Real-Time Electronic Bycatch Reporting Pilot Project

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Final Report

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By

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Executive Summary

The 2012 RSA project, "Real-Time Electronic Bycatch Reporting", has continued from the progress gained on the 2010 RSA project of the same name. The intent of both projects was to develop and implement computer software and associated equipment as well as to collect and disseminate real-time bycatch data in order to maintain catches below allowable catch targets of yellowtail flounder. The Ocean Land Resource Assessment Consultants (Olrac), have continued to work with the Coonamessett Farm Foundation (CFF) to optimize the software interface using additional hardware and to perform according to standards set by both the Coonamessett Farm Foundation and partners in the scallop industry. The Olrac software has been installed with the necessary equipment and data transfer authorizations on laptops on ten limited access scallop vessels in New England. The program has advanced to the point where the fishermen can seamlessly enter catch data with minimal impact on fishing activities. The data can then be sent to shore via Boatracs in a very simple, user-friendly manner and stored on the CFF servers. Bycatch rates can calculated and sent back to the vessels, or the data can be analyzed to determine seasonal trends in fishing activity and bycatch movements. The project has fulfilled all of the objectives and is ready to be expanded to the rest of the fleet to increase high quality, low-cost data collection throughout the US sea scallop industry.

Background

A real-time catch reporting tool has been designed in order to change the way fishery stakeholders collect fishery data in order to maximize catch and minimize bycatch while increasing productivity throughout the industry. The software has been designed to allow for data collection at sea, real-time data transfer to shore, and subsequent data transfer back to the vessel to notify fishermen of bycatch rates (Fig. 1). The Coonamessett Farm Foundation Inc. has collaborated with the software development company Olrac SPS International (hereafter referred to as Olrac) to design and build the Olrac DDL fishery sampling and reporting software. The software allows easy data collection in the field including location, catch, environmental and additional user defined data entry fields.

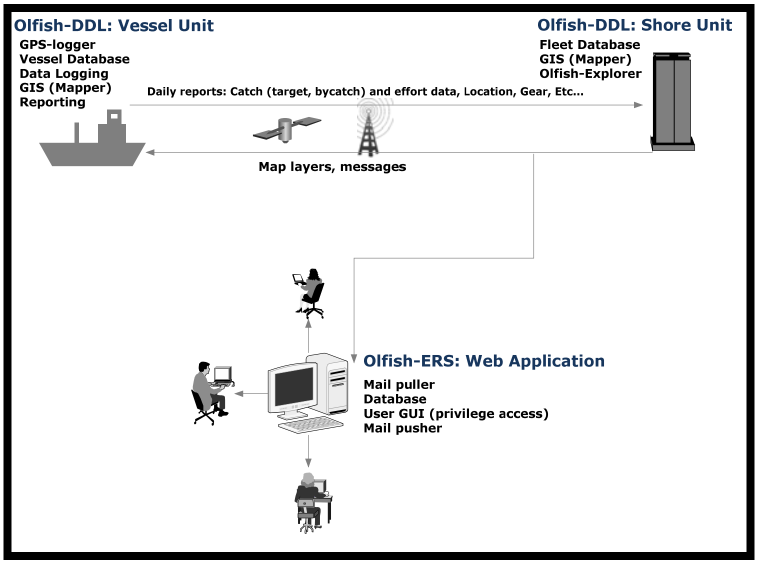

Figure 1. Schematic of data flow from the ship to shore and back.

The first six months of the project (2010) focused on data modeling, or "blueprinting" the data elements to be incorporated into the Olrac software components. This was an iterative process, incorporating suggestions from Coonamessett Farm Foundation (CFF) staff, scallop industry representatives, the Olrac development team, and components from paper logbook forms. Olrac developed two customized software elements for CFF and the limited access scallop fleet, as follows:

Olrac–Dynamic Data Logger Scallop (Olrac DDL) – Vessel software used to record data and send reports to the Olrac-DDM.

Olrac–Dynamic Data Manager Scallop (Olrac DDM) – Web-based reports management database, used to aggregate and analyze reports sent from the Olrac DDL and transmit bycatch reports back to the fleet.

While the Olrac software has been designed and implemented into several fisheries around the world, it needed to be tailored to Limited Access scallop fishery. For example, the software is currently utilized in the offshore lobster fishery in the Northeastern US. While several of the data entry fields may be similar (latitude, longitude, depth, etc.), many of the fields had to be modified to accommodate the specific fishery needs and data collection differences between typical Olrac clients and the scallop fishery. This meant modifying the software to include fields in order to input scallop catch weights, discards of several commercially important species, dredge specifications, as well as weather and tow information. After software design was complete, it was tested both on land using proxy catch and GPS simulations as well as on the F/V Celtic in New Bedford in the spring of 2011. Initial testing both using proxy catch information on land and in real-time on fishing trips resulted in several modifications to both the software and hardware to optimize the system. This included reworking the method of catch input, redefining on-deck sampling procedures and investigating a new method of ship-to-shore data transmission (Fig. 2).

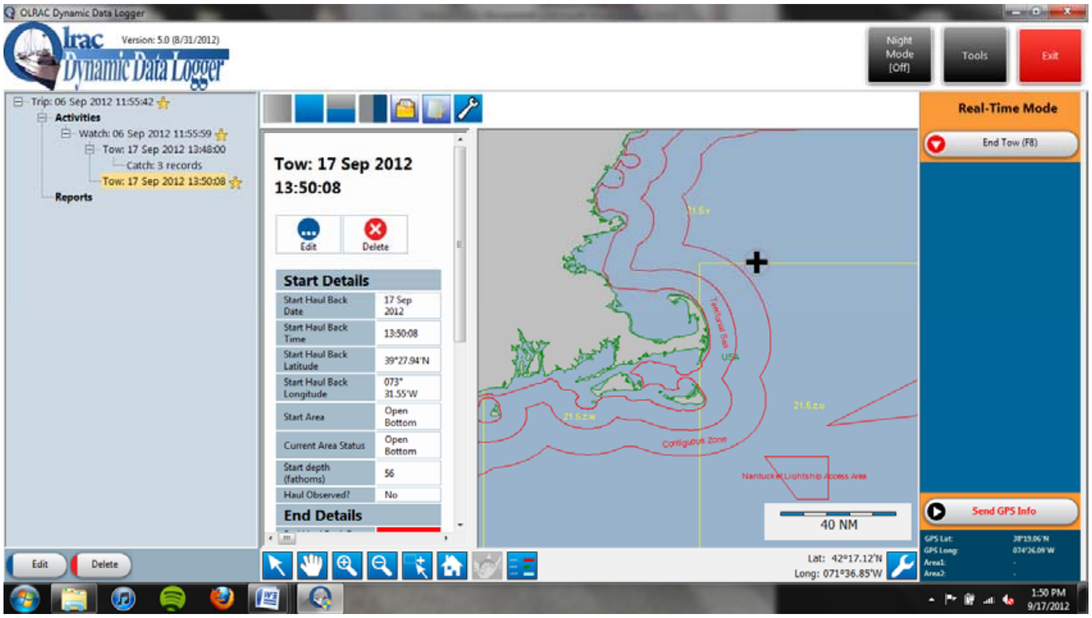

Figure 2. Olrac DDL (ship-based data collection software) showing current vessel location.

The software has been developed according to specifications outlined by CFF, which include numerous data fields, which may be, presently or in the future, important for vessel operators and owners in the scallop industry. It is crucial not to limit the amount or type of information collected through the software, in order to accommodate future needs of the sea scallop fishery. We therefore decided to leave potential for collecting many types of data, which may or may not be utilized by every vessel. Information such as lunar phase, amount of wire out, depth of tow, and dredge size have been included, as well as catch amounts for all species found within the scallop industry. The users may determine which fields they deem most necessary, and turn off or omit those fields which may not be critical. Current data fields can also be modified on the Olrac system, so as to allow for the various defined lists of values to be added to and amended as necessary. For example, the software is pre-loaded with a defined list of species, gear types, ports, and units of measure and product types by species.

A web-based interface is also provided as part of the Olrac software, which enables designated users (including the fishermen themselves) to view data sent to shore from the vessels. This interface allows for different user types with different associated access rights. Industry members are able to see the trips and individual hauls carried out by their own vessel(s), and the catch taken and bycatch ratio (for all species) for each haul. Every day, each vessel sends a catch report to the CFF server with their scallop and yellowtail catch for the previous 24-hr period. This information is then processed by the CFF server software, and is made anonymous through incorporation into a fleet-wide average of catch effort and bycatch rates in that particular area. Each vessel can then receive a density map with a fleet-wide average of meat weights and bycatch rates. Through this processing technique there is no way for any vessel to receive information that is specific to any particular vessel, and has not been made anonymous through averaging and incorporation into a fleet-wide average (Fig. 3).

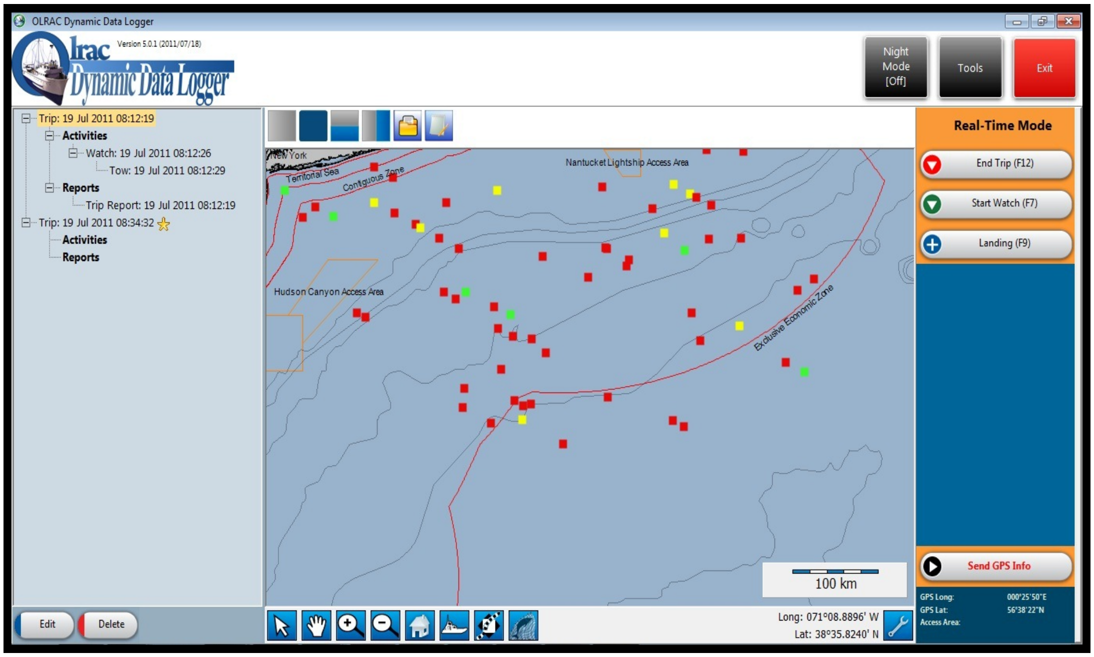

Figure 3. Generalized bycatch hotspot map which is sent back to the vessel. Red boxes are high bycatch areas, yellow boxes are medium bycatch areas, and green boxes are low bycatch areas.

In addition, a variety of queries are provided that should prove useful to scientists, fisheries managers and the fishermen themselves. The following are examples of the types of queries available: bycatch ratio by day, for a specific vessel, during a defined period; bycatch ratio by gear type over a defined period; and catch weight (both targeted and by-catch species) by gear type attribute. Current management techniques rely on observer data, which is costly to collect and the quality of which has been questioned by both managers and fishermen. This system could prove to be the most comprehensive data collection operation in the fishing industry, since it relies on fishermen accurately reporting their own catch information. While initially this may seem a duplicitous biological sampling effort, it may become clear as the project progresses that this method is more efficient at providing higher quality data than current methods.

2012 Electronic Monitoring Project Progress

DDL (ship) Software development

The software was designed so that as much information as possible (eg. tow times and dredge specifications) could be logged automatically when the computer is connected to GPS. Therefore, fishermen would only need to manually input a minimal amount of catch information in order to determine discard rates and total catch volume. CFF researchers and fishermen discovered during beta testing aboard the F/V Celtic that the original catch input procedure was too cumbersome to be considered as a potential fishery protocol. Several conversations with the Olrac team led us to rework the data entry method, and redesign it to be a grid-based system, instead of a text field-based input strategy (Fig. 4).

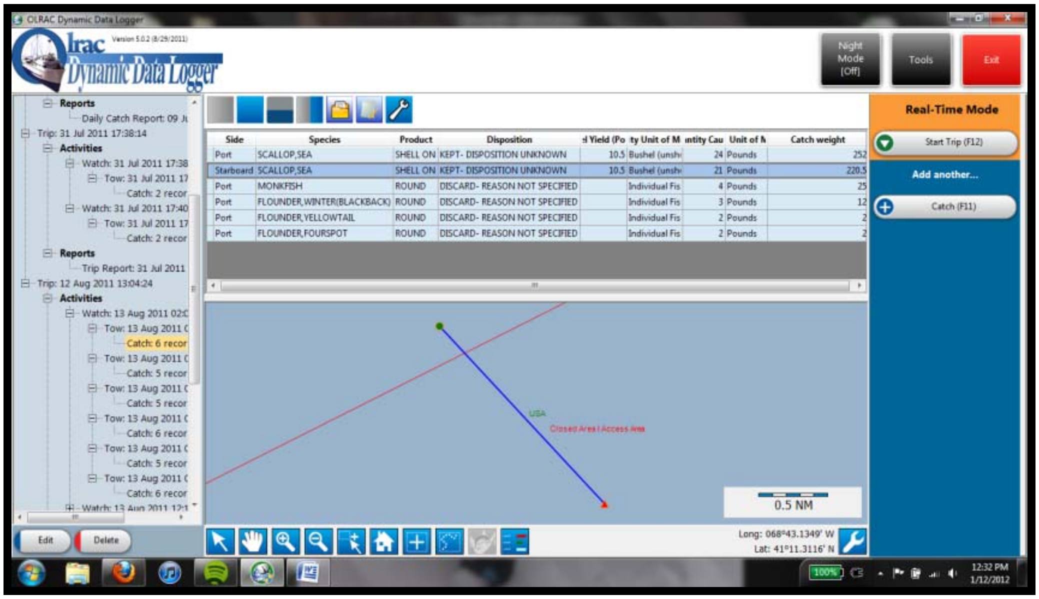

Figure 4. Updated grid-based catch module of the Olrac DDL software.

There were two problems with the software as it was originally delivered to CFF researchers; 1) it was too cumbersome to enter catch data as well as transmit the information to shore leading to inefficient operation and 2) the data was transmitted over the current Boatracs WBUI program, which presented numerous technical and logistical constraints. Therefore, in the early fall of 2011, CFF researchers communicated their issues to Olrac software developers, and the programmers began fixing the issues. The software developers completely revamped the sampling input module by changing it from the overly cumbersome field-based method to a much more intuitive grid-based method.

In addition to the transition to grid-based data entry, several other modifications were made to the program as outlined by the CFF researchers. The software was initially designed to function as a comprehensive data input tool. However, during beta testing, the program was inadequate as both a; 1) fisheries data collection tool, and 2) scientific data collection tool. As the software was configured, there were too many fields for the fishermen to constantly input, and they were reluctant to use the software as it interfered with fishing operations. Additionally, CFF scientists would use the software on research trips, though several fields were lacking for research purposes. Therefore, the Olrac software developers integrated the ability for administrative login to the software, which allowed for much greater flexibility in the availability of data fields. By decreasing the number of fields the fishermen were required to input every tow, the fishermen have stated that the program is easier to use and to integrate into normal fishing activities. Additionally, CFF scientists can simply log in as administrator and add the fields necessary for scientific data collection. The program in its current form can satisfy the needs of both scientific and fisheries data collection.

DDM (server) Software development

The central objectives of this project are to record data in real-time on scalloping vessels and to send reports to the server on a regular basis. While the server-based software currently records information sent to shore from the vessels and serves as a critical piece of equipment for a vessel tracking catch rates over time, data transmission to shore and subsequent transmission of area-specific catch ratios back to the boat are the capabilities that will make the fleet more efficient. Olrac software engineers and Coonamessett Farm Foundation have tested the software extensively both on land and at sea to ensure reliable data transmission (Fig. 5).

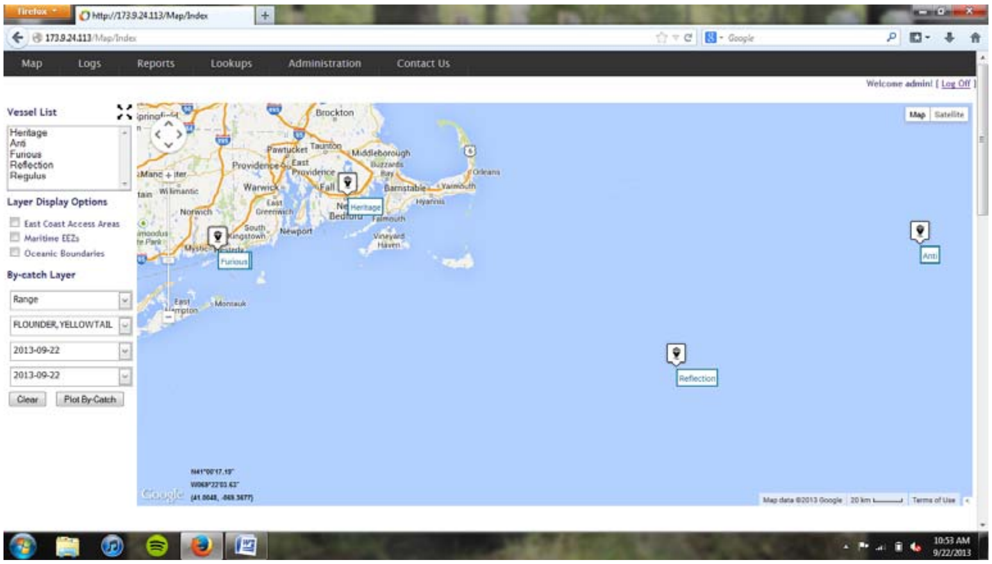

Figure 5. Screen shot of the shore-side DDM server. Note the fishing vessels Anticipation and Reflection are currently fishing, while the others are at port in either New Bedford, or Stonington, CT.

The OLRAC-DDM program runs on a server at the CFF offices and uses a Windows server (API) protocol to monitor a Boatracs file location for incoming data from the vessels. When a new data set arrives, it is downloaded and saved to the database after data validation. Once a day the DDM generates a density map of by-catch ratios in terms of defined bycatch species to scallop (target species). Bycatch ratios can be extracted for different periods (for example, High bycatch areas for the past day, week, or month). These ratios produce a collection of coordinates identifying bycatch hot spots. For example, the skipper can choose to target low bycatch areas and to avoid high bycatch areas. The ratios are categorized so as to allow for the grouping of bycatch ratios into “high”, “medium” and “low” by-catch ratios. These categories are entirely configurable by the user, thus enabling the user to declare even more ratios and categories (e.g. critically high, high, medium, low and very low). The categories are declarable in terms of percentages (e.g. live weight scallop to live weight yellowtail).

The bycatch report runs automatically on a regular basis (e.g. daily, at 5pm, the data up until 12 noon on that day will be analyzed). The data is sent back to all the vessels via email, as a list of coordinates, which can then be viewed via the mapper so as to enable the skipper to direct his fishing to the appropriate areas when he commences his next fishing activity. The DDM has no mechanism by which operational data can be added manually. It can only import the data captured on the DDL. The DDM comprises of a SQL Server database, a web front-end as well as a set of windows services (PROCESSOR) for the pulling and pushing of messages in and out of the system. Access to the web front-end is password protected and new users can only be configured by the system administrator. It enables designated users (including the fishermen themselves) to view data sent to shore from the vessels. The user is able to see the density maps sent to the vessels, over various time periods, thus enabling the user to view by-catch ratios over time, and across different access areas (Fig. 6).

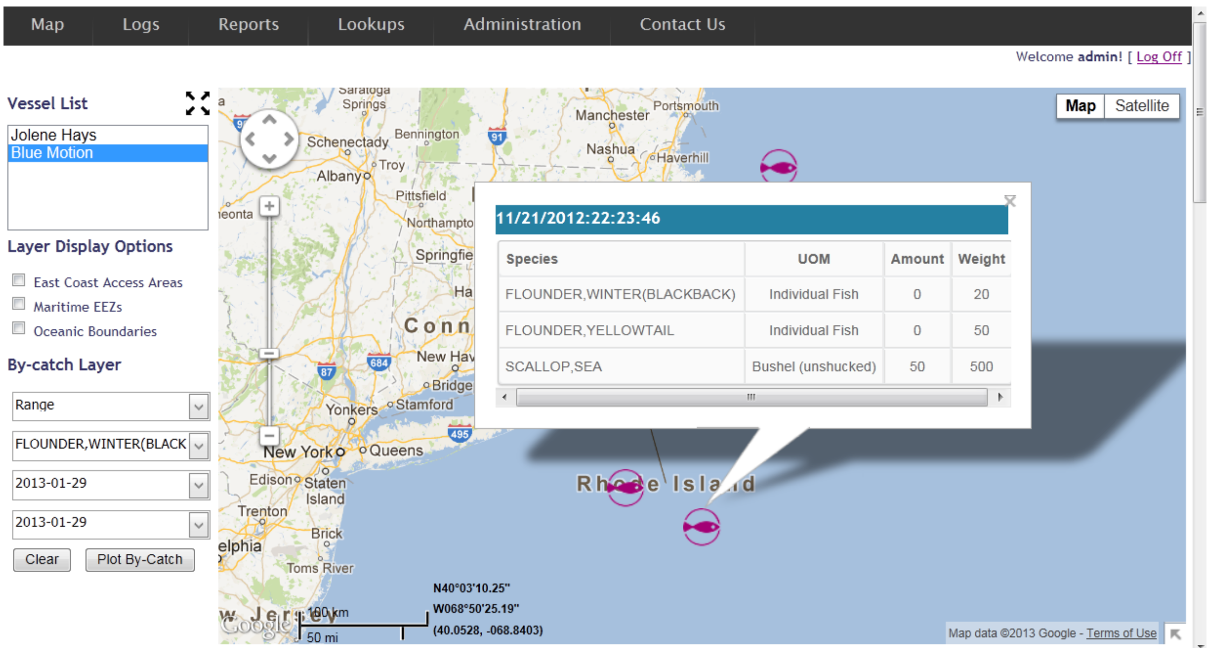

Figure 6. Each owner and captain has access to only the vessels which they operate. Note on the left side of the screen only two vessels are visible. When each vessel is clicked on, it will show the tows on the map.

The vessel positions are derived from the vessels' data reports. At any point you can click the Map menu option to get back to this view – the map will be reloaded to this display.

The sidepanel has the following functionality:

- You can minimize it using the icon next to the 'Vessel List' label
- You can select any vessel in the 'Vessel List' to pan to that vessel location on the map. The pan will work at any zoom level.
- The 'Layer display options' allow you to toggle the various layers available in the system
- The 'Bycatch Layer' section allows you to specify various parameters to generate a bycatch report.

Bycatch report generation is an automated process. The only configuration allowed is when the user wants the report to be generated – and this is only controlled by whoever has access to the physical server. When a bycatch report is generated, it is automatically queued for sending. The Olrac Mail Pusher regularly checks for outgoing messages and sends them to the intended recipients via email.

The system has generic screens for the viewing, editing and exporting of data, shown in the screenshot below (Fig. 7). By logging into the data viewing screen, any administrator can export the necessary data according to variable queries defined by the user. For example, if the user is interested in what depths yellowtail flounder were caught in the month of May, they can click on “tow data” and specify the month and species of interest. With another single click those data can be exported to a number of different file formats for data analysis (.xls, .xlsx, .pdf, .csv, etc.).

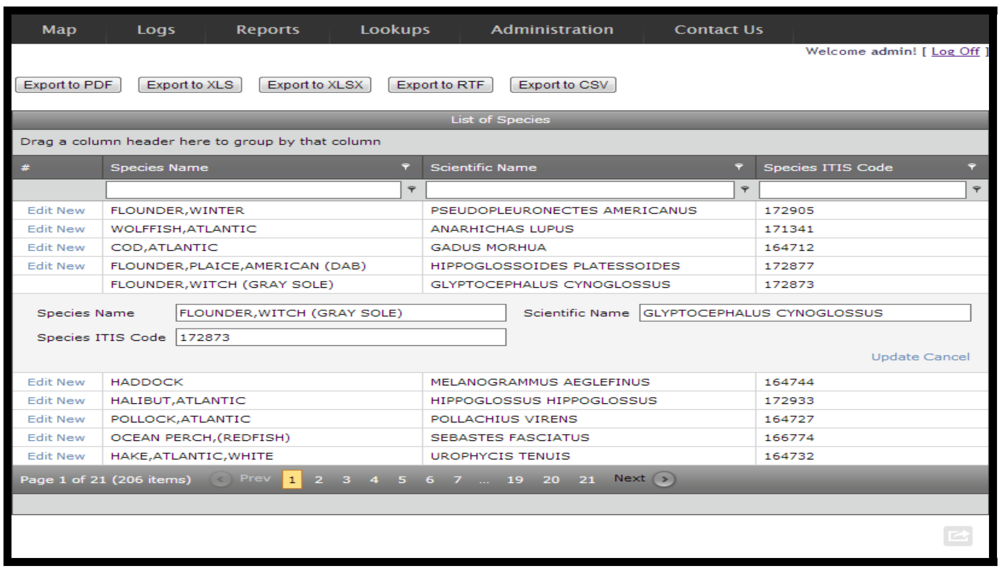

Figure 7. Data export screen on the DDM (server-side) software. The data saved on the server can be queried by any number of potential data groupings defined by the end user.

Transmission of data from shore-to-ship

In the initial planning stages of the Olrac DDL software, Boatracs was chosen as the method to transfer data to shore. This was chosen due to the fact that the majority of Limited Access scallop vessels have Boatracs as a ship-board VMS system installed, and Boatracs has the software available to allow for data transfer through an outside computer. However, in the initial testing of the software aboard the F/V Celtic, it was found that the Boatracs interface (WBUI program) may impede wide spread integration of the data transmission system into the scallop fleet. Since using Boatracs to transmit the daily catch reports requires advanced computing skills and time, CFF researchers determined that it was imperative for the success of the project to find a new method of data transmission. CFF has investigated other hardware platforms that potentially transmit data more consistently and at cheaper rates using the Iridium satellite network instead of the Boatracs system (Qualcomm satellite network). CFF researchers were introduced to Succorfish by the Olrac team as a good alternative to Boatracs for data transmission. Succorfish is a UK-based development and manufacturer of bespoke marine tracking, asset management and control solutions.

The Succorfish system was promised to have the capability to switch data transmission to cellular networks when near to shore, which significantly reduces cost (Fig. 8). The new system was also promised to have improved signal strength, reducing “dead spots” while simultaneously improving transmission speeds and reducing transmission costs, and the hardware is significantly less expensive on the new system as well. This should allow for email use, weather information, and other data use by fishermen at sea, potentially leading to further integration into fleet operations if the platform is not strictly used for scientific purposes.

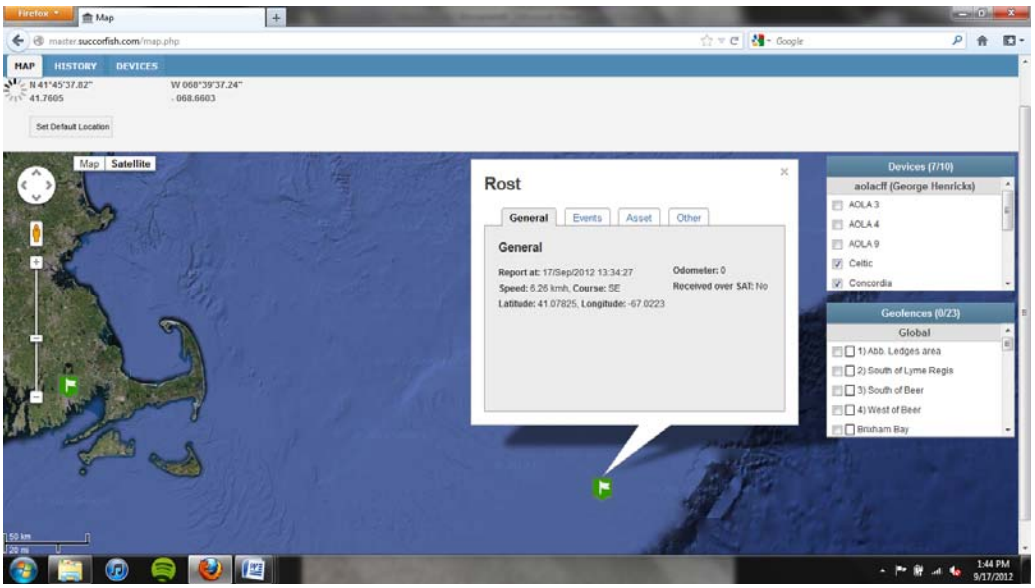

Figure 8. Succorfish web-based mapper function. All vessels participating in the program can be viewed at once from any internet-connected computer, without any additional software.

The Succorfish communication platform was promised to be delivered to the CFF researchers in September 2011, then January 2012, then April 2012. In April 2012, one unit was installed on the F/V Celtic, though not complete and without a working integration box to allow it to communicate with the computer. As of August 2012, all of the ten units were installed on fishing vessels in New Bedford, MA or Stonington, CT (Table 1), and all of the units were communicating with the satellites, though they were not able to transmit data.

Vessel Name	***State***	
Vanquish	MA	Done
Anticipation	MA	Done
Celtic	MA	Done
Contender	MA	Done
Edgartown	MA	Done
Venture	MA	Done
Reflection	MA	Done
Heritage	MA	Done
Furious	CT	Done
Regulus	CT	Done

Table 1. Vessels in the pilot program equipped with Succorfish satellite transmission hardware.

As of the initial hardware delivery date in August 2012, all of the installed units are communicating location data successfully with the Iridium satellite network. However, that is the only piece of information that the units are capable of delivering, which is much less functionality that was guaranteed over 24 months prior. Therefore, in March of 2013, after installing nine pilot-program units, we asked Succorfish to set yet another firm deadline to deliver the product. They set a deadline of April 25th, and although they had missed over ten deadlines in the past, we had to make clear that they had to make this deadline or we would explore other directions. The deadline passed with no delivery (as of this writing there is still no working product). Therefore, the CFF researchers were forced to go with the only other working satellite transmission product available; Boatracs. The NOAA VMS compliance team was consulted, and data ports were opened for all ten participating vessels (Table 1), with authorization from NOAA to use their existing VMS Boatracs unit for data transmission for this product. CFF researchers then purchased ten WBUI cables from Boatracs, and were trained on the updated BT Vessel software, which replaced the older WBUI software. The new BT Vessel software is much more intuitive, and seamless to operate with the Olrac data collection software, as data transmission is now automatic (Fig. 9).

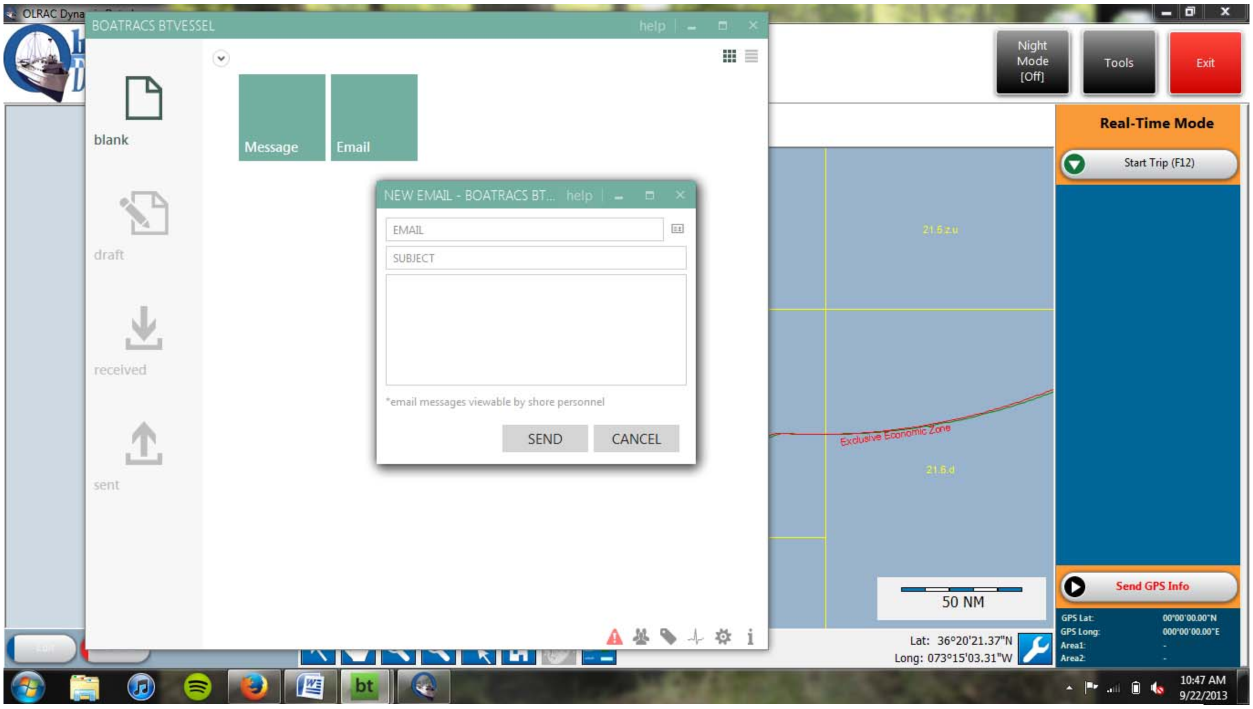

Figure 9. Olrac DDL opened to start a new trip. Boatracs BT Vessel software opened with new email message pop-up opened.

After working through several initial issues with Boatracs data transmission, the system now works seamlessly, and the complete setup has been installed on ten pilot-program vessels. The captain and mate were trained on each vessel in how to use the software and then went on a trip. Following the initial trip, CFF researchers met with the captains to debrief and receive insights on how better to optimize the software, how best to train future captains, and issues that arose while at sea collecting data. There are new complications that arise on each additional trip and we continue to develop new ways to improve the system. Currently, all ten vessels are sending data to shore, and the shore-side DDM server is collecting the data to be averaged and sent back to the vessels.

Data analysis

The program has evolved since the initial planning stages in 2009, to a fully functional data collection and transmission tool. All of the ten pilot-project vessels participating (Table 1) had a fully functioning system as of winter of 2013. Therefore, in the entirety of 2013, every vessel did not have the opportunity to submit their data on the CFF designed system. However, in 2014, all ten participating vessels have submitted reports on all of their fishing trips thus far. This includes over 1095 tows, with position data and catch information for every tow without a single crash of the program. While the data transmitted by the ten vessels does not accurately assess the fishing behavior of the entire fleet, analyzing the incoming data demonstrates the potential for this program for both the industry and fishery managers. The main objective of the pilot program was to design and implement a reliable system that would easily integrate into fishing operations. The program has succeeded in this sense and the scallop and bycatch data set will be expanded with additional vessel participation.

By mapping all of the scallop catch data from the incoming vessels, it is easy to look at the areas of fishing pressure over the entire season (Fig. 10).

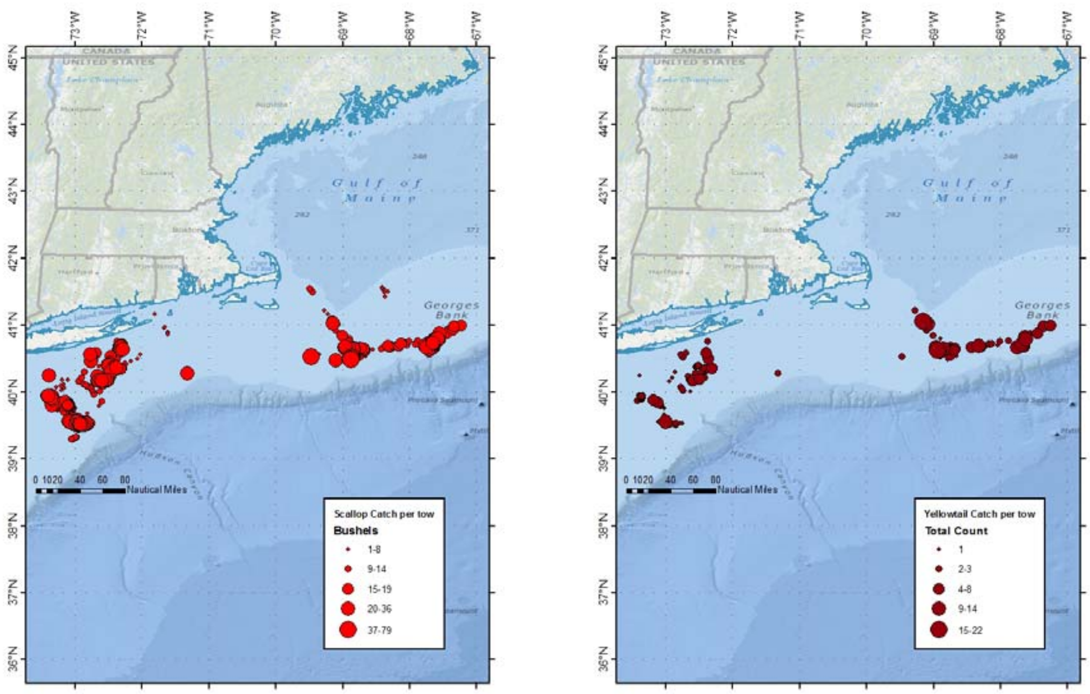

Figure 10. Graphic on the left showing total scallop catch per tow in bushels over the entire 2013-2014 season thus far. Graphic on the right showing total yellowtail flounder bycatch per tow for the entire 2013-2014 season thus far.

However, more importantly, because the fishing vessels are all fishing at their own pace, and throughout the entire calendar year, there is almost always more than one vessel sending in data at all times. We can compare fishing pressure and bycatch rates across broad areas of the fishing grounds with the ten currently participating vessels and a minimal additional cost. The data set will become more robust with greater vessel participation over a broader geographic range and can be used for seasonal analysis in management of the fishery. For example, one could compare fishing pressure and bycatch rates between months to examine seasonal variability (Figs. 11-12). If the industry and managers were able to more accurately determine the scallop catch rates throughout the year, and perhaps more importantly, significant bycatch choke species (i.e. yellowtail flounder), the scallop fishery could operate much more efficiently without unnecessary accountability measures or closures.

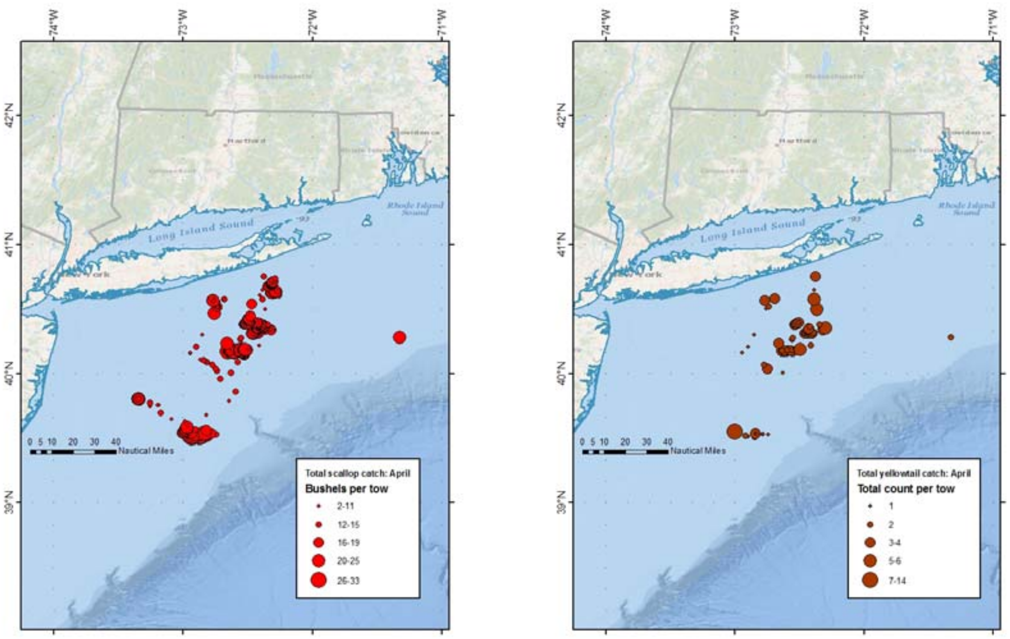

Figure 11. Graphic on the left showing total scallop catch per tow in bushels in April 2014. Graphic on the right showing total yellowtail flounder bycatch per tow for April 2014.

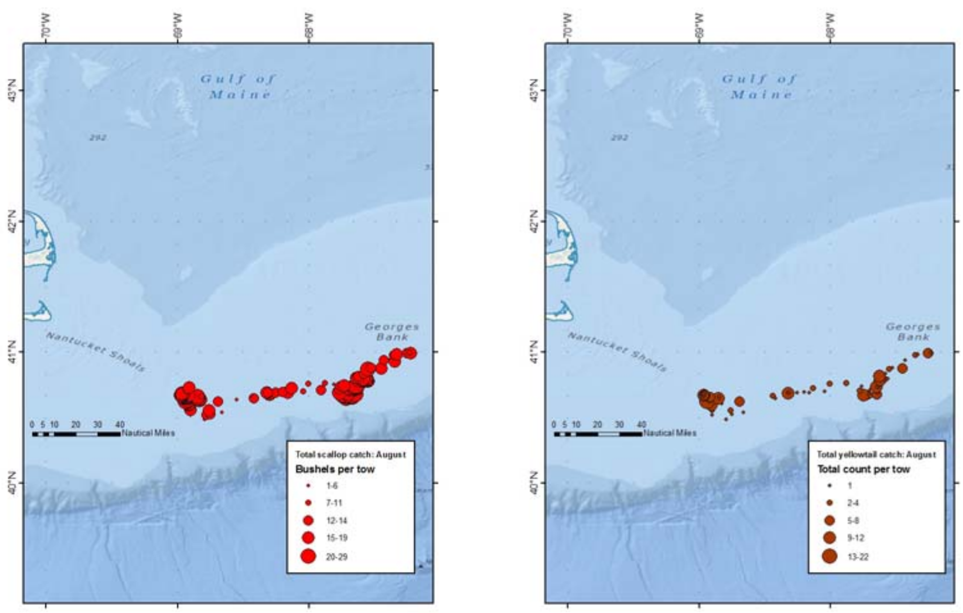

Figure 12. Figure 10. Graphic on the left showing total scallop catch per tow in bushels in August 2014. Graphic on the right showing total yellowtail flounder bycatch per tow for August 2014.

Perhaps most importantly is the ability to identify the areas where bycatch rates are highest at a fine spatial resolution. Several bycatch avoidance programs have attempted to solve this problem by dividing the fishing grounds into areas. While reporting bycatch per area is a great first step, our data analysis indicates that the spatial resolution is too broad to effectively change fishing behavior. Our results to date indicate that distribution of commercially valuable fish bycatch species is highly variable, sometimes at a very fine spatial scale. The difference between catching all scallops with no bycatch, or reasonably high bycatch with the same scallop catch, can be the difference of mere miles or less (Fig. 13). By segmenting the fishing grounds into areas, some of these subtle differences can be missed. However, distributing bycatch maps that show areas of high bycatch at a high spatial resolution serves to better inform fishermen's' decisions. Overlaying the bycatch maps onto the same bottom contour maps the fishermen currently use provides fishermen with a point of reference to note where the areas of bycatch are high or low. The fishermen may then simply reference the map and note that moving a few miles in one direction may decrease bycatch rates substantially for the same scallop catch.

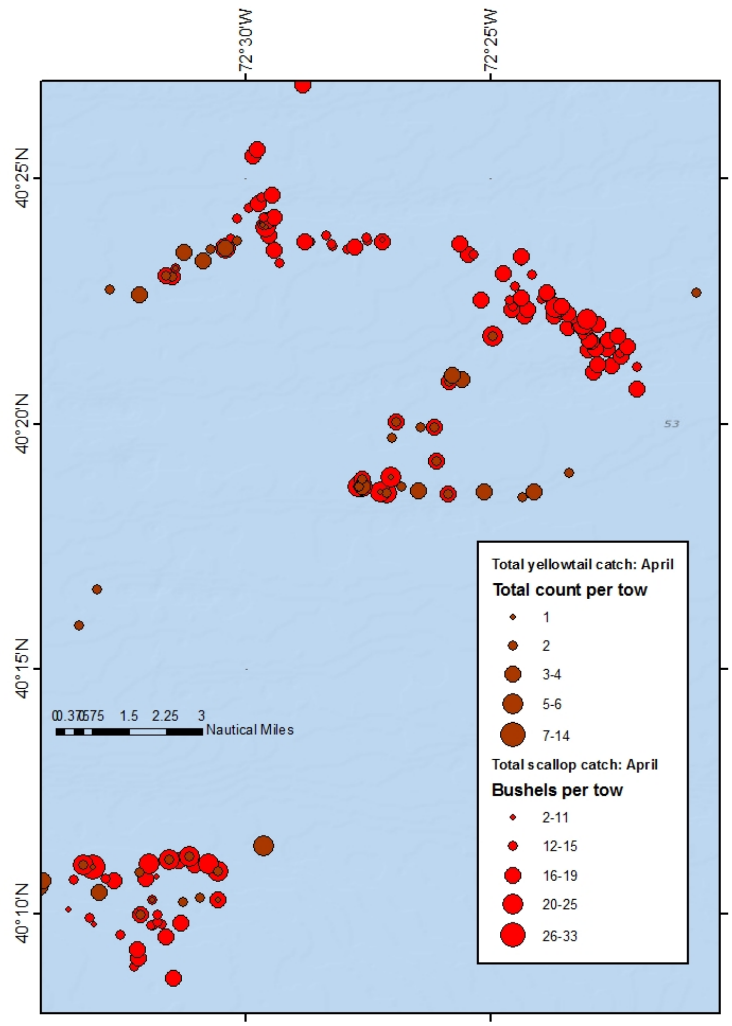

Figure 13. Total scallop catch per tow, and total yellowtail catch per tow, for vessels participating in the pilot-program, for the month of April 2014 in Southern New England. By correctly sizing the scallop catch and YT bycatch circles, in areas of a high scallop catch to YT bycatch, the bycatch is obscured in the plot indicating a good area to fish. Where bycatch is high, the scallop catch is obscured, indicating an area to avoid. In the top of the graphic, there are areas of high scallop catch with few yellowtail caught. However, less than two miles south there are high rates of yellowtail caught with fewer scallops caught per tow. If the fishermen had access to bycatch maps produced with these data, it may be illustrative enough to impact fishing behavior.

Future research direction:

The ten vessels that are currently sending catch information back to the CFF servers are serving several functions simultaneously in this developing program. They are reporting on the functionality of the software, which has led to ongoing ever-improving modifications to the software functionality. They are sending catch data to shore, which will be analyzed for trends and quality. They are providing valuable social information on the willingness of the fleet to participate as well as correlations between technical knowledge and ability for the captain and crew to successfully integrate the data collection system into fishing activities.

Electronic VTR capacity. Olrac has developed a pilot eVTR based on specifications released by NOAA's Northeast Fisheries Service Regional Office. This eVTR functionality, updated with recent NOAA standards, can be added to the Scallop product. As of 2014, scallop vessels are now permitted to submit eVTR s, thought FLDRS (NOAA program) is the only NOAA certified eVTR solution. Olrac is currently working on eVTR certification, and plans to be able to be a second eVTR option in 2014.

Researcher Data Set. A data set will be added to the vessel software, Olrac DDL, to be used by researchers when onboard. This screen would allow researchers to record data about turtles and experimental gear, for example.

Email Alerts. A feature will be added to the Olrac DDM (shore software) to allow the administrator to send email alerts to the vessels, such as weather alerts, NOAA announcements, and news on software version updates and on updates to master data. A history of all emails can be kept on both the DDM and on the vessel DDL.