Executive Summary

This document analyzes a proposed management change to establish electronic monitoring (EM) as a part of the North Pacific Fishery Management Council (Council)'s fisheries research plan for the fixed gear groundfish and halibut fisheries of the Gulf of Alaska (GOA) and Bering Sea and Aleutian Islands (BSAI). The Council's fisheries research plan is implemented by the North Pacific Observer Program at the National Marine Fisheries Service (NMFS)'s Alaska Fisheries Science Center, and its purpose is to collect data necessary for the conservation, management, and scientific understanding of the groundfish and halibut fisheries off Alaska. This document analyzes alternatives that would allow an EM system, which consists of a control center to manage the data collection, connected to an array of peripheral components including digital cameras, gear sensors, and a global positioning system (GPS) receiver, onboard vessels to monitor the harvest and discard of fish and other incidental catch at sea, as a supplement to existing human observer coverage.

This analysis was developed with input from a Council committee, the fixed gear EM Workgroup. In 2014, the Council appointed the EM Workgroup to develop and refine an EM program for integration into the Observer Program. The EM Workgroup provides a forum for all stakeholders, including the commercial fishing industry, agencies, and EM service providers, to cooperatively and collaboratively design, test, and develop EM systems, and to identify key decision points related to operationalizing and integrating EM systems into the Observer Program in a strategic manner.

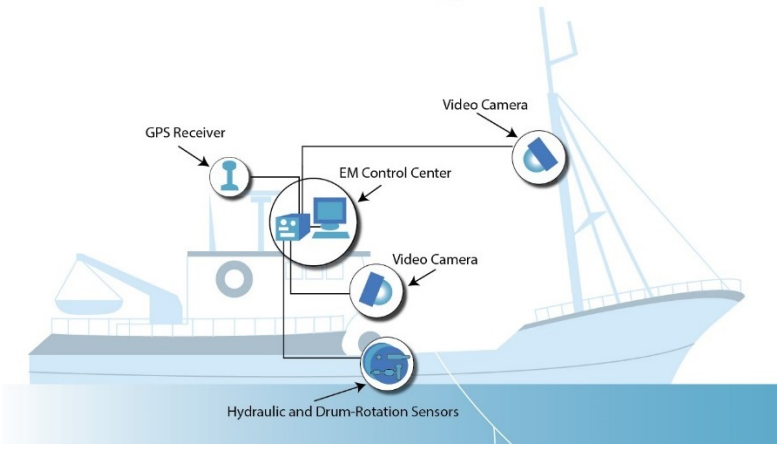
What is electronic monitoring?

For more info, see Section 1.1

In broad terms, electronic monitoring is the use of technology to collect data from fishing vessels. EM can collect a variety of different data, including retained catch, discarded catch, fishing location, and compliance with Federal fisheries regulations. An "EM system" encompasses the spectrum of EM equipment with varying features and capabilities, depending on the specific goal of the monitoring program. An EM system typically consists of a control center to manage the data collection and an array of peripheral sensor components that include: video cameras, GPS receiver, gear sensors, and optionally a communications transceiver (Figure ES-1). The EM system should be a comprehensive data collection platform, designed to record large volumes of sensor and image data, operating autonomously for long periods of time. A typical EM system deployment is shown in Figure ES-2. This analysis anticipates that the EM system will change over time, as technological improvements are made.

Figure ES-1 Example of an electronic monitoring (EM) system

Figure ES-2 Example of an EM system setup



Purpose and Need

For more info, see Section 1.2

In February 2016, the Council adopted the following statement of purpose and need:

> To carry out their responsibilities for conserving and managing groundfish resources, the Council and NMFS must have high quality, timely, and cost-effective data to support management and scientific information needs. In part, this information is collected through a comprehensive fishery monitoring program for the groundfish and halibut fisheries off Alaska, with the goals of verifying catch composition and quantity, including of those species discarded at sea, and collecting biological information on marine resources. While a large component of this monitoring program relies on the use of human observers, the Council and NMFS have been on the path of integrating technology into our fisheries monitoring systems for many years, with electronic reporting systems in place, and operational EM in a compliance capacity in some fisheries. More recently, research and development has focused on being able to use EM as a direct catch estimation tool in fixed gear fisheries.
>
> The fixed gear fisheries are diverse in their fishing practices and vessel and operational characteristics, and they operate over a large and frequently remote geographical distribution. The Council recognizes the benefit of having access to an assorted set of monitoring tools in order to be able to balance the need for high-quality data with the costs of monitoring and the ability of fishery participants, particularly those on small vessels, to accommodate human observers onboard. EM technology has the potential to allow discard estimation of fish, including halibut PSC and mortality of seabirds, onboard vessels that have difficulty carrying an observer or where deploying an observer is impracticable. EM technology may also reduce economic, operational and/or social costs associated with deploying human observers throughout coastal Alaska. Through the use of EM, it may be possible to affordably obtain at-sea data from a broader cross-section of the fixed gear groundfish and halibut fleet.
>
> The integration of EM into the Council's fisheries research plan is not intended to supplant the need for human observers. There is a continuing need for human observers as part of the monitoring suite, and there will continue to be human observer coverage at some level in the fixed gear fisheries, to provide data that cannot be collected via EM (e.g., biological samples).
>
> The Council and NMFS have considerable annual flexibility to provide observer coverage to respond to the scientific and management needs of the fisheries. By integrating EM as a tool in the fisheries monitoring suite, the Council seeks to preserve and increase this flexibility. Regulatory change is needed to specify vessel operator responsibilities for using EM technologies, after which the Council and NMFS will be able to deploy human observer and EM monitoring tools tailored to the needs of different fishery sectors through the Annual Deployment Plan.

Alternatives

For more info, see Chapter 2

In February 2016, the Council adopted three alternatives and Option B to be analyzed as part of the Council's EM Integration analysis. Option A was added for analysis at initial review in October 2016, at which time the Council identified Alternative 2 as the Preferred Alternative for this action.

Alternative 1: No Action - EM is not a tool in the Council's Research Plan

Alternative 2: Allow use of EM for catch estimation on vessels in the EM selection pool (Preferred)

Option A: Allow EM as a monitoring tool when fishing IFQ in multiple areas

Option B: Require full retention of rockfish species with associated dockside monitoring

Alternative 3: Allow use of EM for compliance monitoring of vessel operator logbooks used for catch estimation

Alternative 1

Under the No Action, or status quo, alternative, at-sea fisheries monitoring in the partial coverage category is accomplished with a human observer pool, through a flexible deployment plan that allows the Council and NMFS to make annual policy choices on which vessels are monitored in different selection pools, and the selection rates assigned to each pool. In 2015 and 2016, the Council has authorized a select number of hook-and-line catcher vessels to be included in the zero selection pool for human observers, while these vessels are testing the feasibility of using EM for at-sea fisheries monitoring. While the at-sea data collected from these vessels have been important for developing the EM program, it has not been used for managing the fishery. Under the status quo, the industry observer fee that is assessed in partial coverage fisheries, 1.25 percent of the ex-vessel value of all landings to support at-sea monitoring, can only be used to fund the human observer program.

Alternative 2 ***Preferred Alternative***

Alternative 2 would integrate EM into the Observer Program to allow EM to be used in addition to human observers for the purpose of monitoring at-sea fixed gear groundfish and halibut fishing activity in the partial coverage category of the Observer Program. The implementation of Alternative 2 would bring EM as an option into the process by which the Council and NMFS make annual policy choices on which vessels are monitored in different selection pools, and the level of monitoring required for each pool. The integration of EM into the Observer Program would mean that NMFS would enfold EM into their Observer Program infrastructure, management, and oversight, including the annual process of developing the Annual Deployment Plan (ADP) and evaluating the monitoring program through the Annual Report. The reviewed EM at-sea data would be used in catch estimation for NMFS' catch accounting and fishery management.

Regulatory changes under this alternative include identifying the process by which fixed gear vessels could opt to be in the EM selection pool versus the human observer pool. The regulations would also specify the responsibilities of vessel operators while participating in the EM selection pool. The regulations will direct each vessel operator to comply with a Vessel Monitoring Plan that specifically tailors the requirements to the vessel's unique characteristics.

On an annual basis, the Council and NMFS will determine what deployment model is appropriate for the EM selection pool or pools through the ADP. Annual decision points may include whether there is to be an EM selection pool, and if so, the fisheries, gear or operational types, or vessel sizes in the EM selection pool, the EM selection rate and selection mode, and primary service ports for EM. An important part of this annual process would be the allocation of the available budget between human observer deployment and EM deployment.

Under this alternative, NMFS will set up a contract or grant with one or multiple EM service providers to install and service EM equipment, and to collect and review EM data. The contract or grant will specify hardware and field service specifications, and EM data review (both as to timeliness and specificity) and archiving requirements. Because a contract is likely to be for multiple years, and some of the deployment decisions have a significant impact on EM provider costs (for example, the number and location of primary service ports), there may be some deployment decisions that are made on a multi-year cycle consistent with the EM contract, rather than varying annually in the ADP. Similarly, it is anticipated that the EM system will change over time, as technological improvements are made, and these changes will be accommodated in the contract or grant.

Under Alternative 2, the Council would incorporate EM as a monitoring option in the Council's "fisheries research plan", which is how the Magnuson-Stevens Act refers to the Observer Program. The Council's

groundfish FMPs would be amended to reflect the inclusion of EM. As a result, the industry observer fee could be used to pay for at-sea monitoring either through EM or human observers.

Option A under Alternative 2: EM as a monitoring tool when fishing IFQ in multiple areas

An option under Alternative 2 would allow vessel operators in the EM selection pool to retain IFQ or halibut CDQ exceeding the amount available in the individual area being fished if they are either carrying an observer or EM. Under the current regulations, vessel operators may retain IFQ or halibut CDQ exceeding the amount available in the individual area being fished *only* if they have an observer onboard the vessel. Under this option, vessels that are in the EM selection pool will be able to flag that they intend to fish for IFQ in multiple areas when they log their fishing trip. They will agree to meet the compliance requirements for using EM on such a trip, which may be the same as those in the EM selection pool, or may include more stringent requirements such as requiring constant power to the EM system, completion of an effort logbook, and immediate submission of their EM data at the conclusion of the trip (see discussion in Section 3.6.3.2). If the trip would have been selected for EM use regardless, the data will be reviewed as normal and used for catch estimation, except that it will also be sent to the Office of Law Enforcement. If the trip would not otherwise have been selected, the data needed by Enforcement will be extracted and it will not used for catch estimation.

Since 2013, the only option available to retain catch from multiple areas in partial coverage is if the vessel is randomly selected for observer coverage. It is uncertain how many IFQ and halibut CDQ vessel owners are facing restrictions because of the current regulations. Because regulations governing halibut IFQ and CDQ fishing in multiple regulatory areas are addressed in both Federal fishery regulations and IPHC regulations, implementation would require coordination with the IPHC at their annual meeting.

The EM Workgroup, the Council's Observer Advisory Committee, and NMFS all support including the option to allow EM as a monitoring tool when fishing IFQ in multiple areas in the Council's Preferred Alternative. The EM Workgroup noted that this option provides additional incentive for vessels to join the EM selection pool, and that it would not unduly add to the cost of the program as the capital investment in the EM equipment is already committed to that vessel, and therefore the cost would not trade off directly with, for example, the ability to deploy observer days in another fishery during that time. There is some cost associated with video review of non-selected trips, but it is not likely to be high. The OAC highlighted that EM will allow effective compliance of IFQ harvest in each IFQ area, and providing a different choice will potentially reduce the anecdotal current practice of repeatedly logging and cancelling trips until a trip is selected for observer coverage, in order to fish in multiple areas. In Section 3.6.3.2, NMFS articulates its recommendation to allow vessels to use an EM system in lieu of carrying an observer for data quality, cost savings, and monitoring and enforcement reasons.

Option B under Alternative 2: Rockfish retention

Under Alternative 2, the analysis includes an option to require retention of all rockfish species by vessels when using EM. Current regulations require discard over maximum retainable amounts (MRAs) when an allocated species is closed to directed fishing (bycatch status)[1], or discard of any amount of the species once it is placed on prohibited species status. While EM studies to date have shown that in most cases, it is possible to identify fish to the species or species complex required for management, there are some rockfish species groupings that are difficult to distinguish. Under this option, vessels that are using EM would be required to retain all rockfish, so that the rockfish could be speciated dockside once they are landed. The Council has not included this option as part of the preferred alternative. Rather, the Council

[1] The only exception to this is for incidental catch of demersal shelf rockfish (DSR) species in Southeast Outside waters (NMFS reporting area 650), where full retention of all DSR species in area 650 is required.

initiated a separate analysis to evaluate a universal rockfish retention requirement, whereby full rockfish retention to apply across the board to all fixed gear vessels, rather than limiting it only to fixed gear vessels using EM. Industry representatives on the EM Workgroup supported a universal retention requirement because it would result in a consistent regulation for rockfish retention across all regulatory areas and species, and would apply regardless of whether a vessel is using EM. Retaining rockfish would also reduce waste if the retained rockfish were donated or otherwise used.

Alternative 3

Under Alternative 3, all vessel operators in the EM selection pool would be required to complete a logbook of discarded target species and key bycatch species of concern. For rockfish species, where species identification can be challenging, full retention of all species would be required. All other incidental species would be estimated from the EM video audit and/or from the human observer strata. Vessel operators would be required to log and retain the following species:

EM Program Requirements	Longline	Pot
Require operators to log all discards of:	halibut, sablefish, Pacific cod, and sculpins	Pacific cod, octopus, crab, and sculpins
Require EM vessels to retain for dockside monitoring:	all rockfish	
Other requirements:	logging of all seabird interactions	

All vessels would carry EM systems, and to verify the accuracy of the logbooks, a review of the footage from EM cameras would be used to audit the operator logbooks. The exact amount could be specified annually in the ADP based on available budget, but in keeping with similar programs elsewhere, might begin at a threshold of 10 to 20 percent.

The regulations would prohibit falsifying the logbook data. If the logbook is found to be inaccurate, based on the EM audit, then that may result in a violation. As with Alternative 2, the regulations would identify the process by which vessels could opt to be in the EM selection pool versus the human observer pool. The regulations would also specify the responsibilities of vessel operators while participating in the EM selection pool, in terms of completing the logbook, installation and maintenance of the EM system, catch handling requirements, and what happens in case of EM system failure. It would be regulated that each vessel operator must comply with a Vessel Monitoring Plan designed specifically for his or her vessel.

On an annual basis, the Council and NMFS would determine whether to allow an EM option in the ADP, and vessel operators would be able to opt into the EM pool. NMFS would set up a contract or grant with an EM service provider to install and service the EM systems, as with Alternative 2, with the additional task of auditing the logbooks against EM data. As the Council and NMFS have not yet tested the logbook model in the Alaska fisheries, some cooperative research would be necessary to develop an appropriate EM logbook. Once it is part of the Council's "fisheries research plan", the logbook/EM system could be funded through the industry observer fee.

Rationale for the Council's Preferred Alternative For more info, see Section 2.4.1

The Council developed an EM Program for the the fixed gear fisheries to address the fleet's desire for an alternative way to collect data from these fisheries. Fixed gear fishery participants in the partial coverage category identified unique issues with carrying an observer. EM systems are a monitoring tool that effectively balances the need for high-quality data with the costs of monitoring and the ability of fishery participants to accommodate human observers onboard. EM systems collect data for NMFS estimate discards of fish, including halibut, and mortality of seabirds, onboard vessels that have difficulty carrying an observer or where deploying an observer is impracticable. The Council intends the EM Program to reduce economic, operational, and social costs associated with deploying human observers throughout coastal Alaska. Through the use of EM, it may be possible to affordably obtain at-sea data from a broader

cross-section of the fixed gear groundfish and halibut fleet and increase flexibility to respond to the scientific and management needs of these fisheries.

At initial review in October 2016, the Council selected Alternative 2 as the preferred alternative. Alternative 2 integrates EM into the established Observer Program process by which the Council and NMFS can annually determine the best monitoring tool for the Alaska fixed gear fisheries, through the Observer Annual Deployment Plan. Through that process, the Council and NMFS will consider how to optimize observer and EM deployment for fisheries in the partial coverage category each year, based on an analysis of the costs, budget, and effort.

The cooperative research and pre-implementation to date has shown that data from EM systems deployed at sea can be used for catch estimation in fishery management. The research has identified that EM data can effectively identify almost all of the species or species groupings required for management, that the systems are sufficiently reliable, and that image quality is generally high. While the emphasis of pre-implementation work to date has not been on timeliness of data, improvements planned for 2017 and beyond are likely to ensure an acceptable turnaround time of data from EM video review. Some data necessary for catch estimation, fishery management, and stock assessment cannot be collected from EM systems, but that data can be obtained from at-sea observers onboard other fixed gear vessels that are fishing in similar areas and at similar time periods, as there will continue to be observers deployed in the Alaska fixed gear fisheries.

The Council has identified Alternative 2 as preferred in part because it is the model that more closely mirrors the current partial coverage category of the Observer Program. The Observer Program includes a data collection program where observers are randomly chosen to observe fishing trips, with the intent that, to the extent practical, the presence of the observer does not affect the vessel's operational choices. Alternative 2 is in keeping with this application of the current Observer Program. While there are certainly additional responsibilities for vessel operators to install and maintain the EM system should they choose to opt-in to the EM selection pool, the intent is largely to allow the vessel to continue its normal fishing practice, and allow the cameras to capture data observations that are then extracted, onshore, through video review. In contrast under Alternative 3, the model changes, so that the vessel operator instead takes on the role of data collector, and is responsible for accurately completing a logbook that will be used for catch estimation. This creates additional burden for the vessel operator, especially on small vessels where the operator may be actively involved in hauling in the catch. Under Alternative 3, the EM system is used for a compliance and enforcement role, where vessel operators who are found to have been inaccurate in their logbook based on the EM audit, will be subject to a potential enforcement violation.

Both alternatives require the same investment in EM equipment purchase, installation, and servicing, which will be paid for out of the observer fee. There may be some reduction in the cost of video review under Alternative 3, but it comes at the expense of implementing a logbook system that creates additional burden on both the vessel operator and enforcement personnel. As vessels have a choice whether to opt-in to the EM selection pool, the additional burden of the logbook model may discourage vessels from participating at all.

Additionally, the logbook model is unsuited to the Alaska partial coverage situation, where all vessels pay a standard fee for monitoring. The fleet lacks the incentive of a reduction to the individual's expenditure for monitoring to promote accuracy in the logbook accounting. In other regions where the logbook system is being used effectively, it is being used to monitor catch share programs, which have very different data needs and monitoring incentives.

Integrating EM into the Observer Program For more info, see Section 3.1

The analysis breaks out different components that have been identified within the EM program:

1. EM Deployment Design	***Goal:*** *Use best available information to design the EM deployment methods, including the EM selection pool, which meet policy and data collection goals.*
2. Participation	***Goal:*** *A pool of EM participants that are capable and committed to making EM work on their boats.*
3. Equipment and installation	***Goal:*** *Appropriate EM equipment (wiring/sensors, cameras, monitors, hard drives) gets properly installed on each vessel, at the right port, and in a timely fashion, with the least interruption to the fishing plan.*
4. Operation	***Goal:*** *Each vessel operator maintains a functioning EM system throughout the fishing trip and there is a good process for maintaining quality control and addressing equipment failures.*
5. Data and equipment retrieval	***Goal:*** *EM equipment with data returned to NMFS timely and in good condition.*
6. EM data and Catch Accounting	***Goal:*** *Extract information from EM system and integrate it into the Catch Accounting System in a timely manner so that data can be used in management.*
7. EM data retention and storage	***Goal:*** *Retain EM data (video and data derived from video review) in an appropriate format.*
8. Feedback mechanisms	***Goal:*** *All participants have the opportunity to provide timely feedback to address problems and improve the EM Program.*
9. Fees/ Funding/ Costs	***Goal:*** *Use Observer Program fees or other sources of funding to pay for the EM equipment, installation, and maintenance.*

All the EM program components listed above apply under both alternatives. For Alternative 3 only, however, there is an additional program requirement, the catch logbook, which is described below:

10. Catch logbook *Alternative 3 only*	***Goal:*** *Each vessel operator maintains an accurate logbook with discarded catch of key target and bycatch species.*

Each of these components will be implemented through various available implementation vehicles. These include the regulations, the Annual Deployment Plan (and Annual Report), the EM service provider contract (or grant), the Vessel Monitoring Plan (which defines the placement of EM equipment onboard each individual vessel, and sets out operator responsibilities for maintaining EM equipment and for fish handling practices conducive to camera monitoring), and NMFS administration. Figure ES-3 provides a preliminary assessment of how the different pieces of the EM program fit together under each of these implementation vehicles. The numbers in parentheses correspond to the ten EM program components identified above.

Figure ES-3 Preliminary assessment of EM components, organized by implementation vehicle

The numbers in parenthesis correspond to the ten EM program elements identified above.

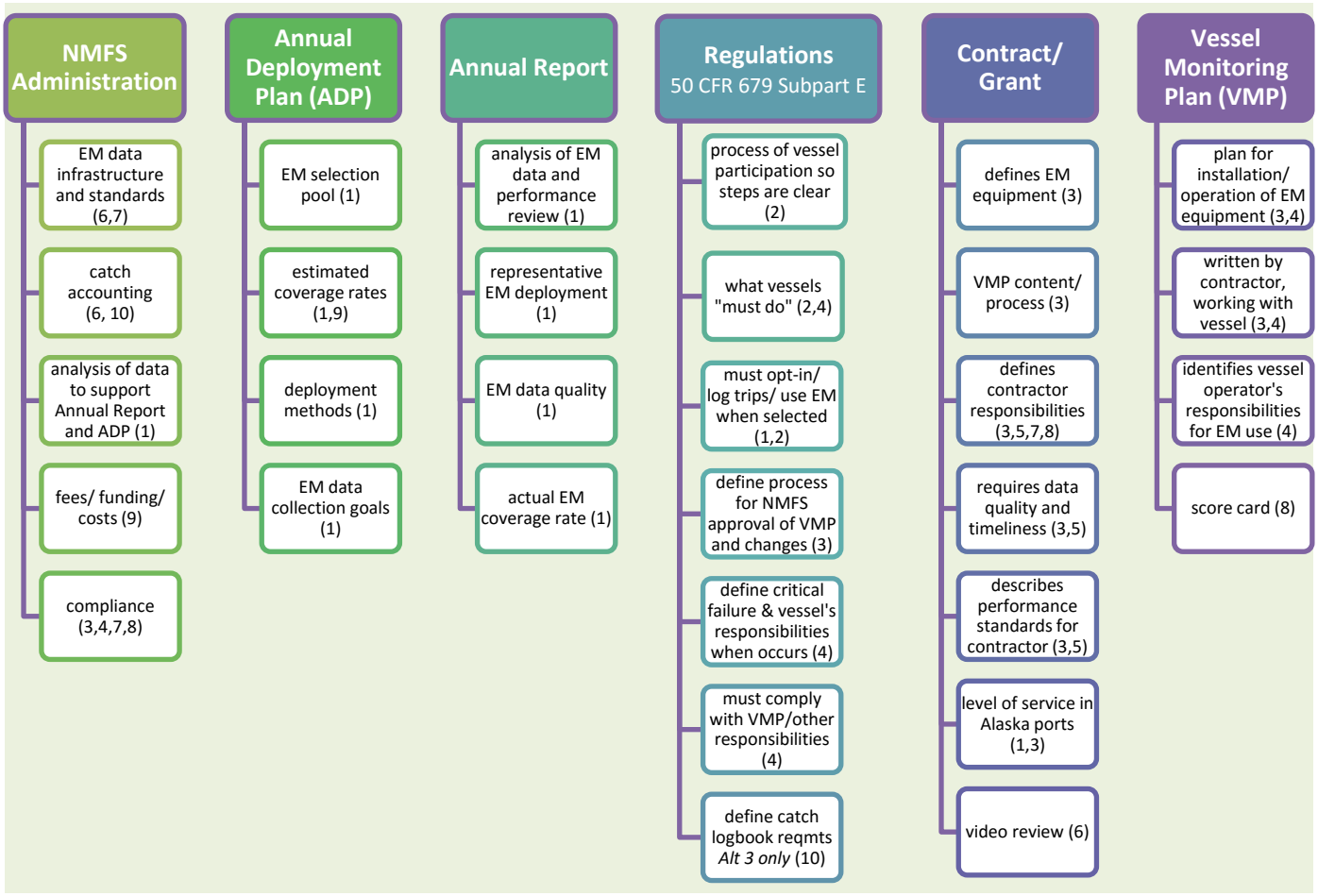
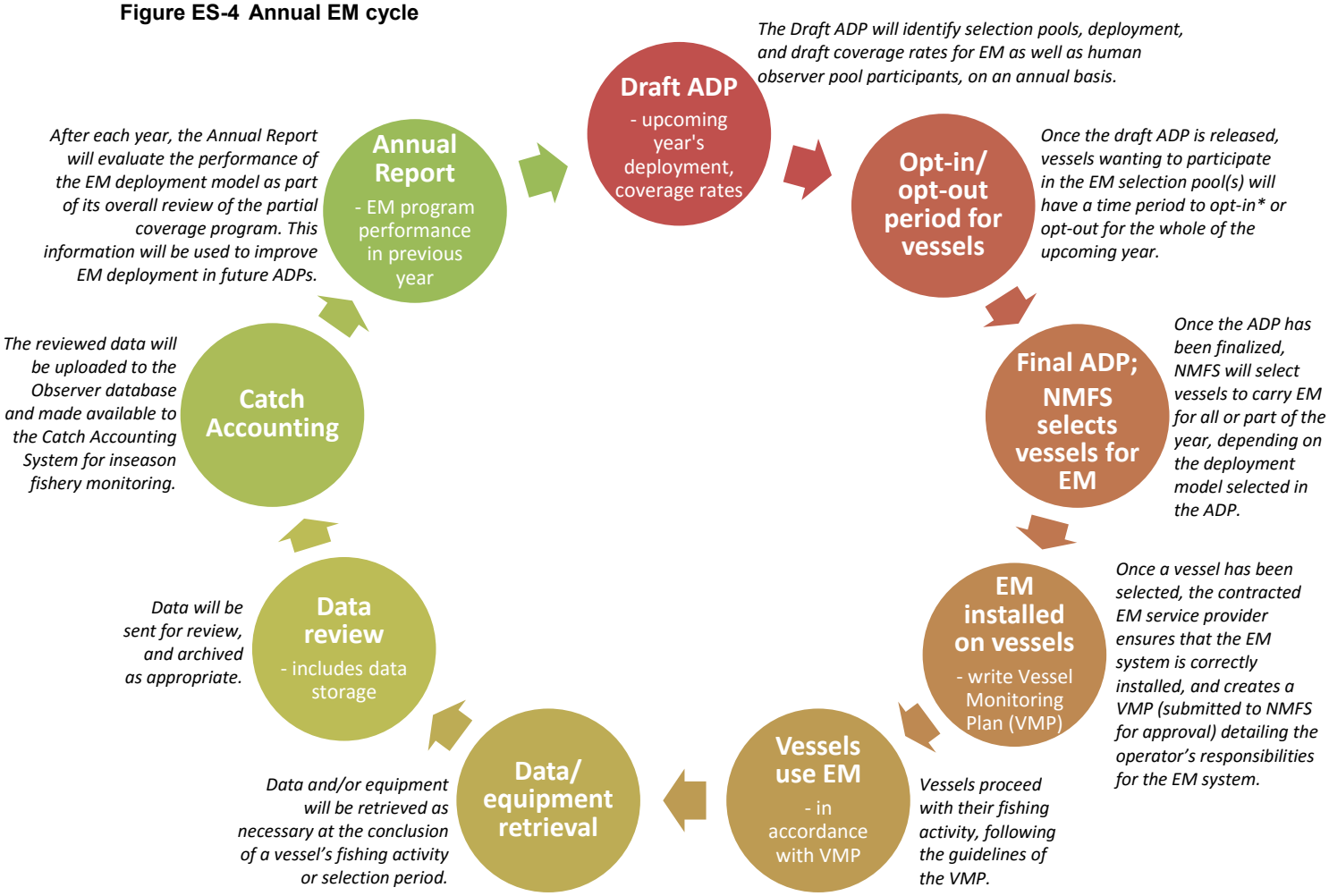


Figure ES-4 illustrates how these pieces fit together in an annual cycle of the EM program, once implemented. The figure applies to both Alternative 2 and Alternative 3, but under Alternative 3 the additional component of catch logbooks is not illustrated. Vessels would complete catch logbooks during fishing activity, and these would be submitted directly to NMFS as a data source for catch accounting.

Figure ES-4 Annual EM cycle



*Once a vessel has initially opted-in, it remains in the EM selection pool for all future years, until either the vessel opts out, or the EM selection pool is changed (through the ADP) such that the vessel is no longer eligible. Vessels will opt-in or opt-our through the existing Observer Declare and Deploy System (ODDS).

Allocating deployment between the EM and observer pools

For more info, see Section 3.1.4

Under Alternatives 2 and 3, an EM selection pool would be established in the Annual Deployment Plan (ADP). The ADP process provides a mechanism for NMFS and the Council to re-evaluate deployment and improve efficiency in the sampling design. The sampling design involves two elements: 1) how the population of partial coverage trips is divided (stratification); and 2) what proportion of the total observer deployments are to occur within these divisions (allocation). In developing an ADP that includes allocation to both observer and EM selection pools, NMFS and the Council will need to consider the impact of each pool, and possible participation, on the ability to meet the Council and the Observer Program's monitoring goals. An important constraint is budget: the Council and NMFS will annually determine the rate of observer coverage and EM coverage that can be afforded with the budget from fee revenues. The amount of coverage allocated to both EM and observer deployments will be determined

annually in the ADP based on an analysis of the costs, budget, and effort in the partial coverage category. "Optimal" allocation is a design that achieves the most precision for the least cost, and NMFS will need to incorporate costs of both observer and EM deployment into the allocation analysis. Another important part of the annual ADP analysis will be understanding gaps in observer data when a portion of the partial coverage vessels opt-in to EM. During this process, NMFS and the Council can balance EM coverage with maintaining representative observer coverage.

Use of the observer fee, and EM service contracts

For more info, see Sections 3.2 and 3.3

Alternatives 2 and 3 anticipate using the industry observer fee that is authorized under the Magnuson-Stevens Act, to pay for at-sea monitoring either through EM or observers. The Act is specific that the fee may be collected for stationing observers or EM systems onboard vessels or at processors, and may be used for inputting collected data, but not for administrative overhead. For the observer program, NMFS has separated costs into shoreside and at-sea costs, where at-sea costs are conducted by a service provider and are paid by using fees, and shoreside costs are paid by NMFS. A similar model is proposed for EM, however some EM activities, such as video review and data storage, are not so easily categorized. They would be conducted by a service provider, and could be paid for by fees, but are shoreside costs and thus could also be paid for by NMFS.

Responsible party	EM task	Funding source
EM service provider	EM equipment	Observer fee
	EM field services (VMP, travel, field staff, installation, communication with vessels, training)	
	Video review	to be determined
	Data storage	
	Dockside monitoring (if required)	
NMFS	Annual Deployment Plan / Annual Report	NMFS
	Catch accounting / data management	
	ODDS, EM opt-in / opt-out process	
	Contract/grant development and management	
	Video reviewer training, communication, audit	

NMFS is considering several approaches for implementing EM services under an operational program. Due to timing issues, NMFS has requested Federal funds for EM deployment in 2018 to bridge from pre-implementation to the operational EM program funded by fees. At the current time, the most likely approach under consideration is for NMFS to use the existing grant with PSMFC to fund EM deployment for 2018. In 2019, NMFS would transition to an observer fee-funded multi-year contract, which would include both EM services and observer services under a single contract. The contract could be awarded to multiple providers, and individual components of the contract would be administered through task orders. This timing dovetails with the renewal of the current partial coverage contract for observer services.

Council process for EM development

For more info, see Section 3.5

This analysis evaluates proposed actions that would allow EM to be used for monitoring partial coverage fixed gear groundfish and halibut fisheries. It is anticipated that EM technology will change over time, as improvements are made. Research to date has focused on the hook-and-line and pot vessels over 40 ft length overall, but the Council may want to use EM in other fixed gear sectors in the future also. The Council's EM Workgroup has developed a process for developing EM technology, and applying it to different fixed gear sectors, in order to ensure that EM is continually providing quality monitoring data. As the Council and NMFS consider annually whether to use an EM selection pool as part of the Annual Deployment Plan, they will need to consider what is known about the reliability of the available EM technology, its suitability for the different fishing patterns or vessel configurations of the subject fleet, and the ability of vessel operators to successfully interact with the technology onboard. In the future, EM

development may be funded with NMFS funds or through grants, such as from the National Fish and Wildlife Foundation, similar to how the pre-implementation has been funded since 2014.

Figure ES-5 identifies the different stages of EM technology that are currently being developed in the fixed gear sector in Alaska, and how far they are likely to have progressed by 2018. Development work to date has focused on using EM for catch estimation, as described in Alternative 2. If the Council is interested in pursuing development work for Alternative 3, the logbook audit approach, under current planning, it would be at the operational testing stage. The use of the standard cameras as the auditing device would be mature, but no work has yet been done in Alaska to develop appropriate EM logbooks designed to work with an EM audit system.

Figure ES-5 Stages of EM development, and anticipated stage of Alaska fixed gear EM development in 2018

	Fisheries	Technology
Proof of Concept	• <40 ft hook-and-line catcher vessels	• Automatic species identification through video review
Pilot Program		• Stereo cameras • E-logbooks
Operational Testing		• *Logbooks with EM audit (Alt 3)*
Pre-Implementation	• Pot catcher vessels	• Standard cameras for pot
Mature	• >40 ft hook-and-line catcher vessels	• Standard cameras for hook-and-line

EM data

For more info, see Section 3.7

Under Alternatives 2 and 3, data collected with EM will be integrated into the Observer database and in the Catch Accounting System. This will allow EM data to be used for fishery management and stock assessments[2]. The first step is to review and extract the data from the video. During pre-implementation of EM in the hook-and-line fisheries, video review has been conducted by Pacific States Marine Fisheries Commission (PSMFC). In the future, this work may continue to be conducted by PSMFC or contracted to a video review company, but the methods being utilized by PSMFC provide a model for what is anticipated under a regulated program. Reviewers assessed the completeness of the sensor and video data during each trip, the quality of the imagery, and recorded species to the lowest identifiable taxonomic level possible, by count, damage to fish, disposition (retained or discarded), and whether the discard was intentional or a drop-off from the line. Halibut were assessed to determine the release method and condition for each fish. A review rate was calculated as review minutes divided by sort minutes.

Timeliness of data: An important factor in using EM data for catch estimation is time needed for video review, and the overall turnaround time from when a vessel finishes a trip to when data are available for inseason management. The amount of time necessary to conduct video review varies by target fishery. Review rates were similar in the halibut and sablefish fisheries at approximately half of real time (e.g., one hour of catch handling time could be reviewed in 30 minutes). The review rate in the Pacific cod fishery was slower and close to real time (e.g., one hour of catch handling could be reviewed in about one hour). Reasons for the longer review time in the Pacific cod fishery include hauls tending to have a greater variety of species; the practice of stern hauling, which is more difficult to review due to having a side view of the line (as opposed to a top down view); and more night fishing occurring, with consequent poorer lighting conditions. The overall turnaround times for video data were tracked in 2016, and recommendations have been made in 2017 to reduce scenarios where there has been a long time between the fishing event and arrival of the hard drive at PSMFC for video review.

[2] Under Alternative 3, EM data will be used in conjunction with logbook data for fishery management.

Video and sensor data completeness: Under Alternative 2, a census of catch will be collected within an EM trip, and expansions will not generally be necessary to complete estimation at the haul and trip-level. In situations where hauls are missing video or sensor data, then the hauls will be considered "unsampled" and estimates will be made using trip level information, which rely on neighboring haul information within an observed EM trip. The highest impact of missing data is when the sensor data is missing, as in these circumstances, the video reviewers have no way to determine how many hauls occurred on the trip and there is no way to determine how much video might be missing. In 2016, the sensor data was complete on about 75 percent of trips. The number of hauls in 2016 with gaps in video data that occurred during catch coming onboard was low,[3] likely at about 1.5 percent of hauls. Video was more likely to be incomplete on the vessel's first or second trip. These results indicate that there is a learning curve for vessel operators to get used to operating the EM system, and also for the EM service provider to customize the EM system for each vessel.

Image quality: The majority of the video was of high quality in 2016 (78 percent). Of the hauls with medium quality (16 percent), poor camera angles and water spots caused the majority of degradation. Low quality (5 percent) was mostly caused when video from one or more cameras was missing, so video reviewers had to rely on wide-angle deck camera(s), which does not provide a close-up view of catch coming up on the line.

Species identification: In 2016, video reviewers identified a high proportion of retained and discarded catch to species level. Exceptions were generally species groups that are known to be problematic, including short and longspine thornyhead rockfish, shortraker and rougheye/blackspotted rockfish, and arrowtooth and Kamchatka flounders. The results of EM species identification in 2015 and 2016 are similar to previous work conducted on EM in the hook-and-line fisheries in Alaska, namely that comparison of species identification of catch between observer estimation and EM showed statistically unbiased and acceptable comparability for almost all species except for some that could not be identified beyond the species grouping levels used in management.

Data elements that will continue to rely on observer data: Because EM systems currently being deployed cannot collect all the data needed for catch estimation, data from at-sea observers on vessels that choose not to opt into the EM pool will be used. These data elements include average weights of fish, to allow conversion of EM counts to weight for EM species caught; species ratios for groups that are difficult to distinguish, such as shortraker and rougheye/blackspotted rockfish; and halibut mortality, as while EM seems to get a reasonable profile or release method, the IPHC does not currently have any method to compare the release method to a corresponding mortality signature, and resultant mortality rate. Given the continuing reliance on at-sea observers for EM catch estimation, it will be valuable, as part of the Annual Deployment Plan process, to evaluate the potential for gaps in the observer data.

Enforcement Recommendations

For more info, see Section 3.6

NOAA Office of Law Enforcement (NOAA OLE) recognizes that under Alternative 2, the development of an EM system to supplement the Observer Program has as its primary objective the management of the fisheries and data collection. However, an effective EM program must also have compliance components to contribute to that goal. The following describes the compliance tools that would be needed to ensure a functioning EM program that meets that primary objective:

- An EM system should integrate GPS as a compliance, data, and management tool that is tamper resistant and low maintenance; provides independent date/time stamp of position in the EM data set; records gear type, fishery, and fishing effort; has two communication, data transmission, and electronic signatures; provides data to the owner/operator for voluntary compliance; and maps an overlay of federal areas and restrictions.

[3] Excluding hauls associated with a software problem on a single longline Pacific cod vessel which was rectified once identified.

- Any components or tools for compliance implemented by this program should be consistent with other regulatory programs (e.g., the Observer Deploy and Declare System (ODDS), Vessel Monitoring System (VMS) transmission requirements, and electronic logbooks, if required).
- NOAA OLE envisions visiting vessels either at sea or while at the dock to verify that the systems are functioning correctly and are in compliance with the vessel's vessel monitoring plan.
- Data reviewers and EM service providers should report substantive potential violations observed aboard the vessels to NOAA OLE.
- Data retention should be sufficient to allow for compliance review and complex investigations, anticipated to be between 3 to 5 years but dependent on national guidelines.
- Regulations should specify that the vessel must comply with its VMP while using the EM system at sea, and provide guidance to vessel owners and operators about their responsibilities to maintain a functioning EM system. NOAA OLE is considering various methods to verify that EM systems are on and functioning correctly, including whether to require real time transmission of system health data.
- Regulations should include a provision to prohibit a vessel from fishing in the case of chronic EM equipment system failures due to flagrant disregard for the requirements of a successful EM catch estimation program. NOAA OLE would only invoke this regulatory provision to prohibit a vessel from fishing under the most extreme circumstances when all other methods of bringing a vessel into compliance have failed. This regulatory provision would work in concert with issuing violations for failure to comply with the vessel monitoring plan and regulations.

EM will likely provide some support for enforcement of other regulations. During EM video review, the data reviewers would record potential violations and report to NOAA OLE. Thresholds for reporting violations would need to be developed. Additionally, as the program develops, additional compliance-only EM components may be integrated. The use of cameras to verify seabird streamer line use, which is required for hook-and-line vessels under pre-implementation, is one such example.

Another example is the option, proposed by the EM Workgroup and supported by NMFS, to allow vessels to fish IFQ in multiple areas with the use of an EM system. **Because EM in this instance would be used as a compliance tool, some additional requirements may apply when a vessel is using their EM system to fish IFQ in multiple areas**, regardless of whether less stringent rules apply to other vessels in the EM selection pool.

1) The system would require a reliable power source that would be operating at all times (24 hours a day) after the vessel left port to conduct IFQ fishing in multiple areas.
2) All vessels would need to complete an effort logbook.
3) Vessels that completed an IFQ in multiple areas trip may be required to submit their hard drive and effort logbook to the designated video reviewer at the end of the trip, rather than allowing for multiple trips before hard drive submission.
4) The video reviewer would determine the amounts of IFQ catch by area, and keypunch the effort logbook, and submit the data to NOAA OLE.

Summary of Alternatives by Operational Differences

		Alternative 1 Human observer program only	Alternative 2 EM as tool for catch estimation	Alternative 3 Logbook as tool for catch estimation, with EM verification
Operational Differences	*Observer fee*	1.25% of ex-vessel value for all landings in partial coverage fisheries	No change	No change
	Coverage requirements	Determined annually in ADP (in 2016, all vessels ≥40' in gear-specific stratum)	EM selection pools determined annually in ADP; vessels may opt in/out of selection pools annually	Same
		Target coverage rates determined annually in ADP (15% in 2016)	EM target coverage rates determined annually in ADP (30% in 2016)	100% coverage of all vessels in selection pool
	Retention requirements	Rockfish over the maximum retainable amount must be discarded*	Option: require rockfish retention for dockside monitoring for vessels when using EM	Require rockfish retention for dockside monitoring for all vessels in EM selection pool
	Source of catch estimation discard data	Observer data	EM video review for all species, and observer data	Vessel logbook for key species (target and incidental species of management concern); EM video review for remaining; observer data
	Amount of data	Observers randomly sample catch on a random selection of trips	EM intended to capture all hauls on EM-selected trips; video review of a random selection of hauls with complete sensor and video data provides a census of catch	Logbook of information on discard of key species required for all vessels; EM audit of a random selection of hauls, smaller proportion than Alt 2
	Timeliness of data	Observer report is transmitted at trip-end	Hard drives mailed at end of trip; EM video review turnaround is high priority	Logbook data is transmitted at end of trip; EM video review for audit/ estimating remaining species is lower priority
	EM system components	None	Sensors, control box, deck cameras, rail cameras	Same as Alt 2, plus catch logbook
	Key enforcement mechanism	Vessel required to comply with observer regulations	Vessel required to comply with Vessel Monitoring Plan (VMP) and regulations	Same as Alt 2, plus vessel required to accurately report catch in logbook**

* except demersal shelf rockfish in Southeast Outside; ** where NOAA Office of Law Enforcement determines the standard of reporting "accuracy"

Environmental Assessment For more info, see Section 4.1

Improving data reliability was one of the primary drivers for restructuring the Observer Program in 2013. By allowing the use of EM as part of the Observer Program, NMFS would maintain the ability to provide the unbiased discard information used in the Catch Accounting System and would increase flexibility to adapt monitoring to specific data needs, by collecting data from vessels where observer coverage is not practicable. The coverage rate for human observers is expected to decrease, as the finite fees would be used to fund both deployment of observers and EM. The Council and NMFS would, however, decide annually how to balance EM coverage with observer coverage, relying on analyses to evaluate potential gaps in observer data resulting from EM participation.

Additionally, this document analyzes the impacts of changes to the data collected under the alternatives by comparing the data currently collected by observers with the data that would be collected with EM. In those instances where certain data can only be collected by observers, and not by EM, the impact of implementing either EM alternative would only be to reduce, and not eliminate, the amount and sometimes the timeliness of that data. This is because both EM alternatives contemplate the use of EM (Alternative 2), or of a logbook with EM audit (Alternative 3), as a supplement to human observer deployment, rather than a replacement for it. Observer data will continue to be used to provide estimates for the fishing activities without coverage or where EM does not collect that specific data. A detailed

evaluation of how the Catch Accounting System generates estimates from the available observer data, and the impact of gaps in coverage, has been provided in a previous analysis.[4]

Groundfish, halibut, prohibited, and ecosystem component species For more info, see Sections 4.2-4.4

Human observers (Alternative 1) collect type, size, sex, length, and weight of all organisms in samples, and collect biological samples such as scales, tissues, age structures (otoliths), and stomachs. Observers may also conduct special research projects that provide scientists with other information. With the current EM camera technology, cameras record the catch as it comes onto the vessel. From the video, we get a census of the species (or species groupings) of fish caught and the number of fish, their disposition and condition. NMFS cannot collect weight data with current EM technology, which NMFS uses to estimate biomass. Weight data would need to be extrapolated from the observer data and applied to the data collected with EM. NMFS also cannot collect sex data with current EM technology. Data on sex ratios are useful to determine which parts of the population are being affected by fisheries. This is particularly true for species (like grenadiers) where there are geographical or depth-related differences in the distribution of males versus females. Additionally, NMFS cannot collect biological samples with EM.

Under Alternatives 2 and 3, an iterative process would be used through the ADP and Annual Report to refine sampling protocols for EM to meet catch accounting and stock assessment needs in the hook-and-line and pot gear fisheries. Alternative 3 uses a logbook to collect data on key target and bycatch species, and all other incidental species would be estimated from EM video audit. As the amount of video review is likely to be reduced under Alternative 3, less EM data would be collected from the vessels selected to use a logbook and EM than from those selected to use EM under Alternative 2. An option under Alternative 2, and a requirement under Alternative 3, would oblige the vessel operator to retain all rockfish while using EM. With full retention, landed rockfish could be differentiated and counted at the processor; this may require additional dockside monitoring.

Marine mammals For more info, see Section 4.5

Observers conduct statistically reliable monitoring of fishing operations and to record information on all interactions between fishing operations and marine mammals. The Observer Program reports mammal interactions to Marine Mammal Laboratory staff and estimates are made independent of the Catch Accounting System. Observers record the species, number, and types of interaction (including location, date and time, gear type, catch composition, fishing depth) with marine mammals, and the length, tissue samples, photographs, and disposition (e.g., dead, released alive) of marine mammals caught in the gear.

Under Alternative 1, restructuring has brought vessels into the partial coverage program which operate closer to shore and in areas where there was previously little to no observer information, such as the inside waters of southeast Alaska, and nearshore waters in southeast Alaska and the Kenai Peninsula. As marine mammals occur nearshore, we now have the ability to collect observer data on fishery interactions with marine mammals with a better spatial distribution of sampling relative to the fishery footprint. Under Alternatives 2 and 3, cameras would be able to record dead animals coming on board the vessel, but would be unable to record animals that fell off the gear prior to coming on board or being entangled in gear. No marine mammal interactions with gear have been recorded in the EM data collected during pre-implementation, so there is no data on the ability to identify marine mammal species with EM. Depending on the vessels that opt for EM selection, the implementation of EM may decrease the gains made in collecting data on marine mammal interactions in the fishery. Under Alternatives 2 and 3, observer data will continue to be used to provide estimates for the fishing activities without coverage.

[4] NMFS. 2015. Final Supplement to the Environmental Assessment for Restructuring the Program for Observer Procurement and Deployment in the North Pacific. September 2015. https://alaskafisheries.noaa.gov/sites/default/files/analyses/finalea_restructuring0915.pdf

Seabirds For more info, see Section 4.6

The majority of observed seabird bycatch in fisheries occurs in the hook-and-line fisheries. The restructuring of the Observer Program extended partial coverage to the halibut fisheries off Alaska, addressing a long-standing data gap for seabird bycatch estimates. Observers collect the number, species identifications, and tag recoveries of seabirds caught or killed by fishing gear, and report on seabird mitigation measure compliance (e.g., streamer lines) (Alternative 1). These data are used to estimate total bycatch of seabirds, and particularly those birds of conservation concern at risk of interaction with hook-and-line gear, including albatrosses.

Seabird data collection measures have been part of the 2015 and 2016 EM research and pre-implementation plans, with a primary objective for seabird monitoring in 2016 being to record presence/absence of streamer lines (seabird mitigation measures) during setting of hook-and-line gear on EM-observed trips. Fishermen are also required to hold caught seabirds up to a camera for identification purposes. While both observers and EM allow reporting of compliance with streamer lines, the observer can provide context for a particular situation, and can work with vessel operators in real-time to correct any potential issues. The ability to identify seabird species is similar when using observers and EM, as experts found the 2016 protocols for displaying seabirds to the camera and the camera picture quality were sufficient as long as fishermen adhered to catch handling protocols. Observers are able to collect specimens, however, and bring them onshore for identification. This could be a responsibility of the vessel operator with EM, although protocols and procedures for fishermen to collect specimens and bring them onshore for identification would need to be developed. It is likely that new or modified special purpose salvage permits from USFWS would be necessary.

Summary of Environmental Impacts of the Alternatives

		Alternative 1 Human observer program only	Alternatives 2 and 3 EM alternatives
Environmental Assessment Impacts	***Goals achieved with restructuring***	Unbiased discard data	Yes
		Ability to adapt monitoring to specific needs	More flexibility for monitoring on vessels where human observers are not practicable Less human observer coverage as fee is supporting both options
	Data collection		Where EM cannot duplicate an observer function, impact is a reduction in overall data not elimination of that data; observer data will be used to generate estimates, per established procedures.
	Fish	Species ID, count – based on sample	Yes, based on census
		Weight/ sex/ length	No
		Biological samples/ special projects	No
	Marine mammals	Information on interactions (location, date/time, gear, fishing depth, catch composition)	Not unless brought onboard dead No marine mammal interactions recorded to date in pre-implementation
		Information on gear entanglements (length, tissue samples, disposition)	No
	Seabirds	Species ID, count, tag recovery, collect specimens	Yes for species ID and count, if handling protocols adhered to Procedures needed if vessel operators are asked to collect specimens
		Compliance with streamer lines	Yes

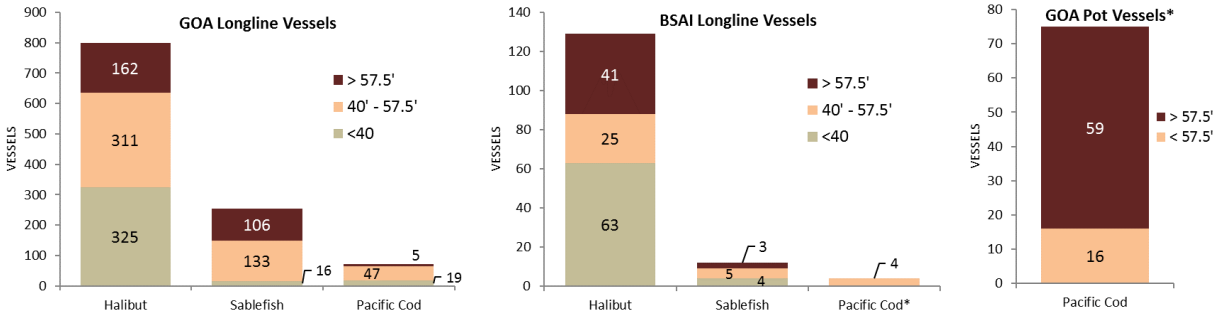
Regulatory Impact Review

Potential EM vessels

For more info, see Section 5.6

This analysis evaluates integrating EM as an option for the fixed gear groundfish and halibut fisheries that are currently in partial coverage under the Observer Program. Hook-and-line participants in these fisheries primarily target halibut, sablefish, and Pacific cod, and pot gear participants target Pacific cod[5]. Figure ES-6 provides an overview of the number of vessels that participated in these target fisheries in 2015, by vessel size category. The majority of participation across all target species occurs in the GOA management area. Participation by vessels of less than 40' LOA primarily occurs in the halibut fishery. Vessels of 57.5' LOA or greater make up less than 20% of the fleet targeting halibut, but account for around 46% of catch. Vessels in that size category make up the majority of the pot gear.

Figure ES-6 Count of longline and pot vessels fishing in 2015, by gear type, target fishery, and size category



Source: Catch Accounting System, provided by NMFS AKRO.

* Vessel size categories <40' and 40-57.5' LOA have been combined, and pot vessels in the BSAI are not shown, in order to preserve confidentiality.

In 2016, the EM Pre-implementation Program was available to longline vessels from 40 to 57.5 ft length overall, with service port locations offered in Sitka and Homer, and limited support in remote ports. Vessels were required to carry EM, if selected, for all trips during a 2 to 4 month selection period[6]. As of July, the 2016 EM selection pool included 51 vessels. Table ES-1 provides summary information on the 2015 fishery participation when using hook-and-line gear of the 51 vessels that are in the 2016 EM selection stratum. This information is used as a basis for modeling the effort patterns of at least one class of vessels that might be part of a fully implemented EM stratum (the EM pool will evolve as large vessels (>57.5'), small vessels (<40'), and pot gear vessels opt into the stratum). The vessels had an average trip length of 3.5 days (1,448 days over 418 trips) over all ports and trip targets when using hook-and-line gear. While this profile does not predict the stratum's demographics in 2017 or under a fully implemented program, it is informative in that this set of vessels represents fixed-gear operators who are motivated to carry EM equipment. Understanding the timing and location of fishing among this subset of the fixed-gear fleet could play into the Council's annual decision as to where and to what extent field support services should be provided, and where efficiencies can be realized.

[5] A small amount of catch was made on trips targeting sablefish with pot gear in 2015 (3 vessels landed 120 mt in the BSAI); draft regulations are pending to allow longline pot gear for sablefish in the GOA. Pot gear is not used to target halibut.

[6] In 2017, the Council is considering a pre-implementation plan that would use a trip selection approach, where vessels log each trip and are randomly selected to use EM on that trip. The pre-implementation pool is also open to all vessels ≥40' fishing either hook-and-line or pot gear.

Table ES-1 2015 hook-and-line effort by landing port for vessels in the 2016 EM pool

Landing Port	Vessels	Trips	Days Fished	Average Trip Length
Sitka	24	187	538	2.9
Seward	10	64	266	4.2
Kodiak	7	37	154	4.2
Homer	8	31	91	2.9
Yakutat	5	31	102	3.3
Juneau	5	16	65	4.1
Petersburg	4	12	49	4.1
Dutch Harbor/Nome/ St Paul*	4	16	98	6.1
Sand Point	C	C	C	3.0
King Cove	C	C	C	5.5
Port Alexander/Wrangell*	3	9	26	2.9
Other Alaska	C	C	C	2.0
Total	**46**	**418**	**1,448**	**3.5**

Source: ADFG/CFEC Fish Tickets, data compiled by AKFIN in Comprehensive_FT. C= Confidential
* Dutch Harbor, Nome, and St. Paul Island, and Port Alexander and Wrangell, are combined to maintain confidentiality.

Methodology for cost analysis

For more info, see Section 5.4

The EM funding and cost landscape is complex. The expense of EM, whether at the program level or on a per-vessel or per-day basis, is an important factor in the Council's determination regarding net benefits, but it is only part of the equation. In selecting a preferred alternative, the Council considered cost effectiveness (i.e., costs in terms of what the program provides) and how well the alternative addresses the management issues identified in the purpose and need statement. In other words, the Council's recommendation is not contingent on a finding that the near-term monetary cost profile of EM is different from (or lower than) that of a program that only deploys human observers. As such, this analysis does not seek to assign a dollar cost to an EM program of a given size and scope in any future year. Rather, it uses the best available information on what the Alaska fixed-gear EM program costs, in its present state, to establish a baseline for an ongoing deployment decision-making process over the life of the program.

Acknowledging the limitations to projecting accurate EM costs for a given deployment design in a given future year, the objectives of this RIR as it relates to monetary-cost analysis are to (1) define key cost drivers, and describe how those drivers affect the program's total cost profile, contingent on factors that are expected to vary over time or are contingent on program design choices that are yet to be made (Section 5.7.4); (2) estimate the unit cost of deploying EM in 2016, recognizing that these figures reflect a research-oriented program that does not cover the pot gear sector or the fleet of vessels that is less than 40' LOA, and that these estimates provide a useful baseline to track Alaska hook-and-line EM costs over time (Section 5.8.2.1); and (3) characterize the trade-offs in EM services that can be provided under various budget constraints, where "budget" is defined as the portion of the monitoring fee pool that would otherwise be used to purchase human observer-days for the partial coverage category and link expenditures of the monitoring fee-base on EM to the Observer Program's need for – and ability to purchase – observer-days (Section 5.8.2.2).

Cost factors

For more info, see Section 5.7.4

To evaluate EM costs, the analysis considers four factors: fixed versus variable costs, startup versus ongoing costs, cost trajectory, and uncertainty regarding program design.

- Any given category contains a mix of variable costs and fixed costs. Variable costs scale positively with the amount of activity in the program or the amount of services provided. Fixed costs can be thought of as overhead, and their unit cost might actually decrease as more vessels join the EM fleet or take more trips.

- Cost factors can also be categorized by those that are one-time ("startup") costs, periodic costs, and ongoing costs. Startup costs tend to be overhead costs or fixed costs of management, such as reprogramming aspects of the Catch Accounting System. Once the Alaska EM program transitions to a regulated program, its will have benefitted from the fact that some of those cost-intensive investments in human capital and program infrastructure occurred during pre-implementation, when they were funded by NMFS and other grant monies. For example, planned purchases to support the draft 2017 pre-implementation program would result in potentially 90 EM hardware sets purchased and installed on hook-and-line vessels[7], and another 30 EM systems on pot vessels. Some cost factors are predictably periodic, meaning that costs occur at predictable intervals. For example, hardware will need to be replaced or upgraded on a regular basis.
- The price of EM services and components will change over time ("cost trajectory"). Some cost factors are weighted towards the early years of the program; those costs can be generally categorized as "capacity building" activities. Other cost factors could decrease over time, either as a result of capacity building (e.g., fewer field services required) or of competition and technological development (e.g., the cost of new hardware or video review time decreases). Cost factors that are otherwise similar might have a different trajectory over time, however the analysts generally assume that costs will decrease over time as the program moves past startup costs and as implementation inefficiencies are overcome.
- Finally, the size, scope, and nature of the EM program in any given post-implementation year has not been determined yet, nor is it intended to have been. The analysts refer to these as cost uncertainties. The action alternatives establish a process through which data objectives and deployment strategies that affect costs are made annually. The EM program's annual deployment design will also be dictated by available funding and by the demand for observer-days to meet sampling needs in non-EM strata. The EM stratum is intended to be an option for vessel operators, thus the number of vessels in the stratum, their distribution across delivery ports, and the number of trips they make each year will likely vary on an annual basis. Elements that were thought to have a declining cost trajectory might behave differently as the objectives or design of the program is redefined.

Table ES-2 summarizes monetary cost factors for evaluating an EM program.

The design of field service deployment and the definition of operator responsibilities are also likely to impose costs on vessel operators that are not directly denominated in dollar expenditures.[8] Program design elements that create demands on operators' time, affect trip plans, or alter at-sea operations result in opportunity costs. Though not quantified in this analysis, opportunity costs reflect the value of what a stakeholder could have generated if he or she were not otherwise obligated. The values that could have been generated might be denominated in terms of production (harvest efficiency) or utility (satisfaction with the monitoring program, or time available for non-labor activities). Program designs that result in high non-monetary costs could cause vessel owners on the margin to disengage from the fishery by selling quota shares or allowing their shares to be fished on platforms that are less impacted by the Observer Program's requirements. To the extent that vessel operators disengage from the fishery as a result of the monitoring plan, the program affects the distribution of benefits from the resource and the supply of employment opportunities.

[7] The plan calls for the pre-wiring and installation of camera and sensor systems on 90 vessels, and the purchase of 60 control centers that can be rotated among the fleet.
[8] Non-monetary costs might extend to non-harvesting shoreside stakeholders such as processors depending on whether the design of the EM program creates new responsibilities such as dockside monitoring, and how those responsibilities are apportioned.

Table ES-2 Characterization of selected EM cost factors (viewed as annual costs over the life of the program

Category	Cost Factor	Trajectory	Uncertainty
Hardware	Control Center*	Null or Decreasing	Start-up pool; Size of EM Pool; Depreciation/Breakage rate
	Camera/Sensor Package	Decreasing	Start-up pool; Size of EM Pool; Depreciation/Breakage rate; Undefined required peripherals
	Installation	Decreasing	Start-up pool
	Hard-Drives	Decreasing	New technologies
	Software Licensing	Null or Decreasing	Contract requirements; Competition
Field Support	Re-installation	Unknown	Demographics; Port capacity
	Control Center Rotation	Unknown	Deployment method; Port capacity
	Labor/Travel	Null or Decreasing	Demographics; Deployment method; Port capacity
	Project Mgmt.	Unknown	Contract requirements
	Training	Decreasing	Port capacity
	Data Retrieval	Decreasing	Operator responsibilities; Demographics; Automated data transmission
	Dockside Monitoring**	Null or Increasing	Undefined data objectives
Data Analysis	Video Review Time	Unknown	Data objectives; Size of EM Pool
	Review Labor/Training	Null or Unknown	Data objectives; Labor turnover
	Software Licensing	Null or Decreasing	Contract requirements; "Open-source"
	Project Mgmt.	Unknown	Port capacity; Contract requirements; Competition
Administrative	Data Integration	Decreasing	Pre-Implementation work; Data objectives
	Data Auditing	Unknown	Data objectives; Contract requirements
	Data Storage	Decreasing	New technologies; Undefined requirements
	Deployment Mgmt.	Increasing	Demographics; Size of EM Pool
	Outreach	Decreasing	Size of EM Pool; Port capacity
	Project Mgmt.***	Unknown	Deployment method; Port capacity; Data objectives

* The analysts make no assumptions about the future unit-cost of proprietary hardware, but note that market competition could be a factor.
** Not part of the Pre-Implementation program. Cost could come out of the human observer side of the deployment budget.
*** NMFS/FMA costs would not come out of the Observer Program's deployment budget, as is the case under status quo.

Unit cost exercise

For more info, see Section 5.8.2.1

The cost of EM programs in other regions have typically been assessed in terms of how much the program costs per vessel, per trip, or per monitored sea-day ("unit costs"). Unit costs are a useful metric for tracking the cost of a given EM program at a moment in time, although they fail to capture the trajectory of costs as they tend to conflate fixed and variable costs and are too simplistic to recognize the cost impact of program uncertainties. The analysts express reservation about using unit costs as a tool to compare EM's cost *effectiveness* across regions or against human observer programs.

Only those cost factors that would be paid for through the monitoring fees that are collected from the industry (i.e., the 1.25% ex-vessel fee) have been considered for this cost exercise. The analysts have established a single methodology for estimating unit costs (per vessel, per trip, per sea-day) of the 2016 EM program. That methodology is applied to 12 different scenarios that could, conceivably, describe the 2016 program in retrospect. The need for twelve different scenarios (I – XII) stems from the many unknowns involved in costing out a 2016 program that is in the midst of purchasing and operation. Moreover, the 2016 program is distinct in that it is both an operating pre-implementation monitoring program and an effort to build up capacity for future years. The individual scenarios are not described in detail in this Executive Summary, but they vary based on high and low spending cases, how 2016 partial year data is reflected, how previously spent funds were credited towards 2016 hardware purchases, and how aggressively pre-purchasing of hardware for 2017 will be carried out through the end of 2016.

Table ES-3 summarizes the results of this exercise in costing out the 2016 fixed-gear EM program. The unit cost estimates in the major columns of the table represent three different presumptions about which

tasks might be funded through the observer fee, as opposed to being absorbed in NMFS' budget (EM Contractor only; EM Contractor and Video Review; EM Contractor and Video Review and Data Storage). The twelve scenarios provide a range within which to consider the unit costs of the 2016 EM program, and should be understood with the three following caveats. First, the 2016 program was not designed with cost-efficiency as the primary goal. Second, all unit cost estimates would be lower if there were more fishing effort in the EM pool. Third, this basic model is set up in a manner suggesting that non-hardware provider costs are inversely related to hardware purchasing in 2016. That relationship is merely an artifact of the analysts' inability to enumerate the EM provider's field service, travel, and management costs. Hardware purchasing and field service spending levels during the pre-implementation phase are certain to differ from the levels that will be observed in a mature program.

Table ES-3 Unit cost estimates for the 2016 hook-and-line EM program, under three different assumptions of the EM costs that might be paid from the observer fee

Scenario	2016 Prog. Cost	Unit Cost ($)								
		EM Contractor			Contractor + Vid. Review			Contractor + Review + Data Storage		
		Per Vessel	Per Trip	Per Day	Per Vessel	Per Trip	Per Day	Per Vessel	Per Trip	Per Day
I	$453,278	26,663	7,952	1,988	29,396	8,767	2,192	29,730	8,867	2,217
II	$187,140	11,008	3,283	821	13,741	4,098	1,025	14,075	4,198	1,050
III	$424,478	24,969	7,447	1,862	27,702	2,868	2,066	28,036	8,361	2,091
IV	$158,340	9,314	2,778	694	12,047	3,593	898	12,381	3,692	923
V	$651,450	21,715	5,714	1,429	24,446	6,433	1,609	24,779	6,521	1,631
VI	$271,450	9,048	2,381	595	11,779	3,100	775	12,113	3,188	797
VII	$622,650	20,755	5,462	1,365	23,486	6,181	1,545	23,819	6,269	1,567
VIII	$242,650	8,088	2,129	532	10,819	2,848	712	11,153	2,935	734
IX	$508,800	16,960	4,463	1,116	19,691	5,182	1,296	20,024	5,270	1,318
X	$393,600	13,120	3,453	863	15,851	4,172	1,043	16,184	4,259	1,065
XI	$492,000	16,400	4,316	1,079	19,131	5,035	1,259	19,464	5,123	1,281
XII	$376,800	12,560	3,305	826	15,291	4,024	1,006	15,624	4,112	1,028

EM cost tradeoffs under budget constraints

For more info, see Section 5.8.2.2

Estimated unit costs of the 2016 Alaska fixed-gear EM program provide a useful baseline for future program evaluations, but the metric is inherently limited in its ability to capture the evolution of individual program elements' cost profiles over time. Another approach is to consider what is known about the variations in cost of each element, based on cost trajectory or program design, and consider the total of these costs in the context of a range of plausible EM budget scenarios. This exercise allows the reader to conceptualize potential trade-offs between the scope of the EM program and other monitoring needs.

Program elements include hardware/software (costs are profiled at the annual, per-vessel level so that total program costs can be scaled up or down depending on the size of the EM stratum that is being imagined in a given future year), field service (costs are expected to vary across both time (trajectory) and program design choices (uncertainty)), video review and data storage (it is yet to be determined whether these costs will be paid through the monitoring fee or NMFS's budget). Some cost items, such as program management, do not scale with the size of the fleet or the effort in the EM stratum in any manner, but might decrease over time as the program matures and requires fewer hours of management, reporting, and coordination with the regulatory development process. Other cost items, such as the number of ports in which local trained technicians are provided, scale with participation and effort to a degree, but not on a per-vessel or per-trip basis. The service cost items that behave more like variable costs will scale differently depending on the program's deployment model – "vessel selection" or "trip selection." Holding the size of the EM fleet steady over time, it is reasonable to expect that demand for services will

trend downward – approaching a steady state – as initial installations convert to re-installations, as service travel demand decreases, or as routine maintenance and software management can be handled remotely or by the vessel operator. Finally, it is also important to recognize that the cost *effectiveness* of dollars spent providing field services may vary depending on the level of effort in the EM stratum and the selection probability for vessels that have received costly installations and technical support.

The manner in which the **annual budget for EM** is determined is a policy choice that is yet to be made, and the basis for the budget could evolve as the Council and the Observer Program gain a sense of the program's scope, true cost, and value. For the purpose of discussion, the analysis considers three ways to scope an EM budget: as a function of the number of vessels in the EM stratum, the amount of effort (trips or sea-days) relative to the non-EM strata, or the proportion of total monitoring fees remitted by the vessels in the EM stratum during the preceding year. The consideration of EM budgets includes options to divide up only the non-trawl proportion of the EM budget, to ensure that the program is "revenue neutral" towards the trawl sector. Based on approximations of those metrics drawn from recent years, the potential EM budget ranges between $287,000 and $957,500, out of a total fee base of $3.83 million. At the largest level, the remaining $2.87 million would afford approximately 2,680 observer-days, which is less than the 4,500 and 5,300 observer-days per year used during 2014 and 2015, but these levels were only achieved with supplementary Federal funds. During those years, monitoring fees were used to purchase 2,600 to 3,000 observer-days. The analysis suggests that the cost of an EM program is likely to exceed the amount of the monitoring fees that would have been generated by the vessels in the EM stratum during the preceding year. However, the existing pre-implementation program, which provided the baseline for some of the cost profiles, was not designed to minimize costs. It is entirely possible that an EM program could be deployed within a given budget constraint, but doing so – at least in the near-term – would likely require cost-conscious design choices.

Impacts of Alternative 2 ***Preferred Alternative*** **For more info, see Section 5.8.2.3**

EM participants: The EM program is structured as a stratum into that vessels may choose whether or not to opt into. While there are certainly both benefits and costs to participating in EM, one would assume that vessel operators who volunteer for the program perceive an individual net benefit. The main category of costs for EM vessels is the "non-monetary" time and opportunity costs. These costs include the time that operators and crew might spend working with the provider on installation and maintenance, or completing duty-of-care tasks that are defined as operator responsibilities in the ADP (currently outlined in the 2017 Pre-Implementation Plan). Some time and opportunity costs might fall more heavily on vessels that operate out of remote ports, where the program could potentially require them to remain in port until a technician can travel to correct a critical EM system failure or transit to a nearby port with a local EM technician. The potential onus of these operator responsibilities will be defined as the Council, NMFS, and stakeholders on the EM Workgroup balance the trade-offs between providing service in all areas and the cost of the program. While this analysis uses the term "non-monetary" to describe time and opportunity costs, modifications to a vessel's business plan or an individual's labor schedule do impose economic costs. Over the course of the Observer Program and the EM pre-implementation phase, NMFS and EM providers have worked with fishermen to minimize the unintended operational impacts of monitoring, and that practice is expected to continue.

Other partial coverage harvesters: All vessel owners who pay monitoring fees hold a stake in the quantity and quality of the biological and management data that are generated through the combined efforts of the Observer Program. While vessel owners are the direct payers of the fee (along with their processing partners), hired skippers and crew members are affected by the quality of information that is available to fishery managers, as the adequacy and timeliness of data influence catch limits and season closures that, in turn, affect opportunities for labor. The most apparent mechanism for the action alternatives to affect non-EM fishery participants is "competition" for limited monitoring deployment

funds across the various partial coverage strata. The potential effect depends on the scope of the program, which will evolve and be analyzed and adjusted annually.

Processors: Alternative 2 is not expected to have a substantial impact on shoreside processors. Though not part of the 2016 Pre-Implementation Plan or the draft 2017 Plan, it is possible that the ADP in some future year could define a dockside monitoring component of the EM program, and if so, a processor might have to make adjustments to its catch monitoring and control plan if it has one. Responsibilities for dockside monitoring costs, should they exist, have not been fully defined, as the need for dockside monitoring under Alternative 2 is thought to be low at the present time.

Observer Program: In terms of how integrating EM might impact the deployment of observers in other partial coverage strata, the direction of the effect is determined largely by the cost of deploying EM. In general, if the cost of EM deployment is disproportionately high relative to the amount of data that the stratum is producing, then it is likely that the budget for purchasing observer-days will be curtailed (absent additional sources of funding). The analysts are limited in their ability to identify a cost tipping-point beyond which EM expenses have a net negative impact on the number of observer-days that can be afforded. The Council is under no obligation to limit the scope of the EM program to a level that has no effect on observer deployment. If the Council selects Alternative 2, it is merely committing to an annual process through which these trade-offs will be analyzed in the fleet and budgetary context that exists at the time.

Impacts of IFQ in multiple areas option under Alternative 2 For more info, see Section 5.8.3

It is uncertain how many IFQ and halibut CDQ vessel owners are facing restrictions due to the current regulations, although testimony by IFQ fishery representatives in June 2013 first identified this issue for the Council. To the extent that vessels are affected and are willing to opt in to the EM selection pool, implementation of this option could reduce the costs of fishing in multiple IFQ areas, and reduce the potential for increased amounts of unfished IFQ if vessel owners cannot combine "clean-up" trips for multiple areas. By participating in the EM pool, they would have the freedom to engage in multiple areas trips at little or no cost. All beneficiaries of this option would already be part of the EM selection pool, with an EM system installed and a duty of care for the system while it is onboard, so there would be little or no additional burden from the equipment; if NMFS Enforcement requires that power be maintained to the system 24 hours a day during an IFQ in multiple areas trip, there may be some additional cost to keeping the generator on longer. Implementation of Alternative 2 without this option could cause some harvesters for whom an IFQ in multiple areas trip is a regular fishing practice to avoid joining the EM selection pool, as they would have no pathway to get an observer.

For the Observer Program, the implementation of this option could alleviate a potential source of data quality bias by giving harvesters an option to take IFQ in multiple areas trips legitimately, at the harvester's convenience, if they join the EM selection pool. There may be some cost to NMFS or the partial coverage fee budget from a slight increase in video review and data storage costs, depending which budget is ultimately responsible for video review and data storage costs. There may be an increase in enforcement activity as a result of this option, as Enforcement takes on the role of verifying IFQ in multiple areas trips.

Impacts of rockfish retention option under Alternative 2 For more info, see Section 5.8.4

Vessel operators might experience an opportunity cost if they are required to retain species that fetch a lower ex-vessel value than what they are targeting on the trip *and* if those retained fish displace stowage capacity for higher value fish. This negative outcome is more likely to occur on smaller vessels with limited hold capacity, though it could occur on any vessel that fills its hold on a given trip. That effect would be exacerbated if the species is on PSC status, and thus cannot be sold after it is landed. Of the

three primary target species for fixed gear vessels (halibut, sablefish, and Pacific cod), rockfish are most likely to be encountered on halibut trips due to the similar depths at which the species tend to be found. If any perceived negative impact occurs only when carrying EM, this option might create a disincentive for vessel owners to opt into the EM stratum, reducing engagement in the program and the maximum range of its net benefits to the nation.

The benefits of full retention are primarily centered around improved data quality (rockfish identification) and the simplification of vessel operators' at-sea responsibility for identifying species. Shoreside processors are stakeholders in the overall quality of data collection, but could experience small to moderate negative impacts in the form of additional responsibilities and/or monitoring costs. The two categories of potential processor costs are dockside monitoring and responsibility for disposal of non-marketable catch after delivery. Requiring full retention could also create an avenue for the Observer Program to collect biological samples from the EM stratum, which obviously cannot be collected through video review

Impacts of Alternative 3 For more info, see Section 5.8.5

Alternative 3 anticipates similar EM program requirements to Alternative 2, with the addition of catch logbooks. The alternative requires all vessels in the EM stratum to carry an EM system, which could increase the hardware/software cost profile of the program, especially compared to Alternative 2 where, in pre-implementation, control centers will be rotated among hook-and-line participating vessels. The full retention requirement could also bring with it a need to incorporate dockside monitoring into the program, as in Alternative 2, Option 1. Relative to Alternative 2, the cost of the EM program under Alternative 3 would be driven by the difference in the amount of video that is being reviewed. It is not possible to quantify this marginal difference at this time because the size of the EM stratum, the selection rate for coverage, and the proportion of video that would be reviewed to audit logbook quality (e.g., 10% to 20%) are not defined. Vessel operators might experience moderate time costs related to logbook responsibilities. These costs would be additional to those involved with EM system installation and maintenance, which are described under Alternative 2.

The overall cost profile of the EM program under Alternative 3 will also depend on frequency of logbooks being found out of sync with what reviewers find in the video data; in other words, costs are driven by logbook quality. Logbook quality will be at least partially determined by the fleet's experience with EM logbooks (i.e., the number of vessels that are new to the EM stratum), or the number of vessels that take only a small number of trips per year. The analysts would expect vessels that have, or accrue, less experience filling out EM logbooks to require a greater amount of re-review and logbook correction after the initial audit. If participation in the EM stratum shifts generally towards vessels that take only one or two trips per year, the cost-effectiveness of the program could decrease. As discussed under Alternative 2, these vessels impose higher per-vessel costs on the program in terms of hardware and field services, in addition to higher data analysis costs. The cost of additional review for non-compliant logbooks would be borne by NMFS, and could not be paid through industry monitoring fees.[9] Over time, however, it is reasonable to expect the quality of EM logbooks to increase and the cost of data analysis to stabilize after a period of fleet learning and EM socialization.

[9] NMFS Alaska Region has the authority to charge a monitoring fee to industry under Section 313 of the MSA, but those fees may only be derived from a recovery based on landings. In other words, NMFS may use the ex-vessel based monitoring fee to fund the collection and review of video data or logbooks, but would need explicit authority from Congress to charge a separate fee for a particular duty such as re-reviewing video triggered by a non-compliant logbook. Charging a separate fee, in addition to the fee recovered from landings, might implicate the augmentation of appropriations laws that bar agencies from imposing agency costs for agency responsibilities onto industry. NMFS would not use the monitoring fee to cover the cost of typical agency responsibilities, such as routine management and reporting, or the administrative cost of developing a new logbook format for EM. (NOAA GC AK. Personal Communication, 2016.)

As with Alternative 2, it is important to keep in mind that the cost of the EM program – and thus its impact on the Observer Program's overall mission – is limited by the fact that this action merely authorizes a new use of monitoring fees, but does not guarantee that the EM stratum will be part of the monitoring plan in any or all future years. If the economic and non-economic costs of the program outweigh the anticipated benefits, or do not improve the cost-effectiveness of data collection, then the ADP would not recommend an EM stratum.

Summary of Economic Impacts of EM Alternatives

		Alternative 2	Alternative 3
		EM as tool for catch estimation	Logbook as tool for catch estimation, with EM verification
RIR Impacts	***Vessels in the EM selection pool***	• Vessels choose whether to join EM, therefore they have made the net benefit is positive • Main costs are opportunity costs – time on installation, maintenance, at-sea operator responsibilities. May be more onerous for vessels operating in remote ports, where EM service is less frequent.	
	Catch Logbook	Alt 2: Not applicable	Alt 3: additional time cost for completing the catch logbook, and risk of violation if logbook is inaccurate
	Rockfish retention	Alt 2: Council option • simplifies rockfish requirements • Opportunity cost for retaining species that displace higher value fish; more likely to affect smaller vessels with less hold capacity	Alt 3: required
	Vessels in partial coverage but not using EM	• All who pay the fee have a stake in good data • "Competition" for limited deployment funds from the observer fee	Alt 3: 100% EM system requirement increases hardware costs, but logbook audit model means less cost for data review
	Processors	• No substantial impact unless dockside monitoring or full retention is required	
	Rockfish Retention	Alt 2: Council option • Costs from responsibility for disposal of non-marketable catch, and potential changes to accommodate dockside monitoring	Alt 3: required
	Observer Program	• Cost of EM affects Observer Program overall by impacting deployment in other strata • Alternatives regulate a process to allow EM, rather than a specific EM outcome • Council and NMFS will have annual opportunity to consider appropriate budget tradeoff between EM and human observer deployment	
	Rockfish retention	Alt 2: Council option • Rockfish retention would improve data quality for rockfish, provides opportunity to get biological samples, but may increase costs if dockside monitoring is required	Alt 3: required
	Catch Logbook	Alt 2: Not applicable	Alt 3: logbook quality may affect costs, as inaccuracies will drive need for more thorough EM review