

The Advent of Electronic Logbook Technology - Reducing Cost and Risk to Both Marine Resources and the Fishing Industry

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Abstract—Fisheries management all around the world is hampered by the lack, or poor quality, of critical data on fish resources and fishing operations. The main reasons for the chronic inability to collect good quality data during fishing operations is the culture of secrecy common among fishers and the lack of modern data gathering technology onboard most fishing vessels. In response, OLRAC-SPS, a South African company, developed fisheries data-logging software (eLog in short) and named it Olrac. The Olrac eLog solution is capable of collecting, analysing, plotting, mapping, reporting, tracing and transmitting all data related to fishing operations. Olrac can be used by skippers, fleet/company managers, offshore mariculture farmers, scientists, observers, compliance inspectors and fisheries management authorities. The authors believe that using eLog onboard fishing vessels has the potential to revolutionise the entire process of data collection and reporting during fishing operations and, if properly deployed and utilised, could transform the entire commercial fleet to a provider of good quality data and forever change the way fish resources are managed. In addition it will make it possible to trace catches back to the actual individual fishing operation, to improve fishing efficiency and to dramatically improve control of fishing operations and enforcement of fishing regulations.

Keywords—data management, electronic logbook (eLog), electronic reporting system (ERS), fisheries management

I. INTRODUCTION

ONE of the fundamental setbacks to effective fisheries management is the lack of reliable, good-quality and cohesive data on fishing operations (i.e. catches, fishing effort, gear, locations and relevant environmental conditions). While quantitative methods for managing fisheries have developed with considerable complexity, the quality of the available data remains an obstacle for meaningful advances in fisheries management. There are a number of aspects to the problem, not all of which are technical. A culture of protecting catch data and disinformation is common amongst fishers, fishing companies and even formal state-run offices, and significant education is needed in order to change this culture.

Another problem is the poor quality of historic data in many fisheries around the world. Much energy is wasted and important opportunities lost because of the uncertainty surrounding crucial historic data. For example, there are typically many factors related to catch-per-unit-effort (CPUE) data, a key index of trends in resource abundance, which are not recorded, and hence cannot be incorporated into statistical analyses. Frequently, this missing data is crucial to management decisions. For scientists, unreliable data leads to inaccurate and unreliable stock assessment and adversely affects their ability to provide the regulators with sound management advice. For fishers and commercial managers, the lack of sound data significantly reduces their ability to utilise past experience and performance history for commercial purpose. As a result, poor management decisions based on unreliable analyses are made, often with substantial cost and risk to fish resources and to fishers.

Although there is presently greater awareness amongst scientists and resources managers with regards to the importance of collecting fishing data, there is still confusion about exactly which data is needed, and how to collect and store them. It is common for skippers to record scientific, commercial and compliance data on a number of different official forms while still maintaining its own, private, handwritten, notebook. In good cases this data is later, manually digitised into complex spreadsheets, or different databases, often, however, vital information is left in an unusable paper form or gets lost.

So even when good will is present, technically, the absence of a flexible and comprehensive system for capturing and transferring essential data during fishing operations is a major obstacle. With the advent of satellite communication systems and broadband on many fishing vessels, and as computers become more commonly used on fishing boat wheelhouses, opportunity was created to introduce modern database technology to real time, fishery data recording and transmission.

II. OBJECTIVES AND APPROACH

OLRAC-SPS, a South African company, decided to develop a data collection and management system it has named Olrac for the specific use of operators and managers in the marine environment with a special focus on the commercial fishing industry. Bearing in mind the often uneasy relationship between the various industry participants, as discussed above, it was crucial that this technology would be viewed as an asset to fishers, and not solely as another enforcement tool.

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This approach guided the development of Olrac from its initiation more than 12 years ago. The vision for Olrac is to be software that would not only bring order and accuracy to the data-gathering process, but would also bring real value to its users. This paper briefly describes key features of Olrac and the motivation for their development.

A. Dynamic Real Time data Logger

Current, paper-based, data-logging techniques do not allow for catches to be timely calculated and as a result over-catch of annual TAC is sometime detected too late. In order for the quota allocation to ensue, catch data needs to be submitted, cross-checked and processed as close as possible to the actual fishing event. Similarly, data regarding the distribution and abundance of protected species is often reported too late and as a result bycatch of such species is too high or alternatively expensive fishing operations need to be aborted when bycatch is brought up in large quantities. Olrac allows vessels of an entire fishing fleet to report catches (targeted and bycatch) to a master shore-server in real time and receive feedback, summery statistics shortly thereafter. This allows for a more coordinated fishing operation, both in terms of commercial catch control and bycatch avoidance.

B. Spatial Visualization and Data Integration

Commercial fishing operations need to be managed both temporally and spatially as quotas are allocated both per time unit (year or fishing season) and per location (EEZ, or management area). In addition Marine Protected Areas (MPAs) are now a common management tool. For this reason it was decided that Olrac is essentially a data recording and reporting tool, it will also include a GIS component which will allow the visual observation of vessel position with regards to the different management zones and will also enable continuous tracking of vessel movement (just like VMS) and the spatial marking of catch and fishing effort.

C. Flexibility

Electronic logbooks cannot be simple "off-the-shelf" software products. Apart from multiple discrepancies within the fishing industry in the same country (differing regulations for different countries, different vessel-types, fishing methods, gear, targeted species etc.), different groups require different data. Commercial managers are interested in data which will enhance the company and the vessel's commercial viability, enforcement authorities need catch and effort data relevant to fishing regulations, scientists require data which will provide them with insight into the biology and population dynamic of fish while conservation groups are mainly interested in the impact of fishing on the environment and other, non-commercial, species. Our vision for the envisaged electronic logbook was that it should be able to cater for data needs of very diverse groups as it is unrealistic to expect fishers to collect data on multiple software platforms. Software with rigid configuration would be unable to adapt itself to the unique data recording requirements of each party. However it is also unrealistic to expect fishers to absorb the cost of a client specific data logging platform. It is therefore that the planned eLog system needed to be highly customizable to

satisfy the user specific requirements for, to address the data needs of many data recipients and still to be deployed on one software platform.

D. Data Analysis

A final consideration was the need to include data analysis tools as part of the software's capabilities, so that real added-value could be derived from the data stored within the software's database. Such analytical tools would specifically target the interest of fishers and company owners who would be able to use it to maximize their fishing efficiency by using predictive models to indicate, for example, prime fishing locations under certain conditions based on the historic data collected for similar circumstances in the past. The dependence of these predictions on accurate and well-logged historic data would also motivate users to gather data diligently and regularly.

III. TECHNOLOGY DESCRIPTION

A. System Overview

Olrac is the culmination of 13 years of careful design and development. It is a third-generation product and it encompasses 1000s of hours of consultations with fishery scientists, resource and commercial management personnel, fishers and years of field testing. It provides a complete solution for the collection, management and reporting of any type of data related and relevant to the commercial fishing operation. Olrac is made of two basic components in order to cater for the entire data flow, from sea to shore [Fig. 1].

- 1) The onboard, data collection component named Olrac Dynamic Data Logger or Olrac-DDL.
- 2) A web application server named Olrac- Dynamic Data Manager or Olrac-DDM which its main function is to receive, store and disseminate data and reports coming from Olrac-DDL or, if needed, from other, third party, electronic logbooks.

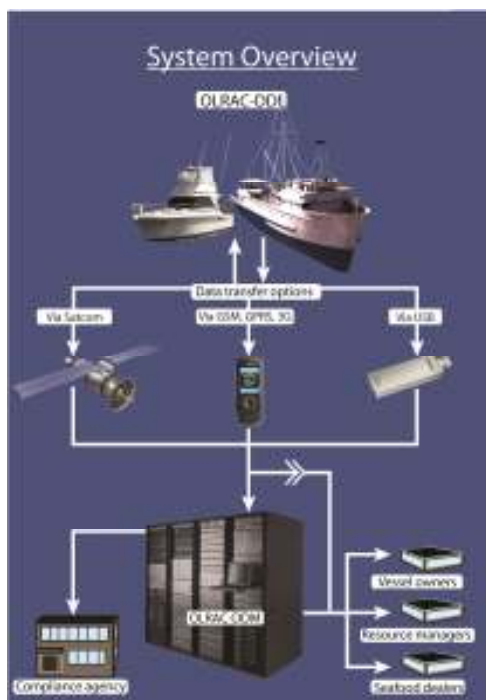


Fig. 1 Overall structure of the Olrac data collection and management system

IV. OLRAC DYNAMIC DATA LOGGER (DDL)

A. Basic Functionality

Olrac-DDL is a touch-screen-ready utility that captures data during fishing trip [Figs. 2 and 4]. The user can collect any type of data in any form or format. These include numerical and alphanumeric fields, free text comments, date, time, location, and even images and video clips. Olrac allows data to be inserted from guiding images [“Infographs” Figs. 2 and 5b] to make data entry as easy and as intuitive as possible. Each mode of data entry has its own unique data entry interface, specifically designed for the type of data recorded. Olrac-DDL is highly customizable and can be easily modified to address vastly different data recording and reporting needs. It enables individual users to configure the software to suit their specific requirements.

B. Overall Structure (Figs. 3 and 4)

Olrac-DDL features an “intelligent” Dynamic Commands Bar (DCB) which changes dynamically to guide the user during the data entry process. Like all other Olrac’s components the DCB is a fixed feature of Olrac but it can be configured to accommodate vastly different data recording

requirements. For example, the same basic underlying user interface can have different DCBs and can be used to collect data for totally different forms of fishing (trawl, longline, purse seine, traps, etc.) or other vessel activities (sea-farms maintenance, cargo delivery, coastal guard patrols, oceanographic surveys, etc.).

Other fixed features of Olrac-DDL are: the “Data Tree” [Fig. 4] which is used to organise data, observations and reports captured and generated by Olrac DDL, the “Browser” which is used to present the user with recorded data, generated reports and varieties of maps’ layers [Fig. 4].

With Olrac-DDL, it is possible to prevent unwanted configuration changes in cases where data definition is strictly controlled by a higher level management body (examples are: company head offices, management agencies, scientific program managers, etc.). In such cases, it is possible to “hard” configure Olrac-DDL and constrain the user’s ability to hide or ignore certain fields. This is mainly done in order to “force” uniformity and full data logging execution when Olrac-DDL is used for regulation-controlled data logging activities.

Data collected by Olrac-DDL can be used to generate any type of reports in any format (XML, HTML, CSV, PDF, etc.). These reports can be saved and transferred to other databases (Olrac-DDM or other third party databases) either by using portable storage devices or by using whatever communication system available onboard (SatCom, GSM, GPRS, 3G and even vessel VMS (Vessel Monitoring System) if permitted.



Fig. 2 Olrac vessel unit on a tablet PC

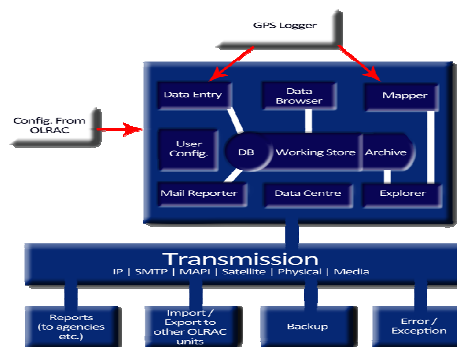


Fig 3 Olrac-DDL basic structure

Olrac-DDL makes extensive use of dropdown lists which include, text, images and infographs [Figs 2, 4a, 4b and 5c] whenever possible. The use of dropdown lists to enter data helps to maintain data integrity, thus minimising typos and also, significantly reduce data entry time. Olrac-DDL also allows users to set up upper and lower limits for any numerical field in order to prevent “out of range” numerical input.



Fig. 4 Olrac-DDL main dashboard screen



Fig 5a



Fig 5b



Fig 5c

Figs. 5 a,b,c: Examples for Olrac-DDL Data Editor where images and dropdown lists are used for data entry

C. GPS LOGGER

Olrac-DDL can act as a GPS application when the deployment computer is connected to a GPS receiver [Fig. 6]. This allows Olrac-DDL to track vessel movements, during and between fishing operations. It also incorporates a Geographical



Fig 6: Olrac's standalone GPS-Logger

Information System (GIS) panel for easy viewing of vessel movements and other operational fishing data [Fig. 4]. The Olrac GPS-Logger is a standalone utility which tracks vessel's movements even if Olrac-DDL is closed. It connects to the vessel's GPS receiver (VMS transponder or a standard GPS outputting NMEA strings on a serial or USB connection) using the system Device Logger. The Device-Logger can read any serial port information and can, therefore, be extended to extract data from outputted by devices such as echo sounders and anemometers, amongst others.

V. DATA MANAGEMENT APPROACH

A. Real Time Activities and Events

Olrac-DDL allows for “real-time” data entry of observations, catch, fishing effort, fishing gear and other activities as they happen. The intelligent Command Bar is used to guide the user through the data entry process to ensure a linear sequence of events (as they happen). However, when it is not feasible to enter data in real time it is possible to enter any data after the event took place. In order to ease data entry in non-real time mode, the user can access the GPS-Logger database and enter vessel location at any particular time by simply pointing at the relevant date/time record in the GPS-Logger database. This utility in Olrac-DDL is called the “Time Machine”.

B. Data Storage

Olrac-DDL uses a hybrid approach to data storage. It uses XML files (“bins”) to store trip data during active vessel operations and relational databases to store historic data. Active trip data can be archived into the storage database once the trip has ended and, if necessary or permitted, un-archived back, for editing. A key feature of Olrac-DDL is its ability to automatically synchronise and configure the relational databases with the software XML bins. As a result the database structure is always kept in synchronization with the configuration of the user-specific version of Olrac-DDL.

All data captured by Olrac-DDL are organised into classes (or levels or tables). Each class has fields and a set of children classes.

For example, one Olrac-DDL might let the user capture information for levels called Trips, Sets and Catches. A Trip class can have many Sets and a Set can have many Catches. Each class can contain any number of fields. Typical fields for a Trip could be, for example, Departure Date, Departure Time, Departure Port and Skipper Name. Possible Set fields could include Start Time, Start Latitude, Start Longitude, Gear Used, etc. Possible Catch fields include Species Caught, Weight, Products, etc.



Fig. 7 Olrac-DDL backhand database interface (Data Centre)

C. Reporting

Data collected by Olrac-DDL can be transmitted to the shore in two basic forms:

1. Raw, original data – using Olrac internal data Import/Export utility. This utility can export data in row (original) form to the Olrac Shore Server. This utility also allows Olrac DDL to receive configuration data and upgrades from the Shore Unit.
2. Summarized reports – Olrac-DDL can also generate specific reports as required by the regulatory bodies, compliance agencies and any other permitted reports recipient [Fig. 8]. These reports use only the relevant and permitted subset of the data recorded by the onboard unit.



Fig 8: Report Manager

Olrac-DDL can compile reports required by commercial clients for their own internal use. However, reports can also be used by any other authorised data recipients examples are: compliance agencies, scientific and conservation groups and any other permitted third party commercial or non-commercial

data recipients. Eligible third party data recipients can receive data selectively based on their needs and permission level. Olrac DDL can provide output in a generic (native) XML or CSV format, or can comply with regulations and predefined schemas (XSD or other). Examples of management agencies whose regulations and schemas have been implemented by the Olrac-DDL are the EU commission, AFMA (Australian Fisheries Management Agency), NOAA (the USA National Oceanic and Atmospheric Administration) and the DFO (Fisheries and Oceans Canada). Sending reports from Olrac-DDL to a third party on the shore can involve some or all of the steps illustrated in Fig. 9.

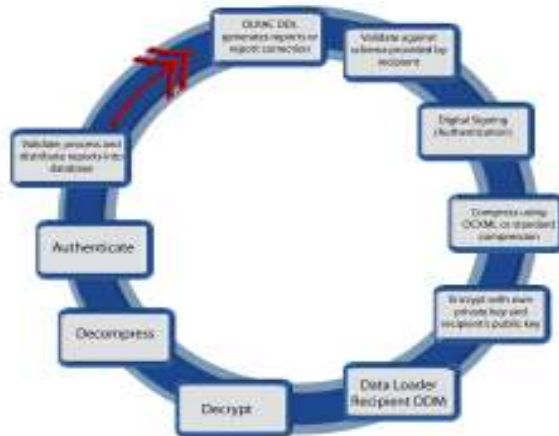


Fig. 9 Transmission process from Olrac-DDL to Shore Database

In addition Olrac-DLL can generate output reports as PDF, HTML, BMP, CSV, Excel files or even as a formal hardcopy logsheet as may be required by the compliance authorities. Reports can be generated automatically by predefined triggered events such as the crossing of certain geographical lines and date/time signals or manually by the user as required. Once generated, reports can be saved to a report queue, viewed, edited, sent and resent. The user can view the reports in legible HTML format or as XML or CSV before sending them out. Reports can be compressed, authenticated and encrypted to fit any set of transmission requirements. For example, Olrac-DDL can implement secure, end-to-end transmission protocol that allows users to transmit secure XML reports, using X.509 digital certificates according to the W3C XML security standards. As Olrac-DDL compiles the required reports automatically using the pre-entered vessel's activities data, Olrac-DDL reporting utility senses "automatically" any change in relevant data and will generate a correction report in order to reflect such change.

VI. OLRAC GIS

Olrac GIS [Fig 10] is an add-on, optional, visual data analysis module specifically designed to work with the Olrac DDL main database. It allows the user to generate subsets of related data captured by Olrac-DDL. Olrac-GIS can then present relevant dependent variables (for example catch, fishing time or CPUE) in tabulated form, graphs or spatial

density maps. Data can be filtered in order to allow comparative presentation of such variables under different conditions. For example, graphs can be drawn showing CPUE as a function of time, moon phase, current strength etc. Subset definitions, i.e. the list of classes and fields selected for the subset can be saved for re-use.

With Olrac GIS it is possible to add calculated fields and to use them just as pre-entered data. For example, the calculations of CPUE by dividing catch weight by fishing duration. Olrac GIS allows the user to create and set up any number of calculated fields and to edit and delete them.

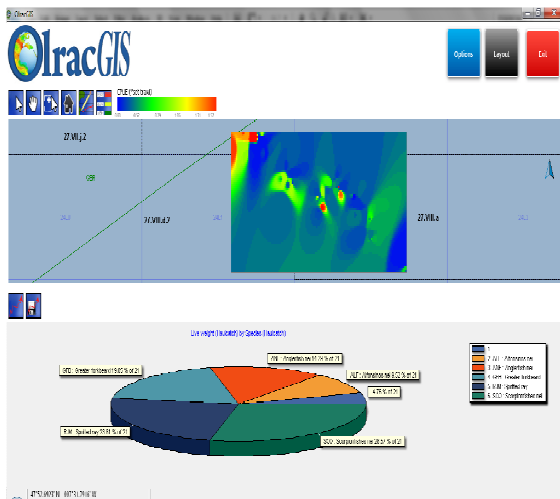


Fig 10 Olrac-GIS: CPUE density map with species breakdown pie chart

VII. OLRAC DYNAMIC DATA MANAGER

A. Functional Overview

Olrac-DDM is a complete web application server solution for the management and dissemination of vessel's reports (catch, landing, vessel movement) as were received from the vessels using any of the transmission methods available to the vessel [Fig. 1] or even entered directly when allowed. Olrac DDM server has been designed to allow its scope to broaden to manage other management needs such as vessel registry, quota management, sales and transshipment of products and more. Olrac-DDM is deployed on an MS Windows Apache server running PHP and SQLServer. The web viewer of Olrac DDM is using Google maps as its GIS interface [Fig. 11]. It can be hosted on the client's server or on Olrac-SPS servers.



Fig 11: Olrac-DDM WebViewer: Vessels location using Google Maps

Olrac-DDM allows the user to swap between languages. The interface, as well as all lookup values, change based on the language selection.

VIII. OUTCOMES AND CONCLUSION

The results from the first wide-spread, ongoing attempt to introduce electronic logbook systems to the commercial fishing fleets were mixed (Olrac and number of other systems). A review by World Fishing Magazine (Special Report: 21 Dec 2010) was titled "EU failing to introduce electronic fishing records". The EU is the first region in the world which introduced electronic logbooks on a large scale (by the end of 2012 all EU vessels above 12 m should, solely use, electronic logbooks to record and report commercial fishing data. From this reason the entire international fishery compliance community is keenly watching the outcome of this attempt.

Although the article suggests some success with the deployment of eLog technology in UK and Holland it is clear from the title that to date the overall outcome is not great. It is interesting to note that the UK and Holland are, for the time being, the only two EU countries that open the market to a number of eLog vendors on a competitive basis. Several other EU countries opted for tender approaches, where a successful bidder, often the cheapest solution, is selected to provide its solution to the entire fishing fleet. Other EU countries decided to develop eLog internally, mainly in order to save money but also in order to maintain state control over the technology used. Holland and the UK where commercial vendors were invited to offer their eLog software solutions to fishers directly applied vigorous certification processes before allowing such products into the market. Holland and the UK also offered fishers once-off state grant for this purpose.

In the EU most of the difficulties in the implementation of eLog technology can be attributed to a number of key factors. Key among them was, to our opinion, a top bottom deployment approach which was adopted by the national compliance authorities. This, often, resulted in a very bureaucratic and somewhat autocratic style of engagement with both, eLog vendors and the fishing industry ("the Brussels syndrome").

Another problem we observed was the result of very minimalistic approach to this new technology. As its deployment was compliance driven the common vision adopted by decision makers was to simply convert existing

paper logsheet into their electronic equivalent. No attempt was made to use the modern computerized and multimedia technology to completely revolutionise the process of data collection during commercial fishing operations.

It also didn't help that in most countries it was decided to tender (winner gets it all) the deployment of eLogs. In addition to the fact that in many cases tender objectives were poorly defined and contained many contradictions, in general the selection of the successful bidder was cost driven while technical merit received significantly less score. Also in many cases the XML schemas (XSDs) were poorly written and contained many errors and contradictions. The reality is that to date new XSD schemas are published on a regular basis making it very difficult for eLog vendors to offer final eLog software.

Other difficulties were due to the very complex and sometimes not intuitive reporting rules which can be, under certain scenarios, very complex and lost on fishers (and developers). In addition, virtually no country offered, together with the introduction of electronic logbook, a national training program and left the fishers to come to terms with this technology on their own. Also in many cases it was expected that eLogs would make use of very old SatCom technology and VMS technology which in addition to making deployment more difficult also significantly increased reports transmission costs.

In our opinion, it is too early to declare the introduction of the eLog to Europe as a failure; it obviously has a long way to go before one could declare it as success. A somewhat surprising observation we had is that despite the initial resistance by fishers to eLog technology, once the technology was installed on board their fishing vessels the rate of acceptance and development competence in its use was relatively fast.

Another country where electronic logbooks including the Olrac-DDL eLog has been formally introduced in recent years is Australia. In Australia, unlike Europe, eLogs were offered as a non-compulsory, alternative technology to the traditional, end of trip, paper logbook reports. Also, eLog technology has been adopted by the federal government agency, AFMA (Australian Fisheries Management Agency) but not so much by the different states. Subsequently fishers received mixed messages regarding the objectives and advantages of the eLog and as such, many, for various reasons, decided to simply ignore the available technology. In spite of this, there are some signs that the approach taken by the authorities is changing alongside the attitude of many younger fishers for whom the idea of replacing tedious paper-reporting with a neat and easy-to-use computerised substitute is highly attractive. It is possible that the slower introduction implemented by AFMA may ultimately pay dividends. Firstly, it has allowed for more time to solve the many technical issues which inevitably accompany the implementation of any new technology to a new environment. Secondly, the "freedom to choose" approach has generated far less resentment from fishers who, as opposed to their European counterparts, have not felt that this technology was being forced on them and have been drawn to it of their own reasoning.

Unlike Europe and Australia the USA has adopted a bottom-up approach. In the USA, Marine resources are managed per fishery and region, by both State and Federal agencies. All eLog initiatives are independent from one another and are not part of a centralized national plan. Very recently NOAA published schema for the Electronic Vessel Trip Reporting (eVTR). This is, at this stage, a voluntary scheme only. Being a voluntary proposal, takes by fishers is slow and not enthusiastic with costs and data security stated as the main reservation points. In the USA legislation does not allow eLog software to utilise the GPS stream coming from the VMS (unless exception granted).

In the USA, a pilot work we have with a North Atlantic Scallop fishery demonstrates how it is possible to cut down unintended catches of yellowtail flounder (a scallop bycatch) by real-time reporting of yellowtail flounder bycatch to a central server and the redistribution of bycatch summary maps back to fishers all automatically and all in real-time.

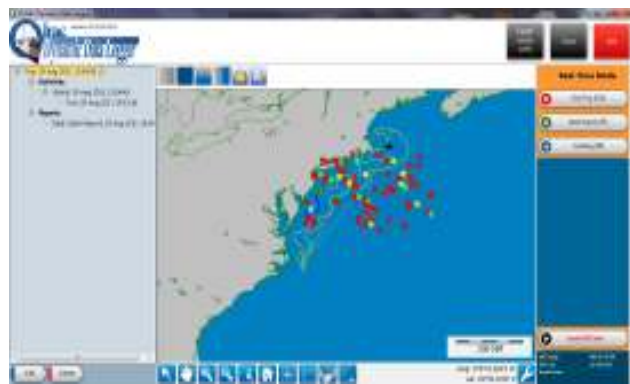


Fig. 12 A combined yellowtail flounder bycatch versus scallop catch ratio map as was compiled and sent from Olrac-DDM server to Olrac-DDL

Similarly to Europe, Canada (DFO, East Coast) has chosen a top bottom approach with centralized coordination Electronic reporting becoming mandatory. To date no official implementation schedule has been released. While the DFO has developed its own, "in-house" eLog software, fishers will be given the option to choose a 3rd party software, the competition by state with commercial vendors is problematic and sometime discourage the development of eLog technology in such cases. The DFO is soon to release national standards by which eLog vendors can be certified. XSD for Gulf of St. Lawrence Northern shrimp, lobster, snow crab, and NAFO Groundfish expected soon.

Other eLog clients are observers and conservation groups. Olrac-SPS developed a particular version of Olrac-DDL for an international conservation group named Albatross Task Force (ATF). The ATF Olrac-DDL is used by ATF observers onboard vessels to record data related to sea-bird mortality during fishing operations. Research conducted by ATF aims at reducing seabird mortality without adversely affecting CPUE. The solutions developed by Olrac allow the collection of over 300 fields. Data is reported to shore and meta-shore units of Olrac-DDL.

So where do we go from here? To our mind, there is no going back. As with a myriad of other industries in the world, and even more so in this case due to the complex nature of fish resources, the need for large amounts of good quality and accurate data will compel the transition from the paper logbook approach to its computerised counterpart until such time as the latter becomes the standard.

Presently, the entire process is being driven by the compliance authorities. This is a good thing because at least they are forcing the change, but it is also unfortunate because of the minimalistic and bureaucratic mode with which such bodies perceive the needs and capabilities of electronic logbooks, and consequently do not persuade or push for more aggressive use of such technology. A simple example is the total lack of interest by the compliance authorities in any data regarding the environment even though such information is critical to our understanding of fish population dynamics. We hope that with further education and as more fishers gain first-hand experience using eLog technology themselves, the need for authoritative enforcement of eLog technology will decrease and more enthusiasm about the transition will be generated from a ground-roots level.

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