Memorandum

To: North Pacific EM Workgroup

From: Howard McElderry

Date: September 11, 2014

Re: EM Cooperative Research Plan

Purpose

At the August 13, 2014 EM Workgroup conference call the cooperative research program was discussed in light of the upcoming SSC review. Comments were made that Track 1 needed to have clearer research objectives, analytical methods, and deliverables, in order to be ready for SSC review, as well as a budget and responsible party for each component. It was also pointed out that the research tracks needed to integrate with each other better, and they need to address the Council's problem statement for EM: *The Council requests that NMFS provide a strategic planning document for electronic monitoring (EM) that identifies the Council's EM management objective of collecting at-sea discard estimates from the 40' – 57.5' IFQ fleet, and the timeline and vision for how the EM pilot project in 2013 and future years' projects will serve to meet this objective, including funding(October 2012 Council Motion).* Also: *The Council recommends use of a catch estimation approach to develop EM for the halibut and sablefish fisheries (June 2013 Council recommendation).*

I offered to examine the track 1 program more closely to facilitate further discussion at the EM Workgroup meeting on 23-24 September in Anchorage. I started my investigations by reviewing the cooperative research track documents, then reviewing the Strategic Plan for EM/ER in the North Pacific, and other related background documents. I then considered the mandate for the EM working group and how the research components could feed into this process. Next, I consulted with a number of the workgroup members to share my thoughts and test some ideas. I concluded that the best approach for this document would not be a rewrite the track 1 research document, but rather reframe the EM cooperative research program to help build a more common vision among members of the EM Workgroup.

Track 1 Research Overview

The May 2014 draft of the track 1 research plan outlined a broad goal of gathering information to help stakeholders understand the key decision points related to the strategic deployment of EM. A research design was built on the premise that 'standard' (i.e., commercially available) EM technology is widely used in a variety of fisheries around the world and the main obstacles for implementation rested with program planning and design, rather than the development of new technology. This was not intended to challenge the value of research track 3 (advanced EM technology development), but rather to encourage a more holistic planning approach to the deployment of EM technology in Alaskan fixed gear fleets.

The track 1 research approach was two pronged. Firstly, provide better definition of the specific information requirements for technology based monitoring of Alaskan fixed gear fleets. The information needs as outlined in a NOAA memorandum delivered to the EM Workgroup in February 2014 are a starting point but further discussion is required for clarification because different levels of specificity have different program cost and operational consequences. The various information elements need to be explored to separate 'must haves' from 'would be nice' elements, taking into consideration the cost implications and level of complexity of each element. The specific issues are identified later in this document and the point here is that specificity is important from the beginning as it informs technology development, program design, and benchmarks for measuring success.

The second prong of the track 1 research program involved testing operational components. With data analysis centralized and under the oversight of Pacific States Marine Fisheries Commission, the primary area of focus for this effort was development of port based program support infrastructure, and on-board procedures required to support EM, both of which are outlined later in this document. Previous EM pilot studies in Alaska have suffered because they either failed to establish locally based EM support services, failed to apply rigorous onboard procedures, or failed to gather the necessary operational data to inform EM program design.

Track 1 envisioned establishing operational infrastructure in two ports (Sitka and Homer) to support deployment of EM technology on host fishing vessels. This work would provide a better understanding of field operation requirements in an Alaskan setting, but also create a controlled setting for deployment of EM technology and enable industry to gain familiarity with EM. With skilled technicians in place and EM systems deployed on vessels, the basic operational elements would enable technology based monitoring on a limited scale, experiment with different approaches, and develop procedures that inform program design and facilitate future program scaling to other ports.

Track 1 began in spring 2014 with deployment of EM systems on nine vessels in the two ports. Over 40 trips were monitored using systems from Archipelago Marine Research Ltd and Saltwater Inc. before the end of June 2014 when host vessels transitioned to other fisheries. PSMFC will be analyzing data sets from trips where the EM data are complete and where dockside monitoring information could be used to assess rockfish species identification. Both service providers were tasked to document their respective efforts and provide a summary of lessons learned. The interim funding provided to support contractor involvement for the track 1 research effort ended in June 2014 and hence, contractors currently have no funding mandate for this program.

A Framework for EM Program Design

The track 1research plan emphasizes a program design approach, yet the draft document did not define this process well. In my view, the goal of gathering information to help stakeholders understand the key decision points related to the strategic deployment of EM is dependent upon developing a comprehensive program design process. A successful program design is the result of careful consideration of available funds, the information needs, the fishery characteristics, the technology (hardware and software), program operations (services), and vessel obligations. This is an iterative process of design, data gathering, evaluation, re-design, etc. to arrive at a series of viable alternatives. The design process should seek to optimize data (quantity, quality, timeliness) against operational impact and cost considerations. The scope is larger than just technology because of the significance of the other program elements. For example, the service cost for operations can often be the same or greater magnitude than the amortized technology cost, and technology cannot be deployed in a fishery without a well designed service framework. As well, all EM technologies impose a certain level of obligations on participating vessels, obligations which require evaluation since they potentially represent an area of hidden cost (or lost opportunity) to the vessel. The program design has to be operationally feasible and scalable across the broad geography of the fishery. Hence, a successful program design must be holistic, considering all aspects of the program, not just the technology. A number of key program design elements and design issues are described below.

1. **Available Funds** – An Australian colleague recently pointed out to me that some Commonwealth fisheries operated under the principle of attempting to keep the costs of management, research and enforcement under 5% of the gross value of the fishery. The 100% coverage of fixed gear fleets in BC, Canada runs at about 3% of the landed catch value. In Alaska, the 1.25% levy on the landed catch value provides a similar way of assigning a budget goal for monitoring. While these figures vary by region and are just targets, they serve to frame the discussion when considering different monitoring approaches. A business planning approach is needed to consider options, evaluate risks associated with the options, and develop alternatives in order to come up with the most viable options with the available funds. The process not only forces the design approach to work within certain boundaries, but also incorporates only those parts of the program that can be justified. Discussion about available funds needs to be included up front as it will guide all aspects of program development.

2. **Information Needs** – The aforementioned NOAA memo contains useful information to start the discussion on the information requirements for monitoring the fixed gear fleets. Without carrying out any pilot studies it is possible to review the information needs and make a preliminary assessment of the potential challenges. Some of the information needs (e.g., fishing location) are very easily satisfied with EM and are perhaps more accurate than what is possible with an observer. Other information needs are more difficult to satisfy with EM, including some that are also difficult to satisfy with observers. Putting a standard forward when there are known areas that cannot be easily achieved (with any method) does not properly frame the EM program development process. It is useful to conduct an *a priori* exercise to identify areas of potential challenge, consider alternative approaches and evaluate each in terms of a cost-benefit framework. This assessment can then be informed by directed trials and data gathering efforts to refine approaches. Below are some examples of issues:

   - Hook counts can be derived from image review of standard EM systems, self-reported from fisher logs, verified in EM imagery, or potentially by automated enumeration with image recognition technology. Each approach carries a number of program consequences in terms of data quality, program cost, and operational impact. The latter approach (image recognition) carries an additional development cost since the technology is not available.

- The species composition in the fixed gear fisheries includes a range of fish species that vary considerably in occurrence patterns and level of identification difficulty by EM. To illustrate this point, the following table lists fish species from the 2013 Area 2C survey data (courtesy of IPHC) using 20-hook count observations from the top 80% of stations (halibut catch rate by weight). EM identification ability has been included, based on previous experience.

Common Name	# Observed	EM ID Ability
Pacific Halibut	1,574	High
Spiny Dogfish	629	High
Sablefish (Blackcod)	467	High
Longnose Skate	241	High
Pacific Cod	119	High
Redbanded Rockfish	114	High
Arrowtooth Flounder	99	High
Lingcod	73	High
Silvergray Rockfish	27	High
Spotted Ratfish	23	High
Sleeper Shark	21	High
Big Skate	16	High
Walleye Pollock	3	High
Black Rockfish	2	High
China Rockfish	1	High
Bocaccio	1	High
Aleutian Skate	46	Low
Rougheye Rockfish	35	Low
Shortraker Rockfish	27	Low
Shortspine Thornyhead	18	Low
Alaska Skate	1	Low
Coho Salmon	1	Low
Yelloweye Rockfish	189	Medium
Quillback Rockfish	37	Medium
Canary Rockfish	12	Medium
Copper Rockfish	1	Medium
Giant Wrymouth	1	Medium
Petrale Sole	1	Medium
Rock Sole	1	Medium
Yellowmouth Rockfish	1	Medium

This type of presentation provides insights about where identification problems may occur and allows discussion on the potential risks associated with difficult to identify species. About half the species are easily identifiable with standard EM systems and represent over 90% of the total pieces. Less than a quarter of the species (6% of the pieces) are medium in identification ability, meaning that they are discernible in some but not all circumstances. The balance of species (3% of the pieces) has low identification ability and usually require specimen 'in hand' to identify properly. Many of the identification challenges simplify to species pairs (e.g., shortraker and rough-eye rockfish). Some issues are intrinsic to all monitoring approaches, and the level of investment both in technology or operational procedure may not be justified. Some of the identification challenges involve unimportant species that may not warrant special consideration while others will. The point of this exercise is to identify the problem areas, determine where the critical risks lie, and consider where improvement is needed. In many instances, species identification can be improved with higher resolution cameras or more carefully controlled on-board catch handling procedures, yet both remedies create an additional cost to the monitoring program.

- Weight is another catch accounting element that requires *a priori* consideration. None of the EM technologies in the research program are considering direct weight, but rather indirect approaches deriving weights from fish lengths, or applying an average weight to the number of pieces. The weight from length method is possible with standard EM technology but with a considerable post processing analysis burden. Early results with the track 3 suggest that automated length measurement can be achieved with a camera chute system but there will be a post processing requirement unless species identification can also be automated. Both standard and advanced EM systems will require structured onboard catch handling procedures to control how the fish is presented to the camera, a potential burden to crew that needs to be evaluated and justified. The application of standard piece weights is a much simpler approach but the methodology and associated risks require further examination.
- Halibut viability assessment is an important information element and observations easily made from imagery do not align with the IPHC viability categories. The most likely way to improve on this would be through more structured catch handling protocols but alternative approaches should be considered first.
- Estimation of discards is highlighted in the problem statement and therefore the method for catch fate determination is important. The species listed in the table above can be assigned to different categories of retention: almost always kept, almost always discarded, and conditionally discarded (e.g., size, weight, trip limits, etc.). Among the discarded catch, some are discarded at the rail, some are brought aboard and discarded once assessed, and some released later for reasons such as use as bait, species targets achieved, or limited hold capacity. Discarded fish may drop off prior to or after breaking the water surface. Given the importance of discard estimation, there needs to be a discussion that considers different catch species in relation to their retention patterns with typical landing methods to determine the most suitable methodology. This analysis informs the technology investment, on board methods, and data analysis procedures.

3. **Fishery Characteristics** - Monitoring approaches need to be considered in the context of the fishery itself. Basic information about the number of vessels, landing ports, and fishery activity have a direct influence on the design and planning of EM program infrastructure. Also important are the characteristics of the vessel and industry attitudes toward monitoring in order to determine the suitability of the different types of technology being considered.

4. **Sampling Design –** Council has expressed a preference for an estimation approach (i.e., sample, not census) for monitoring the fixed gear fleet. The operational challenges of a random sample approach should be considered in the context of the temporal and spatial aspects of the fishery. The number of EM service locations will strongly influence program costs. As well, the 'burn in' period for hosting EM systems on vessels often results in unproductive data collection effort to make adjustments to system specifications and develop onboard procedures that are conducive to the data needs.

5. **EM Program Elements –** Within an EM program there are several areas of program design that require consideration. The main elements are outlined below:

   - **Technology** – This consists of the physical hardware and software that is placed aboard fishing vessels. The technology needs to be considered in terms of a number of factors including cost, performance characteristics, suitability to the fleet, portability (movement of equipment between ports and vessels), commercial availability and product support. Another technology issue concerns portability of EM data – does it require shipping hard drives or are summarized (processed) data available via the Internet?

   - **Field Services –** This consists of the port based services including installation of EM systems, ongoing repair and maintenance, data retrieval, outreach (EM program presence), etc. As mentioned, this infrastructure is important and takes time to establish. Factors influencing the complexity of field services include the technical difficulty of installing and management of EM systems and the level of oversight required to ensure on board protocols are followed. These issues determine the complexity of technical skill sets required as well as the degree of scalability of field services to other fishing ports.

   - **Data Services** - All EM programs will require an analysis component that translates data sets recorded on the EM system to finished fishery catch effort data. Physical resources include analysis tools, IT systems and operational procedures. The skill set and level of analysis complexity for analysts will influence the scalability of data services as the program grows. Other considerations with data services include the level of analysis effort required and timelines required to process finished data sets.

   - **Host Vessel Responsibilities –** As mentioned earlier, vessels hosting EM systems will be required to provide duty of care responsibilities. These obligations are varied and include meeting minimum power and other and system installation requirements, ongoing activities such as performing self-test routines and cleaning cameras, interfacing with program staff, and following prescribed onboard catch handling procedures which limit how and where catch is handled. As well, there may be additional requirements such as maintain fishing logs and retention of certain species. All of these elements directly impact fishing operations.

Observations about Tracks 1-4 Research

As previously noted, the research tracks are not well integrated and need to better address the Council's problem statement. Track 1 provides a holistic operational program design approach for standard EM systems, yet the approach should be applied to both technology approaches being considered. Track 1 should integrate directly with track 2 as presumably only viable EM deployment methodologies should compared against at-sea observers. Ownership of track 1 is complicated by the fact that while it is an industry initiative, the research encompasses a number of areas that would logically be carried out by a variety of groups including: service providers, industry, Council staff, PSMFC staff, and NMFS staff. Track 1 does not have an agency sponsor hence funding is uncertain.

The purpose of track 2 and 3 research is *'to test the efficacy of various EM systems to provide scientific data to estimate discard'* and does not incorporate other issues that would inform an EM program design. Track 2 and 3 research is structured to compare 'standard' EM systems against a more advanced EM design (stereo rail and a camera chute system) and also against methods used by at-sea observers. The standard system is a finished, commercially available product and the more advanced EM system is currently being developed and tested. The timelines for these tracks are therefore misaligned because the prototype and product development work for the advanced technology is still needed before it can be compared with commercially available EM products. Industry acceptance of track 3 appears to be low because of concerns about possible impacts to onboard operations.

Track 4 (ER technologies) is very important but not relevant to the issue of developing an alternative approach to observer-based monitoring. This work should be carried out and developed products should be suitable for both monitored and unmonitored vessels, and for different types of EM systems.

None of the research tracks provide a clearly defined project plan, timeline, outputs and budgets. In my view, the existing structure of the research plan reinforces the polarity between the various EM Workgroup members.

Suggested Reframing of Cooperative Research Program

In my view, the research tracks focus on the right kinds of questions but the program should be reframed to better align with the Council problem statement. The research tracks should be revised as follows:

- **Track 1:** Program design planning – the design framework outlined in this document.
- **Track 2:** Evaluating the feasibility of standard EM systems – This is similar to track 2 but integrates closely with track 1 outputs and includes an operational focus. There should be a component of infrastructure development and methods testing, as outlined earlier in this document, prior to simultaneous deployment of EM and at-sea observers.
- **Track 3:** Evaluating the feasibility of a new EM design (stereo camera systems) - This should include a product development component as well as the operational focus outlined above.
- **Track 4:** EM logbooks – No change except the point above about integration with both standard and advanced system.

Unlike the original cooperative research draft, the research tracks are much more integrated. Track 1 is primarily a task process led through the EM Workgroup. Responsibilities for the various work elements would rest with multiple groups, based on experience and subject matter expertise. These elements need to be more fully defined and appropriately funded. Similarly tracks 2 and 3 have multiple responsible parties with results feeding into the workgroup process.

At this early stage in the cooperative research program development I think it would be helpful if the EM Workgroup could develop an EM program implementation vision. The draft track 1 research plan suggested a scaled implementation, starting with a few ports and a small number of participating vessels, then expanding to other ports and including a larger portion of the fleet. This allows for trial and error on a small scale, then building out as procedures become more established. This limited implementation would eventually transition to a fully operational EM program when data quality standards are achieved and vessel selection procedures become randomized to support data expansion. In my view, a scaled implementation approach is the only practical way of building an EM program. The infrastructure investments made during the cooperative research phase directly tie with the longer term implementation goal.

The level of program support needed from the fleet should not be underestimated. Scaled program growth provides a setting for crew to work with the technology, develop ways to support EM data collection needs without compromising their operations, and build program acceptance. One of the most important lessons learned from development of EM program in BC was the high level of industry involvement through all phases of program design and implementation. An EM program will fail without strong industry support.

Conclusions

In my view, the program design framework outlined in this document should be the main focus of EM Workgroup. The design process should result in development of different monitoring alternatives that consist of different technology and different approaches using these technologies. It is unlikely that there will be a ‘one size fits all’ solution. The monitoring alternatives should consider the broad range of issues and framed against the likely level of funding available. This is an iterative process that will require additional field studies, data collection and analysis to further refine and evaluate viable alternatives. As mentioned, the methodology outlined in Track 2 and 3 (i.e., comparison with at-sea observer) should only be carried out with the viable monitoring alternatives. The most promising alternatives can then be put forward to Council staff for further analysis and development.

As a final comment, I think the composition of the EM group is excellent, representing the broad range of skills needed for this research task, and involves people who are truly committed to solving this problem. The group is not aligned to a common goal yet and I’m hopeful that the holistic framework suggested above will help build a collective vision. It may also be helpful to consider some guidelines for engagement to support the job at hand and ensure that participants negotiate in good faith with the public interest in mind, seeking to understand the interests of others, and building on as much agreement as possible.