One Fish, Two Fish, Red Fish, Rockfish: Human-Based Video Review in a Hardware-Focused World

Courtney Donovan
Pacific States Marine Fisheries Commission

Electronic monitoring has recently become an important topic in commercial fisheries. While most discussions tend to focus on the hardware and management aspects, it seems easy to overlook a crucial element of any electronic monitoring program: the point at which data are captured during the human-conducted review of collected video and sensor data. Specialized software is important for expediting the review of raw video data since the integrated features and efficiency of the software affect the resulting review times, and therefore the cost of review, as well as overall data quality. Pre-analysis review of electronic monitoring data could be improved by further research and development of specialized software, and attempts to solve the already existing problems facing current programs.

The PSMFC West Coast electronic monitoring program is operating as a compliance tool and potential substitute for At-Sea Catch Monitors collecting IFQ discard data. Scientific Observers will not be replaced by EM on the West Coast due to the fact that they are collecting biological data that an EM system cannot collect. At-Sea Catch Monitors and Observers are the most expensive piece of an observer program. Likewise, video review is the most expensive component of an EM program.

Specialized software is essential for any successful EM program. This software facilitates the production of high-quality data, and also saves time by expediting the review process, therefore reducing program costs. PSMFC has contracted EM provider Archipelago Marine Research (AMR). AMR has developed proprietary software called Electronic Monitoring Interpret (EMI), which is used to review raw EM data. Many discussions have taken place on whether EM programs should use proprietary or open-source software. Free, open-source software can be problematic because it is not tailored to the specific needs of an EM program. Free programs that frequently crash are unreliable and unrealistic for data review, and increase review time and cost for an already expensive process. The developers of free, open-source software have no obligation to end-users, so no one can be held accountable for a solution when problems arise. Open-source software could be used for EM in the future, but it would need to be designed to suit the specific needs of an EM program.

Using EMI, the review process is streamlined by having an all-in-one program that allows simultaneous video review and data entry. Within the program, reviewers are able to view raw video and sensor data, as well as input and save data. The software provides a visual line graph of sensor activity integrated with synced video data. The line graph, or sensor signature, improves review time by providing a method to easily find fishing activity without having to sort
through text files, spreadsheets, and hours of video. The sensor signature of each fishery allows reviewers to quickly and efficiently identify trips and hauls for each data drive. EMI is configured differently to meet the data-collection needs of each fishery, and date/time/location of fishing activity is automatically recorded for each data point entered within the program.

From 2012-May 2015, PSMFC conducted a pre-implementation study to test the viability of EM as a source of data to document individual accountability of catch and bycatch. This study spanned 4 sectors of the IFQ fishery: shoreside whiting, mothership catcher vessel whiting, fixed gear, and bottom trawl. Review of the data covered 100% of the video during sorting activity. Data collection included species ID and weight for all retained and discarded catch, as well as individual counts for retained sablefish in the Fixed Gear fishery. The resulting data was compared to Catch Monitor/Observer data, logbook data, and fish ticket data. Based on the results from the pre-implementation study, the Pacific Fishery Management Council (PFMC) implemented Exempted Fishing Permits (EFPs) on the West Coast, permitting the use of EM to monitor discarded IFQ species, instead of an At-Sea Monitor.

Many improvements to the EM program were developed as a result of the pre-implementation program:

1) PSMFC discovered the importance of in-season feedback to vessels and AMR technicians regarding camera placement, system function, and crew behavior.
2) Internal protocols were developed for all gear types, and subsequent revisions were made when necessary.
3) For the Bottom Trawl fishery, a study was designed to test the ability of EM to accurately determine halibut viability. Data collected for halibut included: time onboard & off-board, estimated length and weight, amount of movement, estimated codend fullness, and catch composition.
4) To aid in the estimation of weights for retained and discarded catch on both Bottom Trawl and Fixed Gear vessels, volumetric density was derived from container measurements.
5) On fixed gear vessels, to more accurately estimate discarded species weights using lengths, a color-coded measurement strip was created. Currently, this measurement strip is predominantly used on West Coast EFP Fixed Gear fishery vessels as a tool to length predated and discarded IFQ fish. The length of the fish is converted to a weight that can be deducted from the vessels quota more accurately.

West Coast EFPS became active in May 2015 for compliance monitoring of at-sea IFQ discards. The majority of vessels are participating in Maximized Retention, while only 1 vessel is participating in Optimized Retention. Maximized Retention vessels are allowed to discard 1 tote/haul of operational discards, unavoidable discards, prohibited species, fish over 6 feet in length, invertebrates, debris, and predated fish (Fixed Gear vessels only). The Optimized
Retention vessel is allowed to discard everything listed in Maximized Retention, as well as Arrowtooth Flounder, English and Dover Sole, and Pacific Hake, with sorting and toting of these four species prior to discarding.

Originally, all EFP data was going to be subsampled for review. Due to new vessel retention requirements, reduced discard amounts, and modified data collection guidelines, review time has decreased from pre-implementation study review time, and current review of EFP data is 100% of video during sorting. Data collection is now focused on discarded fish, retained prohibited species, and retained priority species (Cowcod, Yelloweye, Canary, and Bocaccio Rockfish).

PSMFC has been tasked with reviewing data from the Alaska Fixed Gear pilot project. PSMFC is reviewing data from 4 different studies: SE Alaska Longline volunteer vessels, IPHC survey, Northern Endurance setline, and Northern Endurance Pot. The data review for each study is guided by a set of review guidelines. Each study has a set of review standards that guides the data review process. The review software (EMI) has been configured to reflect the need to collect data regarding sensor gaps, and to categorize these gaps according to the reason for their occurrence: vessel power failure, fishermen pushing the power switch, etc. Multiple unaffiliated groups are working on this project together, which complicates and delays the decision making process.

PSMFC reviewers have an important role in EM projects. Reviewers interpret and convert raw video and sensor data into usable data that can be analyzed and then sent to Vessel Account Systems or reported to fisheries managers. Reviewers also develop review protocols for different fisheries, and provide crew behavior feedback to vessels, as well as camera placement and system performance feedback to AMR technicians.

Although EM technology has progressed so much in the past few years, there are still opportunities for improvement in the program. Weight estimation is still problematic, and continuing studies regarding volumetric density could prove to be quite useful. Discards in the whiting fishery that occur in the water, such as a blowout panel or net bleed, are also difficult to estimate. Another challenge EM is facing is accurate species ID. Some species look extremely similar, and can only be distinguished by looking closely at dorsal spines or gill rakers. Future developments of review software could also be helpful. Improvements such as: a built-in tool that auto-captures fish length; built-in range and depth for species to help alleviate some misidentifications; auto-calculation of container volume when given measurements; image library where pictures of each fish are auto-saved for more efficient QA/QC; and the ability to adjust the contrast within each video window to enhance views during less than ideal conditions (glare, night lighting). With these improvements, the review of raw data from electronic monitoring systems may become more efficient, and the resulting data more reliable.
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Components of a Successful Electronic Monitoring Program

- Vessels and Willing Participants
- Camera Systems
- Field Services
  - Install Systems
  - Retrieve hard drives
  - Fix camera systems
- Software to Expedite Review Time
- Review Sensor and Video Data
- Database to Support Infrastructure and Analysis of Data
Electronic Monitoring Software

Electronic Monitoring Interpret™ (EMI)
Integrated Sensor & Video Data

- Hydraulic Pressure
- Speed/GPS
- Drum Rotation
Fishery-Specific Sensor Signatures

Fixed Gear (Trap) Fishery

Trip Begin

Hauls

Trip End
All-in-One Program
West Coast Groundfish Trawl Catch Share Program
Pre-implementation Outcome:

In-Season Feedback

Internal Development of Review Protocol

Volumetric Density for Weight Estimation

Measurement Strip for Discarded Fish

Council’s Implementation of EFPs on West Coast
Current EFP EM Program at PSMFC

West Coast Exempted Fishing Permit (EFP)

Catch Accounting: Logbook Data

Logbook Data Validation: EM Data

Differing Logbook & EM Estimates → Decision by NMFS

Vessel Proportion Comparison:
Total per Fishery vs. EFP Participants per Fishery

- **Bottom Trawl**
  - EFP: 7 vessels
  - Total: 68 vessels

- **Trap**
  - EFP: 7 vessels
  - Total: 14 vessels

- **MSCV Whiting**
  - EFP: 12 vessels
  - Total: 19 vessels

- **Shoreside Whiting**
  - EFP: 19 vessels
  - Total: 25 vessels
EFP Review

EFP vs Pre-EFP:
Average Haul Review Rate & Average Actual Sort Time Comparison

- **Bottom Trawl**
  - Pre-EFP 2013: 132.7 minutes
  - Pre-EFP 2014: 114.8 minutes
  - Pre-EFP 2015: 128.6 minutes
  - EFP 2015: 195.6 minutes
  - Average Review Time: +21%

- **Fixed Gear: Trap**
  - Pre-EFP 2013: 54.1 minutes
  - Pre-EFP 2014: 84.9 minutes
  - Pre-EFP 2015: 132.5 minutes
  - EFP 2015: 111.3 minutes
  - Average Review Time: +5%

- **Mothership Catcher Vessel Whiting**
  - Pre-EFP 2013: 32.0 minutes
  - Pre-EFP 2014: 43.8 minutes
  - Pre-EFP 2015: 34.4 minutes
  - EFP 2015: 34.4 minutes
  - Average Review Time: +10%

- **Shoreside Whiting**
  - Pre-EFP 2013: 79.5 minutes
  - Pre-EFP 2014: 62.5 minutes
  - Pre-EFP 2015: 65.6 minutes
  - EFP 2015: 65.6 minutes
  - Average Review Time: -37%

- **Average Actual Sort Time (minutes)**
  - Pre-EFP 2013: 132.7 minutes
  - Pre-EFP 2014: 114.8 minutes
  - Pre-EFP 2015: 128.6 minutes
  - EFP 2015: 195.6 minutes
  - Average Actual Sort Time: +5%

- **Average Review Time (± %)**
  - Pre-EFP 2013: -29%
  - Pre-EFP 2014: -41%
  - Pre-EFP 2015: -54%
  - EFP 2015: -75%

- **Pre-EFP 2013**
  - Pre-EFP 2014
  - Pre-EFP 2015
  - EFP 2015

- **Time (minutes)**
  - 0
  - 20
  - 40
  - 60
  - 80
  - 100
  - 120
  - 140
  - 160
  - 180
  - 200

- **Pre-EFP**
  - 2013
  - 2014
  - 2015
Discarded Species Weight Estimation

Software Development

Accurate ID of Some Similar Species

- Petrale & Flathead sole
- Shortspine Thornyhead
- Longspine Thornyhead
- Shortraker Rockfish
- Roughey Rockfish
Why are PSMFC human video reviewers important?

Raw video & sensor data → Interpret & convert to usable data → Data analysis → Results sent to Vessel Account Systems or reported to fisheries managers
Questions?