Appendix I. Summary of monitoring methods

The intent of this summary is to provide the reader with more detailed technical information on various methods of fisheries monitoring. Depending on whether the fishery is being monitored for bycatch, overall characterization or compliance with regulations, these methods will vary in their appropriateness and effectiveness. Some of these methods may be appropriate ways to monitor the golden crab fishery in the South Atlantic.

Onboard Observers

Onboard observers are used in several U.S. fisheries to collect biological data. Usually only a portion of the trips conducted by the fleet are required to have observers on them. Some international fisheries have required 100% observer coverage and in some cases, the observers have also been responsible for reporting violations of regulations. Onboard observers are typically the most expensive means of collecting biological data. In the U.S. at-sea observers have usually been paid for through NMFS or fishermen or through a cost-sharing arrangement.

South Atlantic Snapper Grouper Pilot Program (4/06-5/07 and ongoing)

In 2006, the Gulf and South Atlantic Fisheries Foundation conducted a pilot study to characterize the catch and fate of discards in the snapper grouper vertical hook-and-line fishery of the South Atlantic. The major goals of this program were to gather catch, effort, and disposition data. Beginning in late 2006, two fishery observers were trained and began onboard observation. So far, this research has placed observers on board over 19 different commercial fishing vessels and accumulated over 130 observed sea days. Although formal data analysis has not begun, preliminary analysis shows an average of 7 days per trip and 55 sets per trip. However, there was considerable variance depending upon the size of the vessel with a range of trip length from 2 to 11 days and number of sets from 14 to 113. Analysis of catch and discard fate began in the Fall of 2007 and a presentation was made to the South Atlantic Fishery Management Council at their June 2008 meeting. The intent of this project was not to form a stand-alone dataset, but to augment currently available datasets (Jepson, 2007). Catch characterization trips were completed in all four South Atlantic states with eight (8) trips in NC, ten (10) in SC, six (6) in GA and four (4) in FL. Trip lengths ranged from 2 to 13 days with an average of 7 days per trip overall. The number of sets per trip ranged from 14 to 142 with an overall average of 61 sets per trip. Trip length varied with vessels from North Carolina making shorter day trips averaging 4 days in length, while vessels in the three other South Atlantic states averaging longer trips closer to the overall average of 7 days. A final report for this project is currently under development.

Electronic Monitoring (EM)

Electronic (video) monitoring has been used in the British Columbia Limited Access Program fisheries, some Alaskan fisheries (crab), the Pacific whiting fishery, among others. Pilot programs to determine the feasibility of using EM in general and the feasibility of using EM as a replacement for at-sea observers have been conducted in various places and reports on these pilot programs are summarized below.

In general, EM has been used or tested in trawl, longline, and hook-and-line fisheries. Video monitoring is sometimes used in place of at-sea observers, to supplement at-sea observers, and/or as a means to audit electronic logbook data. Use varies depending on the objectives of the fishery with regards to discarding and individual catch tracking. Pilot programs have shown video monitoring systems (this includes data review) to be less expensive than at-sea observers and to be capable of identifying discard occurrences and species-specific identification.

1) In "Discussion Paper on Issues Associated with Large Scale Implementation of Video Monitoring," Kinsolving (2006) assesses what current EM technology can and cannot do well for the Alaska rockfish trawl fishery. He writes,

Video, either alone or in conjunction with other data gathering equipment (electronic monitoring, or EM), is becoming an increasingly viable technology for monitoring some types of fishing activity or enhancing the ability of observers to gather fisheries data. The technologies associated with EM are in a state of rapid development. The combination of increasingly effective data compression algorithms, increased computer processing power, and the rapidly decreasing cost of data storage have reached a point where, on a technology level, electronic monitoring is ready for large scale implementation for some fisheries monitoring applications. However, while many of the technical issues associated with the collection of EM data have been addressed, neither NMFS nor the fishing industry have fully addressed many of the infrastructural and cost related issues associated with larger scale EM program implementation.

Based on studies conducted to date, it appears that EM technology is able to:

- *Function sufficiently reliably in the marine environment.*
- *Identify fishing events (e.g. net deployment, line retrieval) and the location where those events took place.*
- *Determine when and if discard events take place on trawl catcher vessels.*
- *Verify compliance with seabird avoidance measures on longliners.*
- *Assist an observer in monitoring activities in otherwise unobservable areas of catcher/processors.*

On the other hand, EM systems are only moderately able to:

- *Quantify the amount of discards on trawl vessels.*
- *Detect and identify seabird bycatch to species on longliners.*
- *Estimate the species composition and number of fish in longline catch.*

The at-sea portion of the technology, while the focus of most research to date, is only one component of an effective EM system. For an EM system to function properly, the data collected at-sea must undergo some degree of methodical review. In the studies conducted to date, this review has been fairly meticulous, with the assumption being that most missed events have been due to technology and data collection issues rather than *data review issues. While such an approach is necessary when testing the applicability of a given technology, it does serve to possibly over-inflate the total cost of an effective EM program.*

The document by Kinsolving (2006) includes an overview of the 2005 Kodiak electronic monitoring project where two video monitoring systems are compared. Cost projections were based on the assumption of 18 boats, where each boat fishes an average of 7 trips, and trip length will average 3 days, of which there is 24 hours of activity to review. Total minimum and maximum costs are laid out in the document. Total equipment costs (including installation and maintenance) per vessel ranged from $5,875 to $13,325 per year. The cost of maintenance and storage was estimated at $100 per trip. Although data review costs could vary enormously depending on how much data are reviewed, the document assumes that a full review would cost approximately $50,000 per year for all vessels together (see table below).

2) McElderry et al. (2003) conducted a large scale deployment of electronic monitoring systems on the 2002 BC halibut longline fishery to evaluate the feasibility of EM as an alternative to observer-based at-sea monitoring. Two cameras per vessel were used for this project. In some cases, at-sea observers were deployed on the same vessels as the EM system. In these cases, comparisons could be made between observer and reviewed EM video to determine accuracy of recorded information. The authors note that overall, EM and observer catch estimates agreed within 2% and individual identifications by hook agreed in over 90% of the catch records. They also note that there was close agreement between EM and observers regarding whether a fish was kept or discarded and the time, location, and depth at the set start and finish. The authors concluded that EM is a promising tool for at-sea monitoring applications depending on specific fishery management objectives regarding monitoring. They also note it would have a substantially lower cost than at-sea observers. They suggest two ways to use EM for the BC longline fishery: 1) an integrated EM-observer program using both methods in a complimentary fashion to achieve fleet sampling objectives; and 2) using EM and an electronic fishing log as an at-sea monitoring audit tool. While at-sea observers cost CA$320 per vessel per day for fishermen and CA$130 per day for the federal government, EM cost about CA$210 per vessel per day (see table below).

Comment [m1]: What does this stand for?

3) McElderry et al. (2004) assessed the feasibility of electronic monitoring for the Cape Cod longline haddock fishery where bycatch rates of cod must be closely monitored. The primary objectives of the project were to evaluate the effectiveness of electronic monitoring in estimating the at-sea catch of haddock and cod, assess the suitability of EM systems for various components of the fleet, obtain skipper and crew feedback on EM suitability, and foster fleet education on EM monitoring as well as verify EM derived catch information by comparison with like data from observers. Two cameras per vessel were used for this pilot program. Costs were estimated at $1,200 per vessel per day for the pilot project (see table below). A full EM program cost per vessel is suspected to be much less. In general, McElderry (2003) estimated that EM programs run between 20-60% of the cost of an at-sea observer program.

McElderry et al. (2004) provide information on an EM program for the British Columbia groundfish longline fishery that involves less than full data review requirements. They write:

One possible fleet monitoring design might involve large-scale deployment of EM systems on the fleet with image data selectively analyzed according to a specific sample design. In this way, the analysis effort changes from full interpretation of all imagery from a fishing trip to sampling the fleet, monitoring imagery for sets or portions of sets. British Columbia's groundfish longline fishery is adopting this approach to provide full catch accountability in their 17,000-seaday fishery. Fishing vessels will carry EM systems on a fishing trip and fishers will keep a careful record of catch in an electronic fishing log (included as part of the EM system). The logbook data will be audited with catch data from EM imagery and the level of agreement will prescribe the amount of image viewing required. This unique monitoring approach provides cost effective monitoring, more actively engages industry in data collection, and, when analysis cost is applied individually, provides a positive stimulus for accurate catch accounting by industry.

Table Summarizing Pilot Program Evaluation of the Use of Electronic Monitoring (EM) for Various Fisheries.

Type of fishery	**Discard concerns?**	**Equipment costs**	**Data review costs**
Alaska Rockfish Trawl	Yes	$5,900-$13,300 per vessel annually	$50,000 for all vessels per year
Cape Cod Longline for Haddock	Yes, cod	(two cameras) $1,200 per vessel per day for pilot project, developed EM program would be less costly	Not specified, paid for by federal government
BC Halibut Longline Fishery (LAP fishery)	Yes, various rockfish species	(two cameras) CA$210 per vessel per day	Not specified, paid for by federal government

References

Kinsolving, Alan. 2006. "Discussion Paper on Issues Associated with Large Scale Implementation of Video Monitoring". National Marine Fisheries Service.

McElderry, H. 2003. Sustainable Fisheries Management Using Electronic Fisheries Monitoring. Seafood NZ. 11(6).

McElderry, H. J. Schrader, and J. Illingworth. 2003. The Efficacy of Video-Based Electronic Monitoring for the Halibut Longline Fishery. Fisheries and Oceans Canada Research Document 2003/042.

McElderry, H., J. Illingworth, D. McCullough, and J. Schrader. 2004. Electronic Monitoring of the Cape Cod Haddock Fishery in the United States – A Pilot Study. Unpublished report prepared for Cape Cod Commercial Hook Fishermen's Association (CCCHFA) by Archipelago Marine Research Ltd., Victoria, BC Canada.

Electronic Logbooks

Electronic logbooks improve the accuracy of data collection at the species level by allowing fishermen to report catch data at sea throughout a fishing day rather than reporting pounds of fish as determined by the dealer. The electronic logbooks also enable the collection of more accurate bycatch information by allowing the reporting of bycatch while at sea at the time of the actual discard. Additionally, electronic logbooks also offer practical business benefits for the user (fishermen) in that all data that are recorded are available for the fishermen; they can see their data overlaid on nautical charts by species, by area, and by time period. Fishermen also have the ability to see their own catch per unit effort statistics for different time periods.

South Atlantic Electronic Logbook Pilot Project

Electronic logbooks have been used in several fisheries in the U.S. including fisheries in New England. As required by Amendment 4 to Snapper Grouper Fishery Management Plan, commercial fishermen fishing for South Atlantic snapper grouper have been required to fill out a paper logbook since 1992. In 2002, the SAFMC and Technology Planning and Management Corporation (TPMC) (now Perot Systems Government Services [PSGS]) tested the use of electronic logbook reporting using the Thistle Marine™ electronic logbook. This device is "ruggedized" for small boat fisheries and is designed specifically for fisheries logbook recording and biological sampling during fishing operations. The project examined the proposition that an electronic logbook can collect all of the data elements presently required by the paper logbook program and can collect more accurate and comprehensive bycatch and catch location information.

The Thistle Marine HMS-110, (Thistle box), is an off-the-shelf device that is ideally suited to electronic data collection on small, open wheelhouse vessels such as those in the snapper/grouper fishery. The device is totally self-contained, weatherproof, and can be operated with a gloved hand. Power is supplied through a cable that is plugged into the back of the device and connected to the boat's 12-volt power supply. The same cable also interfaces the Thistle box with the vessel's GPS unit using a standard NMEA (National Marine Electronics Association) connection. After a fishing trip, the fisherman brings the unit home, connects it to the phone line, and sends and saves the data on Thistle Marine's secure website. The unit's ease of installation and durability make it ideal for small fishing vessels where 110-volt power is not available for a PC or an open wheelhouse precludes having a computer onboard.

The 2002 project was implemented on two commercial snapper/grouper vessels in South Carolina and North Carolina from May, 2002 through November, 2002. The electronic logbook pilot program recorded:

- Number of fish caught (although pounds can be recorded instead, number of fish was more expeditious in this case)
- Number of fish discarded
- Number of crew
- Number of lines
- Number of hooks per line
- Date (when interfaced with vessel's GPS)
- Time (when interfaced with vessel's GPS)
- Location (when interfaced with vessel's GPS)

The second major goal of this project was to examine the feasibility of using an electronic logbook to record biological

information on the catch that is retained and on the component that is discard. A final presentation was given to the Council and Snapper Grouper Advisory Panel at their December 2002 meeting and the results were well received by the fishermen involved, members of the Snapper Grouper Advisory Panel, and by Council members[1].

By far, the greatest challenge to implementing an electronic logbook on a commercial fishing vessel is integrating the data collection flow into the vessel's

[1] The pilot project collected over four thousand data points representing nineteen commercial snapper grouper trips aboard two bandit vessels. Thirteen hundred catch observations were recorded representing just over five hundred anchor sets. Both landed catch and discards were recorded in numbers of fish for twenty-nine different species. In addition, the electronic logbook recorded nearly twice as many species landed per trip than the paper logs. The reason for this is most likely a result of recall error when filling out paper logs and the seafood dealer's practice of combining smaller quantities of fish of different species and reporting them as one.

fishing operations. Almost all of the time spent on this pilot project and most of the programming changes made to the Thistle box were to fit data collection into the workflow of the fishermen during fishing operations.

When interfaced with the vessel's GPS, the Thistle box can be viewed as an "event" recorder. Each event that is entered is stamped with the date, time, and location from the GPS receiver. In the lobster fishery where the system was first conceived, an event is each time a trap is hauled or a string of traps is hauled. For the snapper/grouper fishery pilot project, TPMC identified the events associated with the way bandit fishermen fish their gear. When the fisherman identifies where they want to fish, they drop anchor and remain in that location until they are done fishing and prepare to move on to another location.

After dropping anchor, the fisherman will record the event on the Thistle box, noting the date, time, and location of the event. When fishing is complete, the fisherman will note that event by recording the pounds of fish kept by species and the number of fish discarded by species. The date, time, and location would again be recorded to complete the overall fishing record for this site. A trip would be composed of a number of these two events at each fishing site.

drop anchor ⟶ **fish** ⟶ **haul anchor** ⟶ **record data**

This pilot program was funded again in 2004 and 2005 and applied to a larger number of vessels. Details regarding the best software and hardware to use for the snapper grouper fleet are still being determined. Thus far, several options have been tested[2].

Comment [m2]: See above. Need update.

It should be noted that all participants found the charting capabilities of the P-Sea WindPlot software to be an excellent addition to their standard electronic navigation

[2] Boatracs and Skymate VMS units were used for electronic submission. Shoreside testing revealed that the Skymate unit had a transmission success rate of only 50% while the Boatracs unit had a 100% success rate. The cost for a Skymate unit is $1599 plus installation and activation costs compared to $3195 plus installation costs for the Boatracs unit.

Several laptop and tablet PCs were tested, but the best option for the money seemed to be Dell laptops (Dell Inspiron 2600, Latitude D505 and C640). Although susceptible to glare problems, there were no failures of these units during two year deployments in open and closed wheelhouses.

Of the e-logbook software considered (Thistle, Windplot, UNH) the UNH was used on a greater proportion of vessels as the Windplot software could not track simultaneous effort in fixed gear fisheries. The UNH software could capture simultaneous effort, but could not dissociate effort from trips (setting a trap on one trip and retrieving on another trip). This was dealt with by allowing manual entry of set times and haul durations. The Thistle software could not handle multiple species records for a haul, as it was developed for lobster fishing and only accommodated one species record.

Data were transmitted off the vessel and to an email address by VMS, and loaded to Oracle tables using a PLSQL script.

equipment. However, the use of these computer systems has not been without a few minor issues, considering the corrosive environment in which they have been deployed.

Although not yet developed for the electronic logbook pilot programs in the South Atlantic, it has been suggested that electronic logbook data could be submitted via a VMS satellite transmission. This would enable real-time data collection.