS or Councils if they create an unfunded requirement. For example, selecting a sampling fraction whose cost exceeds available appropriations funding would violate anti-deficiency laws. Thus, costs of a program design should be chosen carefully and stay within projected limits, followed by actual performance tracking over time. The relevancy to implementation of EM/ER is that the scope of the funds required for EM/ER need to be in proportion to the expected benefit. Moreover, the agency should not commit to a future program of EM/ER or any other fishery-dependent reporting system unless the anticipated costs are clearly documented and a means to pay them are identified as part of the policy decision. To ensure alignment between data collection policies and funding availability, a protective "no unfunded mandates" policy would help protect the industry and the government from data collection program decisions that are financially unsustainable.

Costs do vary widely for EM, ER, observers, logbooks and other methods depending on the specifics of the fishery and the program design. Therefore, it is important that cost templates be developed and completed for each particular fishery and program design under consideration to ensure fair and relevant cost comparisons of future policy options.

Table 1. REVENUES FROM PROPOSED TAXES ON SEAFOOD LANDINGS

TAX ON LANDINGS IN 2010	AMOUNT	REVENUE AT 2%	REVENUE AT 3%
All U.S. Commercial Landings*, by Pound	8,230,587,000	$164,611,740	$246,917,610
All U.S. Commercial Landings*, by Value	**$3,733,370,000**	$74,667,400	$112,001,100
EEZ Commercial Landings of Fish and Shellfish by U.S. Fishing Craft Off U.S. Shores, by Pound	5,292,156,000	$105,843,120	$158,764,680
EEZ Commercial Landings of Fish and Shellfish by U.S. Fishing Craft off U.S. Shores, by Value	$2,661,513,000	$53,230,260	$79,845,390
Commercial Landings of Fish and Shellfish by U.S. Fishing Craft in International Waters, by Pound	501,108,000	$10,022,160	$15,033,240
Commercial Landings of Fish and Shellfish by U.S. Fishing Craft in International Waters, by Value	$329,402,000	$6,588,040	$9,882,060
U.S. Marine Recreational Harvest, by Pound	196,824,000	$3,936,480	$5,904,720
EEZ Recreational Harvest, by Pound	53,875,000	$1,077,500	$1,616,250

Table 2 TAX ON PROCESSED FISHING PRODUCTS	AMOUNT	REVENUE AT 2%	REVENUE AT 3%
Edible Products: Fresh and frozen, canned, cured, by Value	**$8,512,920,000**	$170,258,400	$255,387,600
Industrial Products: Bait and animal food, meal, oil, and other, by Value	**$508,753,000**	$10,175,060	$15,262,590

Table 3 TAX ON IMPORTS FISHING PRODUCTS	AMOUNT	REVENUE AT 2%	REVENUE AT 3%
Edible Products, by Pound	5,456,266,000	$109,125,320	$163,687,980
Edible Products, by Value	$14,807,678,000	$296,153,560	$444,230,340

Source:

Fisheries of the United States, 2010.

* Includes fish, shellfish, and other categories