Project Period: 06/01/2011 - 12/31/2012
Award Amount: $200,000.00
Matching Contributions: $275,000.00
Project Location Description (from Proposal): Tests will take place in federal waters off of California, Oregon, and Washington.

Project Summary (from Proposal): Test whether video can accurately determine fish species. Success of the west coast groundfish trawl Individual Fishing Quota program depends on finding an affordable monitoring alternative to human observers.

Summary of Accomplishments: Four participating vessels have been identified. An array of cameras has been installed on the vessels which monitor the back deck area. Three platforms designs have been constructed that will be used to capture images of all fish which will be sampled as discards.

Lessons Learned: It is much easier to conceptualize how a camera could be mounted above a table to capture images of discarded fish than it is to construct a working table that could utilized on different fishing vessels. Each vessel is unique in its construction and deck lay out. Deployment of video camera equipment and associated platforms can not interfere with the safety of those on board the vessel.

<table>
<thead>
<tr>
<th>Conservation Activities</th>
<th>Determine if Electronic Monitoring is less costly than human observers</th>
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<tbody>
<tr>
<td>Progress Measures</td>
<td>Other Activity Metric (Dollar for Dollar)</td>
</tr>
<tr>
<td>Value at Grant Completion</td>
<td>Comparison of monthly costs</td>
</tr>
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<table>
<thead>
<tr>
<th>Conservation Activities</th>
<th>Determine if Electronic Monitoring can identify species as well as a human observer</th>
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<tbody>
<tr>
<td>Progress Measures</td>
<td>Other Activity Metric (Direct comparison of species identification by human observers and EM images)</td>
</tr>
<tr>
<td>Value at Grant Completion</td>
<td>Zero difference</td>
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<tr>
<th>Conservation Outcome(s)</th>
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<tbody>
<tr>
<td>Conservation Indicator Metric(s)</td>
<td>Other Outcome Metric (*)</td>
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<tr>
<td>Baseline Metric Value</td>
<td>*</td>
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<tr>
<td>Metric Value at Grant Completion</td>
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<td>Long-term Goal Metric Value</td>
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<tr>
<td>Year in which Long Term Metric Value is Anticipated</td>
<td>0</td>
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Final Programmatic Report Narrative

**Instructions:** Save this document on your computer and complete the narrative in the format provided. The final narrative should not exceed ten (10) pages; do not delete the text provided below. Once complete, upload this document into the on-line final programmatic report task as instructed.

1. **Summary of Accomplishments**
   In four to five sentences, provide a brief summary of the project’s key accomplishments and outcomes that were observed or measured.

   The selection and purchase of the right digital camera was made and they were installed first on two boats then on two additional boats. Considerable time was spent on the design of a discard table/chute from which to obtain fish images. Two boats dropped out of the project and the cameras were redeployed on two alternative vessels. Video images were obtained for the back deck work area of the vessels as well as fish images. From the fish images an exam video was prepared, posted on the web, and the link was circulated with the three state fish and wildlife agencies, NMFS, an observer company, and fishermen. There were twenty people that took the species identification test. The tests were collected and then score for correct answers.

2. **Project Activities & Outcomes**

   **Activities**
   
   - Describe and quantify (using the approved metrics referenced in your grant agreement) the primary activities conducted during this grant.

   The project got off to a delayed start as a result of several personnel changes in SaltWater Inc., the primary subcontractor. SaltWater operates an approved observer company and internal company needs required that key personnel were assigned to new tasks or relocated. Once the personnel issues were resolved and stabilized, the four participating vessels were identified. Each of these vessels had the full support of the project by the vessel owner and crew. These vessel range in size from 58 feet to 85 feet, which is range of most vessels operating in the groundfish trawl fishery.

   Select cameras – Traditional analog video camera systems are limited in their ability to capture images of sufficient clarity for fish identification. The primary goal of this project was to explore the use of digital cameras to provide significantly higher quality images which could allow species identification and ultimately allow the development of image recognition software which could identify species of fish.

   The subcontractor, Saltwater Inc., had to identify and test an appropriate camera that met the project needs of durability, image quality, and cost. They tested multiple cameras and decided the Mobotix high definition cameras were the best suited to the demands of the fishing industry.

   The Mobotix camera provides a 360-degree panoramic view, capturing the entire back deck of a small fishing vessel using only one camera.
For this project, in order to reduce the size of stored video files, we filmed deck surveillance video at a resolution of 1 megapixel 1280x960. For fish ID, we filmed at a resolution of 3 megapixels and were able to get images of sufficient clarity for reviewers to ID individual fish from video.

Install cameras - Due to safety concerns as well as the unique configuration of each vessel it was clear that each camera array was to be custom fit on each vessel. The camera arrays covering activity on the back deck of the vessels was the easiest to achieve. Cameras mounting on the house or mast provided excellent coverage.

Since the primary objective of this project is determine whether species identification and size can be obtained from video images, the design of the platform that discarded fish must pass over and the location of their placement has been time consuming. We developed three basic designs which provide a high level of flexibility to accommodate a good range of size of vessels.

The largest of these platforms is a stainless steel table with protective walls and an overhang where the camera mounted. This design is intended to be securely fixed to the vessel’s deck. The drawback to this design is it size, which on smaller vessels can present an obstacle. (See pictures).

The second is a fold-out stainless steel table mounted to bid board or railing which takes up far less space and with mounting brackets can allow its removal and storage. The camera is mounted on an overhang which folds down for storage (See pictures).

The last and certainly the most mobile is a rigid mat which can be laid on the deck surface. This approach is simple, but the placement of the cameras and the mat will be critical to ensure useable images. If this approach proves to be workable it will be very useful on the smallest vessels in the fleet which do not have much available deck space.

Ultimately, what work the best was the mounting the camera on a common 2x4 piece of lumber attached to the top of a wood working shop portable stand (see picture). This arrangement allowed the crew to store the camera in the galley area of the boat and quickly place the grid mat and camera on the back deck for capturing images. The camera and stand could then be folder-up and stored once again in the galley. This arrangement took up little space and was always out of the way on the work deck (See pictures).

Lastly, the procedures have been clearly laid out for all of the crew to understand how the discarded fish will flow through this system. Each vessel will be following the same set of instructions regardless of which platform they may be using on any trip.

Video coverage (back deck and fish) – One of the first installations was on a smaller vessel and the camera was mounted on the top of the house. Video from the first fishing trip with this arrangement was shared with folks in the enforcement community. They did not like the images from this placement. The camera angle was too low, resulting in blind spots behind fishermen working on the back deck. Their suggestion was to place the camera higher up in the rigging or on the boom. All other cameras were place up in these higher locations and that produced images which looked straighter down on the back deck where every thing could be seen with no blind spots.
Switching boats – Through the course of the project there arose the need to remove the cameras from a couple of boats and replace them on alternative vessels. There was also the situation where the owner of one vessel was offered a job for his vessel, crew, and himself to work as a Salmon tender in Alaska. This opportunity occurred with very little notice and the vessel departed to Alaska prior to having the camera equipment removed and place upon an alternative vessel. The laptop with all of the video data as well as the cameras were collected once the vessel returned to Astoria in the fall.

Prepare test video – Once all of the video files had been gathered, a video to be used as a fish identification test was prepared. The video was prepared by cutting selected fish images from the fish image data files. Each fish video image was labeled with a consecutive number in the bottom center of the screen. In total the there were 37 different fish images. This represented a mix of species, most of which are covered by the Pacific Groundfish Fishery Management Plan (FMP) but included several which are caught incidentally and are not included in the FMP. The video ran for roughly 8 minutes.

The video was converted into five different common video formats (avi, wmv, mpg, mov, and asf) which can be played on most media player.

Circulate test video request – A request was sent to individuals involved in groundfish research or management asking for volunteers to take the fish identification video test and to circulate this request widely within their departments. This list included individuals at the NMFS Northwest Fisheries Science Center, NMFS Southwest Fisheries Science Center, Washington Department of Fish and Wildlife, Oregon Department of Fish and Wildlife, California Department of Fish and Game. In addition to these agencies, ten commercial groundfish trawlers and Saltwater Inc were asked also to reach out to volunteers.

In total 20 individuals took the test. This broke down to:

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<tr>
<th>Agency/Group</th>
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<td>WDFW</td>
<td>3</td>
</tr>
<tr>
<td>ODFW</td>
<td>7</td>
</tr>
<tr>
<td>NMFS – SWFSC</td>
<td>5</td>
</tr>
<tr>
<td>Observer</td>
<td>1</td>
</tr>
<tr>
<td>Fishermen</td>
<td>4</td>
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It is unclear why there was no response from either California Department of Fish and Game or the National Marine Fisheries Service Northwest Science Center. Some of these people were currently port samplers, some had worked on groundfish in the past, and some were more involved in management and had not had field exposure in many years.

Collect response and score - The results of the test varied greatly. Perhaps some people should not have taken the test. It should not be surprising that those currently employed as observers and port samplers did much better at identifying the species of fish correctly than those that are not daily identifying fish. Additionally, complicating the ability of reviewers to identify the correct species, no information was provided as to what depth of water or general area along the coast the sample had been taken. In contrast, an observer on a boat would know what area the boat was fishing and could easily determine the water depth. So view reviewers were handicapped, making their task much more difficult that the job of an observer or sampler.
Correct answers ranged from 49% to 89% for all species, and from 48% to 93% when only including FMP species. The percentage correct increased dramatically when evaluated at the genus and at the family level.

Lighting turned out to be a problem, but not as expected. At first it was assumed that lighting on the fish and mat would be a good thing. Much like the photo studio or television set where large lights brighten the image. In the case of video cameras, the camera automatically adjusts to bright light by reducing the aperture in the lens. Therefore when the sun would appear from behind some clouds, the increase light bouncing off of the white grid mat would cause the camera to adjust to the brightest areas and the image of the fish lying on the mat would darken, making visual identification difficult. Nearly every person taking the test commented on the darkness of some of the images.

Additionally, it was learned that the lightness/darkness quality is also influence by which file format is being viewed and which media player is being used to view the video. These are two issues which were not anticipated going into the testing. Since we did not ask which media player was being used or which file format had been viewed, the influence of these two variables can not be evaluated in reviewing the score results.

It is clear however, that if media player and file format were standardized, and the properly trained people were examining video to determine species, it could be accomplished with a very high level of accuracy.

• Briefly explain discrepancies between the activities conducted during the grant and the activities agreed upon in your grant agreement.

Need to switch boats –
It was believed that four boats could be selected and that they then would carry the cameras through the duration of the project, but real world situations dictate what will occur. Problems developed early with two boats in Astoria and the deployment of the fish camera tables. Both the fixed leg table and the portable camera chute were too large and bulky for the size of the boats. Hard feeling developed between the fishermen and the Saltwater representative and both fishermen requested to be removed from the project.

The camera from one of these boats was then installed on another trawler in Astoria. However, within weeks of the installation, the vessel owner was offered an opportunity for himself and crew as a Salmon tender in Alaska. This vessel left on very short notice and the camera remained on the vessel until it returned in the fall.

In the south, the camera that was place on a vessel in Brookings had to be removed when that vessel decided to switch form groundfish fishing to Pink shrimp fishing. The cameras were then installed upon another boat in Brookings, but were removed when that vessel was awarded a NMFS trawl survey contract.

In total, video images were capture from six different vessels rather than the anticipated four. Other than time gaps and delays, the inclusion of different vessels did not compromise the study.
Motion sensor rather than hydraulic sensors – By leaving the cameras off while the vessel was running or while the gear was down and fishing the amount of data stored on the hard drives could be reduced greatly. It was anticipated that hydraulic sensors would be utilized to detect when fishing operations was being conducted. However, the camera selected had a motion detection feature built in to it software, which accomplished the same effect without having to modify any of the hydraulic lines on the vessel. Whether this would satisfy the potential regulatory needs of the use of cameras was not addressed and for the purpose of the study did not compromise the results.

Outcomes

- Describe and quantify progress towards achieving the project outcomes described in your grant agreement. (Quantify using the approved metrics referenced in your grant agreement or by using more relevant metrics not included in the application.)

We have been able to place cameras on the vessels to provide complete coverage of the back deck area. This allows the complete observation of all activities including any possible discarding at sea. The design and location of a platform with a dedicated camera to observe and record the size and species of any fish would could be discarded was a major problem. We have produced three designs which conform to the needs of this project and are compatible with the fishing operations of the vessel. These platforms needed to durable and stable while not interfering with the activities of the crew or jeopardizing the safety.

- Briefly explain discrepancies between what actually happened compared to what was anticipated to happen.

The level of cooperation between the observer and the crew at times was strained. Any fish, that was not to be retained and to first be recorded by the observer. In most situations the once the observer had completed his or her work, that person then discarded the fish. In some cases this was done without saving the specimen to be videoed later. It is believed that the possibility of cameras replacing observers was viewed as a threat to some observers.

- Provide any further information (such as unexpected outcomes) important for understanding project activities and outcome results.

3. Lessons Learned

Describe the key lessons learned from this project, such as the least and most effective conservation practices or notable aspects of the project’s methods, monitoring, or results. How could other conservation organizations adapt their projects to build upon some of these key lessons about what worked best and what did not?

The project demonstrated that species identification of discarded fish can be obtained from video images. However, to achieve an acceptable level of accuracy the video file format and video media play used in the review must be standardized and selected for optimal quality. Additionally, just as observers are now trained in species identification, individuals’ task with viewing video images of discarded fish must be properly trained.

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4. Dissemination

Briefly identify any dissemination of lessons learned or other project results to external audiences, such as the public or other conservation organizations.

Efforts to inform folks in government agencies, academia, environmental groups, and the fishing industry began shortly after receive the grant. In May 2011, Leipzig participated on a panel at a conference sponsored by Oregon State University and Sea Grant on the use of Electronic Monitoring held in Portland, Oregon.

In February 2012 Leipzig participated on a panel at a conference sponsored by Environmental Defense Fund on the benefits and lessons learn in the Pacific Groundfish IFQ program. He spoke to the need to continue pursuing video monitoring as a method to reduce the cost of the program.

In February 2013, Leipzig gave a presentation on the video project at a workshop sponsored by the Pacific Fishery Management Council.

Leipzig and others from the fishing industry have spoke to the Pacific Fishery Management Council about the need to begin moving forward with a regulatory package to incorporate the use of video monitor in the IFQ fishery.

5. Project Documents

Include in your final programmatic report, via the Uploads section of this task, the following:

- 2-10 representative photos from the project. Photos need to have a minimum resolution of 300 dpi and must be accompanied with a legend or caption describing the file name and content of the photos;
- report publications, GIS data, brochures, videos, outreach tools, press releases, media coverage;
- any project deliverables per the terms of your grant agreement.

**POSTING OF FINAL REPORT:** This report and attached project documents may be shared by the Foundation and any Funding Source for the Project via their respective websites. In the event that the Recipient intends to claim that its final report or project documents contains material that does not have to be posted on such websites because it is protected from disclosure by statutory or regulatory provisions, the Recipient shall clearly mark all such potentially protected materials as “PROTECTED” and provide an explanation and complete citation to the statutory or regulatory source for such protection.

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