# Electronic Monitoring of Alaska Halibut and Sablefish Quota Share Fisheries

## 2011 - 2012 Pilot Project Report

In 2010, the North Pacific Fishery Management Council (Council) voted to restructure the North Pacific Observer Program. The restructured program will change the way vessels pay for and obtain observer coverage and extend coverage to include vessels under 60' and halibut vessels for the first time. Implementation of the restructured observer program is scheduled to begin in January 2013.

In response to well documented stakeholder testimony on the problems associated with carrying human observers on small boats, the Council approved a motion to *"develop electronic monitoring as an alternative tool for fulfilling observer coverage requirements with the intent that it be in place at the same time as the restructured observer program" (Council Motion June 2010).*

## Pilot Program

Immediately following the 2010 Council action, a coalition of industry associations representing small fixed gear vessels from Sitka, Petersburg, Homer and Juneau went to work to ensure a workable alternative to human observers would be available upon program implementation. With funding from the National Fish and Wildlife Foundation, longline organizations launched a two year pilot program in 2011 to field test Electronic Monitoring (EM) as an at-sea monitoring tool for the halibut and sablefish fisheries. Our project partners were the Alaska Fisheries Science Center (AFSC), which provided project design advice, and Archipelago Marine Research (AMR), which provided the electronic monitoring systems. This report documents the project.

### EM pilot program highlights:

- EM systems proved reliable and adaptable to a variety of vessel configurations.
- EM systems monitored 41 trips, 158 sea days and recorded 215 hauls.
- EM data allowed species level identification for 94% of fish on reviewed hauls.
- EM costs, including data analysis, were $198/sea day for Sitka vessels and $332/sea day for Homer vessels.
- EM offers a substantial savings when compared to the cost of human observers under the restructured Observer Program.

***A collaboration involving:***

*Alaska Longline Fishermen's Association, Southeast Alaska Fishermen's Alliance, Petersburg Vessel Owners Association, Kachemak Bay Fishermen's Association, Archipelago Marine Research, NMFS Alaska Fisheries Science Center.*

*Funding provided by the National Fish and Wildlife Foundation*

## Monitoring Objective

> ***The monitoring objective was to achieve an independent estimate of total catch.***

Electronic monitoring is a versatile tool that can create customized at-sea monitoring programs to achieve a variety of objectives, including estimating total catch or ensuring compliance with specific regulations. At the request of the AFSC, the primary monitoring objective for this pilot program was to assess catch and catch composition, particularly at-sea discards, on halibut and sablefish longline vessels under 60 feet.[1] Further refinement of this objective established that the EM system would provide an independent estimate of total catch. Discards at the roller would be noted in the video analysis. Other discards would be determined by subtracting the landed catch on fish tickets from the total catch estimate.

To estimate total catch, EM systems can either be designed to verify logbooks, as in the Canadian system, or to provide an independent census of total catch. Logbook verification can provide near real-time data for in-season management. However, as the halibut and sablefish quota share fisheries are not constrained by bycatch limits, real-time data is not required for catch accounting. Additionally, logbooks are not currently required on sablefish vessels less than 60'. Therefore, in consultation with the AFSC, a census of EM data collected was used to estimate total catch.

Once this monitoring objective was clearly defined, camera placement, fish handling procedures, data capture rates, and a number of other program design decisions could be made.

## Components and Design

In the pilot program, the EM system deployed consisted of three components: an on-board computer system, two cameras, a sensors package consisting of a hydraulic sensor, a rotation sensor and a GPS antenna.

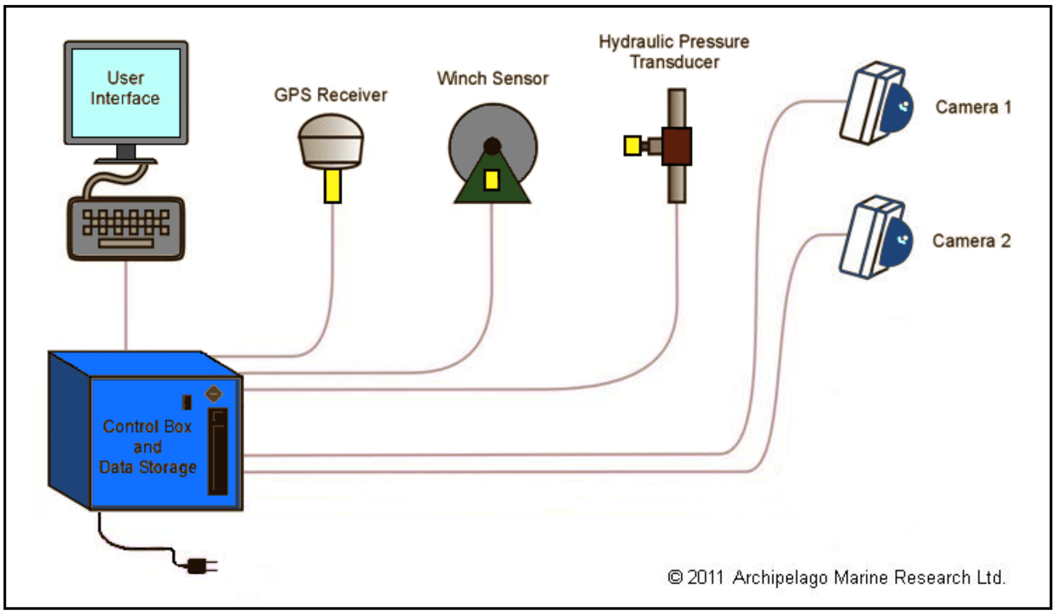
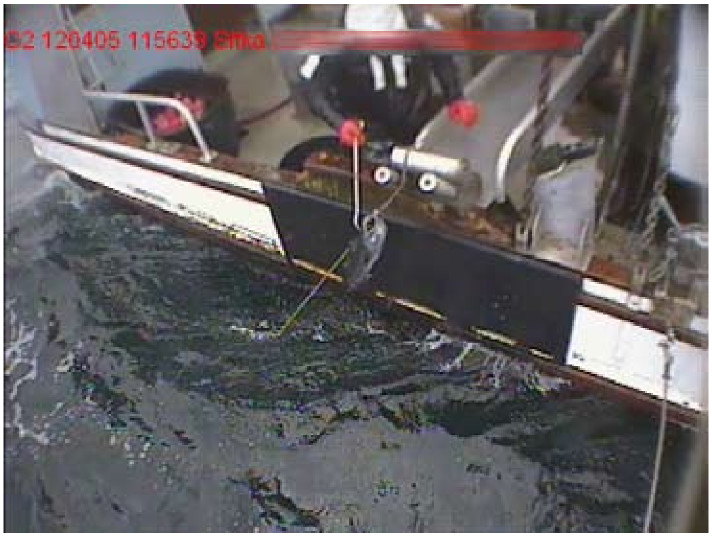



*Figure 1. Schematic diagram of the electronic monitoring system, which can record video data from multiple cameras per vessel.*

The systems used in this project were Archipelago's v4.2 EM Observe hardware running v3.0 EM Record software. This system is presently in use on hundreds of boats worldwide and collects much of the data used to manage the British Columbia groundfish fishery. The onboard computer system or "control box" is the heart of the system and contains a hard drive for recording the video images and the software to activate the cameras. The control box software also monitors and records input from each sensor, providing a complete record of the system's performance and vessel activity during a trip. On board the vessel, the control box is powered by either 12V or 110V and is operated by a simple keyboard and monitor mounted in the wheelhouse. To certify that the installation is done correctly and to ensure proper sensor function, the EM system contains a diagnostic component in the software that runs each time the system is powered up. This "function test" compares the current sensor reading with pre-calibrated values and requires the vessel operator positively verify that the current reading is within tolerance.

[1] March 2011 OAC meeting minutes Page 5.



*Typical wide angle view on Sitka vessels.*

*Typical close-up view on Sitka vessels.*

In Sitka, two 640x480 pixel resolution analog cameras were mounted outboard of the roller to provide coverage of the groundline being hauled, thus capturing all fish brought onboard, those discarded at the roller, and any that dropped off the groundline at the surface. One camera was set for a wide angle view and one for a close-up view to aid in species identification. In Homer the same cameras were mounted under the shelter deck and off the stern of the vessel, aimed at the roller or where the longline would break the surface of the water to capture the similar information.

A sensor package consisting of a hydraulic pressure sensor, a rotation sensor, and a GPS unit were installed to activate camera recordings and to monitor vessel activity. To ensure system reliability, activity on either the hydraulic pressure sensor or the rotation sensor could independently activate camera recording. The GPS unit provided a continuous record of vessel activity and location of longline sets.

## Deployment Plan

Electronic monitoring systems require a significant investment in equipment. To ensure cost-effectiveness, this equipment must be deployed at sea for as many days as possible over the lifespan of the equipment and must be designed to meet the varied fishing patterns of the fleet. Because the onboard computer system is the most expensive component in an EM system, the pilot project worked with AMR to develop "plug and play" capabilities allowing the control box to be easily rotated from vessel to vessel to maximize sea days. This approach also allows significant flexibility to accommodate changes in fishing plans and a wide range of sampling strategies.

*EM control box with 'plug-in play' connections.*

Installation of the cameras and sensor packages requires technical expertise. For this reason, the pilot program was focused on two Alaska hub communities: Sitka and Homer. Vessels were pre-wired by a visiting technician with the camera and sensor packages, leaving only the "plug and play" control box to install when the vessel was ready to fish.

The vessel operators provided approximate fishing schedules to a local program coordinator and, when a vessel was selected to carry an EM system, the local program coordinator or the vessel operator installed the control box and tested the installation using the function test. Camera alignment was also checked against a reference image collected by a certified technician during the install. The results of the function test were stored on the hard drive and could be retrieved to validate correct system operation prior to departure. Upon completion of two or more fishing trips, the program coordinator rotated the control box onto the next vessel, retrieving the data and replacing the hard drive in the process.

The final part of the deployment plan was providing the vessel operators with clear written guidelines for operating and maintaining the EM system while fishing. Vessel specific monitoring plans were developed that contained instructions on performing the function test, contacting technical support with any problems, and detailed operator responsibilities while fishing.


*Typical wide angle view on Homer vessels.*

*Typical close-up view on Homer vessels.*

## Pilot Program Results

A total of ten vessels were pre-wired to receive EM systems, six in Sitka and four in Homer. The vessels were selected to provide a variety of hull and deck configurations and included both conventional “fixed” gear and “snap-on.” Sitka vessels hauled longline gear using a side mounted roller or davit. Homer vessels hauled longline gear over the stern and had removable aluminum shelter decks. The EM systems used in the pilot program proved adaptable to these diverse and challenging installation conditions.

***The pilot program used EM systems to monitor 41 trips over 158 sea days and recorded 215 hauls.***

Each community received two control boxes to rotate among the pre-wired vessels. EM systems were opportunistically rotated to provide at-sea coverage for at least two fishing trips per vessel. Several vessels carried the EM systems for considerably more than the two trip minimum. The duration of deployment was determined by the program coordinator, the fishing locations, and the schedules of the vessels.

In Sitka, the EM systems were deployed on 24 trips for 102 days at sea monitoring 87 hauls. In Homer, the EM systems were deployed on 17 trips for 56 days at sea monitoring 128 hauls. In total, the EM systems deployed under the pilot program captured 41 trips, 158 sea days, and recorded 215 hauls.

| Community | # of vessels | # of trips | # of sea days | # of hauls |
|---|---|---|---|---|
| Sitka | 6 | 24 | 102 | 87 |
| Homer | 4 | 17 | 56 | 128 |
| **Total** | **10** | **41** | **158** | **215** |

*Table 1. Number of vessels, trips, sea days and hauls monitored under the pilot program by community.*

## System Reliability

The GPS sensors accurately recorded the vessel's position without significant interruption 99.9% of the time.[2] The GPS sensor track was used to monitor all vessel activity from the time the vessel left port. GPS data also allowed quick identification of longline haul start and end points based on distinctive course and speed changes that were aligned with sensor activity.

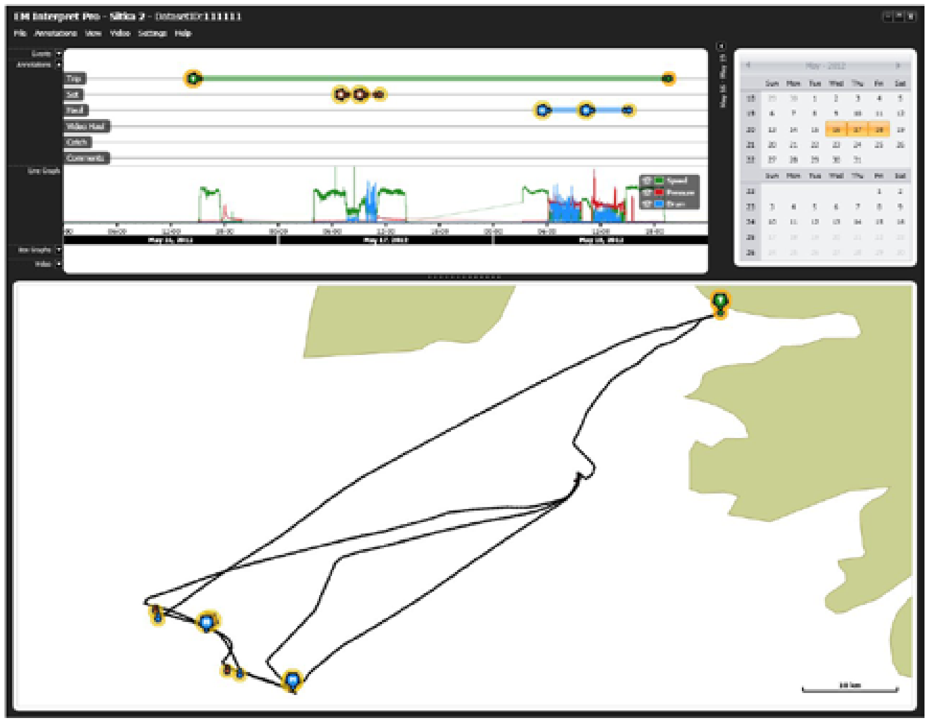


*Figure 2. EM systems use a variety of sensors in addition to cameras to monitor vessel activity. This figure illustrates how a graphic display of the combined sensor data allows fishing activity to be quickly detected.*

System reliability was measured by the performance of the individual sensors and the successful capture of a complete video record of each longline haul. During the pilot program, the hydraulic pressure sensors, which are the primary activation trigger for camera recording, functioned with 99.5% reliability. The errors associated with the four times the hydraulic pressure sensors failed to activate the cameras were caused by the activation pressure threshold being set too high on one vessel, a condition easily remedied with a calibration adjustment.

Rotation sensors were installed on fixed gear vessels to monitor sheave rotation and on the hydraulic drums of snap-on vessels to monitor both setting and hauling activity. Due to line-of-sight difficulties and displacement caused by normal fishing operations, the use of a rotation sensor for redundant camera activation on pilot program vessels functioned properly only 40.1% of the time. This issue can be effectively addressed with the addition of a second hydraulic pressure sensor.

Overall, 95.3% of the hauls monitored on all vessels had a complete video record (video was recorded for the entire haul). Four of the incomplete video records were due to the hydraulic pressure sensor failing to activate the camera due to an incorrect pressure sensor threshold and six of the incomplete video records resulted from the EM system not receiving power while at sea.

***The EM systems captured a complete video record of 95.3% of the longline hauls.***

| Sensor | Reference Amount | % Reliability |
|---|---|---|
| GPS Sensor (does not include night time gaps) | 2,215 trip hrs. | 99.9% |
| Hydraulic Pressure | 215 Hauls | 99.5% |
| Rotation sensors | 215 Hauls | 40.1% |
| Complete Video Capture of Haul | 215 Hauls | 95.3% |

*Table 2. Sensor performance during the pilot program.*

[2] Excludes night-time gaps when the engine was powered down and the EM system was in sleep mode. Momentary lapses lasting less than 30 seconds were not included.

## Video Quality

At the end of each deployment, the control box was retrieved and data was downloaded from the removable hard drive. The data was later reviewed using specialized software to determine fishing effort, system performance, and video quality. Video quality was assessed as high, medium, and low or unusable for each longline haul. High and medium quality data were used for further analysis of catch composition by haul.

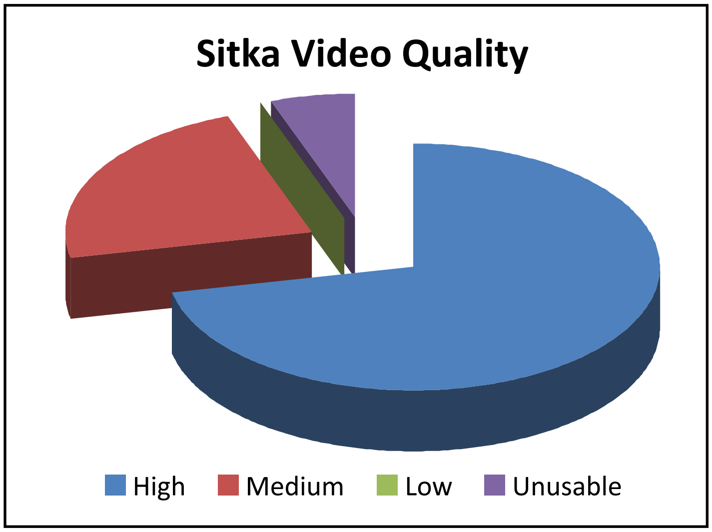
For Sitka vessels 72% of sets had high quality video, 23% Medium and 5% low or unusable quality. Thus 95% of the longline hauls on Sitka vessels provided video quality that was usable for determining catch composition. For the Homer vessels, 2% of sets had high quality video, 49% medium and 49% low or unusable quality. Video in Homer suffered from much higher rates of low quality than is typically found in projects elsewhere. This can be attributed to three factors: camera placement, low levels of operator familiarity and lack of timely feedback. The low ceilings of the shelter decks forced the cameras to be in proximity to moving gear and fish spray, coating the lenses in debris and obstructing the views. The skippers involved cleaned the lenses before each trip as instructed, but they were not sufficiently familiar with the EM systems to use the wheelhouse monitors during a trip to ground truth lens cleanliness. Because the hard drives were only collected after the deployment was complete, this problem was not detected early enough to change camera placement or to instruct crews to clean the lenses before each haul. As a result only 51% of the longline hauls on Homer vessels provided video quality that could be used for determining catch composition.

Throughout the pilot project, video quality was mostly dependent on operator maintenance rather than environmental factors. In other countries using EM systems, education and outreach have proven the most effective method of improving video quality during initial implementation, and data collection rates of ~98%+ are observed. For the pilot program, a mandatory data quality and quantity review after the first trip would have significantly improved video quality by allowing adjustments to the EM equipment or development of supplemental operating instructions.


**High Quality**

**Medium Quality**

**Low Quality**



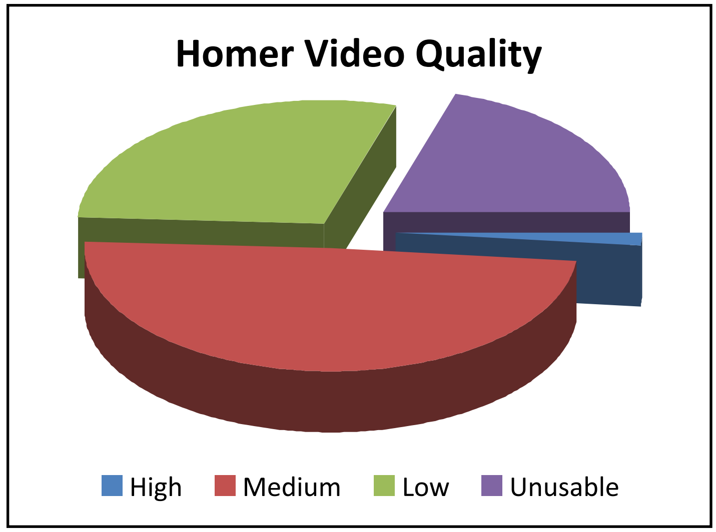




*Figure 3. Quality of video captured from longline hauls in Sitka and Homer. Homer video quality was lower due to camera placement and inadequate guidelines on camera maintenance.*

## Data Review

AFSC, Alaska Longline Fishermen's Association, and AMR analyzed the data to evaluate the efficacy of determining catch composition from the video data collected. The review was intended to inform data analysis procedures under the restructured observer program in time for the 2013 implementation. Set location and retrieval times came from reviewing the GPS data using AMR's EMI software to annotate trip data.

***AMR technicians were able to review video footage of longline hauls at an average of 1.5 times hauling speed and identify 94% of fish to the species level.***

A total of 14 hauls were reviewed for catch composition by AMR technicians. Data review speeds varied from one to two times hauling speed. This is consistent with the 1.5:1 review rate common to EM monitoring of longline hauls in other programs around the world.

In total AMR technicians documented 9,139 of fish with 94% identified to the species level. Skates, sculpin, grenedier, and rockfish were the most difficult species to identify and were often assigned to the species group level.

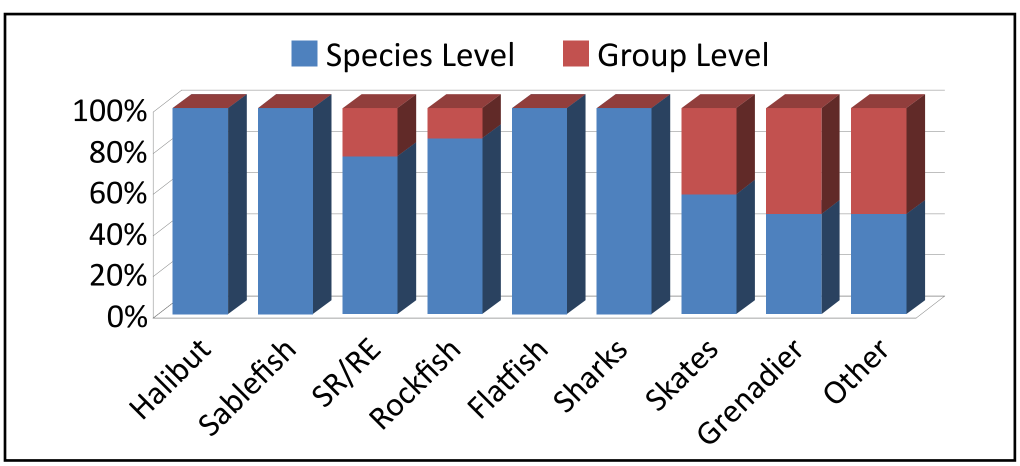



*Figure 4. Ability of EM data reviewers to identify fish to the species level across various categories. Data is based on AMR reviewed longline sets from the pilot program.*

## Cost Effectiveness

To be cost effective, EM systems should be comparable to the cost of human observer coverage. Under the restructured human observer program, these costs were initially estimated at $467 per day, but have escalated to approximately $980 per day with the 2013 deployment plan. This pilot program documented that EM system costs can be considerably lower than human observer costs.

The equipment necessary for each community in the pilot program included the following:

- two EM control boxes,
- eight to twelve cameras and housings,
- a full complement of spare parts, and
- sufficient wire, sensors and materials to pre-wire all vessels.

The components of an EM system are robust and built to last for many years. Based on past performance, AMR recommended amortizing EM system hardware over a 5-year period as a conservative estimate of equipment life. Using the 5-year amortization, the annualized equipment cost for Sitka was $7,080. For Homer, the annualized equipment cost was $6,160.

Pre-wiring a vessel required six to ten hours of technician time and the cooperation of the vessel operator. Once pre-wired, rotation of the control boxes between vessels required approximately ½ hour to install and perform a function test, and ½ hour to remove the unit and download the data. Because EM systems are new to Alaska, the technical expertise to install the systems was not locally available. Therefore a technician was flown into each community to perform system installs. Once EM is operational on the Alaska fleet, local businesses will likely perform this service. Installation and rotation costs for the six Sitka vessels totaled $4,575 (excluding travel). For the four Homer vessels, installation and rotation costs totaled $3,375 (excluding travel).

To estimate data analysis costs, AMR reviewed 14 hauls to determine total catch and provide a finished data set. Reviewing speed varied between one and two times hauling speed, depending on video quality. Because of variability in soak times, longline vessels in Sitka averaged 0.9 hauls/sea day, and the longline vessels in Homer averaged 2.3 hauls/sea day. For Sitka vessels, the average haul lasted 2.7 hours. For Homer vessels, the average haul lasted 1.9 hours. Using a 1.5:1 viewing ratio and AMR's current billing rate for video review, the average data analysis cost per sea-day would be $84 for Sitka vessels and $162 for Homer vessels.

| Sitka | | | |
|---|---|---|---|
| | Cost | Days at Sea | Cost/ Day |
| Equipment | $7,080 | 102 | $69 |
| Installation and Rotation | $4,575 | 102 | $45 |
| Data review cost/sea day | | | $84 |
| **Total cost/sea-day** | | | **$198** |

| Homer | | | |
|---|---|---|---|
| | Cost | Days at Sea | Cost/ Day |
| Equipment | $6,160 | 56 | $110 |
| Installation and Rotation | $3,375 | 56 | $60 |
| Data review cost/sea day | | | $162 |
| **Total cost/sea-day** | | | **$332** |

*Table 3. EM costs based on estimates from pilot program data. EM costs reflect equipment, field services and data review costs, and do not include overhead, project management or travel costs.*

To evaluate cost effectiveness, the annualized equipment costs, the installation costs and the estimated data review costs for each community were summed and divided by the number of sea days the EM systems were deployed. This results in an estimated $198/sea day cost for Sitka and $332/sea day cost for Homer. Maximizing the at-sea deployment days of EM systems could have further reduced costs. The pilot program only required vessels to carry the EM systems for a minimum of 2 trips. An alternate deployment plan which maximizes sea days could easily be designed to further reduce costs.

## Discussion and Findings

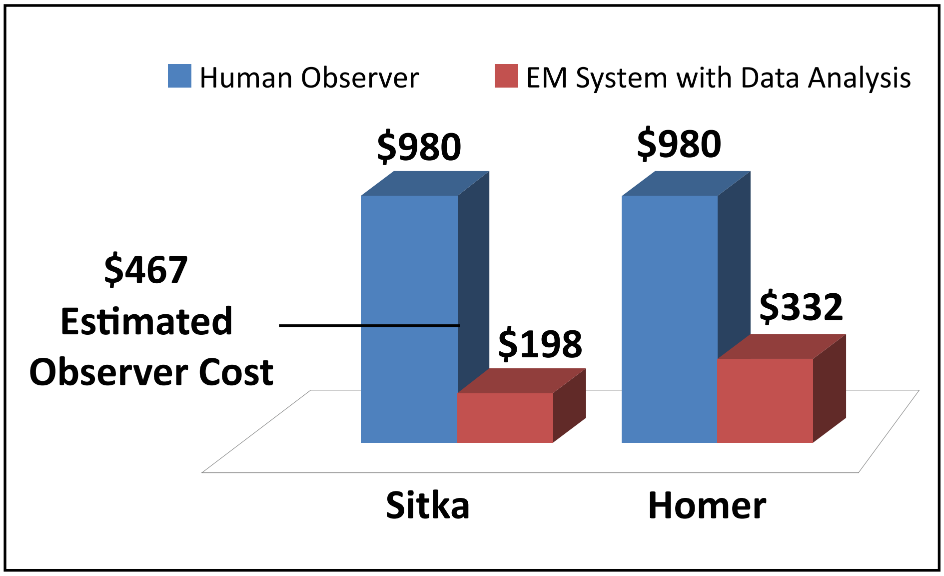



*Figure 5. Human observer costs based on 2013 restructured North Pacific Observer Program contract. EM costs based on estimates from pilot program data. EM costs reflect equipment, field services and data review costs, and do not include overhead and project management or travel.*

By most measures, the EM pilot program was a success. Data obtained through the program met the joint industry/NMFS objective of securing an independent estimate of total catch. EM systems were readily adapted to a wide range of vessel configurations and fishing patterns capturing complete video records of 95.3% of the longline hauls. EM data allowed species level identification for 94% of fish on reviewed hauls. EM proved comparable yet more cost effective to the initial $467/day estimate for human observers. When compared to the approximately $980 per day cost of human observers under the 2013 deployment plan, EM offers a remarkable potential cost savings to the program. EM is perceived by the industry be less intrusive and more compatible with normal fishing operations than human observers, thus reducing observer induced bias. EM also reduces costs to individual operations by eliminating room, board, and insurance costs associated with human observers. Finally, by pre-wiring vessels, EM eliminates the problems of ensuring observers are available and on board vessels when the vessel is ready to fish. Given the weather limitations faced by the halibut/sablefish fleet operating off Alaska, the "ready to fish" aspect of EM makes it highly suited to Alaska's small boat fleet.

Successful operation of EM systems requires cooperation of the fleet. Throughout the pilot program most vessel operators were eager to participate and committed to the program's success. Vessel owners who were initially hesitant became cooperative once they understood EM was being developed as an alternative to human observers for vessels that would soon be tasked with providing at-sea data. This project established that EM can be an effective and successful at-sea monitoring system if vessel owners are aware that failure to successfully maintain and operate the system will result in assignment of human observers. A follow-up visit to each vessel after the first trip would have greatly improved video quality and corrected sensor settings.

**IN SUMMARY**, the Electronic Monitoring Pilot Program completed the necessary dockside and at-sea testing of EM systems in the Alaska halibut and sablefish quota share fisheries. Many lessons were learned that will inform the development of a full-scale EM program. Full-scale deployment now awaits NMFS development of protocols incorporating EM as an integrated component of the restructured North Pacific Observer Program.

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RETURN SERVICE REQUESTED

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